

CITY AND COUNTY OF DENVER
STATE OF COLORADO



DENVER
THE MILE HIGH CITY

DEPARTMENT OF PUBLIC WORKS

Contract Documents

Contract Number: 201845550



Asbury & Tejon Park

December 5, 2018



NOTICE OF APPARENT LOW BIDDER

Iron Woman Construction & Environmental Services, LLC
5680 Emerson Street,
Denver, CO 80216

The EXECUTIVE DIRECTOR OF PUBLIC WORKS has considered the Bids submitted on **February 7, 2019**, for work to be done and materials to be furnished in and for:

Contract 201845550, Asbury & Tejon Park

as set forth in detail in the Contract Documents for the City and County of Denver, Colorado. It appears that your Bid is fair, equitable, and to the best interest of the City and County; therefore, said Bid is hereby accepted at the bid price contained herein, subject to the approval and execution of the Contract Documents by the City in accordance with the Charter of the City and County of Denver, and to your furnishing the items specified below. The award is based on the total bid items: **one hundred and ten (110) base bid items (01-21326.03 through 32-97.00.01), and twenty one (21) add alternate bid items (30-02 through 33-46.00.01)**, the total estimated cost thereof being: **Two Million, Six Hundred Two Thousand, One Hundred Forty-Two Dollars, and Fifteen Cents (\$2,602,142.15)**.

It will be necessary for you to appear forthwith at the office of the Department of Public Works, Contract Administration, 201 W. Colfax Ave., Dept 614, Denver, Colorado 80202, to receive the said Contract Documents, execute the same and return them to the Department of Public Works, Contract Administration within the time limit set forth in the Bid Package Documents.

In accordance with the requirements set forth in the Contract Documents, you are required to furnish the following documents:

- a. Insurance Certificates: General Liability and Automotive Liability, Workman's Compensation and Employer Liability;
- b. Payment and Performance Bond along with One original Power of Attorney relative to Performance and/or Payment Bond; and,

All construction Contracts made and entered into by the City and County of Denver are subject to Affirmative Action and Equal Opportunity Rules and Regulations, as adopted by the Manager of Public Works, and each contract requiring payment by the City of one-half million dollars (\$500,000.00) or more shall first be approved by the City Council acting by ordinance and in accordance with Section 3.2.6 of the Charter of the City and County of Denver.

Prior to issuance of Notice to Proceed, all Equal Opportunity requirements must be completed. Additional information may be obtained by contacting the Director of Contract Compliance at (720-913-1700).

Denver Public Works/Office of the Executive Director
201 West Colfax Avenue, Dept 608 | Denver, CO 80202

www.denvergov.org/dpw

p. 720.865.8630 | f. 720.865.8795



NOTICE OF APPARENT LOW BIDDER

CONTRACT NO. 201845550

Page 2

The Bid Security submitted with your Bid, will be returned upon execution of the Contract and furnishing of the Performance Bond. In the event you should fail to execute the Contract and to furnish the performance Bond within the time limit specified, said Bid Security will be retained by the City and County of Denver as liquidated damages, and not as a penalty for the delay and extra work caused thereby.

Dated at Denver, Colorado this 21st day of February 2019.

CITY AND COUNTY OF DENVER

By *Eulois Cleckley*
Eulois Cleckley
Executive Director of Public Works

cc: (CAO), Treasury (taxaudadmin@denvergov.org), Cindy Ackerman, (DSBO), (PM), Prevailing Wage(prevailingwage@denvergov.org), File.

Denver Public Works/Office of the Executive Director
201 West Colfax Avenue, Dept 608 | Denver, CO 80202
www.denvergov.org/dpw
p. 720.865.8630 | f. 720.865.8795

CITY AND COUNTY OF DENVER
STATE OF COLORADO



DENVER
THE MILE HIGH CITY

DEPARTMENT OF PUBLIC WORKS

Bid Form Package

Contract Number: 201845550



Asbury & Tejon Park

December 5, 2018

**CITY AND COUNTY OF DENVER
DEPARTMENT OF PUBLIC WORKS**

**TABLE OF CONTENTS
FOR
BID FORM AND SUBMITTAL PACKAGE**

Table of Contents	BF-1
Bidder's Checklist	BF-2 through BF-3
Bid Form and Submittal Package Acknowledgment Form	BF-4 through BF-5
Bid Form	BF-6 through BF-8
List of Proposed Minority/Woman Business Enterprise(s)	BF-9 through BF-12
Commitment to Minority/Woman Business Enterprise Participation	BF-13
Minority/Woman Business Enterprise Letter(s) of Intent & Checklist	BF-14 through BF-15
Joint Venture Affidavit	BF-16
Joint Venture Eligibility Form	BF-17 through BF-19
Bid Bond	BF-20
Diversity and Inclusiveness in City Solicitations Form	BF-21 through BF-24



DENVER

THE MILE HIGH CITY

This Checklist is provided solely for the assistance of the bidders, and need not be returned by Bidders with your BID FORM PACKAGE.

BIDDER'S CHECKLIST

These forms comprise the Bid Form and Submittal Package. Designated forms must be completed and turned in **at the time of Bid Opening**. Bidders should refer to the Contract Documents, particularly the Instructions to Bidders, accompanying this package, in completing these forms.

FORM/ PAGE NO.	COMMENTS	COMPLETE
BF-4 – BF-5	a.) Legal name, address, Acknowledgment signature and attestation (if required.)	<input checked="" type="checkbox"/>
BF-6+	a.) Fill in individual bid item dollars and totals in Numerical figures only b.) Complete all blanks c.) Legal name required	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/>
BF-7	a.) Write out bid total or bid totals in words and figures in the blank form space(s) provided b.) Calculate Textura® Construction Payment Management System Fee from chart on pg. BF-3 and write % and fee in the space provided	<input checked="" type="checkbox"/>
BF-8	a.) List all subcontractors who are performing work on this project	<input checked="" type="checkbox"/>
BF-9 – BF-10	a.) Fully complete List of Proposed Minority /Woman Business Enterprise Bidders, Subcontractors, Suppliers, Manufacturers, or Brokers – check appropriate boxes.	<input checked="" type="checkbox"/>
BF-11	a.) Complete all blanks b.) If Addenda have been issued, complete bottom section.	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/>
BF-12	a.) Complete appropriate sections - signature(s) required. b.) If corporation, then corporate seal required.	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/>
BF-13	a.) Fully complete Commitment to Participation	<input checked="" type="checkbox"/>
BF-16	a.) If applicable, fully complete Joint Venture Affidavit (Submit 10 days prior to Bid Opening date)	<input checked="" type="checkbox"/>
BF-17 – BF-19	a.) If applicable, fully complete Joint Venture Eligibility Form (Submit 10 days prior to Bid Opening date)	<input checked="" type="checkbox"/>
BF-20	a.) Fill in all Bid Bond blanks b.) Signatures required c.) Corporate Seal if required d.) Dated e.) Attach Surety Agents Power of Attorney or Certified or cashier's check made out to the Manager of Revenue referencing Bidder's Company and Contract Number.	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/>
BF-21- BF-24	a.) Each bidder, as a condition of responsiveness to this solicitation, shall <u>complete and return</u> the "Diversity and Inclusiveness in City Solicitations Information Request Form" with their Bid.	<input checked="" type="checkbox"/>

Textura @ Construction Payment Management System (“Textura”)

Bidder recognizes and agrees that it shall be required to use the Textura® Construction Payment Management System (“Textura”) for this Project to request payment from the City and to pay subcontractors. All certified subcontractors or suppliers who are listed for participation towards any assigned program goal must be paid via Textura. All fees associated with Textura are to be paid by the bidder for billings for work performed. Bidders are required, when preparing a bid, to enter the price of Textura on the line provided for the service. The fee is all inclusive of all subcontractor, project and subscription fees associated with Textura. The bidder will calculate the fee based on a percentage of their total bid, and then include it on the line item provided in the bid form labeled “Textura@ Construction Payment Management System Fee”. This expense becomes part of the contract and billable to the City. All costs including, but not limited to, costs associated with training, entering data, and/or utilizing Textura other than the Textura Construction Payment Management System Fee are overhead and shall not be reimbursed by the City. Bidder will be responsible for any tax on the Textura fee. As with other taxes, the City will not reimburse bidder for this cost and therefore this cost should be included in bidder’s bid. Textura will invoice the awarded bidder directly.

Project Value	Project Fee (GC + Sub Usage)
\$250,000 - \$499,999.99	\$1,625
\$500,000 - \$999,999.99	\$3,250
\$1,000,000 - \$2,999,999.99	\$5,850
\$3,000,000 - \$4,999,999.99	\$9,100
\$5,000,000 - \$9,999,999.99	\$12,220
\$10,000,000 - \$19,999,999.99	\$20,345
\$20,000,000 - \$49,999,999.99	\$32,500
\$50,000,000 - \$99,999,999.99	\$48,750
\$100,000,000 - \$199,999,999.99	\$69,095
\$200,000,000 - \$299,999,999.99	\$85,345
\$300,000,000 - \$399,999,999.99	\$109,720
\$400,000,000 - \$499,999,999.99	\$142,220
\$500,000,000 - \$999,999,999.99	\$162,500
\$1,000,000,000 - \$1,999,999,999.99	\$345,345
\$2,000,000,000 - \$4,999,999,999.99	\$650,000
\$5,000,000,000 - \$9,999,999,999.99	\$1,015,625
\$10,000,000,000 or greater	\$1,503,125

For more information:

<http://www.denvergov.org/content/denvergov/en/contract-administration/bidding-process.html>

**CITY AND COUNTY OF DENVER
DEPARTMENT OF PUBLIC WORKS**

BID FORM AND SUBMITTAL PACKAGE ACKNOWLEDGMENT

CONTRACT NO. 201845550

ASBURY & TEJON PARK

BIDDER: IRON WOMAN CONSTRUCTION & ENVIRONMENTAL SERVICES LLC
(Legal Name per Colorado Secretary of State)

ADDRESS: 5680 EMERSON ST.
DENVER, CO 80216

The undersigned bidder states that the undersigned bidder has received and had an opportunity to fully and thoroughly examine a complete set of the Contract Documents for **CONTRACT NO. 201845550, ASBURY & TEJON PARK**, made available to the undersigned bidder pursuant to Notice of Invitation for Bids dated December 5, 2018.

The undersigned bidder acknowledges that a complete and final set of the Contract Documents for the referenced Project, the components of which are identified below, are bound and maintained as the record set of Contract Documents by the Contract Administration Division of the Department of Public Works and that this Record Set is available for examination by the undersigned bidder.

The undersigned bidder, having thoroughly examined each of the components identified below and contained in Contract Documents, **HEREBY SUBMITS THIS BID FORM AND SUBMITTAL PACKAGE**, fully understanding that the Contract Documents, as defined in Paragraph 1 of the contract, including this executed Bid Form and Submittal Package, constitute all of the terms, conditions and requirements upon which this submission is based and further understanding that, by submission of this Bid Form and Submittal Package, the City shall rely on the representations and commitments of the undersigned bidder contained herein.

The following completed documents comprising this Bid Form and Submittal Package will be included with and, by this reference, are expressly incorporated into the Contract Documents specified at Paragraph 1 of the Contract:

- Bid Form and Submittal Package Acknowledgment Form
- Bid Form
- List of Proposed Minority/Woman Owned Business Enterprise(s)
- Commitment to Minority/Woman Owned Business Enterprise Participation
- Minority/Woman Owned Business Enterprise(s) of Intent
- Joint Venture Affidavit (if applicable)
- Joint Venture Eligibility Form (if applicable)
- Bid Bond
- Certificate of Insurance

The following designated documents constitute that portion of the Contract Documents made available by the Notice of Invitation for Bids, but not included in the Bid Form and Submittal Package:

- Notice of Invitation for Bids
- Instructions to Bidders
- Addenda (as applicable)
- Equal Employment Opportunity Provisions (Appendix A and Appendix F)
- Contract Form
- General Contract Conditions
- Special Contract Conditions
- Performance and Payment Bond
- Notice to Apparent Low Bidder
- Notice to Proceed
- Contractor's Certification of Payment Form
- Final/Partial Lien Release Form
- Final Receipt
- Change Orders (as applicable)
- Federal Requirements (as applicable)
- Prevailing Wage Rate Schedule(s)
- Technical Specifications
- Contract Drawings
- Accepted Shop Drawings

The undersigned bidder expressly assumes responsibility for the complete contents of these designated documents as bound together with the Bid Form and Submittal Package submitted herewith and designated the Contract Documents.

IN WITNESS WHEREOF, the undersigned bidder has signed personally or by duly authorized officer or agent and duly attested.

BIDDER:

Name: **SHAUN EGAN**
By: _____
Title: **PRESIDENT**

ATTEST:

By: _____

[SEAL]



**CITY AND COUNTY OF DENVER
DEPARTMENT OF PUBLIC WORKS**

BID FORM

**CONTRACT NO. 201845550
ASBURY & TEJON PARK**

BIDDER IRON WOMAN CONSTRUCTION & ENVIRONMENTAL SERVICES LLC
(Legal Name per Colorado Secretary of State)

TO: The Manager of Public Works
City and County of Denver
c/o Contract Administration
201 West Colfax, Dept. 614
Denver, Colorado 80202

The Undersigned Bidder, having examined the plans, technical specifications, and remainder of the proposed Contract Documents as designated and enumerated in the General and Special Contract Conditions and any and all addenda thereto; having investigated the location of and conditions affecting the proposed Work; and being acquainted with and fully understanding the extent and character of the Work covered by this bid, and all factors and conditions affecting or which may be affected by Work, HEREBY SUBMITS THIS BID, pursuant to an advertisement of a Notice of Invitation for Bids as published on **December 5, 2018**, to furnish all required materials, tools, appliances, equipment and plant; to perform all necessary labor and to undertake and complete: **CONTRACT NO. 201845550, ASBURY & TEJON PARK**, in Denver, Colorado, in full accordance with and conformity to the Plans, Technical Specifications, and Contract Documents hereto attached or by reference made a part hereof, at and for the following price(s) set forth on this Bid Form.

The following documents, which taken as a whole constitute the Contract Documents for this Project, and which are incorporated herein, by reference, were made available to the Bidder as provided in the Advertisement of Notice of Invitation for Bids, were received by the bidder, and form the basis for this bid:

Advertisement of Notice of Invitation for Bids
Instructions to Bidders
Commitment to M/WBE Participation
Article III, Divisions 1 and 3 of Chapter 28, D.R.M.C.
Bid Bond
Addenda (as applicable)
Equal Employment Opportunity Provisions (Appendix A and Appendix F)
Bid Form
Contract Form
General Contract Conditions
Special Contract Conditions
Performance and Payment Bond
Notice to Apparent Low Bidder
Notice to Proceed
Contractor's Certification of Payment Form
Final/Partial Lien Release Form
Final Receipt
Change Orders (as applicable)
Federal Requirements (as applicable)
Prevailing Wage Rate Schedule(s)
Technical Specifications
Contract Drawing
Accepted Shop Drawings
Certificate of Insurance

Bid Form**Asbury & Tejon - Schedule A**

Pay Item #	Bid Item Description and Unit Price	Estimated Quantity	Estimated Cost
01-21.26.03	ALLOWANCE FOR - SEE PROJECT SPECIFICATIONS PROCUREMENT OF CARLSONATOR SYSTEM at the unit price of \$ Fifty Thousand Dollars and No Cents true and verifiable costs + mark up	1	A/A \$ <u>50,000.00</u>
2-1.1b	REMOVE COMBINATION CONCRETE CURB, GUTTER AND SIDEWALK (3'-11") <i>Add'l Info: Remove Monolithic Concrete 6" Vertical Curb, Gutter and Sidewalk (4'-0")</i> at the unit price of <u>\$4.00</u> per linear foot	284	LF \$ <u>\$1,136.00</u>
2-2.1	REMOVE CONCRETE SIDEWALK at the unit price of <u>\$1.00</u> per square foot	2,832	SF \$ <u>\$2,832.00</u>
2-2.4	REMOVE CONCRETE CHANNEL PAVING <i>Add'l Info: Concrete Trickle Channel through Park</i> at the unit price of <u>\$1.00</u> per square foot	4,002	SF \$ <u>4,002.00</u>
2-11.1a	REMOVE EXISTING 8" SANITARY SEWER PIPE at the unit price of <u>\$6.00</u> per linear foot	137	LF \$ <u>\$822.00</u>
2-11.2n	REMOVE EXISTING 48" STORM SEWER PIPE at the unit price of <u>\$11.00</u> per linear foot	28	LF \$ <u>\$308.00</u>
2-11.2n	REMOVE EXISTING 48" STORM SEWER PIPE <i>Add'l Info: Carlsonator System Area</i> at the unit price of <u>\$11.00</u> per linear foot	26	LF \$ <u>\$286.00</u>
2-11.2o	REMOVE EXISTING 54" STORM SEWER PIPE at the unit price of <u>\$16.00</u> per linear foot	15	LF \$ <u>\$240.00</u>

Asbury & Tejon - Schedule A

Pay Item #	Bid Item Description and Unit Price	Estimated Quantity		Estimated Cost
2-11.6n	REMOVE 48" RCP FLARED END SECTION at the unit price of <u> \$107.00 </u> each	3	EA	<u> \$ 321.00 </u>
2-11.6o	REMOVE 54" RCP FLARED END SECTION at the unit price of <u> \$224.00 </u> each	1	EA	<u> \$ 224.00 </u>
2-12.1	REMOVE EXISTING SANITARY MANHOLE at the unit price of <u> \$224.00 </u> each	1	EA	<u> \$ 224.00 </u>
2-12.7	REMOVE EXISTING STRUCTURE <i>Add'l Info: Existing South Pond Outlet Structure</i> at the unit price of <u> \$224.00 </u> each	1	EA	<u> \$ 224.00 </u>
2-13.1	REMOVE EXISTING STORM INLET at the unit price of <u> \$224.00 </u> each	1	EA	<u> \$ 224.00 </u>
02-22.13	VIBRATION ASSESSMENT at the unit price of <u> \$25,889.00 </u> lump sum	1	LS	<u> \$ 25,889.00 </u>
02-56.13.14	GEOFABRIC FOR WASTE CONTAINMENT <i>Add'l Info: Orange Warning Barrier Geotextile</i> at the unit price of <u> \$0.91 </u> per square yard	12,600	SY	<u> \$ 11,466.00 </u>
02-82.16.10	CERTIFIED ASBESTOS INSPECTOR (CABI)/AIR MONITOR at the unit price of <u> \$30,140.00 </u> lump sum	1	LS	<u> \$ 30,140.00 </u>

Asbury & Tejon - Schedule A

Pay Item #	Bid Item Description and Unit Price	Estimated Quantity	Estimated Cost
3-2a	<p>HAULING OF CONTAMINATED MATERIALS TO DENVER/ARAPAHOE DISPOSAL SITE (DADS) ASBURY & TEJON SUPPLEMENTAL</p> <p><i>Add'l Info: HAUL SOIL/ASBESTOS, INCLUDES EXCAVATION AND ALL APPROPRIATE TRANSPORT AND HANDLING OF MATERIALS PER STATE AND LOCAL REQUIREMENTS; Refer to supplemental Measurement & Payment</i></p> <p>at the unit price of <u> \$53.00 </u> per cubic yard</p>	9,361	CY <u> \$ \$496,133.00 </u>
3-4a	<p>ROCK EXCAVATION ASBURY AND TEJON SUPPLEMENTAL</p> <p><i>Add'l Info: Earthwork, Rock Excavation; See Supplement 31 23 00 Earthwork; Refer to supplemental Measurement & Payment</i></p> <p>at the unit price of <u> \$41.00 </u> per cubic yard</p>	1,155	CY <u> \$ \$47,355.00 </u>
3-5a	<p>CLEARING AND GRUBBING ASBURY AND TEJON SUPPLEMENTAL</p> <p><i>Add'l Info: See Supplement 31 23 00 Earthwork; Refer to supplemental Measurement & Payment</i></p> <p>at the unit price of <u> \$45,349.00 </u> lump sum</p>	1	LS <u> \$ \$45,349.00 </u>
3-5b	<p>MUCK, REPLACE WITH APPROVED MATERIAL ASBURY AND TEJON SUPPLEMENTAL</p> <p><i>Add'l Info: Excavation, Muck, Replace with Approved Material; See Supplement 31 23 00 Earthwork; Refer to supplemental Measurement & Payment</i></p> <p>at the unit price of <u> \$35.00 </u> per cubic yard</p>	300	CY <u> \$ \$10,500.00 </u>
3-7a	<p>HEALTH & SAFETY PLAN</p> <p>at the unit price of <u> \$2,828.00 </u> lump sum</p>	1	LS <u> \$ \$2,828.00 </u>

Asbury & Tejon - Schedule A

Pay Item #	Bid Item Description and Unit Price	Estimated Quantity	Estimated Cost
20-3be	ASPHALT BASE COURSE, S, RAP 20%, N=75, 64-22. at the unit price of <u> \$15.00 </u> per square yard inch	2,400	SY-IN <u> \$36,000.00 </u>
20-4	ASPHALT ROTOMILL <i>Add'l Info: Removal of Asphalt, Assumed 10-Inch Thickness of Asphalt to be Removed</i> at the unit price of <u> \$0.69 </u> per square yard inch	8,100	SY-IN <u> \$ 5,589.00 </u>
30-1b	RIPRAP TYPE L <i>Add'l Info: Soil Riprap, See Supplement 31 37 00</i> at the unit price of <u> \$43.00 </u> per square yard	123	SY <u> \$5,289.00 </u>
30-1c	RIPRAP TYPE M <i>Add'l Info: Void-Filled Riprap, See Supplement 31 37 00</i> at the unit price of <u> \$57.00 </u> per square yard	540	SY <u> \$30,780.00 </u>
30-2b.1	GROUTED BOULDERS (30" DIAMETER) <i>Add'l Info: North Pond Landscape Boulders (Loose Boulders and Boulders Set in Concrete Pad). See Supplement 31 37 19</i> at the unit price of <u> \$454.00 </u> each	35	EA <u> \$15,890.00 </u>
30-2k	BOULDER (4 FOOT DIAMETER) <i>Add'l Info: Landscape Boulder 24-inch to 48-inch average range per detail on Sheet L400. See Supplement 31 37 00</i> at the unit price of <u> \$781.00 </u> each	52	EA <u> \$40,612.00 </u>
30-2k	BOULDER (4 FOOT DIAMETER) <i>Add'l Info: Slab Stone Boulder Stone Step (size to achieve 4-foot wide trail with 6" height per step) per detail on Sheet L400. See Supplement 31 37 00</i> at the unit price of <u> \$1,023.00 </u> each	10	EA <u> \$10,230.00 </u>

Asbury & Tejon - Schedule A

Pay Item #	Bid Item Description and Unit Price	Estimated Quantity		Estimated Cost
30-2k	BOULDER (4 FOOT DIAMETER) <i>Add'l Info: 30-inch to 36-inch boulder set in concrete walk per detail on Sheet L503. See Supplement 31 37 00</i> at the unit price of <u>\$ 449.00</u> each	11	EA	\$ <u>4,939.00</u>
34-2.3e	18" DIAMETER C-76 RCP, CLASS III at the unit price of <u>\$ 56.00</u> per linear foot	37	LF	\$ <u>2,072.00</u>
34-2.3n	48" DIAMETER C-76 RCP, CLASS III <i>Add'l Info: 30-Degree Bend</i> at the unit price of <u>\$ 694.00</u> per linear foot	7	LF	\$ <u>4,858.00</u>
34-2.3n	48" DIAMETER C-76 RCP, CLASS III <i>Add'l Info: Carlsonator System Area</i> at the unit price of <u>\$ 245.00</u> per linear foot	12	LF	\$ <u>2,940.00</u>
34-7.1a	8" DIAMETER PVC PIPE <i>Add'l Info: Solid Wall PVC</i> at the unit price of <u>\$ 57.00</u> per linear foot	130	LF	\$ <u>7,410.00</u>
34-7.1g	24" DIAMETER PVC PIPE <i>Add'l Info: Carlsonator System Area Solid Wall PVC</i> at the unit price of <u>\$ 326.00</u> per linear foot	20	LF	\$ <u>6,520.00</u>
34-12.1a	4' DIAMETER PRECAST MANHOLE WITH TYPE A BASE & CONCENTRIC CONE <i>Add'l Info: w/ Outside Drop</i> at the unit price of <u>\$ 5,598.00</u> each	1	EA	\$ <u>5,598.00</u>
34-12.1c	4' DIAMETER PRECAST MANHOLE WITH TYPE C BASE & CONCENTRIC CONE at the unit price of <u>\$ 3,646.00</u> each	1	EA	\$ <u>3,646.00</u>

Asbury & Tejon - Schedule A

Pay Item #	Bid Item Description and Unit Price	Estimated Quantity	Estimated Cost
34-12.7	CAST-IN-PLACE SPECIAL STRUCTURE <i>Add'l Info: North Pond Inlet - Structure #1</i> at the unit price of <u>\$33,210.00</u> each	1	EA \$ <u>33,210.00</u>
34-12.7	CAST-IN-PLACE SPECIAL STRUCTURE <i>Add'l Info: North Pond Water Quality - Structure #2</i> at the unit price of <u>\$23,003.00</u> each	1	EA \$ <u>23,003.00</u>
34-12.7	CAST-IN-PLACE SPECIAL STRUCTURE <i>Add'l Info: South Pond Inlet - Structure #3</i> at the unit price of <u>\$30,864.00</u> each	1	EA \$ <u>30,864.00</u>
34-12.7	CAST-IN-PLACE SPECIAL STRUCTURE <i>Add'l Info: South Pond Inlet - Structure #4</i> at the unit price of <u>\$29,339.00</u> each	1	EA \$ <u>29,339.00</u>
34-12.7	CAST-IN-PLACE SPECIAL STRUCTURE <i>Add'l Info: South Pond Water Quality - Structure #5</i> at the unit price of <u>\$23,473.00</u> each	1	EA \$ <u>23,473.00</u>
34-12.7	CAST-IN-PLACE SPECIAL STRUCTURE <i>Add'l Info: Installation of Carlsonator Vault System and any other appurtenances associated with the Carlsonator system. This bid item also includes repairs to the existing irrigation system that are impacted during the installation of the Carlsonator system.</i> at the unit price of <u>\$18,562.00</u> each	1	EA \$ <u>18,562.00</u>

Asbury & Tejon - Schedule A

Pay Item #	Bid Item Description and Unit Price	Estimated Quantity	Estimated Cost
34-12.7	CAST-IN-PLACE SPECIAL STRUCTURE <i>Add'l Info: 8-foot diameter manhole with internal weir wall (Carlsonator System Area). Manhole shall conform to CDOT M&S Standards (M-604-20).</i> at the unit price of <u>\$ 16,182.00</u> each	1	EA \$ <u>16,182.00</u>
34-12.7	CAST-IN-PLACE SPECIAL STRUCTURE <i>Add'l Info: 8-foot diameter manhole (Carlsonator System Area). Manhole shall conform to CDOT M&S Standards (M-604-20).</i> at the unit price of <u>\$ 15,008.00</u> each	1	EA \$ <u>15,008.00</u>
34-12.8	UNCOVER AND RAISE (ADJUST) MANHOLE at the unit price of <u>\$ 533.00</u> vertical feet	1	VF \$ <u>533.00</u>
34-13.1a	8" PIPE OUTSIDE DROP at the unit price of <u>\$ 2,188.00</u> each	1	EA \$ <u>2,188.00</u>
34-14.4	CONCRETE COLLARS <i>Add'l Info: Concrete Closure 8" Sanitary Sewer</i> at the unit price of <u>\$ 1,832.00</u> each	1	EA \$ <u>1,832.00</u>
34-16.2a	SINGLE #16 INLET WITH OPEN THROAT at the unit price of <u>\$ 5,294.00</u> each	1	EA \$ <u>5,294.00</u>
34-17.1a	PRE-VIDEO INSPECTION OF 8" DIAMETER SEWER PIPE at the unit price of <u>\$ 1.00</u> per linear foot	221	LF \$ <u>221.00</u>
34-17.2a	CLEANING OF 8" DIAMETER SANITARY PIPE at the unit price of <u>\$ 2.00</u> per linear foot	221	LF \$ <u>442.00</u>

Asbury & Tejon - Schedule A

Pay Item #	Bid Item Description and Unit Price	Estimated Quantity		Estimated Cost
34-17.3a	8" DIAMETER SANITARY SEWER BY-PASS PUMPING at the unit price of <u>\$102.00</u> per linear foot	130	LF	\$ <u>13,260.00</u>
40-7	REMOVE TREES (>6" DIAMETER) at the unit price of <u>\$141.00</u> each	6	EA	\$ <u>846.00</u>
40-8	REMOVE BUSHES at the unit price of <u>\$103.00</u> each	3	EA	\$ <u>309.00</u>
40-8	REMOVE BUSHES <i>Add'l Info: (Around Existing Flared End Sections)</i> at the unit price of <u>\$56.00</u> each	15	EA	\$ <u>840.00</u>
41-1	TRAFFIC CONTROL at the unit price of <u>\$41,063.00</u> lump sum	1	LS	\$ <u>41,063.00</u>
43-1b	STORM WATER MANAGEMENT (SCENARIO 2) See SCS 23.0 at the unit price of <u>\$32,638.00</u> lump sum	1	LS	\$ <u>32,638.00</u>
44-1	DEWATERING <i>Add'l Info: See See Supplement 31.23.19.01 Water Control and Dewatering</i> at the unit price of <u>\$2,113.00</u> lump sum	1	LS	\$ <u>2,113.00</u>
47-1	CONSTRUCTION SURVEYING <i>Add'l Info: Includes intermediate As Built survey drawings for Playground Equipment area, sub drainage systems, etc., incremental surveys to measure earthwork and Final As-Built Survey</i> at the unit price of <u>\$20,532.00</u> lump sum	1	LS	\$ <u>20,532.00</u>

Asbury & Tejon - Schedule A

Pay Item #	Bid Item Description and Unit Price	Estimated Quantity	Estimated Cost
47-2	SURVEY MONUMENTATION at the unit price of <u>\$587.00</u> each	5 EA	\$ <u>2,935.00</u>
50-1	MOBILIZATION at the unit price of <u>\$119,187.00</u> lump sum	1 LS	\$ <u>119,187.00</u>

Bid Form

Asbury & Tejon - Schedule B

Pay Item #	Bid Item Description and Unit Price	Estimated Quantity	Estimated Cost
01-56.39.01	TREE & SHRUB RETENTION, MAINTENANCE AND PROTECTION <i>Add'l Info: This is for existing established trees and shrubs protected and maintained during construction activities; includes water. See Denver Forestry requirements.</i> at the unit price of <u>\$23,465.00</u> lump sum	1	LS \$ <u>23,465.00</u>
01-56.39.02	TREE PROTECTION FENCING [orange plastic] at the unit price of <u>\$1.00</u> per linear foot	4,500	LF \$ <u>4,500.00</u>
01-56.39.03	TREE PROTECTION FENCING [6' chain link] <i>Add'l Info: Includes Tree Wrap</i> at the unit price of <u>\$7.00</u> per linear foot	4,500	LF \$ <u>31,500.00</u>
02-41.00.01A	REMOVE SEE ADDITIONAL NOTES ==> <i>Add'l Info: Removal of concrete pads under bench and picnic tables</i> at the unit price of <u>\$4.00</u> per square foot	160	SF \$ <u>640.00</u>
02-41.00.01E	REMOVE SEE ADDITIONAL NOTES ==> <i>Add'l Info: Remove Picnic Table and Benches</i> at the unit price of <u>\$82.00</u> each	3	EA \$ <u>246.00</u>
32-13.13.02	CONCRETE PAD SEE ADDITIONAL NOTES ==> <i>Add'l Info: 6" Depth, Concrete Pad for Picnic Tables and Benches.</i> at the unit price of <u>\$9.00</u> per square foot	509	SF \$ <u>4,581.00</u>

Asbury & Tejon - Schedule B

Pay Item #	Bid Item Description and Unit Price	Estimated Quantity	Estimated Cost
32-13.13.03	CONCRETE WALK SEE ADDITIONAL NOTES ==> <i>Add'l Info: 6" Depth, Width Varies per plans. This bid item includes 252 LF of thickened edge per detail 3 on Sheet L501. Includes Aggregate Base Course.</i> at the unit price of <u>\$9.00</u> per square foot	7,350	SF \$ <u>66,150.00</u>
32-13.13.04	CONCRETE CURB ADDITIONAL NOTES ==> <i>Add'l Info: 6-inch high curb head adjacent to park bench concrete pad</i> at the unit price of <u>\$25.00</u> per linear foot	28	LF \$ <u>700.00</u>
32-15.40.01	CRUSHED STONE PAVING <i>Add'l Info: Crusher fines - Trail</i> at the unit price of <u>\$3.00</u> per square foot	350	SF \$ <u>1,050.00</u>
32-33.00.01	PARKS SPEC SITE FURNISHINGS - PICNIC TABLES <i>Add'l Info: Procure/install per plan set detail - Concrete Pad paid under Concrete</i> at the unit price of <u>\$3,138.00</u> each	2	EA \$ <u>6,276.00</u>
32-33.00.02	PARKS SPEC SITE FURNISHINGS - BENCH <i>Add'l Info: Procure/install per plan set detail - Concrete Pad paid under Concrete</i> at the unit price of <u>\$1,361.00</u> each	3	EA \$ <u>4,083.00</u>
32-80.00.01	IRRIGATION SYSTEMS - SEE PLAN SHEETS FOR DETAILS <i>Add'l Info: Also includes new mainline connections</i> at the unit price of <u>\$136,682.00</u> lump sum	1	LS \$ <u>136,682.00</u>

Asbury & Tejon - Schedule B

Pay Item #	Bid Item Description and Unit Price	Estimated Quantity	Estimated Cost
32-84.33.01	AUTOMATIC IRRIGATION CONTROLLERS (installation per plan set) <i>Add'l Info: Installation of New Toro Controller Assembly that will furnished to contractor by Denver Dept of Parks and Recreation.</i> at the unit price of <u>\$2,693.00</u> each	2	EA \$ <u>5,386.00</u>
32-91.13.01	SOIL PREPARATION <i>Add'l Info: Sodded Areas Only</i> at the unit price of <u>\$ 0.30</u> per square foot	41,475	SF \$ <u>12,442.50</u>
32-91.13.50	SOIL PREPARATION - MULCH PER PLAN SET (BEDDING AREAS) at the unit price of <u>\$2.00</u> per square foot	1,313	SF \$ <u>2,626.00</u>
32-92.20.01	WET MEADOW SEED MIX [per plan set] INCLUDES SOIL AMENDMENTS Certified Installer & Certified Pesticide applicator included <i>Add'l Info: Soil Preparation included in seed cost</i> at the unit price of <u>\$0.22</u> per square foot	18,690	SF \$ <u>4,111.80</u>
32-92.20.02	TRANSITIONAL NATIVE SEED MIX [per plan set] INCLUDES SOIL AMENDMENTS Certified Installer & Certified Pesticide applicator included <i>Add'l Info: Soil Preparation included in seed cost</i> at the unit price of <u>\$ 0.19</u> per square foot	13,965	SF \$ <u>2,653.35</u>
32-92.20.03	UPLAND NATIVE SEED MIX [per plan set] INCLUDES SOIL AMENDMENTS Certified Installer & Certified Pesticide applicator included <i>Add'l Info: Soil Preparation included in seed cost</i> at the unit price of <u>\$ 0.15</u> per square foot	77,700	SF \$ <u>11,655.00</u>

Asbury & Tejon - Schedule B

Pay Item #	Bid Item Description and Unit Price	Estimated Quantity		Estimated Cost
32-92.20.04	WETLAND SOD [per plan set] Certified Installer & Certified Pesticide applicator included <i>Add'l Info: Soil Preparation included in sod cost</i> at the unit price of <u>\$7.00</u> per square foot	5,355	SF	\$ <u>37,485.00</u>
32-92.23.01	PARKS SPEC SODDING (NOT WETLAND) KENTUCKY BLUEGRASS, Certified Installer & Certified Pesticide applicator included at the unit price of <u>\$0.62</u> per square foot	41,475	SF	\$ <u>25,714.50</u>
32-93.00.01	ROCKY MOUNTAN MAPLE 2" CALIPER [acer glabrum](includes maintenance until final acceptance) at the unit price of <u>\$727.00</u> each	7	EA	\$ <u>5,089.00</u>
32-93.00.02	SHAGBARK HICKORY 2" CALIPER [carya ovata](includes maintenance until final acceptance) at the unit price of <u>\$698.00</u> each	2	EA	\$ <u>1,396.00</u>
32-93.00.03	HACKBERRY 2" CALIPER [celtis occidentalis] (includes maintenance until final acceptance) at the unit price of <u>\$680.00</u> each	5	EA	\$ <u>3,400.00</u>
32-93.00.04	SMOKE TREE 2" CALIPER [cotinus coggygria] (includes maintenance until final acceptance) at the unit price of <u>\$493.00</u> each	3	EA	\$ <u>1,479.00</u>
32-93.00.05	RADIANT CRABAPPLE 2" CALIPER [malus 'radiant'] (includes maintenance until final acceptance) at the unit price of <u>\$651.00</u> each	2	EA	\$ <u>1,302.00</u>
32-93.00.06	AMERICAN PLUM 2" CALIPER [prunus americana] (includes maintenance until final acceptance) at the unit price of <u>\$657.00</u> each	4	EA	\$ <u>2,628.00</u>

Asbury & Tejon - Schedule B

Pay Item #	Bid Item Description and Unit Price	Estimated Quantity		Estimated Cost
32-93.00.07	BUR OAK 2" CALIPER [quercus macrocarpa] (includes maintenance until final acceptance) at the unit price of <u>\$698.00</u> each	7	EA	\$ <u>4,886.00</u>
32-93.00.08	RED OAK 2" CALIPER [quercus rubra] (includes maintenance until final acceptance) at the unit price of <u>\$698.00</u> each	4	EA	\$ <u>2,792.00</u>
32-93.00.101	PANCHITO MANZANITA 5 GALLON [Arctostaphylos x coloradoensis 'Panchito'] (includes maintenance until final acceptance) at the unit price of <u>\$68.00</u> each	7	EA	\$ <u>476.00</u>
32-93.00.102	CREEPING WESTERN SAND CHERRY 5 GALLON [Prunus besseyi 'Pawnee Buttes'] (includes maintenance until final acceptance) at the unit price of <u>\$44.00</u> each	6	EA	\$ <u>264.00</u>
32-93.00.103	ROCKY MOUNTAIN SUMAC 1 GALLON [Rhus glabra cismontana] (includes maintenance until final acceptance) at the unit price of <u>\$28.00</u> each	16	EA	\$ <u>448.00</u>
32-93.00.104	GREEN MOUND CURRANT 1 GALLON [Ribes alpinum 'Green Mound'] (includes maintenance until final acceptance) at the unit price of <u>\$38.00</u> each	18	EA	\$ <u>684.00</u>
32-93.00.105	GOLDEN CURRENT 5 GALLON [Ribes aureum] (includes maintenance until final acceptance) at the unit price of <u>\$39.00</u> each	6	EA	\$ <u>234.00</u>
32-93.00.106	BOULDER RASPBERRY 5 GALLON [Rubus deliciosus] (includes maintenance until final acceptance) at the unit price of <u>\$56.00</u> each	5	EA	\$ <u>280.00</u>

Asbury & Tejon - Schedule B

Pay Item #	Bid Item Description and Unit Price	Estimated Quantity	Estimated Cost
32-96.43.01	TREE REMOVAL, STORAGE, TRANSPLANTING (includes maintenance until final acceptance) <i>Add'l Info: Asbury and Tejon Parks Specifications detail all tree firm Contractor Consulting Arborist qualifications</i> at the unit price of <u>\$2,933.00</u> each	2	EA \$5,866.00
32-97.00.01	LANDSCAPE MAINTENANCE OF SEEDED AND SODDED AREAS (until final acceptance) <i>Add'l Info: New plantings and transplanted items.</i> at the unit price of <u>\$59,952.00</u> lump sum	1	LS \$59,952.00

Bid Form**Asbury & Tejon - Add Alt 1 (Playground Retrofit)**

Pay Item #	Bid Item Description and Unit Price	Estimated Quantity		Estimated Cost
30-2	GROUTED RIPRAP <i>Add'l Info: Faced Type L and Type M Grouted Riprap (underneath embankment slide chute). See Supplement 31 37 19</i> at the unit price of <u>\$435.00</u> per square yard	22	SY	\$ <u>9,570.00</u>
30-2e	GROUTED BOULDER EDGE (3 FOOT DIAMETER) <i>Add'l Info: 36-inch to 42-inch boulder set in concrete curb wall per detail on Sheet L503. See Supplement 31 37 19</i> at the unit price of <u>\$183.00</u> per linear foot	60	LF	\$ <u>10,980.00</u>
30-2e	GROUTED BOULDER EDGE (3 FOOT DIAMETER) <i>Add'l Info: Stacked Boulder Walls (30" Boulders) per detail on Sheet L503. See Supplement 31 37 19</i> at the unit price of <u>\$120.00</u> per linear foot	262	LF	\$ <u>31,440.00</u>
01-21.26.001	PARKS PRODUCT ALLOWANCE - SEE PROJECT SPECIFICATIONS PLAY EQUIPMENT <i>Add'l Info: Playground Play Structures Procurement A-K</i> at the unit price of \$ One Hundred Eighty Seven Thousand Dollars and No Cents true and verifiable costs + mark up	1	A/A	\$ <u>187,000.00</u>
02-41.00.01A	REMOVE SEE ADDITIONAL NOTES ====> <i>Add'l Info: Remove Safety Surface</i> at the unit price of <u>\$1.00</u> per square foot	3,800	SF	\$ <u>3,800.00</u>
02-41.00.01B	REMOVE SEE ADDITIONAL NOTES ====> <i>Add'l Info: Remove all Play equipment, footings ect.</i> at the unit price of <u>\$2,364.00</u> lump sum	1	LS	\$ <u>2,364.00</u>
02-41.00.01C	REMOVE SEE ADDITIONAL NOTES ====> <i>Add'l Info: Existing Play Pit Edge, as shown on plans</i> at the unit price of <u>\$4.00</u> per linear foot	165	LF	\$ <u>660.00</u>

Contract No. 201845550
A&T Park

Asbury & Tejon - Add Alt 1 (Playground Retrofit)
AA1 BF-6.18

December 5, 2018

Asbury & Tejon - Add Alt 1 (Playground Retrofit)

Pay Item #	Bid Item Description and Unit Price	Estimated Quantity	Estimated Cost
02-41.00.02	REMOVE SPECIAL ITEM SEE ADDITIONAL NOTES ====> <i>Add'l Info: Remove, protect and store existing entrance boulder/stone</i> at the unit price of <u> \$45.00 </u> each	1	EA \$ <u>45.00</u>
03-30.00.01	CAST IN PLACE CONCRETE SEE ADDITIONAL NOTES ==> <i>Add'l Info: Structurally Reinforced Concrete Wall 12" wide X approximate average height 60" per plans and detail on Sheet L502.</i> at the unit price of <u> \$382.00 </u> per linear foot	106	LF \$ <u>40,492.00</u>
32-13.13.03	CONCRETE WALK SEE ADDITIONAL NOTES ==> <i>Add'l Info: 6" Depth, Width Varies per plans. This bid item includes 252 LF of thickened edge per detail 3 on Sheet L501. Includes Aggregate Base Course.</i> at the unit price of <u> \$12.00 </u> per square foot	2,100	SF \$ <u>25,200.00</u>
32-13.13.05	CONCRETE RAMP WITHIN PARK AREA SEE ADDITIONAL NOTES ==> <i>Add'l Info: Three ramps in playground, Includes fiber mesh and Aggregate Base Course underneath ramp.</i> at the unit price of <u> \$686.00 </u> per cubic yard	6	CY \$ <u>4,116.00</u>
32-15.40.01	CRUSHED STONE PAVING <i>Add'l Info: Crusher fines - Ghost Grove</i> at the unit price of <u> \$3.00 </u> per square foot	350	SF \$ <u>1,050.00</u>
32-18.16.01	ENGINEERED WOOD FIBER PLAYGROUND SURFACING <i>Add'l Info: Qualified installer - coordinate design with under drain system which is a separate bid item;33-46.00.01</i> at the unit price of <u> \$4.00 </u> per square foot	6,300	SF \$ <u>25,200.00</u>

Asbury & Tejon - Add Alt 1 (Playground Retrofit)

Pay Item #	Bid Item Description and Unit Price	Estimated Quantity	Estimated Cost
32-33.00.01	PARKS SPEC SITE FURNISHINGS - PICNIC TABLES <i>Add'l Info: Procure/install per plan set detail - Concrete Pad paid under Concrete</i> at the unit price of <u>\$3,138.00</u> each	2	EA \$ <u>6,276.00</u>
32-33.00.02	PARKS SPEC SITE FURNISHINGS - BENCH <i>Add'l Info: Procure/install per plan set detail - Concrete Pad paid under Concrete</i> at the unit price of <u>\$1,361.00</u> each	3	EA \$ <u>4,083.00</u>
32-33.00.03	PARKS SPEC SITE FURNISHINGS - GHOST GROVE <i>Add'l Info: Procure/install per plan set detail</i> at the unit price of <u>\$6,660.00</u> each	1	EA \$ <u>6,660.00</u>
32-33.00.04	PARKS SPEC SITE FURNISHINGS - LOG STAIR <i>Add'l Info: Procure/install per plan set detail</i> at the unit price of <u>\$3,035.00</u> each	1	EA \$ <u>3,035.00</u>
32-33.00.05	PARKS SPEC SITE FURNISHINGS - LOG FLUME <i>Add'l Info: Procure/Install per plan set detail</i> at the unit price of <u>\$15,295.00</u> each	1	EA \$ <u>15,295.00</u>
32-33.00.06	PARKS SPEC SITE FURNISHINGS SEE ADDITIONAL NOTES ==> <i>Add'l Info: Install previously removed and protected existing boulder per plan set</i> at the unit price of <u>\$856.00</u> each	1	EA \$ <u>856.00</u>

Asbury & Tejon - Add Alt 1 (Playground Retrofit)

Pay Item #	Bid Item Description and Unit Price	Estimated Quantity		Estimated Cost
32-33.50.01	PLAYGROUND EQUIPMENT INSTALLATION PER MFG SPECIFICATIONS - QUALIFIED INSTALLER <i>Add'l Info: Bear Cub, Embankment Slide Chute, Custom PT 5-12, Kidnetix twirl, Deco Spring Rider, Custom PT 2-5, enclosed seat X2, belt seat x2, Primetime swing, Primetime swing add a bay</i>	1	LS	\$ 21,940.00
	at the unit price of <u>\$ 21,940.00</u> lump sum			
33-46.00.01	SUBDRAINAGE FOR PLAYGROUND (includes all piping and appurtenances) <i>Add'l Info: Sheet L502 - described as: 3 ea 6" multiflow systems; 4 connections; 60 LF of Solid wall ADS and 2 sloped concrete daylight encasements to be installed underneath Engineered Wood Fiber Playground Surfacing 32-18.16.01</i>	1	LS	\$ 13,165.00
	at the unit price of <u>\$ 13,165.00</u> lump sum			

Base Bid Items Total Amount (01-21.26.03 through 32-97.00.01 for Schedule A and Schedule B (One Hundred and Ten [110] total Base Bid Items)) \$ 2,183,065.15

Textura ® Fee from table on Page BF-3 (based on Base Bid Items Total Amount) \$ 5,850.00

Base Bid Items Total Amount plus Textura® Fee equals Total Bid Amount \$ 2,188,915.15

<p>Total Bid Amount: TWO-MILLION, ONE-HUNDRED AND EIGHTY-EIGHT THOUSAND, NINE-HUNDRED AND FIFTEEN DOLLARS AND FIFTEEN CENTS Dollars (\$ <u>2,188,915.15</u>)</p>
--

Add Alternate 1 Bid Items Total Amount (21 Bid Items (30-2 through 33-46.00.01)) \$ 413,227.00

If the Manager mails a written Notice of Apparent Low Bidder, addressed to the Bidder's business address stated on this Bid Form, the Undersigned Bidder shall, in accordance with the Contract Documents, be ready to, and shall, within five (5) days after the date of the Notice: (i) execute the attached form of Contract in conformity with this bid; (ii) furnish the required proofs of insurance; and (iii) furnish the required bond or bonds in the sum of the full amount of this bid, executed by a surety company acceptable to the Manager.

IRON WOMAN CONSTRUCTION &

The ENVIRONMENTAL SERVICES LLC, a corporation of the State of COLORADO, is hereby offered as Surety on said bond. If such surety is not approved by the Manager, another and satisfactory surety company shall be furnished.

Enclosed with this bid is a bid guarantee, as defined in the attached Instructions to Bidders, in the amount of 5%. The Undersigned Bidder agrees that the entire amount of this bid guarantee is to be paid to and become the property of the City as liquidated damages, and not as a penalty, if: (i) the bid is considered to be the best by the City; (ii) the City notifies the Undersigned Bidder that it is the Apparent Low Bidder; and (iii) the Undersigned Bidder fails to execute the Contract in the form prescribed or to furnish the required bond and proofs of insurance, within five (5) days after the date of such notification.

The following persons, firms or corporations are interested with the Undersigned Bidder in this bid:

Name: N/A Name: N/A
Address: N/A Address: N/A

If there are no such persons, firms, or corporations, please so state in the following space:



DENVER
OFFICE OF ECONOMIC
DEVELOPMENT

**List of Proposed
MWBE
Bidders, Subcontractors,
Suppliers (Manufacturers) or
Brokers**

Office of Economic Development
Division of Small Business Opportunity
Compliance Unit
201 W. Colfax Ave. Dept. 907
Denver, CO 80202
Phone: 720-913-1999
DSBO@denvergov.org

City & County of Denver Contract No.: 201845550

The undersigned Bidder proposes to utilize all listed firms. The following MWBE(s) firms listed are CURRENTLY certified by the City and County of Denver. Only the level of MWBE participation listed at the bid opening will count toward satisfaction of the project goal. Only bona fide commissions may be counted for Brokers. MWBE prime bidders must detail their bid information below. Please copy and attach this page to list additional MWBE.

Prime Bidder

Business Name: **IRON WOMAN CONSTRUCTION & ENVIRONMENTAL SERVICES LLC**

Address: **5680 EMERSON ST. DENVER, CO 80216**

Contact Person: **TRAVIS WIENS**

Type of Service: **GENERAL CONTRACTOR**

Dollar Amount: \$:

Percent of
Project

Certified MWBE Prime Bidder

Business Name: **JKS INDUSTRIES**

Address: **747 SHERIDAN BLVD**

Contact Person: **JEFFREY KNIGHT**

Type of Service: **DEMO/CONTAMINATED
MATERIALS**

Dollar Amount: \$:
244,599.00

Percent of
Project: **10.34%**

Subcontractors, Suppliers Manufacturers or Brokers (check one box)

<input checked="" type="checkbox"/> Subcontractor	<input type="checkbox"/> Supplier	<input type="checkbox"/> Manufacturer	<input type="checkbox"/> Broker
---	-----------------------------------	---------------------------------------	---------------------------------

Business Name: **JKS INDUSTRIES**

Address: **747 SHERIDAN BLVD.**

Type of Service: **DEMO/CONTM. SOILS**

Contact Person: **JEFFREY KNIGHT**

Dollar Amount: \$:
244,599.00

Percent of
Project: **10.34%**

<input type="checkbox"/> Subcontractor	<input type="checkbox"/> Supplier	<input type="checkbox"/> Manufacturer	<input type="checkbox"/> Broker
--	-----------------------------------	---------------------------------------	---------------------------------

Business Name: **MARTINEZ ASSOCIATES**

Address: **14828 W. 16TH AVE**

Type of Service: **TESTING**

Contact Person:

Dollar Amount: \$:

Percent of
Project

<input type="checkbox"/> Subcontractor	<input type="checkbox"/> Supplier	<input type="checkbox"/> Manufacturer	<input type="checkbox"/> Broker
--	-----------------------------------	---------------------------------------	---------------------------------

Business Name:

Address:

Type of Service:

Contact Person:

Dollar Amount: \$:

Percent of
Project

Rev 031816JE

Subcontractors, Suppliers Manufacturers or Brokers (check one box)							
<input checked="" type="checkbox"/>	Subcontractor (✓)	<input type="checkbox"/>	Supplier (✓)	<input type="checkbox"/>	Manufacturer (✓)	<input type="checkbox"/>	Broker (✓)
Business Name:							
Address:			Type of Service:				
Contact Person:			Dollar Amount: \$:	Percent of Project:			
<input checked="" type="checkbox"/>	Subcontractor (✓)	<input type="checkbox"/>	Supplier (✓)	<input type="checkbox"/>	Manufacturer (✓)	<input type="checkbox"/>	Broker (✓)
Business Name:							
Address:			Type of Service:				
Contact Person:			Dollar Amount: \$:	Percent of Project:			
<input checked="" type="checkbox"/>	Subcontractor (✓)	<input type="checkbox"/>	Supplier (✓)	<input type="checkbox"/>	Manufacturer (✓)	<input type="checkbox"/>	Broker (✓)
Business Name:							
Address:			Type of Service:				
Contact Person:			Dollar Amount: \$:	Percent of Project:			
<input checked="" type="checkbox"/>	Subcontractor (✓)	<input type="checkbox"/>	Supplier (✓)	<input type="checkbox"/>	Manufacturer (✓)	<input type="checkbox"/>	Broker (✓)
Business Name:							
Address:			Type of Service:				
Contact Person:			Dollar Amount: \$:	Percent of Project:			
<input checked="" type="checkbox"/>	Subcontractor (✓)	<input type="checkbox"/>	Supplier (✓)	<input type="checkbox"/>	Manufacturer (✓)	<input type="checkbox"/>	Broker (✓)
Business Name:							
Address:			Type of Service:				
Contact Person:			Dollar Amount: \$:	Percent of Project:			
<input checked="" type="checkbox"/>	Subcontractor (✓)	<input type="checkbox"/>	Supplier (✓)	<input type="checkbox"/>	Manufacturer (✓)	<input type="checkbox"/>	Broker (✓)
Business Name:							
Address:			Type of Service:				
Contact Person:			Dollar Amount: \$:	Percent of Project:			

Rev 031816JE

The undersigned Bidder hereby certifies that the aforementioned subcontractors and suppliers have full knowledge that their names have been offered as subcontractors and suppliers for the work, and the Bidder further certifies that the dollar amount of work to be performed by the aforementioned M/WBE(s) was furnished to the Bidder prior to the bid opening. The undersigned Bidder agrees that after the bid opening, it shall submit to the City an executed and completed W/MBE "Letter of Intent" in three working days (3) on each of its M/WBE subcontractors. The "Letter of Intent" form is contained in the Contract Documents.

The undersigned Bidder acknowledges the right of the City to reject any or all bids submitted, to waive informalities in bids and to re-advertise this Project for bids.

The undersigned certifies that it has carefully checked all works and figures and all statements made in these Bid Forms.

This bid is submitted upon the declaration that neither, I (we), nor, to the best of my (our) knowledge, none of the members of my (our) firm or company have either directly or indirectly entered into any agreement, participated in any collusion or otherwise taken any action in restraint of free competitive bidding in connection with this bid.

Business Address of Bidder: 5680 EMERSON ST.

City, State, Zip Code: DENVER, CO 80216

Telephone Number of Bidder: 720-648-0052 Fax No. 720-484-6463

Social Security or Federal Employer ID Number of Bidder: 81-0863272

Name and location of the last work of this kind herein contemplated upon which the Bidder was engaged:
27th STREET STORM INTERCEPTOR FOR CCOD

For information relative thereto, please refer to:

Name: TRAVIS WIENS

Title: ESTIMATOR

Address: twiens@ironwomancon.com

The undersigned acknowledges receipt, understanding, and full consideration of the following addenda to the Contract Documents:

Addenda Number 1 Date 1/10/2019

Addenda Number _____ Date _____

Addenda Number _____ Date _____

Dated this 7th day of February, 2019.

Signature of Bidder:

If an Individual: _____ doing business
as _____.

If a Partnership: _____
by: _____ General Partner.

If a Corporation: **IRON WOMAN CONSTRUCTION & ENVIRONMENTAL SERVICES LLC**
a LLC Corporation,
by: _____, its President.

Attest: 
Secretary (Corporate Seal)

If a Joint Venture, signature of all Joint Venture participants.

Firm: _____
Corporation (), Partnership () or () Limited Liability Company

By: _____ (If a Corporation)
Attest: _____
Title: _____ Secretary (Corporate Seal)

Firm: _____
Corporation (), Partnership () or () Limited Liability Company

By: _____ (If a Corporation)
Attest: _____
Title: _____ Secretary (Corporate Seal)

Firm: _____
Corporation (), Partnership () or () Limited Liability Company

By: _____ (If a Corporation)
Attest: _____
Title: _____ Secretary (Corporate Seal)



DENVER
OFFICE OF ECONOMIC
DEVELOPMENT

Office of Economic Development
Division of Small Business Opportunity
Compliance Unit
201 W. Colfax Ave. Dept. 907
Denver, CO 80202
Phone: 720-913-1999
DSBO@denvergov.org

**COMMITMENT TO MWBE
PARTICIPATION**

**The undersigned has satisfied the MWBE participant requirements in the following manner
(Please check the appropriate box):**

The Bidder/Proposer is committed to the minimum 10 % MWBE utilization on the project, and will submit Letters of Intent (LOI) for each subcontractor/subconsultant listed in the Bid Forms as follows:
Hard Bids: Three (3) business days after the bid opening.
Request for Proposals/Qualifications: With the proposal when due.
Compliance Plans: With each task/work order

The Bidder/Proposer is unable to meet the project goal of _____% MWBE, but is committed to a minimum of _____% MWBE utilization on the project. The Bidder/Proposer understands that they must submit a detailed statement of their good faith effort under sealed bid procedures, as a matter of responsiveness, or with initial proposals, under contract negotiation procedures; or no later than three (3) days after bid opening as a matter of responsibility as in accordance with DRMC Section 28-62 and 28-67 of Ordinance 85 to the Division of Small Business Opportunity.

The Bidder/Proposer is a certified MWBE in good standing with the City and is committed to self-perform a minimum of _____% of the work on the contract.

Bidder/Proposer (Name of Firm): **IRON WOMAN CONSTRUCTION & ENVIRONMENTAL SERVICES LLC**

Firm's Representative (Please print): **TRAVIS WIENS**

Signature (Firm's Representative): 

Title: **ESTIMATOR**

Address: **5680 EMERSON ST.**

City: **DENVER**

State: **CO**

Zip: **80216**

Phone: **720-648-0052**

Fax: **720-484-6463**

Email: **twiens@ironwomancon.com**

A copy of the MWBE Certification letter must be attached to each Letter of Intent (LOI).

Letter of Intent (LOI) Checklist

*All lines must be completed or marked N/A for Not Applicable
Submit the attached completed checklist with this letter.*

Completed ✓	
<input type="checkbox"/>	Project Number & Project Name
<input type="checkbox"/>	Section A: Name of Bidder/Consultant, Contact Person, Address, City, State, Zip, Phone, Email
<input type="checkbox"/>	Section B: Name of Certified Firm, Contact Person, Address, City, State, Zip, Phone, Email
<input type="checkbox"/>	Designation checked for MBE/WBE, SBE, EBE or DBE
<input type="checkbox"/>	Indirect Utilization: Name of subcontractor/subconsultant, supplier or broker is indicated if using the participation of a 2 nd tier subcontractor/subconsultant, supplier or broker.
<input type="checkbox"/>	Scope of work performed or item supplied by MWBE, SBE, EBE or DBE
<input type="checkbox"/>	Line items performed, if line-item bid.
<input type="checkbox"/>	Copy of MWBE, SBE, EBE or DBE Letter of Certification Attached
<input type="checkbox"/>	Designation checked for Subcontractor/Subconsultant, Supplier or Broker
	If project is a hard bid...
<input type="checkbox"/>	Bidder has indicated dollar amount for value of work going to Subcontractor/ Subconsultant, Supplier or Broker
<input type="checkbox"/>	Bidder has indicated percentage for value of work going to Subcontractor/ Subconsultant, Supplier or Broker
	If project is an RFP/RFQ...
<input type="checkbox"/>	Consultant has indicated percentage for value of work going to Subcontractor/ Subconsultant, Supplier or Broker Name & contact name for MWBE.
<input type="checkbox"/>	Fee amount if fee amount of work to be performed is requested.
<input type="checkbox"/>	Bidder/Consultant's Signature, Title & Date
<input type="checkbox"/>	MWBE, SBE, EBE or DBE Firm's Signature, Title and Date

Select One ✓	SUBMITTED VIA... For Construction Hard Bids ONLY, Bidders are strongly urged to deliver the LOI via one of the methods below. (The preferred method is to scan/email completed forms to email address below. Delivery to any other point cannot be guaranteed timely delivery.)
<input type="checkbox"/>	Email to DSBO@denvergov.org

The complete and accurate information that is required for the Letter of Intent is based on the following sections of the Ordinance 85: Section 28-63 and Section 28-68. Failure to complete this information on the Letter of Intent (LOI) may automatically deem a bid or proposal non-responsive.



Joint Venture Affidavit

The Undersigned swears that the foregoing statements are correct and include all material information necessary to identify and explain the terms and operation of our joint venture and the intended participation by each joint venturer in the undertaking. Further, the Undersigned covenant and agree to provide the City current, complete, and accurate information regarding actual joint venture work and the payment thereof and any proposed changes in any of the joint venture arrangements and to permit the audit and examination of the books, records, and files of the joint venture, by authorized representatives of the City or Federal funding agency, if applicable. Any material misrepresentation will be grounds for terminating any contract which may be awarded and for initiating action under Federal or State laws concerning false statements.

Name of Firm: _____

Print Name: _____

Title _____

Signature: _____

Date: _____

Notary Public

County of _____

State of _____

My Commission Expires: _____

Subscribed and sworn before me this

_____ day of _____, 20_____

Notary Seal

Notary Signature: _____

Notary Commission #: _____

Address: _____

Name of Firm: _____

Print Name: _____

Title _____

Signature: _____

Date: _____

Notary Public

County of _____

State of _____

My Commission Expires: _____

Subscribed and sworn before me this

_____ day of _____, 20_____

Notary Seal

Notary Signature: _____

Notary Commission #: _____

Address: _____



**JOINT VENTURE
ELIGIBILITY FORM**

Joint Venture means an association of two (2) or more business enterprises to constitute a single business enterprise to perform a City construction or professional design and construction services contract for which purpose they combine their property, capital, efforts, skills and knowledge, and in which each joint venturer is responsible for a distinct, clearly defined portion of the work of the contract, performs a commercially useful function, and whose share in the capital contribution, control, management responsibilities, risks and profits of the joint venture are equal to its ownership interest. Joint ventures must have an agreement in writing specifying the terms and conditions of the relationships between the joint venturers and their relationship and responsibility to the contract.

The Division of Small Business Opportunity (DSBO) requires the following information be provided from participants of a prospective joint venture, to assist DSBO in evaluating the proposed joint venture. This Joint Venture Eligibility form and the Joint Venture Affidavit apply if SBEs, EBEs, MBEs, WBEs or DBEs participate in this joint venture.

Please return this form, the Joint Venture Affidavit, and a copy of your Joint Venture Agreement to: Division of Small Business Opportunity, 201 West Colfax Avenue, Denver, CO 80202, at least ten (10) working days prior to bid opening or proposal.

If you have questions regarding this process, please contact DSBO at 720-913-1999.

Joint Venture Information

Name:		Contact Person:	
Address:			
City:	State:	Zip:	Phone:

Joint Venture Participants

Name:		Contact Person:	
Address:			
City:	State:	Zip:	Phone:
% Ownership:	Certifying Entity:	Type Certification & Date: (S/E/M/W or DBE)	
Type of Work for which Certification was granted:			

Name:		Contact Person:	
Address:			
City:	State:	Zip:	Phone:
% Ownership:	Certifying Entity:	Type Certification & Date: (S/E/M/W or DBE)	
Type of Work for which Certification was granted:			

General Information

SBE/EBE/MBE/WBE/DBE Initial Capital Contributions: \$	%
Future capital contributions (explain requirements) (attach additional sheets if necessary):	
Source of Funds for the SBE/EBE/MBE/WBE/DBE Capital Contributions:	
Describe the portion of the work or elements of the business controlled by the SBE/EBE/MBE/WBE or DBE: (attach additional sheets if necessary)	

Describe the portion of the work or elements of the business controlled by non-SBE/EBE/MBE/WBE or DBE: (attach additional sheets if necessary)

JOINT VENTURE ELIGIBILITY FORM

General information

Describe the SBE/EBE/MBE/WBE or DBE's involvement in the overall management of the joint venture (e.g., participation on a management committee or managing board voting rights, etc.) (attach additional sheets if necessary)

Describe the SBE/EBE/MBE/WBE or DBE's share in the profits of the joint venture:

Describe the SBE/EBE/MBE/WBE or DBE's share in the risks of the joint venture:

Describe the roles and responsibilities of each joint venture participant with respect to managing the joint venture (use additional sheets if necessary):

a. SBE/EBE/MBE/WBE or DBE joint venture participant:

b. Non- SBE/EBE/MBE/WBE or DBE joint venture participant:

Describe the roles and responsibilities of each joint venture participant with respect to operation of the joint venture (use additional sheets if necessary):

a. SBE/EBE/MBE/WBE or DBE joint venture participant:

b. Non- SBE/EBE/MBE/WBE or DBE joint venture participant:

Which firm will be responsible for accounting functions relative to the joint venture's business?

Explain what authority each party will have to commit or obligate the other to insurance and bonding companies, financing institutions, suppliers, subcontractors, and/or other parties?

Please provide information relating to the approximate number of management, administrative, support and non-management employees that will be required to operate the business and indicate whether they will be employees of the S/E/MWBE/DBE, non- S/E/MWBE/DBE or joint venture:

	Non- SBE/EBE/M/WBE/DBE	SBE/EBE/M/WBE/DBE	Joint Venture
Management			
Administrative			
Support			
Hourly Employees			

JOINT VENTURE ELIGIBILITY FORM

General Information

Please provide the name of the person who will be responsible for hiring employees for the joint venture.

Who will they be employed by?

Are any of the proposed joint venture employees currently employees of any of the joint venture partners?

	Yes (✓)	No (✓)
--	------------	-----------

If yes, please list the number and positions and indicate which firm currently employs the individual(s). (use additional sheets if necessary)

Number of employees	Position	Employed By

Attach a copy of the proposed joint venture agreement, promissory note or loan agreement (if applicable), and any and all written agreements between the joint venture partners.

List all other business relationships between the joint venture participants, including other joint venture agreements in which the parties are jointly involved.

If there are any significant changes in or pertaining to this submittal, the joint venture members must immediately notify the Division of Small Business Opportunity.

COMP-FRM-015

**CITY AND COUNTY OF DENVER
DEPARTMENT OF PUBLIC WORKS**

BID BOND

KNOW ALL MEN BY THESE PRESENTS:

THAT Iron Woman Construction & Environmental Services, LLC, as Principal, and Fidelity and Deposit Company of Maryland, a corporation organized and existing under and by virtue of the laws of the State of Maryland, and authorized to do business within the State of Colorado, as Surety, are held and firmly bound unto the City and County of Denver, Colorado, as Obligee, in full and just sum of Five Percent (5%) of Total Bid Amount Dollars, (\$ -----), lawful money of the United States, for the payment of which sum, well and truly to be made, we bind ourselves, our heirs, executors, administrators, successors and assigns, jointly and severally, firmly by these presents:

WHEREAS, the said Principal is herewith submitting its bid, dated February 7, 2019, for the construction of: **CONTRACT NO. 201845550, ASBURY & TEJON PARK**, as set forth in detail in the Contract Documents for the City and County of Denver, Colorado, and said Obligee has required as a condition for receiving said bid that the Principal deposit specified bid security in the amount of not less than five percent (5%) of the amount of said bid, as it relates to work to be performed for the City, conditioned that in event of failure of the Principal to execute the Contract, for such construction and furnish required Performance and Payment Bond if the contract is offered him that said sum be paid immediately to the Obligee as liquidated damages, and not as a penalty, for the Principal's failure to perform.

The condition of this obligation is such that if the aforesaid Principal shall, within the period specified therefore, on the prescribed form presented to him for signature, enter into a written contract with the Obligee in accordance with his bid as accepted and give Performance and Payment Bond with good and sufficient surety or sureties, upon the form prescribed by the Obligee, for the faithful performance and the proper fulfillment of said Contract, or in the event of withdrawal of said bid within the time specified, or upon the payment to the Obligee of the sum determined upon herein, as liquidated damages and not as penalty, in the event the Principal fails to enter into said contract and give such Performance and Payment Bond within the time specified, then this Obligation shall be null and void, otherwise to remain in full force and effect.

Signed, sealed and delivered this 7th day of February, 2019.

ATTEST

Darlene Craven

Secretary

Iron Woman Construction & Environmental Services, LLC

Principal

By

Shaun S. Egan, President & CEO

Fidelity and Deposit Company of Maryland

Surety

By

Darlene Krings
Darlene Krings, Attorney-in-Fact

Seal if Bidder is Corporation
(Attach Power-of-Attorney)

[SEAL]

**ZURICH AMERICAN INSURANCE COMPANY
COLONIAL AMERICAN CASUALTY AND SURETY COMPANY
FIDELITY AND DEPOSIT COMPANY OF MARYLAND
POWER OF ATTORNEY**

KNOW ALL MEN BY THESE PRESENTS: That the ZURICH AMERICAN INSURANCE COMPANY, a corporation of the State of New York, the COLONIAL AMERICAN CASUALTY AND SURETY COMPANY, a corporation of the State of Maryland, and the FIDELITY AND DEPOSIT COMPANY OF MARYLAND a corporation of the State of Maryland (herein collectively called the "Companies"), by **DAVID MCVICKER, Vice President**, in pursuance of authority granted by Article V, Section 8, of the By-Laws of said Companies, which are set forth on the reverse side hereof and are hereby certified to be in full force and effect on the date hereof, do hereby nominate, constitute, and appoint **Russell D. LEAR, Kristen PEREIRO, Dulce R. HUGGINS, Darlene KRINGS, K'Anne E. VOGEL, Kelly T. URWILLER, Royal R. LOVELL, Wesley J. BUTORAC and Steve J. BLOHM, all of GREELEY, Colorado, EACH** its true and lawful agent and Attorney-in-Fact, to make, execute, seal and deliver, for, and on its behalf as surety, and as its act and deed: **any and all bonds and undertakings**, and the execution of such bonds or undertakings in pursuance of these presents, shall be as binding upon said Companies, as fully and amply, to all intents and purposes, as if they had been duly executed and acknowledged by the regularly elected officers of the ZURICH AMERICAN INSURANCE COMPANY at its office in New York, New York., the regularly elected officers of the COLONIAL AMERICAN CASUALTY AND SURETY COMPANY at its office in Owings Mills, Maryland., and the regularly elected officers of the FIDELITY AND DEPOSIT COMPANY OF MARYLAND at its office in Owings Mills, Maryland., in their own proper persons.

The said Vice President does hereby certify that the extract set forth on the reverse side hereof is a true copy of Article V, Section 8, of the By-Laws of said Companies, and is now in force.

IN WITNESS WHEREOF, the said Vice-President has hereunto subscribed his/her names and affixed the Corporate Seals of the said **ZURICH AMERICAN INSURANCE COMPANY, COLONIAL AMERICAN CASUALTY AND SURETY COMPANY, and FIDELITY AND DEPOSIT COMPANY OF MARYLAND**, this 31st day of January, A.D. 2018.

ATTEST:

**ZURICH AMERICAN INSURANCE COMPANY
COLONIAL AMERICAN CASUALTY AND SURETY COMPANY
FIDELITY AND DEPOSIT COMPANY OF MARYLAND**



By: *Dawn E. Brown*
*Assistant Secretary
Dawn E. Brown*

David McVicker
*Vice President
David McVicker*

State of Maryland
County of Baltimore

On this 31st day of January, A.D. 2018, before the subscriber, a Notary Public of the State of Maryland, duly commissioned and qualified, **DAVID MCVICKER, Vice President, and DAWN E. BROWN, Assistant Secretary**, of the Companies, to me personally known to be the individuals and officers described in and who executed the preceding instrument, and acknowledged the execution of same, and being by me duly sworn, deposeth and saith, that he/she is the said officer of the Company aforesaid, and that the seals affixed to the preceding instrument are the Corporate Seals of said Companies, and that the said Corporate Seals and the signature as such officer were duly affixed and subscribed to the said instrument by the authority and direction of the said Corporations.

IN TESTIMONY WHEREOF, I have hereunto set my hand and affixed my Official Seal the day and year first above written.

Constance A. Dunn



Constance A. Dunn, Notary Public
My Commission Expires: July 9, 2019



Office of Economic Development
 Division of Small Business Opportunity
 201 W. Colfax Ave, Dept. 907
 Denver, CO 80202
 p: 720.913.1888
 f: 720.913.1609
www.denvergov.org/dsbo

Diversity and Inclusiveness * in City Solicitations Information Request Form

Type in your response, print out, sign and date; or print out and complete manually. Please print legibly.

Denver Executive Order No. 101 establishes strategies between the City and private industry to use diversity and inclusiveness to promote economic development in the City and County of Denver and to encourage more businesses to compete for City contracts and procurements. The Executive Order requires, among other things, the collection of certain information regarding the practices of the City's contractors and consultants toward diversity and inclusiveness and encourages/requires City agencies to include diversity and inclusiveness policies in selection criteria where legally permitted in solicitations for City services or goods.

Answer each question below. Missing or incomplete responses will be recorded as "no", "not applicable", or "none". A proposal or response to a solicitation by a contractor/consultant that does not include this completed form shall be deemed non-responsive and rejected.

Business Email Address: estimating@ironwomancon.com

Please include the Email address of the contact person facilitating this solicitation for the City and County of Denver: twiens@ironwomancon.com

Agency Name:

- | | | |
|---|---|--|
| <input type="checkbox"/> Arts and Venue | <input type="checkbox"/> Purchasing Division | <input type="checkbox"/> Sheriff Department |
| <input type="checkbox"/> Auditor Office | <input type="checkbox"/> Human Services | <input type="checkbox"/> Technology Services |
| <input type="checkbox"/> Community Planning | <input type="checkbox"/> Economic Development | <input type="checkbox"/> Other |
| <input type="checkbox"/> Denver International Airport | <input type="checkbox"/> Parks and Recreation | |
| <input type="checkbox"/> Environmental Health | <input type="checkbox"/> Police Department | |
| <input type="checkbox"/> Fire Department | <input type="checkbox"/> Public Works | |

Project Name: ASBURY & TEJON PARK

BID / RFP No.: 201845550

Name of Contractor/Consultant: IRON WOMAN CONSTRUCTION & ENVIRONMENTAL SERVICES LLC

What industry is your business? UNDERGROUND UTILITIES, ENVIRONMENTAL, TRUCKING, & MINING

Address:
5680 EMERSON ST.
DENVER, CO 80216

Business Phone No.: 720-648-0052

Business Facsimile No.: 303-484-6463

OED - Executive Order No. 101
 Diversity and Inclusiveness in City Solicitations Information Request Form
 Rev. 12/29/2015

1. How many employees does your company employ?

- 1-10 51-100
 11-50 over 100

1.1. How many of your company's employees are:

Full-time 100% Part-Time _____

2. Do you have a Diversity and Inclusiveness Program? Yes No

If No, and your company size is less than 10 employees continue to question 11. Complete and sign the form.

If Yes, does it address:

- 2.1 Employment and retention? Yes No
2.2 Procurement and supply chain activities? Yes No
2.3 Customer service? Yes No

3. Provide a detailed narrative of your company's diversity and inclusiveness principles and programs. This may include, for example, (i) diversity and inclusiveness employee training programs, equal opportunity policies, and the budget amount spent on an annual basis for workplace diversity; or (ii) diversity and inclusiveness training and information to improve customer service.

SEE ATTACHED

4. Does your company regularly communicate its diversity and inclusiveness policies to employees?

If Yes, how does your company regularly communicate its diversity and inclusiveness policies to employees? (select all that apply)

- Employee Training
 Pamphlets
 Public EEO postings
 Other
 Not Applicable

5. If you responded that you do not have a diversity and inclusiveness program, describe any plans your company may have to adopt such a program.

6. How often do you provide training in diversity and inclusiveness principles?

- Monthly Annually
 Quarterly Not Applicable Other _____

6.1 What percentage of the total number of employees generally participate?

- 0 - 25% 51 - 75%
 26 - 50% 76 - 100% Not Applicable

7. State how you achieve diversity and inclusiveness in supply and procurement activities. This may include, for example, narratives of training programs, equal opportunity policies, diversity or inclusiveness partnership programs, mentoring and outreach programs, and the amount and description of budget spent on an annual basis for procurement and supplier diversity and inclusiveness.

SEE ATTACHED

8. Do you have a diversity and inclusiveness committee? Yes No

8.1 If Yes, how often does it meet?

- Monthly Annually No Committee
 Quarterly Other _____

8.2 If you responded that you do not have a diversity and inclusiveness committee, describe any plans your company may have to establish such a committee.

9. Do you have a budget for diversity and inclusiveness efforts? Yes No

10. Does your company integrate diversity and inclusion competencies into executive/manager performance evaluation plans? Yes No

11. Would you like information detailing how to implement a Diversity and Inclusiveness program?
 Yes No

If yes, please email XO101@denvergov.org.

I attest that the information represented herein is true, correct and complete, to the best of my knowledge.



Signature of Person Completing Form

2/7/2019

Date

TRAVIS WIENS

Printed Name of Person Completing Form

NOTE: Attach additional sheets or documentation as necessary for a complete response.

*"Diversity and inclusiveness program" means a program that invites values, perspectives and contributions of people from diverse backgrounds, and integrates diversity into its hiring and retention policies, training opportunities, and business development methods to provide an equal opportunity for each person to participate, contribute, and succeed within the organization's workplace. "Diversity" encompasses a wide variety of human differences, including differences such as race, age, gender, gender identity, sexual orientation, ethnicity, physical disabilities, appearance, historically underutilized and disadvantaged persons, as well as social identities such as religion, marital status, socio-economic status, lifestyle, education, parental status, geographic background, language ability, and veteran status."

CITY AND COUNTY OF DENVER

STATE OF COLORADO



DENVER
THE MILE HIGH CITY

DEPARTMENT OF PUBLIC WORKS

Bid Documents Package

Contract Number: 201845550



Asbury & Tejon Park

December 5, 2018

CITY AND COUNTY OF DENVER
DEPARTMENT OF PUBLIC WORKS

TABLE OF CONTENTS FOR CONTRACT DOCUMENTS

BID FORM AND SUBMITTAL PACKAGE	<u>PAGE</u>
Bid Form and Submittal Package (bound separately and attached as part of these Bid Documents)	
Table of Contents	BF-1
Bidder's Checklist	BF-2 through BF-3
Bid Form and Submittal Package Acknowledgment Form	BF-4 through BF-5
Bid Form	BF-6 through BF-8
List of Proposed Minority and Woman Business Enterprise(s)	BF-9 through BF-12
Commitment to Minority and Woman Business Enterprise Participation	BF-13
Minority and Woman Business Enterprise Letter(s) of Intent & Checklist	BF-14 through BF-15
Joint Venture Affidavit	BF-16
Joint Venture Eligibility Form	BF-17 through BF-19
Bid Bond	BF-20
Diversity and Inclusiveness in City Solicitations Form	BF-21 through BF-24
BID DOCUMENTS	
Table of Contents	BDP-1
Statement of Quantities	SQ-1 through SQ-14
Notice of Invitation for Bids	BDP-2 through BDP-3
Instructions to Bidders	BDP-4 through BDP-15
Equal Employment Opportunity Provisions	BDP-16 through BDP-25
Appendix A	
Appendix F	
Contract Form	BDP-26 through BDP-30
Index of the General Contract Conditions	BDP-31 through BDP-35
Special Contract Conditions	BDP-36 through BDP-44
Final/Partial Release and Certificate of Payment Forms (Samples)	BDP-39 through BDP-41
Performance and Payment Bond Form	BDP-45 through BDP-46
Performance and Payment Bond Surety Authorization letter (Sample)	BDP - 47
Notice to Apparent Low Bidder (Sample)	BDP-48 through BDP-49
Notice To Proceed (Sample)	BDP-50
Certificate of Contract Release (Sample)	BDP-51
Prevailing Wage Rate Schedule	6 pages
Index to Technical Specifications	pages i-ii
Technical Specifications	1,093 pages
Contract Drawings	51 pages

Statement of Quantities
Asbury & Tejon - Schedule A

Pay Item #	Description	Estimated Quantity	Units
01-21.26.03	ALLOWANCE FOR - SEE PROJECT SPECIFICATIONS PROCUREMENT OF CARLSONATOR SYSTEM	1	A/A
2-1.1b	REMOVE COMBINATION CONCRETE CURB, GUTTER AND SIDEWALK (3'-11") <i>Add'l Info: Remove Monolithic Concrete 6" Vertical Curb, Gutter and Sidewalk (4'-0")</i>	284	LF
2-2.1	REMOVE CONCRETE SIDEWALK	2,832	SF
2-2.4	REMOVE CONCRETE CHANNEL PAVING <i>Add'l Info: Concrete Trickle Channel through Park</i>	4,002	SF
2-11.1a	REMOVE EXISTING 8" SANITARY SEWER PIPE	137	LF
2-11.2n	REMOVE EXISTING 48" STORM SEWER PIPE	28	LF
2-11.2n	REMOVE EXISTING 48" STORM SEWER PIPE <i>Add'l Info: Carlsonator System Area</i>	26	LF
2-11.2o	REMOVE EXISTING 54" STORM SEWER PIPE	15	LF
2-11.6n	REMOVE 48" RCP FLARED END SECTION	3	EA
2-11.6o	REMOVE 54" RCP FLARED END SECTION	1	EA
2-12.1	REMOVE EXISTING SANITARY MANHOLE	1	EA
2-12.7	REMOVE EXISTING STRUCTURE <i>Add'l Info: Existing South Pond Outlet Structure</i>	1	EA
2-13.1	REMOVE EXISTING STORM INLET	1	EA
02-22.13	VIBRATION ASSESSMENT	1	LS
02-56.13.14	GEOFABRIC FOR WASTE CONTAINMENT <i>Add'l Info: Orange Warning Barrier Geotextile</i>	12,600	SY

Asbury & Tejon - Schedule A

Pay Item #	Description	Estimated Quantity	Units
02-82.16.10	CERTIFIED ASBESTOS INSPECTOR (CABI)/AIR MONITOR	1	LS
3-2a	HAULING OF CONTAMINATED MATERIALS TO DENVER/ARAPAHOE DISPOSAL SITE (DADS) ASBURY & TEJON SUPPLEMENTAL <i>Add'l Info: HAUL SOIL/ASBESTOS, INCLUDES EXCAVATION AND ALL APPROPRIATE TRANSPORT AND HANDLING OF MATERIALS PER STATE AND LOCAL REQUIREMENTS; Refer to supplemental Measurement & Payment</i>	9,361	CY
3-4a	ROCK EXCAVATION ASBURY AND TEJON SUPPLEMENTAL <i>Add'l Info: Earthwork, Rock Excavation; See Supplement 31 23 00 Earthwork; Refer to supplemental Measurement & Payment</i>	1,155	CY
3-5a	CLEARING AND GRUBBING ASBURY AND TEJON SUPPLEMENTAL <i>Add'l Info: See Supplement 31 23 00 Earthwork; Refer to supplemental Measurement & Payment</i>	1	LS
3-5b	MUCK, REPLACE WITH APPROVED MATERIAL ASBURY AND TEJON SUPPLEMENTAL <i>Add'l Info: Excavation, Muck, Replace with Approved Material; See Supplement 31 23 00 Earthwork; Refer to supplemental Measurement & Payment</i>	300	CY
3-7a	HEALTH & SAFETY PLAN	1	LS
3-7b	MATERIAL MANAGEMENT PLAN <i>Add'l Info: Initial draft MMP is included in the technical specifications</i>	1	LS
3-8	UNCLASSIFIED EXCAVATION <i>Add'l Info: See Supplement 31 23 00 Earthwork</i>	1,723	CY
5-1a	IMPORTED FILL SUPPLEMENTAL FOR ASBURY AND TEJON <i>Add'l Info: Earthwork, Imported Fill; See Supplement 31 23 00 Earthwork</i>	7,935	CY

Asbury & Tejon - Schedule A

Pay Item #	Description	Estimated Quantity	Units
5-2a	SUBGRADE MATERIAL (SELECT BACKFILL) <i>Add'l Info: see Supplement 31 23 00 Earthwork</i>	100	TON
5-2b	TOPSOIL <i>Add'l Info: Imported Topsoil, 6" Depth, See Denver Parks & Recreation Specification 32 91 20, Must Meet DPR Chemistry Requirments</i>	3,658	TON
12-1.1	6" CURB AND GUTTER 2' PAN (CD0T T2, IIB)	275	LF
12-1.7	6" CONCRETE CURB HEAD <i>Add'l Info: North Pond</i>	10	LF
12-2.4	MISCELLANEOUS CONCRETE FLATWORK <i>Add'l Info: Removal, dispose and install mow band concrete strip in Carlsonator System Area</i>	55	SF
12-5.2	CONCRETE APRON <i>Add'l Info: WQ Sediment Pad (North Pond) with toewall per CDOT M-601-20 Apron Toe Wall. Includes Steel Reinforcement.</i>	781	SF
12-5.5	CONCRETE ALLEY PAVING <i>Add'l Info: Carlsonator System Area (Includes removal and disposal of existing Alley Paving)</i>	495	SF
12-14	CONCRETE CUT-OFF WALL <i>Add'l Info: Channel Grade Drop Cutoff Wall</i>	12	CY
16-1	SECURITY FENCE <i>Add'l Info: Temporary Jobsite Perimeter Construction Fencing</i>	3,300	LF
16-8	HAND RAIL <i>Add'l Info: Trash Collection Railing. Includes Posts, Horizontal and Vertical Anchor Plates and Anchor Bolts Per Detail on Sheet No. C110</i>	4	LF
20-2be	ASPHALT SURFACE COURSE, SX, RAP 20%, N=75, 64-22.	876	SY-IN

Asbury & Tejon - Schedule A

Pay Item #	Description	Estimated Quantity	Units
20-3be	ASPHALT BASE COURSE, S, RAP 20%, N=75, 64-22.	2,400	SY-IN
20-4	ASPHALT ROTOMILL <i>Add'l Info: Removal of Asphalt, Assumed 10-Inch Thickness of Asphalt to be Removed</i>	8,100	SY-IN
30-1b	RIPRAP TYPE L <i>Add'l Info: Soil Riprap, See Supplement 31 37 00</i>	123	SY
30-1c	RIPRAP TYPE M <i>Add'l Info: Void-Filled Riprap, See Supplement 31 37 00</i>	540	SY
30-2b.1	GROUTED BOULDERS (30" DIAMETER) <i>Add'l Info: North Pond Landscape Boulders (Loose Boulders and Boulders Set in Concrete Pad). See Supplement 31 37 19</i>	35	EA
30-2k	BOULDER (4 FOOT DIAMETER) <i>Add'l Info: Landscape Boulder 24-inch to 48-inch average range per detail on Sheet L400. See Supplement 31 37 00</i>	52	EA
30-2k	BOULDER (4 FOOT DIAMETER) <i>Add'l Info: Slab Stone Boulder Stone Step (size to achieve 4-foot wide trail with 6" height per step) per detail on Sheet L400. See Supplement 31 37 00</i>	10	EA
30-2k	BOULDER (4 FOOT DIAMETER) <i>Add'l Info: 30-inch to 36-inch boulder set in concrete walk per detail on Sheet L503. See Supplement 31 37 00</i>	11	EA
34-2.3e	18" DIAMETER C-76 RCP, CLASS III	37	LF
34-2.3n	48" DIAMETER C-76 RCP, CLASS III <i>Add'l Info: 30-Degree Bend</i>	7	LF
34-2.3n	48" DIAMETER C-76 RCP, CLASS III <i>Add'l Info: Carlsonator System Area</i>	12	LF

Asbury & Tejon - Schedule A

Pay Item #	Description	Estimated Quantity	Units
34-7.1a	8" DIAMETER PVC PIPE <i>Add'l Info: Solid Wall PVC</i>	130	LF
34-7.1g	24" DIAMETER PVC PIPE <i>Add'l Info: Carlsonator System Area Solid Wall PVC</i>	20	LF
34-12.1a	4' DIAMETER PRECAST MANHOLE WITH TYPE A BASE & CONCENTRIC CONE <i>Add'l Info: w/ Outside Drop</i>	1	EA
34-12.1c	4' DIAMETER PRECAST MANHOLE WITH TYPE C BASE & CONCENTRIC CONE	1	EA
34-12.7	CAST-IN-PLACE SPECIAL STRUCTURE <i>Add'l Info: North Pond Inlet - Structure #1</i>	1	EA
34-12.7	CAST-IN-PLACE SPECIAL STRUCTURE <i>Add'l Info: North Pond Water Quality - Structure #2</i>	1	EA
34-12.7	CAST-IN-PLACE SPECIAL STRUCTURE <i>Add'l Info: South Pond Inlet - Structure #3</i>	1	EA
34-12.7	CAST-IN-PLACE SPECIAL STRUCTURE <i>Add'l Info: South Pond Inlet - Structure #4</i>	1	EA
34-12.7	CAST-IN-PLACE SPECIAL STRUCTURE <i>Add'l Info: South Pond Water Quality - Structure #5</i>	1	EA
34-12.7	CAST-IN-PLACE SPECIAL STRUCTURE <i>Add'l Info: Installation of Carlsonator Vault System and any other appurtenances associated with the Carlsonator system. This bid item also includes repairs to the existing irrigation system that are impacted during the installation of the Carlsonator system.</i>	1	EA

Asbury & Tejon - Schedule A

Pay Item #	Description	Estimated Quantity	Units
34-12.7	CAST-IN-PLACE SPECIAL STRUCTURE <i>Add'l Info: 8-foot diameter manhole with internal weir wall (Carlsonator System Area). Manhole shall conform to CDOT M&S Standards (M-604-20).</i>	1	EA
34-12.7	CAST-IN-PLACE SPECIAL STRUCTURE <i>Add'l Info: 8-foot diameter manhole (Carlsonator System Area). Manhole shall conform to CDOT M&S Standards (M-604-20).</i>	1	EA
34-12.8	UNCOVER AND RAISE (ADJUST) MANHOLE	1	VF
34-13.1a	8" PIPE OUTSIDE DROP	1	EA
34-14.4	CONCRETE COLLARS <i>Add'l Info: Concrete Closure 8" Sanitary Sewer</i>	1	EA
34-16.2a	SINGLE #16 INLET WITH OPEN THROAT	1	EA
34-17.1a	PRE-VIDEO INSPECTION OF 8" DIAMETER SEWER PIPE	221	LF
34-17.2a	CLEANING OF 8" DIAMETER SANITARY PIPE	221	LF
34-17.3a	8" DIAMETER SANITARY SEWER BY-PASS PUMPING	130	LF
40-7	REMOVE TREES (>6" DIAMETER)	6	EA
40-8	REMOVE BUSHES	3	EA
40-8	REMOVE BUSHES <i>Add'l Info: (Around Existing Flared End Sections)</i>	15	EA
41-1	TRAFFIC CONTROL	1	LS
43-1b	STORM WATER MANAGEMENT (SCENARIO 2) See SCS 23.0	1	LS

Asbury & Tejon - Schedule A

Pay Item #	Description	Estimated Quantity	Units
44-1	DEWATERING <i>Add'l Info: See See Supplement 31.23.19.01 Water Control and Dewatering</i>	1	LS
47-1	CONSTRUCTION SURVEYING <i>Add'l Info: Includes intermediate As Built survey drawings for Playground Equipment area, sub drainage systems, etc., incremental surveys to measure earthwork and Final As-Built Survey</i>	1	LS
47-2	SURVEY MONUMENTATION	5	EA
50-1	MOBILIZATION	1	LS

Statement of Quantities
Asbury & Tejon - Schedule B

Pay Item #	Description	Estimated Quantity	Units
01-56.39.01	TREE & SHRUB RETENTION, MAINTENANCE AND PROTECTION <i>Add'l Info: This is for existing established trees and shrubs protected and maintained during construction activities; includes water. See Denver Forestry requirements.</i>	1	LS
01-56.39.02	TREE PROTECTION FENCING [orange plastic]	4,500	LF
01-56.39.03	TREE PROTECTION FENCING [6' chain link] <i>Add'l Info: Includes Tree Wrap</i>	4,500	LF
02-41.00.01A	REMOVE SEE ADDITIONAL NOTES====> <i>Add'l Info: Removal of concrete pads under bench and picnic tables</i>	160	SF
02-41.00.01E	REMOVE SEE ADDITIONAL NOTES====> <i>Add'l Info: Remove Picnic Table and Benches</i>	3	EA
32-13.13.02	CONCRETE PAD SEE ADDITIONAL NOTES ====> <i>Add'l Info: 6" Depth, Concrete Pad for Picnic Tables and Benches.</i>	509	SF
32-13.13.03	CONCRETE WALK SEE ADDITIONAL NOTES ====> <i>Add'l Info: 6" Depth, Width Varies per plans. This bid item includes 252 LF of thickened edge per detail 3 on Sheet L501. Includes Aggregate Base Course.</i>	7,350	SF
32-13.13.04	CONCRETE CURB ADDITIONAL NOTES ====> <i>Add'l Info: 6-inch high curb head adjacent to park bench concrete pad</i>	28	LF
32-15.40.01	CRUSHED STONE PAVING <i>Add'l Info: Crusher fines - Trail</i>	350	SF
32-33.00.01	PARKS SPEC SITE FURNISHINGS - PICNIC TABLES <i>Add'l Info: Procure/install per plan set detail - Concrete Pad paid under Concrete</i>	2	EA

Asbury & Tejon - Schedule B

Pay Item #	Description	Estimated Quantity	Units
32-33.00.02	PARKS SPEC SITE FURNISHINGS - BENCH <i>Add'l Info: Procure/install per plan set detail - Concrete Pad paid under Concrete</i>	3	EA
32-80.00.01	IRRIGATION SYSTEMS - SEE PLAN SHEETS FOR DETAILS <i>Add'l Info: Also includes new mainline connections</i>	1	LS
32-84.33.01	AUTOMATIC IRRIGATION CONTROLLERS (installation per plan set) <i>Add'l Info: Installation of New Toro Controller Assembly that will furnished to contractor by Denver Dept of Parks and Recreation.</i>	2	EA
32-91.13.01	SOIL PREPARATION <i>Add'l Info: Sodded Areas Only</i>	41,475	SF
32-91.13.50	SOIL PREPARATION - MULCH PER PLAN SET (BEDDING AREAS)	1,313	SF
32-92.20.01	WET MEADOW SEED MIX [per plan set] INCLUDES SOIL AMENDMENTS Certified Installer & Certified Pesticide applicator included <i>Add'l Info: Soil Preparation included in seed cost</i>	18,690	SF
32-92.20.02	TRANSITIONAL NATIVE SEED MIX [per plan set] INCLUDES SOIL AMENDMENTS Certified Installer & Certified Pesticide applicator included <i>Add'l Info: Soil Preparation included in seed cost</i>	13,965	SF
32-92.20.03	UPLAND NATIVE SEED MIX [per plan set] INCLUDES SOIL AMENDMENTS Certified Installer & Certified Pesticide applicator included <i>Add'l Info: Soil Preparation included in seed cost</i>	77,700	SF
32-92.20.04	WETLAND SOD [per plan set] Certified Installer & Certified Pesticide applicator included <i>Add'l Info: Soil Preparation included in sod cost</i>	5,355	SF
32-92.23.01	PARKS SPEC SODDING (NOT WETLAND) KENTUCKY BLUEGRASS, Certified Installer & Certified Pesticide applicator included	41,475	SF

Asbury & Tejon - Schedule B

Pay Item #	Description	Estimated Quantity	Units
32-93.00.01	ROCKY MOUNTAN MAPLE 2" CALIPER [acer glabrum](includes maintenance until final acceptance)	7	EA
32-93.00.02	SHAGBARK HICKORY 2" CALIPER [carya ovata](includes maintenance until final acceptance)	2	EA
32-93.00.03	HACKBERRY 2" CALIPER [celtis occidentalis] (includes maintenance until final acceptance)	5	EA
32-93.00.04	SMOKE TREE 2" CALIPER [cotinus coggygria] (includes maintenance until final acceptance)	3	EA
32-93.00.05	RADIANT CRABAPPLE 2" CALIPER [malus 'radiant'] (includes maintenance until final acceptance)	2	EA
32-93.00.06	AMERICAN PLUM 2" CALIPER [prunus americana] (includes maintenance until final acceptance)	4	EA
32-93.00.07	BUR OAK 2" CALIPER [quercus macrocarpa] (includes maintenance until final acceptance)	7	EA
32-93.00.08	RED OAK 2" CALIPER [quercus rubra] (includes maintenance until final acceptance)	4	EA
32-93.00.101	PANCHITO MANZANITA 5 GALLON [Arctostaphylos x coloradoensis 'Panchito'] (includes maintenance until final acceptance)	7	EA
32-93.00.102	CREEPING WESTERN SAND CHERRY 5 GALLON [Prunus besseyi 'Pawnee Buttes'](includes maintenance until final acceptance)	6	EA
32-93.00.103	ROCKY MOUNTAIN SUMAC 1 GALLON [Rhus glabra cismontana](includes maintenance until final acceptance)	16	EA
32-93.00.104	GREEN MOUND CURRANT 1 GALLON [Ribes alpinum 'Green Mound'](includes maintenance until final acceptance)	18	EA
32-93.00.105	GOLDEN CURRENT 5 GALLON [Ribes aureum](includes maintenance until final acceptance)	6	EA

Asbury & Tejon - Schedule B

Pay Item #	Description	Estimated Quantity	Units
32-93.00.106	BOULDER RASPBERRY 5 GALLON [Rubus deliciosus](includes maintenance until final acceptance)	5	EA
32-96.43.01	TREE REMOVAL, STORAGE, TRANSPLANTING (includes maintenance until final acceptance) <i>Add'l Info: Asbury and Tejon Parks Specifications detail all tree firm Contractor Consulting Arborist qualifications</i>	2	EA
32-97.00.01	LANDSCAPE MAINTENANCE OF SEEDED AND SODDED AREAS (until final acceptance) <i>Add'l Info: New plantings and transplanted items.</i>	1	LS

Statement of Quantities

Asbury & Tejon - Add Alt 1 (Playground Retrofit)

Pay Item #	Description	Estimated Quantity	Units
30-2	GROUTED RIPRAP <i>Add'l Info: Faced Type L and Type M Grouted Riprap (underneath embankment slide chute). See Supplement 31 37 19</i>	22	SY
30-2e	GROUTED BOULDER EDGE (3 FOOT DIAMETER) <i>Add'l Info: 36-inch to 42-inch boulder set in concrete curb wall per detail on Sheet L503. See Supplement 31 37 19</i>	60	LF
30-2e	GROUTED BOULDER EDGE (3 FOOT DIAMETER) <i>Add'l Info: Stacked Boulder Walls (30" Boulders) per detail on Sheet L503. See Supplement 31 37 19</i>	262	LF
01-21.26.001	PARKS PRODUCT ALLOWANCE - SEE PROJECT SPECIFICATIONS PLAY EQUIPMENT <i>Add'l Info: Playground Play Structures Procurement A-K</i>	1	A/A
02-41.00.01A	REMOVE SEE ADDITIONAL NOTES====> <i>Add'l Info: Remove Safety Surface</i>	3,800	SF
02-41.00.01B	REMOVE SEE ADDITIONAL NOTES====> <i>Add'l Info: Remove all Play equipment, footings ect.</i>	1	LS
02-41.00.01C	REMOVE SEE ADDITIONAL NOTES====> <i>Add'l Info: Existing Play Pit Edge, as shown on plans</i>	165	LF
02-41.00.02	REMOVE SPECIAL ITEM SEE ADDITIONAL NOTES====> <i>Add'l Info: Remove, protect and store existing entrance boulder/stone</i>	1	EA
03-30.00.01	CAST IN PLACE CONCRETE SEE ADDITIONAL NOTES====> <i>Add'l Info: Structurally Reinforced Concrete Wall 12" wide X approximate average height 60" per plans and detail on Sheet L502.</i>	106	LF

Asbury & Tejon - Add Alt 1 (Playground Retrofit)

Pay Item #	Description	Estimated Quantity	Units
32-13.13.03	CONCRETE WALK SEE ADDITIONAL NOTES ==>> <i>Add'l Info: 6" Depth, Width Varies per plans. This bid item includes 252 LF of thickened edge per detail 3 on Sheet L501. Includes Aggregate Base Course.</i>	2,100	SF
32-13.13.05	CONCRETE RAMP WITHIN PARK AREA SEE ADDITIONAL NOTES ==>> <i>Add'l Info: Three ramps in playground, Includes fiber mesh and Aggregate Base Course underneath ramp.</i>	6	CY
32-15.40.01	CRUSHED STONE PAVING <i>Add'l Info: Crusher fines - Ghost Grove</i>	350	SF
32-18.16.01	ENGINEERED WOOD FIBER PLAYGROUND SURFACING <i>Add'l Info: Qualified installer - coordinate design with under drain system which is a separate bid item;33-46.00.01</i>	6,300	SF
32-33.00.01	PARKS SPEC SITE FURNISHINGS - PICNIC TABLES <i>Add'l Info: Procure/install per plan set detail - Concrete Pad paid under Concrete</i>	2	EA
32-33.00.02	PARKS SPEC SITE FURNISHINGS - BENCH <i>Add'l Info: Procure/install per plan set detail - Concrete Pad paid under Concrete</i>	3	EA
32-33.00.03	PARKS SPEC SITE FURNISHINGS - GHOST GROVE <i>Add'l Info: Procure/install per plan set detail</i>	1	EA
32-33.00.04	PARKS SPEC SITE FURNISHINGS - LOG STAIR <i>Add'l Info: Procure/install per plan set detail</i>	1	EA
32-33.00.05	PARKS SPEC SITE FURNISHINGS - LOG FLUME <i>Add'l Info: Procure/Install per plan set detail</i>	1	EA
32-33.00.06	PARKS SPEC SITE FURNISHINGS SEE ADDITIONAL NOTES ==>> <i>Add'l Info: Install previously removed and protected existing boulder per plan set</i>	1	EA

Asbury & Tejon - Add Alt 1 (Playground Retrofit)

Pay Item #	Description	Estimated Quantity	Units
32-33.50.01	<p>PLAYGROUND EQUIPMENT INSTALLATION PER MFG SPECIFICATIONS - QUALIFIED INSTALLER</p> <p><i>Add'l Info: Bear Cub, Embankment Slide Chute, Custom PT 5-12, Kidnetix twirl, Deco Spring Rider, Custom PT 2-5, enclosed seat X2, belt seat x2, Primetime swing, Primetime swing add a bay</i></p>	1	LS
33-46.00.01	<p>SUBDRAINAGE FOR PLAYGROUND (includes all piping and appurtenances)</p> <p><i>Add'l Info: Sheet L502 - described as: 3 ea 6" multiflow systems; 4 connections; 60 LF of Solid wall ADS and 2 sloped concrete daylight encasements to be installed underneath Engineered Wood Fiber Playground Surfacing 32-18.16.01</i></p>	1	LS

**CITY AND COUNTY OF DENVER
DEPARTMENT OF PUBLIC WORKS**

**NOTICE FOR INVITATION FOR BIDS
FOR CONTRACT NO. 201845550**

ASBURY & TEJON PARK

**BID SCHEDULE:
11:00 a.m., Local Time
January 17, 2019**

Sealed bids will be received in Room 6.G.7, 201 W. Colfax Ave., Denver, CO 80202, beginning at 10:30 a.m., no later than 11:00 a.m., on bid day. All properly delivered bids will then be publicly opened and read aloud.

Bids submitted prior to 10:30 a.m. on the specified bid opening date/time shall be presented at the Office of Contract Administration, Attention: David Relaford, Public Works Contract Administration, 201 W. Colfax Ave., Department 614, Denver, CO 80202.

Prior to submitting a bid, the bidder shall consult the Contractor's Bulletin Board located at 201 W. Colfax Ave., 2nd Floor, Denver, CO 80202 and/or www.work4denver.com.

GENERAL STATEMENT OF WORK:

Asbury & Tejon Park is a relatively small park comprised of two parcels near the intersection of West Asbury Avenue and South Tejon Street in the southwest portion of the City and County of Denver. The current stormwater infrastructure located within the park impacts both the function and aesthetics of the park from a recreational standpoint. This project entails the retrofit of the existing detention basins in Asbury & Tejon Park to include water quality and improve recreational aspects of park. The improvements will include regrading the ponds, removing the concrete trickle channel and replacing it with a constructed wetland channel to maximize stormwater quality. The project will include the construction of special structures, pipes, riprap placement, loose and grouted boulder construction, earthwork and fine grading, asbestos mitigation, irrigation work, playground equipment and other miscellaneous surface restoration.

ESTIMATED CONSTRUCTION COST:

The estimated cost of construction for this project is between \$2,044,000 and \$2,500,000.

TEXTURA CONSTRUCTION PAYMENT MANAGEMENT:

Bidders are required, when preparing a bid, to agree it shall use the Textura® Construction Payment Management System ("Textura") to request payment from the City and to pay subcontractors. All certified subcontractors or suppliers who are listed for participation towards any assigned program goal must be paid via Textura. All fees associated with Textura are to be paid by the awarded Contractor. Bidders shall use the pricing scale provided in Instructions to Bidders to price the Textura service appropriately. For details on the company and service, contact the Textura® Corporation at 866-TEXTURA or www.texturacorp.com.

DOCUMENTS AND BID INFORMATION AVAILABLE:

Contract Documents complete with Technical Specifications and, if applicable, construction drawings will be available on the first day of publication at: www.work4denver.com. To download digital Contract Documents at a cost of \$15 per download, reference eBid Document Number #6014587. Contact QuestCDN at 952-233-1632 or info@questcdn.com for assistance.

PRE-BID CONFERENCE:

A pre-bid conference will be held for this Project at 9:00 a.m., local time, on December 17, 2018. This meeting will take place at: the Webb Building, Conference Room 4.I.4, 201 W. Colfax Ave., Denver, CO 80202.

DEADLINE TO SUBMIT QUESTIONS:

January 4, 2018, 10:00 a.m. local time.

PREQUALIFICATION REQUIREMENTS:

Each bidder must be prequalified as a **1E(5)SEWER – OPEN CHANNEL AND POND or 1E(4) - PIPED SEWER at or above the \$3,000,000.00 monetary level** in accordance with the City’s Rules and Regulations Governing Prequalification of Contractors. Each bidder must have submitted a prequalification application a minimum of ten (10) calendar days prior to the bid opening date. Applications must be submitted to the Department of Public Works, Prequalification Section, 201 W. Colfax Ave., Department 614, Denver, CO 80202. To view the Rules and Regulations and to obtain a prequalification application, please visit our website at www.denvergov.org/prequalification or call 720-865-2539 for prequalification information ONLY.

MINORITY AND WOMAN BUSINESS ENTERPRISE PARTICIPATION:

Construction, reconstruction and remodeling contracts made and entered into by the City and County of Denver are subject to Article III, Divisions 1 and 3 of Chapter 28 of the Denver Revised Municipal Code, (Sections 28-31 to 28-36 and 28-52 to 28-90 D.R.M.C) and all Minority and Woman Business Enterprise and Equal Employment Opportunity Rules and Regulations adopted by the Director of the Division of Small Business Opportunity.

Article III, Division 3 of Chapter 28 of the D.R.M.C. directs the Director of the Division of Small Business Opportunity to establish a project goal for expenditures on construction, reconstruction, and remodeling work contracted by the City and County of Denver. The specific goal for this project is:

10% Minority and Woman Business Enterprise (M/WBE) Participation

Project goals must be met with certified participants as set forth in Section 28-60, D.R.M.C. or through the demonstration of a sufficient good faith effort under Section 28-62 D.R.M.C. For compliance with good faith requirements under Section 28-62(b), **the M/WBE percentage solicitation level required for this project is 100%.**

The Director of the Division of Small Business Opportunity urges all participants in City construction, reconstruction and remodeling projects to assist in achieving these goals.

MISCELLANEOUS:

Contracts for construction, reconstruction, and remodeling are subject to the City prevailing wage rate requirements established pursuant to Section 20-76, D.R.M.C.

As its best interest may appear, the City and County of Denver reserves the right to reject any or all bids and to waive informalities in bids.

A modified version of this Notice of Invitation for Bids and the project’s Statement of Quantities is available on the City and County of Denver’s website at: www.work4denver.com.

Publication Dates: December 5, 6, 7, 2018

Published In: The Daily Journal

CITY AND COUNTY OF DENVER
DEPARTMENT OF PUBLIC WORKS

INSTRUCTIONS TO BIDDERS

IB-1 INSTRUCTION TO BIDDERS

These Instructions to Bidders are a part of the Contract Documents and are intended to serve as a guide to bidders. They are general in nature and may be amended or supplemented as needed to support any one specific invitation to bid. Each bidder shall prepare its bid in strict compliance with all requirements of the Contract Documents and by careful application of these instructions.

IB-2 BIDDING

The copy of the Contract Documents contains the Bid Form and Submittal Package for this Project, which must be used to submit a bid hereunder. The bidder must fully complete, execute and submit this Bid Form and Submittal Package, along with any other specified components of the Contract Documents, as its bid for the referenced Project.

A bidder is not required to submit as part of its bid the entire set of Contract Documents distributed by the City pursuant to the Notice of Invitation for Bids, if the bidder executes and submits the Bidder Acknowledgment Form included with the Bid Form and Submittal Package as part of its bid. However, each bidder, by submitting its bid, shall be conclusively presumed to have received and reviewed all of the information contained in the Contract Documents as this term is further defined herein.

Each bid must be enclosed in a sealed envelope, must be addressed to the Manager and must show on the face of the envelope the full name of the bidder, the City Project number, and descriptive title of the Project for which the bid is made.

The advertisement for Notice of Invitation for Bids will identify where and when the bid must be delivered.

IB-3 CONTRACT DOCUMENTS AS PUBLISHED BY CITY

Each bidder shall be responsible for, and shall be deemed to have received, all the information contained in the Contract Documents as distributed by the City pursuant to the Notice of Invitation for Bids, including addenda, whether or not such bidder has reviewed all or part of the Contract Documents in either its hard copy form or in any other format. If organizations or companies other than the City or its design professional distribute the City's Contract Documents for review by prospective bidders, whether in hard copy or via electronic or other media, neither the City nor its design professional shall be responsible for the content, completeness or accuracy of any information distributed or transmitted by any such organization or company.

IB-4 COMPLETING AND SIGNING THE BID FORMS

The bidder must complete the Bid Form by legibly writing or printing in ink, in words and figures as required, all the bidder's prices offered for the Work to be performed. All blank spaces, which require a response of the bidder, must be properly completed in full. If in the process of evaluating a bid, words and figures, as written on the Bid Form by the bidder, do not agree, the written words will govern.

For Bid Forms requiring unit price bids, the bidder shall write in the Bid Form spaces provided a unit price for each item for which a quantity is given and shall also write the product of each unit price and the quantity specified in the "Amount" or "Total" space provided.

Each bidder must sign the Bid Form and give the bidder's current business address. If an individual, the signature must be of the individual offering the bid; if a partnership, the signature must be that of a general partner; and if a corporation, both the president and the secretary must sign and the seal of the corporation must be affixed. Signatures of other persons may be acceptable if the bid contains sufficient evidence, satisfactory to the City in its sole discretion, to indicate that the other persons are authorized to bind the bidder.

IB-5 UNACCEPTABLE BIDS

The City will not accept bids from Bidders not prequalified with the Department of Public Works (if prequalification is required for this project), in arrears to the City upon debt or contract, or which are defaulters (as surety or otherwise) upon any obligation to the City.

IB-6 INFORMAL AND UNBALANCED BIDS

Any alteration, interlineations, erasure, omission, deletion or addition by the bidder to the Bid Form and Submittal Package or other parts of the Contract Documents submitted with the Bid Form and Submittal Package, as originally issued to the bidder, shall render the accompanying bid informal and may constitute cause for rejection.

Any unauthorized addition, conditional or alternate bids, failure to provide a unit price, lump sum amount or authorized alternate item specified or other irregularities of any kind which tend to render the bid incomplete, indefinite or ambiguous shall render the bid informal and may constitute cause for rejection.

Bids that are unbalanced so that each item does not reasonably carry its own proportion of cost or that contain inadequate or unreasonable prices for any item may be rejected. Bids, which have not acknowledged all addenda to the Contract Documents issued for this bid, may also be rejected.

The right is reserved by the City to reject any or all bids and to waive any informalities where it is deemed by the City to be in the best interests of the City to do so.

IB-7 ONLY ONE BID ACCEPTED

The City will accept only one bid for the same work from any one bidder. This includes bids that may be submitted under different names by one business enterprise.

IB-8 BID GUARANTEE

As a guarantee of good faith on the part of the bidder, each bid must be accompanied by a bid guarantee, consisting of either a certified or cashier's check made payable without condition to the order of the City and County of Denver or a bid bond written by an approved corporate surety in favor of the City and County of Denver. If the bid of a bidder is acceptable and the bidder is notified by the Manager that it is considered to be the Apparent Low Bidder and said bidder fails to execute a contract in the form prescribed or to furnish a performance and payment bond with a legally responsible and approved surety or to furnish the required evidence of insurance or satisfy all conditions precedent to contract execution within five (5) days after such notice is made by the City, said bid guarantee shall be forfeited to the City as liquidated damages and not as a penalty.

The bid guarantee shall be in the amount of five percent (5%) of the total bid unless otherwise specified in the Notice of Invitation for Bids and on the form appearing in the Contract Documents in the Bid Form and Submittal Package. Failure to submit a properly executed bid guarantee, on the form provided herein may, in the City's sole discretion, constitute cause for rejection.

Following award and execution of the Contract by the Apparent Low Bidder, or earlier in the sole discretion of the City, bid guarantees of all but the Apparent Low Bidder will be returned. When the Apparent Low Bidder executes the Contract and delivers to the City satisfactory performance and payment bonds, required insurance documentation, and has satisfied all conditions precedent to contract execution by the City, and after approval, if any, by the Council of the City of the proposed Contract with the Apparent Low Bidder, the bid guarantee of the Apparent Low Bidder shall be returned. Such return shall be made within one hundred twenty (120) days from date bids are opened unless otherwise specified in the Special Contract Conditions.

IB-9 SITE INSPECTION AND INVESTIGATIONS

Prior to submitting a bid, the bidder is invited to inspect the work site and its surroundings. Although the bidder is not required to make such an inspection before bidding, for purposes of the Contract it shall be conclusively presumed that by failing to make such an inspection, the bidder has waived the right to later claim additional compensation or time extensions for conditions which would have been evident had the site been inspected.

Drawings and Technical Specifications, defining the Work to be done, were prepared on the basis of interpretation by the design professionals of information derived from investigations of the work site. Such information and data are subject to sampling errors, and the interpretation of the information and data depends to a degree on the judgment of the design professional. In view of this, the bidder is invited to make such additional investigations as the bidder's judgment dictates the need for such investigations. Information about the degree of difficulty of the Work to be done cannot totally be derived from either the Drawings or Technical Specifications or from the Manager or his representatives.

Since the bid information cannot be guaranteed, the Contractor shall have assumed the risks attendant to successful performance of the Work and shall never make claim for additional compensation or time extensions on the grounds that the nature or amount of work to be done was not understood by the bidder at the time of the bidding.

IB-10 INCONSISTENCIES

Any seeming inconsistencies or ambiguities between different provisions of the Contract Documents or any point which the bidder believes requires a decision or interpretation by the City must be inquired into by the bidder by addressing a formal written communication to the Manager of Public Works and sending or delivering it to the offices of the Division of Public Works advertising this Project for bid at least forty-eight (48) hours, excluding Saturdays, Sundays, and holidays, before the time set for the opening of bids

Information about the decision or interpretation made in response to any inquiry will be posted on the Contractor's Bulletin Board (refer to IB-12 CONTRACTOR'S BULLETIN BOARD, for the location of the Contractor's Bulletin Board). If the matter raised requires, in the sole discretion of the Manager, that an addendum to the bid documents be issued, such addendum will be published and each bidder shall be required to acknowledge the addendum by signing and identifying it in the Bid Form when submitting the bid.

After bids are opened, all bidders must abide by the formal response of the Manager, as to any interpretation. The City shall not be bound and the bidder shall not rely on any oral communication, interpretation clarification or determination of the Contract Documents prior to bid opening.

IB-11 WITHDRAWAL OF BID

A bidder may withdraw its bid at any time prior to the time for receipt of bids set forth in the Notice of Invitation for Bids by making written request upon the Manager of Public Works. After such time, no bid may be withdrawn or modified.

Such request must be signed by the persons authorized to bind the bidder as defined in IB-3, COMPLETING AND SIGNING BID FORMS.

IB-12 CONTRACTOR'S BULLETIN BOARD

It shall be conclusively presumed that the bidder has, before submitting any bid, read and shall take full responsibility for all addenda, posted decisions, and other information relevant to the bid posted by the City on the Contractor's Bulletin Board. The Contractor's Bulletin Board is located at 201 W. Colfax, 2nd Floor, Denver, CO 80202, in the Wellington E. Webb Municipal Office Building.

IB-13 PRE-BID MEETING

Bidders are urged to attend the pre-bid meeting(s) scheduled for this Project. Attendance is not mandatory; however, bidders will be held responsible for all information presented at such meeting(s).

IB-14 ADDENDA

As its best interests may require, the City may issue addenda to the Contract Documents. Such addenda shall be posted on the Contractor's Bulletin Board and made available to all persons having purchased a set of Contract Documents as set forth in the Notice of Invitation for Bids contained herein. All bidders must acknowledge receipt of all addenda on the Bid Form at the time of submission of the bid.

IB-15 BID OPENING

Bidders are invited to be present at the bid opening. Unless otherwise suspended, delayed or canceled by posted notice from the Manager, bid opening will occur at the time and place designated in the Notice of Invitation for Bid.

IB-16 EVALUATION OF BIDS AND BASIS OF BID SELECTION

Bids will be evaluated after being read in open meeting at the place designated for such bid opening. All low bidders' bids will be reviewed for responsiveness to the requirements of the Contract Documents and whether or not the bids contain irregularities which could give any bidder an unfair advantage.

Selection will be made on the basis of the lowest, total, responsive, qualified bid, which bid shall include the total base bid set forth on the Bid Form, plus the total of any alternates set forth on the Bid Form and selected by the City during evaluation. Alternates, if any are included in the bid, will be selected in the priority shown on the Bid Form, subject to the limits of available funds. Bid selection will be subject to all requirements and special bidder qualifications contained herein and subject to approval of such resulting Contract in accordance with the Charter and Revised Municipal Code of the City and County of Denver. In addition to all other specified requirements, the City will correct arithmetical errors in all bids and corrected totals only will be considered as the basis of selection.

Upon concluding that the bid is, in fact, the lowest, total, responsive bid to the bidding conditions and that of a responsible, qualified bidder, the City will notify the Apparent Low Bidder.

As its best interests may appear, the City and County of Denver reserves the right to waive informalities in bids, to reject any and all bids and to rebid the Project.

IB-17 NOTICE TO APPARENT LOW BIDDER

The Notice to Apparent Low Bidder, a form of which is included in the Contract Special Conditions Section of the Contract Documents, is issued by the City directly to the selected bidder and informs the bidder that the Manager intends to seek approval of the execution of the Contract by the City in accordance with the Charter and Revised Municipal Code of the City and County of Denver. Specifically, it informs the bidder of its obligations with respect to execution of the Contract and instructs the bidder on how to proceed toward execution of the Contract. The City reserves the right to notify the Apparent Low Bidder, at any time within one hundred twenty (120) days from the date of the opening of the bids, that approval to contract with the Apparent Low Bidder shall be sought in accordance with the Charter and Revised Municipal Code of the City and County of Denver.

In accordance with the terms and conditions contained in the Bid Form and Submittal Package and any additional requirements set forth in the Notice to Apparent Low Bidder or elsewhere in the Contract Documents, the Apparent Low Bidder shall execute the Contract Form contained in the Contract Documents made available by the City for execution in the appropriate number of counterparts. The Apparent Low Bidder shall return the fully executed Contract Document sets, along with any supplemental documents required herein, to the City and shall comply with all other conditions precedent to Contract execution within five (5) days of the date of issuance of the Notice to Apparent Low Bidder by the City. Failure to comply with each of these requirements within five (5) days of the date of issuance of the Notice to Apparent Low Bidder by the City shall render the bid nonresponsive and may constitute cause for rejection.

Issuance of such Notice shall not, however, constitute a commitment on the part of the City or create any rights in the Apparent Low Bidder to any contract with the City.

IB-18 EXECUTION OF CONTRACT

The process of executing a contract requires action by both the apparent low bidder and the City. After it notifies the Apparent Low Bidder, the City will prepare the Contract Documents by incorporating all of the documents submitted by the Apparent Low Bidder into one or more executable copies. Upon notification that contracts documents are ready for execution the Apparent Low Bidder shall execute the contract documents. At this time, the successful bidder shall also provide certain supplemental documents for incorporation into the Contract Documents. These supplemental documents shall include: the properly executed Certificate of Insurance Forms evidencing the apparent low bidder's satisfactory compliance with the insurance requirements set forth in the Contract Documents; a properly executed Payment and Performance Bond Form and appropriate Power of Attorney evidencing the Apparent Low Bidder's satisfactory compliance with the bonding requirements set forth in the Contract Documents; and documentation of compliance with any other conditions precedent to execution of the Contract by the City set forth in the Contract Documents. The insurance and bond forms contained in the Contract Special

Conditions Section of the Contract Documents must be used in satisfying these supplemental document requirements.

These documents are then delivered to the City within the prescribed time period for examination of the documents to determine whether or not the Contractor has correctly executed the Contract and has correctly provided the required supplemental documents and that these documents are satisfactorily and properly completed. From here, all of the documents are forwarded to the City Attorney who will, if the insurance and bonding offered is acceptable and if all other elements of the Contract Documents are in order, recommend that the Manager and the Mayor approve the documents and, when required by the City Charter, prepare an ordinance for submittal to City Council authorizing the execution of the Contract. The City Attorney shall in all applicable instances submit the proposed contract and ordinance to City Council. After City Council approval, the Contract shall be reviewed by the City Attorney and routed for execution by the Mayor, the Clerk for attestation and the Auditor for countersignature and registration. When the total process of contract execution is complete, a Notice to Proceed will be issued and a single executed copy of the Contract will be delivered to the Contractor. Any work performed or a material purchased prior to the issuance of Notice to Proceed is at the Contractor's risk.

IB-19 BONDING REQUIREMENTS

In accordance with the provisions of General Contract Conditions, Title 15, PERFORMANCE AND PAYMENT BONDS, the minimum bonding requirements for this Contract are set forth in the form **CITY AND COUNTY OF DENVER PERFORMANCE AND PAYMENT BOND** contained in the Special Conditions Section of the Contract Documents. Upon receipt of Notice to Apparent Low Bidder, the apparent low bidder must cause this form bond to be purchased, executed and furnished, along with appropriate Powers of Attorney and a surety authorization letter (in form similar to the one attached), to the City in accordance with the instructions contained herein.

IB-20 INSURANCE REQUIREMENTS

The minimum insurance requirements for this Contract are set forth in the Special Conditions Section of the Contract Documents. Bidders are urged to consider, in preparing a bid hereunder, that each condition, requirement or specification set forth in the form certificate must be complied with by the Contractor and all subcontractors performing Work on the Project, unless such requirements are specifically accepted in writing by the City's Risk Management Office. The Contractor must either include all subcontractors performing work hereunder as insureds under each required policy or furnish a separate certificate for each subcontractor. In either case, the Contractor shall insure that each subcontractor complies with all of the coverage requirements.

IB-21 PERMITS AND LICENSES

All permits, licenses and approvals required in the prosecution of the work shall be obtained and paid for by the Contractor.

IB-22 PREVAILING WAGE REQUIREMENTS

Contractor shall comply with, and agrees to be bound by, all requirements, conditions and City determinations regarding the Payment of Prevailing Wages Ordinance, Sections 20-76 through 20-79, D.R.M.C. including, but not limited to, the requirement that every covered worker working on a City owned or leased building or on City-owned land shall be paid no less than the prevailing wages and fringe benefits in effect on the date the bid or request for proposal was advertised. In the event a request for bids, or a request for proposal, was not advertised, Contractor shall pay every covered worker no less than the prevailing wages and fringe benefits in effect on the date funds for the contract were encumbered.

Date bid or request for qualifications/proposals was advertised: December 4, 2018.

Prevailing wage and fringe rates will adjust on, and only on, the anniversary of the date the Contract was fully executed. Unless expressly provided for in this Agreement, Contractor will receive no additional compensation for increases in prevailing wages or fringe benefits.

Contractor shall provide the Auditor with a list of all subcontractors providing any services under the contract.

Contractor shall provide the Auditor with electronically-certified payroll records for all covered workers employed under the contract.

Contractor shall prominently post at the work site the current prevailing wage and fringe benefit rates. The posting must inform workers that any complaints regarding the payment of prevailing wages or fringe benefits may be submitted to the Denver Auditor by calling 720-913-5000 or emailing auditor@denvergov.org.

If Contractor fails to pay workers as required by the Prevailing Wage Ordinance, Contractor will not be paid until documentation of payment satisfactory to the Auditor has been provided. The City may, by written notice, suspend or terminate work if Contractor fails to pay required wages and fringe benefits.

IB-23 TAX REQUIREMENTS

General. Bidders are referred to the General Contract Condition 323, TAXES, as to taxes to which they may be subject in performing the Work under this Contract, including but not limited to sales and use taxes and the Denver Occupational Privilege Tax. The following instructions are to be considered along with the General Contract Conditions and not in lieu of them.

Sales and Use Tax. Construction and building materials sold to contractors and subcontractors for use on structures, roads, streets, highways, and other public works owned by the City and County of Denver are exempt from state, RTD, and Cultural Facilities District sales and use taxes. However, such materials will be subject to sales and use taxes imposed by the City and County of Denver.

It is the responsibility of the Contractor and its subcontractors to apply to the Colorado Department of Revenue (“CDOR”) for a certificate, or certificates, of exemption indicating that their purchase of construction or building materials is for a public project, and to deliver to the City copies of such applications as soon as possible after approval by the CDOR. Bidders shall not include in their bid amounts the exempt state, RTD, and Cultural Facilities District Sales and Use Taxes.

Denver Occupational Privilege Tax. Any employee working for a contractor, or a subcontractor, who earns over \$500 working in Denver during a calendar month, is subject to the payment of the Employee Occupational Privilege Tax. The Contractor and any subcontractor must pay the Business Occupational Privilege Tax for each of its employees who are subject to such tax.

IB-24 DIVERSITY AND INCLUSIVENESS IN CITY SOLICITATIONS

Each bidder shall, as a condition of responsiveness to this solicitation, complete and return the “Diversity and Inclusiveness in City Solicitations Information Request Form” with their Bid.

Using the “Diversity and Inclusiveness in City Solicitations Information Request Form” provided, please state whether you have a diversity and inclusiveness program for employment and retention, procurement and supply chain activities, or customer service and provide the additional information requested on the form. The information provided on the “Diversity and Inclusiveness in City Solicitations Information Request Form” will provide an opportunity for City contractors to describe their own diversity and inclusiveness practices. Contractors are not expected to conduct intrusive examinations of its employees, managers, or business partners in order to describe diversity and inclusiveness measures. Rather, the City simply seeks a description of the contractor’s current practices, if any.

Diversity and Inclusiveness information provided by City contractors in response to City solicitations for services or goods will be collated, analyzed, and made available in reports consistent with City Executive Order No. 101. However, no personally identifiable provided by or obtained from contractor’s will be in such reports.

IB-25 MINORITY AND WOMAN BUSINESS ENTERPRISE (M/WBE) REQUIREMENTS

Article III, Divisions 1 and 3 of Chapter 28, Denver Revised Municipal Code (D.R.M.C.), designated as Sections 28-31 – 28-36 and 28-52 – 28-90 D.R.M.C. and referred to in these Bid Documents as the “M/WBE Ordinance” and any Rules or Regulations promulgated pursuant thereto apply to this Project and are incorporated into these Bid Documents by reference. Generally, the M/WBE Ordinance provides for the adoption of a good faith goals program, to be administered by the Division of Small Business Opportunity

(DSBO), devised to provide increased bidding opportunities for Minority and Woman Business Enterprises (M/WBEs). As such, each bidder must comply with the terms and conditions of the M/WBE Ordinance in making its bid and, if awarded the Contract, in performing all Work thereunder. A bidder's failure to comply with the M/WBE Ordinance, any Rules or Regulations promulgated pursuant thereto, or any additional requirement contained herein shall render the bid non-responsive and shall constitute cause for rejection. Failure by the contractor awarded the contract to comply with M/WBE Ordinance requirements during the performance of the contract is a material breach of the contract, which may result in the in the imposition of sanctions on the Contractor, as deemed appropriate by DSBO. Copies of the M/WBE Ordinance and its accompanying Rules and Regulations are available for the use and review of bidders from DSBO. In order to comply with the bid requirements of the M/WBE Ordinance, a bidder shall either meet the established project goal or, in the alternative, demonstrate that the bidder has made sufficient good faith efforts to meet the goal in accordance with the M/WBE Ordinance.

Meeting Established Goal

In preparing a bid to meet the established Project goal, bidders should consider the following instructions relating to compliance with the M/WBE Ordinance:

1. Under the M/WBE Ordinance, the Director of DSBO ("Director") is directed to establish project goals for expenditures on construction, reconstruction, and remodeling work performed for the City and County of Denver. The specific goal for this project is stated in the Notice of Invitation for Bids bound herein.
2. In preparing its bid, each bidder shall list on the Bid Form pages entitled "List of Proposed MWBE Bidders, Subcontractors, Suppliers, Manufacturers, Manufacturers' Representatives or Brokers" the name, address, work description/supply, committed level of participation and other required information for each M/WBE of any tier which the bidder intends to use in performing the work on this Project. **Only the M/WBEs identified and the precise levels of participation listed for each on the Bid Form page, at the time of bid opening, will be considered in determining whether the bidder has met the designated participation goal. Additional, revised or corrected participation submitted after bid opening will not be considered.** M/WBE bidders may count self-performance or joint venture activity in meeting the M/WBE project goal, but only for the scope of work performed as a commercially useful function and at a percentage level the M/WBE will be performing itself.
3. Any agreement between a bidder or proposer and an MBE or WBE in which the bidder or proposer requires that the MBE or WBE not provide subcontracting quotations to other bidders or proposers is prohibited and shall render a bidder's bid or proposer's proposal nonresponsive. D.R.M.C. 28-63(f)
4. If a bidder/proposer is participating in a joint venture with a certified M/WBE firm, complete the Joint Venture Eligibility Form and Joint Venture Affidavit contained in this bid document/RFP. Submit the aforementioned forms with the firm's Joint Venture Agreement, to the DSBO Director, **at least 10 working days prior to the proposal submittal.** The Joint Venture must be approved prior to the bid opening or proposal submittal by the DSBO Director. Approval by the DSBO Director includes determining the amount the Joint Venture will count towards meeting the project goal.
5. All M/WBEs listed on the Bid Form must be properly certified by the City on or before the date bids are opened in order to count towards meeting the designated goal. DSBO maintains an M/WBE Directory ("Directory"), which is a current listing of M/WBEs that have been certified by the City. A copy of the DSBO Directory is located at DSBO web site at <https://www.denvergov.org/dsbo>. Bidders are encouraged to use the Directory to assist in locating M/WBEs for the work and supplies required on the Project. Bidders are reminded that changes may be made to the Directory at anytime in accordance with the City's M/WBE Ordinance and procedures established to administer this program and a current copy of the Directory must always be used in preparing a bid. M/WBE certification or listing in the Directory is not a representation or warranty by the City as to the qualifications of any listed M/WBE.

6. In accordance with the provisions of the M/WBE Ordinance, DSBO will evaluate each bid to determine the responsiveness of the bid to the requirements of the M/WBE Ordinance. In determining whether a bidder's committed level of participation meets or exceeds the stated M/WBE goal, DSBO shall base its calculation of applicable amounts and percentages on the total base bid amount, not including any listed alternates, of each bid as follows:
 - a. The bid information provided by the agency will be used to determine the total base bid amount of each bid. Each bidder's total base bid amount will be multiplied by the M/WBE percentage established for the project to determine the exact dollar amount of required M/WBE participation for the Project. This amount will then be compared against the exact dollar amounts for the M/WBE committed for participation by the bidder. If the total dollar amount of participation listed meets or exceeds the established M/WBE dollar amount goal listed, then DSBO will determine that the goal has been met.
 - b. In addition, DSBO will determine the exact commitment percentage for each listed M/WBE by dividing the dollar amount listed for each M/WBE by the total base bid dollar amount submitted by the bidder. These individual percentages, when totaled for all listed M/WBE, will establish the total committed percentage level of M/WBE participation that the bidder must comply with during the life of the contract. In all cases, the committed percentage level of M/WBE participation must equal or exceed the assigned M/WBE goal for the Project.
 - c. In providing the exact dollar amount of participation for each listed M/WBE, a bidder should take care never to round up in determining whether or not the total of these amounts meets or exceeds the established percentage goal. The goal must be met or exceeded by dollar amounts and percentages in order for DSBO to determine that the bidder has met or exceeded the applicable M/WBE goal.
 - d. As previously mentioned, compliance with the M/WBE goal will be determined on the base bid alone. If a bid contains alternates, participation contained in any alternate will not count towards satisfaction of the Project goal. However, should any designated alternate be selected by the City for inclusion in the contract ultimately awarded, the M/WBE goal percentage level submitted at bid time, on the base bid, will also apply to the selected alternates and must be maintained for the life of the contract on the total contract amount, including any alternate work. Thus, even though such participation will not be considered in evaluating bids, bidders are urged to consider participation in preparing bids for designated alternates.
 - e. On projects where force account or allowance bid items have been included, bidders must meet the M/WBE goal percentage based upon the total base bid, including all such items that are submitted to the City. However, when a force account or allowance is designated by the City to be either performed or purchased from a specific company, the bidder may back out the dollar amount of the force account or allowance from the total base bid and meet the M/WBE goal on the remaining reduced amount.
 - f. On bids which, at the time of bid opening, are equal to or exceed Five Million Dollars (\$5,000,000.00), including any alternates which may be selected, only sixty percent (60%) of the value of the commercially useful function performed by M/WBE suppliers shall count toward satisfaction of the Project goal. On Projects under Five Million (\$5,000,000.00) the value of the commercially useful function of M/WBE supplier(s) will count at a one hundred percent (100%) level. Manufacturer's representatives and packagers shall be counted in the same manner as brokers.
 - g. In utilizing the M/WBE participation of a Broker only the bona fide commissions earned by such Broker for its performance of a commercially useful function will count toward meeting the Project goals. The bidder must separate the bona fide brokerage commissions from the actual cost of the supplies or materials provided to determine the actual dollar amount of participation that can be counted towards meeting the goal.

7. On or before the third (3rd) working day after bid opening, all of the Bidders are required to submit an executed "Letter of Intent" for each M/WBE listed on the Bid Form as a joint venture member, subcontractor, supplier, manufacturer, manufacturers' representative or broker of any tier. **An MBE or WBE Prime Bidder needs to submit a Letter of Intent for itself for self-performed work**, and must identify their level of participation on the designated M/WBE participation page bound herein. A Letter of Intent shall be submitted only for the M/WBEs listed at the time of bid opening, since this is the only participation that will be counted toward satisfaction of the project goal. A form for the M/WBE Letter of Intent is included with the Bid Form. The M/WBE Letter of Intent is a written communication from the Bidder to the City evidencing an understanding that the Bidder has or will enter into a contractual relationship with the M/WBE or that its subcontractor(s) and supplier(s), manufacturer(s), manufacturers' representative(s) and broker(s) will do so. Each M/WBE Letter of Intent shall be accompanied by a copy of the City and County of Denver's M/WBE certification letter for each proposed M/WBE identified at bid time. Bidders are urged to carefully review these Letters before submission to the City to ensure that they are properly completed and executed by the appropriate parties.

Good Faith Effort.

In preparing a bid to demonstrate a good faith effort, bidders should consider the following instructions relating to compliance with the M/WBE Ordinance:

1. If the bidder or proposer has not fully met the project goal as provided in section 28-60, then it shall demonstrate that it has made good faith efforts to meet such goal. The bidder or proposer shall furnish to the director, within three (3) working days after bid opening by the City or on or before the time of the final project-specific proposal submitted to and authorized by the City pursuant to a competitive selection process, or bid selection by a private owner, a detailed statement of its good faith efforts to meet the project goal set by the director. This statement shall address each of the items in subsection (b) and any additional criteria that the director may establish by rule or regulation consistent with the purposes of this division 3. Good faith efforts must be demonstrated to be meaningful and not merely for formalistic compliance with this Division 3. The scope and intensity of the efforts will be considered in determining whether the bidder or proposer has achieved a good faith effort.
2. The statement of good faith efforts shall include a specific response and verification with respect to each of the following good faith effort categories, which may be further defined by rule or regulation. A bidder or proposer may include any additional information it believes may be relevant. Failure of a bidder or proposer to show good faith efforts as to any one (1) of the following categories shall render its overall good faith effort showing insufficient and its bid or proposal non-responsive:
 - a. If prebid or preselection meetings are scheduled by the City at which MBEs and WBEs may be informed of subcontracting or joint venture opportunities under a proposed contract to be bid, or procured pursuant to the competitive selection process, attendance at such prebid or preselection meetings is not mandatory; however, bidders and proposers are responsible for the information provided at these meetings.
 - b. The bidder or proposer must solicit through all reasonable and available means, the interest of all MBEs and WBEs certified in the scopes of work of the contract. The bidder or proposer must solicit the interest of such MBEs and WBEs within sufficient time, prior to the bid opening or date of final project-specific proposal in the case of a competitive selection process, to allow such MBEs and WBEs to respond to the solicitation. The bidder or proposer must determine with certainty if the MBEs and WBEs are interested by demonstrating appropriate steps to follow up initial solicitations.
 - c. The bidder or proposer must select portions of the work of the contract to be performed by MBEs and WBEs in order to increase the likelihood that the project goal will be achieved. This includes, where appropriate, breaking out contract work items into economically feasible units to facilitate MBE and WBE participation as subcontractors or joint venturers, and for bidder or proposer self-performed work, as suppliers, manufacturers, manufacturer's representatives and

brokers, all reasonably consistent with industry practice, even when the bidder or proposer would otherwise prefer to perform these work items with its own forces. The bidder or proposer must identify what portions of the contract will be self-performed and what portions of the contract will be opened to solicitation of bids, proposals and quotes from MBE and WBEs. All portions of the contract not self-performed must be solicited for MBE and WBE participation. The ability or desire of a bidder or proposer to perform the work of a contract with its own forces does not relieve the bidder or proposer of the responsibility to meet the project goal or demonstrate good faith efforts to do so.

- d. The bidder or proposer, consistent with industry practice, must provide MBEs and WBEs at a clearly stated location with timely, adequate access to and information about the plans, specifications, and requirements of the contract, including bonding and insurance requirements, if any, to assist them in responding to a solicitation.
 - e. The bidder or proposer must negotiate in good faith with interested MBEs and WBEs and provide written documentation of such negotiation with each such MBE or WBE.
 - f. For each MBE or WBE which contacted the bidder or proposer or which the bidder or proposer contacted or attempted to subcontract or joint venture with, consistent with industry practice, the bidder or proposer must supply a statement giving the reasons why the bidder or proposer and the MBE or WBE did not succeed in negotiating a subcontracting, supplier, manufacturer, manufacturer's representative, broker or joint venture agreement, as applicable.
3. The bidder or proposer must provide verification that it rejected each non-utilized MBE and WBE because the MBE or WBE did not submit the lowest bid or it was not qualified. Such verification shall include a verified statement of the amounts of all bids received from potential or utilized subcontractors, suppliers, manufacturers, manufacturer's representatives, brokers or joint venturers on the contract, whether or not they are MBEs or WBEs. In making such a determination of not being qualified, the bidder or proposer shall be guided by the definition of qualified in section 28-54(42), but evidence of lack of qualification must be based on factors other than solely the amount of the MBE's or WBE's bid. For each MBE or WBE found not to be qualified by the bidder or proposer, the verification shall include a statement giving the bidder's or proposer's reasons for its conclusion. A bidder's or proposer's industry standing or group memberships may not be the cause of rejection of an MBE or WBE. A bidder or proposer may not reject an MBE or WBE as being unqualified without sound reasons based on a reasonably thorough investigation and assessment of the MBE's or WBE's capabilities and expertise.
 4. If requested by a solicited MBE or WBE, the bidder or proposer must make reasonable efforts to assist interested MBEs and WBEs in obtaining bonding, lines of credit, or insurance as required by the City or by the bidder or proposer, provided that the bidder or proposer need not provide financial assistance toward this effort.
 5. If requested by a solicited MBE or WBE, the bidder or proposer must make reasonable efforts to assist interested MBEs and WBEs in obtaining necessary and competitively priced equipment, supplies, materials, or related assistance or services for performance under the contract, provided that the bidder or proposer need not provide financial assistance toward this effort.
 6. The bidder or proposer must use the DSBO MBE/WBE directories to identify, recruit, and place MBEs and WBEs.
 7. In determining whether a bidder or proposer has satisfied good faith efforts as to a project goal, the success or failure of other bidders or proposers on the contract in meeting such project goal may be considered.

Continuing Commitments.

In accordance with the provisions of the M/WBE Ordinance, the bidder agrees that it is committed to meeting either the M/WBE participation goal or the M/WBE participation set forth in its statement of good faith. This commitment

must be expressly indicated on the "Commitment to MWBE SBE Participation" form included with the Bid Form. This commitment includes the following understandings:

1. The bidder understands it must maintain M/WBE goals throughout the performance of the Contract pursuant to the requirements set out in D.R.M.C. 28-72.
2. The bidder understands that it must establish and maintain records and submit regular reports, as required, which will allow the City to assess progress in achieving the M/WBE participation goal.
3. The bidder understands that if change orders or any other contract modifications are issued under the contract, the bidder shall have a continuing obligation to immediately inform DSBO in writing of any agreed upon increase or decrease in the scope of work of such contract, upon any of the bases discussed in Section 28-73 of the M/WBE Ordinance, regardless of whether such increase or decrease in scope of work has been reduced to writing at the time of notification.
4. The bidder understands that if change orders or other contract modifications are issued under the contract, that include an increase in scope of work of a contract for construction, reconstruction, or remodeling, whether by amendment, change order, force account or otherwise which increases the dollar value of the contract, whether or not such change is within the scope of work designated for performance by an M/WBE at the time of contract award, such change orders or contract modification shall be immediately submitted to DSBO for notification purposes. Those amendments, change orders, force accounts or other contract modifications that involve a changed scope of work that cannot be performed by existing project subcontractors or by the contractor shall be subject to a goal for M/WBEs equal to the original goal on the contract which was included in the bid. The contractor shall satisfy such goal with respect to such changed scope of work by soliciting new M/WBEs in accordance with Section 28-73 of the M/WBE Ordinance as applicable, or the contractor must show each element of modified good faith set out in Section 28-75(c) of the M/WBE Ordinance. The contractor shall supply to the director the documentation described in Section 28-75(c) of the M/WBE Ordinance with respect to the increased dollar value of the contract.

All bidders are charged with knowledge of and are solely responsible for complying with each and every provision of the M/WBE Ordinance in making a bid and, if awarded, in performing the work described in the Contract Documents. Failure to comply with these provisions could constitute cause for rejection of a bid or subject the selected contractor to sanctions set forth in the M/WBE Ordinance. These instructions are intended only to generally assist the bidder in preparing and submitting a compliant bid. Should any questions arise regarding specific circumstances, bidders must consult the M/WBE Ordinance or contact the Project's designated DSBO representative at (720) 913-1999.

IB- 26 DISCLOSURE OF INFORMATION

All submissions and other materials provided or produced pursuant to this Invitation for Bids may be subject to the Colorado Open Records Law, C.R.S. 24-72-201, et seq. As such, bidders are urged to review these disclosure requirements and any exceptions to disclosure of information furnished by another party and, prior to submission of a bid to the City, appropriately identify materials that are not subject to disclosure. In the event of a request to the City for disclosure of such information, the City shall advise the bidder of such request to give the bidder an opportunity to object to the disclosure of designated confidential materials furnished to the City. In the event of the filing of a lawsuit to compel such disclosure, the City will tender all such material to the court for judicial determination of the issue of disclosure and each bidder agrees to intervene in such lawsuit to protect and assert its claims of privilege against disclosure of such material. Each bidder further agrees to defend, indemnify and save and hold harmless the City, its officers, agents and employees, from any claim, damages, expense, loss or costs arising out of the bidder's intervention to protect and assert its claims of privilege against disclosure under the Open Records Law including, but not limited to, prompt reimbursement to the City of all reasonable attorney fees, costs and damages that the City may incur directly or may be ordered to pay by such court.

IB-27 GENERAL BIDDING INFORMATION

Bidders are instructed to contact the Contract Administrator designated below for this Project for pre-bid, post-bid and general City bidding information. Bidders can also visit www.work4denver.com for information, both general and project specific. The Contract Administrator assigned to this project is David Relaford who can be reached via email at pw.procurement@denvergov.org.

IB-28 PAYMENT PROCEDURE REQUIREMENTS

Bidder recognizes and agrees that it shall be required to use the Textura® Construction Payment Management System (“Textura”) for this Project to request payment from the City and to pay subcontractors. All certified subcontractors or suppliers who are listed for participation towards any assigned program goal must be paid via Textura. All fees associated with Textura are to be paid by the bidder for billings for work performed. Bidders are required, when preparing a bid, to enter the price of Textura on the line provided for the service. The fee is all inclusive of all subcontractor, project and subscription fees associated with Textura. The bidder will calculate the fee based on a percentage of their total bid, and then include it on the line item provided in the bid form labeled “**Textura® Construction Payment Management System Fee**”. This expense becomes part of the contract and billable to the City. All costs including, but not limited to, costs associated with training, entering data, and/or utilizing Textura other than the Textura Construction Payment Management System Fee are overhead and shall not be reimbursed by the City. Bidder will be responsible for any tax on the Textura fee. As with other taxes, the City will not reimburse bidder for this cost and therefore this cost should be included in bidder’s bid. Textura will invoice the awarded bidder directly.

Project Value	Project Fee (GC + Sub Usage)
\$500,000 - \$999,999.99	\$3,250
\$1,000,000 - \$2,999,999.99	\$5,850
\$3,000,000 - \$4,999,999.99	\$9,100
\$5,000,000 - \$9,999,999.99	\$12,220
\$10,000,000 - \$19,999,999.99	\$20,345
\$20,000,000 - \$49,999,999.99	\$32,500
\$50,000,000 - \$99,999,999.99	\$48,750
\$100,000,000 - \$199,999,999.99	\$69,095
\$200,000,000 - \$299,999,999.99	\$85,345
\$300,000,000 - \$399,999,999.99	\$109,720
\$400,000,000 - \$499,999,999.99	\$142,220
\$500,000,000 - \$999,999,999.99	\$162,500
\$1,000,000,000 - \$1,999,999,999.99	\$345,345
\$2,000,000,000 - \$4,999,999,999.99	\$650,000
\$5,000,000,000 - \$9,999,999,999.99	\$1,015,625
\$10,000,000,000 or greater	\$1,503,125

**RULES AND REGULATIONS
REGARDING
EQUAL EMPLOYMENT OPPORTUNITY**

Promulgated and adopted by the Manager of Public Works pursuant to and by authority of Article III, Division 2, Chapter 28 of the Revised Municipal Code of the City and County of Denver, and for the purpose of insuring that contractors, subcontractors and suppliers soliciting and receiving compensation for contract work from or through the City and County of Denver provide equal opportunity in employment without regard to race, color, creed, sex, national origin, age, religion, marital status, political opinion or affiliation or mental or physical handicap and meet certain requirements for the hiring, training, promotion, and treatment during employment of members of ethnic groups subject to differential treatment, including persons of African descent (Black), Spanish-surnamed (Hispanic), Asian-American and American Indian Groups.

RULE I - DEFINITIONS

- A. "City" means the City and County of Denver.
- B. "Manager" shall mean the Manager of Public Works for the City and County of Denver.
- C. "Contract" means a contract entered into with the City and County of Denver, financed in whole or in part by local resources or funds of the City and County of Denver, for the construction of any public building or prosecution or completion of any public work.
- D. "Contractor" means the original party to a contract with the City and County of Denver, also referred to as the "general" or "prime" contractor.
- E. "Director" means the Director of the Division of Small Business Opportunity.
- F. "Subcontractor" means any person, company, association, partnership, corporation, or other entity, which assumes by subordinate agreement some or all of the obligations of the general or prime contractor.
- G. The phrase "Bidding Specifications" as used in Article III, Division 2 of Chapter 28 of the Revised Municipal Code shall include BID CONDITION, INVITATION TO BID, and NOTICE OF PROPOSAL.
- H. "Affirmative Action Program" means a set of specific and result-oriented procedures or steps to which a contractor commits himself to apply every good faith effort to employ members of ethnic minority groups, to include persons of African descent (Black), Spanish surnamed (Hispanic), Asian-American, American Indians, and persons with mental or physical handicap.
- I. "Division of Small Business Opportunity" means the City agency established pursuant to Article III, Division 1 of Chapter 28 of the Denver Revised Municipal Code.

RULE II - NOTICE OF HEARING

When results of conciliation efforts are unsatisfactory to the Manager and he is informed in accordance with Article III, Division 2 of Chapter 28 of the Revised Municipal code that a contractor or subcontractor has apparently failed to meet affirmative action and equal employment opportunity requirements after a reasonable period of notice to correct deficiencies, the Manager will, prior to imposition of any sanctions, afford the general contractor a hearing in order to determine whether the contractor or his subcontractors have failed to comply with the affirmative action and equal employment opportunity requirements of Article III, Division 2 of Chapter 28 of the Revised Municipal Code or of the contract. Written notice of such hearing shall be delivered personally or sent by certified mail, return receipt requested, to the contractor and to any subcontractor involved, at least ten (10) days prior to the date scheduled for the hearing.

RULE III - HEARING

- A. Contractors will appear at hearings and may be represented by counsel, and may present testimony orally and other evidence.
- B. Hearings shall be conducted by one or more hearing examiners designated as such by the Manager.
- C. The Director of the Division of Small Business Opportunity may participate in hearings as a witness.
- D. Hearings shall be held at the place specified in the notice of hearing.
- E. All oral testimony shall be given under oath or affirmation and a record of such proceedings shall be made.
- F. All hearings shall be open to the public.
- G. The hearing officer shall make recommendations to the Manager who shall make a final decision.

REGULATIONS

REGULATION NO. 1 - ORDINANCE:

The Rules and Regulations of the Manager shall be inserted in the bidding specifications for every contract for which bidding is required.

REGULATION NO. 2 - EXEMPTIONS:

Each contract and subcontract, regardless of the dollar amount, shall be subject to affirmative action requirements unless specifically exempted in writing individually by the Manager. Exemptions apply only to "affirmative action" in equal employment opportunity, and are not to be construed as condonation in any manner of "discrimination" or "discriminatory practices" in employment because of race, color, creed, sex, age, national origin, religion, marital status, political opinion or mental or physical handicap.

REGULATION NO. 3 - DIRECTOR OF CONTRACT COMPLIANCE:

The Director of the Division of Small Business Opportunity shall perform the duties assigned to such official by Article III, Division 2 Chapter 28 of the Revised Municipal Code and by the Manager. (1) The Director of the Division of Small Business Opportunity or designated representatives shall inform bidders and contractors of affirmative action procedures, programs, and goals in accordance with the Ordinance at pre-bid and pre-construction conference; (2) make regular on-site inspections; (3) supply contractors and subcontractors with report forms to be completed by them when requested, and furnished to the Director of the Division of Small Business Opportunity; and (4) review payroll records, employment records and practices of general contractors and their subcontractors and suppliers during the performance of any contract. The Director of the Division of Small Business Opportunity shall promptly report apparent affirmative action deficiencies to the Manager.

REGULATION NO. 4 - GOALS AND TIMETABLES:

In general, goals and timetables should take into account anticipated vacancies and the availability of skills in the market place from which employees should be drawn. In addition, where discrimination in employment by a general contractor or any of his subcontractors is indicated, a corrective action program will take into account the need by the general contractor and his subcontractors to correct past discriminatory practices and reach goals of minority manpower utilization on a timely basis through such recruiting and advertising efforts as are necessary and appropriate.

REGULATION NO. 5 - AWARD OF CONTRACTS:

It shall be the responsibility of the Director of the Division of Small Business Opportunity to determine the affirmative action capability of bidders, contractors and subcontractors and to recommend to the Manager the award of contracts to those bidders, contractors and subcontractors and suppliers who demonstrate the ability and willingness to comply with the terms of their contract.

REGULATION NO. 6 - PUBLICATION AND DUPLICATION:

Copies of these Rules and Regulations as amended by the Manager from time to time, shall as soon as practicable and after Notice being published will be made a part of all City Contracts.

REGULATION NO. 7 - NOTICE TO PROCEED:

Prior to issuance of the Notice to Proceed, a sign-off will be required of the Director of the Division of Small Business Opportunity or his designee.

REGULATION NO. 8 - CONTRACTS WITH SUBCONTRACTORS:

To the greatest extent possible, the contractor shall make a good faith effort to contract with minority contractors, subcontractors and suppliers for services and supplies by taking affirmative actions, which include but are not limited to the following:

1. Advertise invitations for subcontractor bids in minority community news media.
2. Contact minority contractor organizations for referral of prospective subcontractors.
3. Purchase materials and supplies from minority material suppliers.

REGULATION NO. 9 - AGENCY REFERRALS:

It shall be no excuse that the union with which the contractor or subcontractor has an agreement providing for referral, exclusive or otherwise, failed to refer minority employees.

REGULATION NO. 10 - CLAUSES:

The Manager shall include the appropriate clauses in every contract and the contractor shall cause to be inserted in every subcontract the appropriate clauses:

1. APPENDIX A: City and County of Denver Equal Opportunity Clause - ALL CONTRACTS funded only with City and County of Denver monies.
2. APPENDIX B: Equal Opportunity Clause (11246) - ALL FEDERAL ASSISTED.
3. APPENDIX C: Section 3 - Assurance of Compliance - HUD ASSISTED PROJECTS.
4. APPENDIX D: Section 3 - Clause - HUD ASSISTED PROJECTS.

All amendments to the appendices shall be included by reference.

REGULATION NO. 11 - SHOW CAUSE NOTICES:

When the Manager has reasonable cause to believe that a contractor has violated Article III, Division 2 of Chapter 28 of the Denver Revised Municipal Code, he may issue a notice requiring the contractor to show cause, within fifteen (15) days why enforcement procedures, or other appropriate action to insure compliance, should not be instituted.

REGULATION NO. 12 - BID CONDITIONS - AFFIRMATIVE ACTION REQUIREMENTS - EQUAL EMPLOYMENT OPPORTUNITY:

1. APPENDIX E: The Bid Conditions - Affirmative Action Requirements - Equal Employment Opportunity as amended and published by the U.S. Department of Labor Employment Standards Administration, Office of Federal Contract Compliance, shall be inserted verbatim for bidding specification for every non-exempt contract involving the use of Federal funds.
2. APPENDIX F: The Bid Conditions - Affirmative Action Requirements - Equal Employment Opportunity as published by the Department of Public Works, City and County of Denver, shall be inserted verbatim as bidding specifications for every non-exempt contract using City funds.

CITY AND COUNTY OF DENVER
DEPARTMENT OF PUBLIC WORKS

APPENDIX A

**CITY AND COUNTY OF DENVER EQUAL OPPORTUNITY CLAUSE -
ALL CONTRACTS**

1. The Contractor will not discriminate against any employee or applicant for employment because of race, creed, color, sex, age, national origin, religion, marital status, political opinion or affiliation, or mental or physical handicap. The Contractor will take affirmative action to ensure that applicants are employed, and that employees are treated during employment without regard to their race, creed, color, sex, age, national origin, religion, marital status, political opinion or affiliation, or mental or physical handicap. Such action shall include, but not be limited to the following: employment, upgrading, demotion, or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship. The Contractor agrees to post in conspicuous places, available to employees and applicants for employment, notices to be provided setting forth the provisions of this nondiscrimination clause.
2. The Contractor will, in all solicitations or advertisements for employees placed by or on behalf of the contractor, state that all qualified applicants will receive consideration for employment without regard to race, creed, color, sex, age, national origin, religion, marital status, political opinion or affiliation, or mental or physical handicap.
3. The Contractor will send to each labor union or representative of workers with which he has a collective bargaining agreement or other contract or understanding, a notice to be provided, advising the said labor union or workers' representatives of the contractor's commitments under this section, and shall post copies of the notice in conspicuous places available to employees and applicants for employment.
4. Each Contractor will comply with all provisions of Article III, Division 2 of Chapter 28 of the Revised Municipal Code, and the rules, regulations, and relevant orders of the Manager and the Director.
5. The Contractor will furnish all information and reports required by Article III, Division 2 of Chapter 28 of the Revised Municipal Code, and by rules, regulations and orders of the Manager and Director or pursuant thereto, and will permit access to his books, records, and accounts by the Manager, Director, or their designee for purposes of investigation to ascertain compliance with such rules, regulations, and orders.
6. In the event of the Contractor's noncompliance with the nondiscrimination clauses of this contract or with any of the said rules, regulations or orders, this contract may be canceled, terminated, or suspended in whole or in part and the Contractor may be declared ineligible for further City contracts in accordance with procedures authorized in Article III, Division 2, Chapter 28 of the Revised Municipal Code, or by rules, regulations, or order of the Manager.
7. The Contractor will include Regulation 12, Paragraph 2 and the provisions of paragraphs (1) through (6) in every subcontract of purchase order unless exempted by rules, regulations, or orders of the Manager issued pursuant to Article III, Division 2, Chapter 28 of the Revised Municipal Code, so that such provisions will be binding on each subcontractor or supplier. The Contractor will take such action with respect to any subcontract or purchase order as the administering agency may direct as a means of enforcing such provisions, including sanctions for noncompliance.

The applicant further agrees to be bound by the above equal opportunity clauses with respect to its own employment practices when it participates in City contracts. The Contractor agrees to assist and cooperate actively with the Manager and the Director in obtaining compliance of subcontractors and suppliers with the equal opportunity clause and the rules, regulations and relevant orders of the Manager, and will furnish the Manager and the Director such information as they may require for the supervision of compliance, and will otherwise assist the Manager and Director in the discharge of the City's primary responsibility for securing

compliance. The Contractor further agrees to refrain from entering into any contract or contract modification subject to Article III, Division 2 of Chapter 28 of the Revised Municipal Code with a contractor debarred from, or who has not demonstrated eligibility for, City contracts.

The Contractor will carry out such sanctions and penalties for violation of the equal opportunity clause as may be imposed upon contractors and subcontractors by the Manager and Director. In addition, the Contractor agrees that failure or refusal to comply with these undertakings the Manager may take any or all of the following actions:

- A. Cancellation, termination, or suspension in whole or in part of this contract.
- B. Refrain from extending any further assistance to the applicant under the program with respect to which the failure occurred until satisfactory assurance of future compliance has been received from such applicant.
- C. Refer the case to the City Attorney for appropriate legal proceedings.

SUBCONTRACTS: Each prime Contractor or Subcontractor shall include the equal opportunity clause in each of its subcontracts.

**CITY AND COUNTY OF DENVER
DEPARTMENT OF PUBLIC WORKS**

APPENDIX F

AFFIRMATIVE ACTION REQUIREMENTS

EQUAL EMPLOYMENT OPPORTUNITY

For All Non-Exempt Construction Contracts to Be Awarded by the
City and County of Denver, Department of Public Works.

NOTICE

EACH BIDDER, CONTRACTOR OR SUBCONTRACTOR (HEREINAFTER THE CONTRACTOR) MUST FULLY COMPLY WITH THE REQUIREMENTS OF THESE BID CONDITIONS AS TO EACH CONSTRUCTION TRADE IT INTENDS TO USE ON THIS CONSTRUCTION CONTRACT, AND ALL OTHER CONSTRUCTION WORK (BOTH CITY AND NON-CITY) IN THE DENVER AREA DURING THE PERFORMANCE OF THIS CONTRACT OR SUBCONTRACT. THE CONTRACTOR COMMITS ITSELF TO THE GOALS FOR MINORITY MANPOWER UTILIZATION, AS APPLICABLE, AND ALL OTHER REQUIREMENTS, TERMS AND CONDITION OF THESE BID CONDITIONS BY SUBMITTING A PROPERLY SIGNED BID.

THE CONTRACTOR SHALL APPOINT A COMPANY EXECUTIVE TO ASSUME THE RESPONSIBILITY FOR THE IMPLEMENTATION OF THE REQUIREMENTS, TERMS AND CONDITIONS OF THESE BID CONDITIONS.

/s/ _____

Manager of Public Works
City and County of Denver

A. REQUIREMENTS - AN AFFIRMATIVE ACTION PLAN:

Contractors shall be subject to the provisions and requirements of these bid conditions including the goals and timetables for minority* and female utilization, and specific affirmative action steps set forth by the Division of Small Business Opportunity (DSBO). The contractor's commitment to the goals for minority, and female utilization as required constitutes a commitment that it will make every good faith effort to meet such goals.

1. GOALS AND TIMETABLES:

The goals and timetables for minority and female participation, expressed in percentage terms for the contractor's aggregate workforce in each trade are as follows:

GOALS FOR MINORITY PARTICIPATION FOR EACH TRADE	GOALS FOR FEMALE PARTICIPATION FOR EACH TRADE
From January 1, 1982 to Until Further Notice	From January 1, 1982 to Until Further Notice
21.7% - 23.5%	6.9%

The goals for minority and female utilization above are expressed in terms of hours of training and employment as a proportion of the total number of hours to be worked by the contractor's aggregate workforce, which includes all supervisory personnel, in each trade, on all projects for the City and County of Denver during the performance of its contract (i.e., The period beginning with the first day of work on the City and County of Denver funded construction contract and ending with the last day of work).

The hours of minority and female employment and training must be substantially uniform throughout the length of the contract in each trade and minorities and females must be employed evenly on each of a contractor's projects. Therefore, the transfer of minority or female employees from contractor to contractor or from project to project for the purpose of meeting the contractor's goals shall be a violation of these Bid Conditions.

If the Contractor counts the nonworking hours of apprentices they must be employed by the Contractor during the training period; the Contractor must have made a commitment to employ apprentices at the completion of their training subject to the availability of employment opportunities; and the apprentices must be trained pursuant to training programs approved by the Bureau of Apprenticeship and Training.

* "Minority" is defined as including, Blacks, Spanish Surname Americans, Asian Americans, and American Indians, and includes both men and minority women.

2. SPECIFIC AFFIRMATIVE ACTION STEPS:

No contractor shall be found to be in noncompliance solely on account of its failure to meet its goals, but will be given an opportunity to demonstrate that the contractor has instituted all the specific affirmative action steps specified and has made every good faith effort to make these steps work toward the attainment of its goals within the timetables, all to the purpose of expanding minority and female utilization in its aggregate workforce. A contractor, who fails to comply with its obligation under the Equal Opportunity Clause of its contract and fails to achieve its commitments to the goals for minority and female utilization has the burden of proving that it has engaged in an Affirmative Action Program directed at increasing minority and female utilization and that such efforts were at least as extensive and as specific as the following:

- a. The Contractor should have notified minority and female organizations when employment opportunities were available and should have maintained records of the organization's response.

- b. The Contractor should have maintained a file of the names and addresses of each minority and female referred to it by any individual or organization and what action was taken with respect to each such referred individual, and if the individual was not employed by the Contractor, the reasons. If such individual was sent to the union hiring hall for referral and not referred back by the union or if referred, not employed by the Contractor, the file should have documented this and their reasons.
- c. The Contractor should have promptly notified the Department of Public Works, and the Division of Small Business Opportunity when the union or unions with which the Contractor has collective bargaining agreements did not refer to the contractor a minority or female sent by the contractor, or when the Contractor has other information that the union referral process has impeded efforts to meet its goals.
- d. The Contractor should have disseminated its EEO policy within its organization by including it in any employee handbook or policy manual; by publicizing it in company newspapers and annual reports and by advertising such policy at reasonable intervals in union publications. The EEO policy should be further disseminated by conducting staff meetings to explain and discuss the policy; by posting of the policy; and by review of the policy with minority and female employees.
- e. The Contractor should have disseminated its EEO policy externally by informing and discussing it with all recruitment sources; by advertising in news media, specifically including minority and female news media; and by notifying and discussing it with all subcontractors.
- f. The Contractor should have made both specific and reasonably recurrent written and oral recruitment efforts. Such efforts should have been directed at minority and female organizations, schools with substantial minority and female enrollment, and minority and female recruitment and training organizations within the Contractor's recruitment area.
- g. The Contractor should have evidence available for inspection that all tests and other selection techniques used to select from among candidates for hire, transfer, promotion, training, or retention are being used in a manner that does not violate the OFCCP Testing Guidelines in 41 CFR Part 60-3.
- h. The Contractor should have made sure that seniority practices and job classifications do not have a discriminatory effect.
- i. The Contractor should have made certain that all facilities are not segregated by race.
- j. The Contractor should have continually monitored all personnel activities to ensure that its EEO policy was being carried out including the evaluation of minority and female employees for promotional opportunities on a quarterly basis and the encouragement of such employees to seek those opportunities.
- k. The Contractor should have solicited bids for subcontracts from available minority and female subcontractors engaged in the trades covered by these Bid Conditions, including circulation of minority and female contractor associations.

NOTE: The Director and the Division of Small Business Opportunity will provide technical assistance on questions pertaining to minority and female recruitment sources, minority and female community organizations, and minority and female news media upon receipt of a request for assistance from a contractor.

3. NON - DISCRIMINATION:

In no event may a contractor utilize the goals and affirmative action steps required in such a manner as to cause or result in discrimination against any person on account of race, color, religion, sex, marital status, national origin, age, mental or physical handicap, political opinion or affiliation.

4. COMPLIANCE AND ENFORCEMENT:

In all cases, the compliance of a contractor will be determined in accordance with its obligations under the terms of these Bid Conditions. All contractors performing or to perform work on projects subject to these Bid Conditions hereby agree to inform their subcontractors in writing of their respective obligations under the terms and requirements of these Bid Conditions, including the provisions relating to goals of minority and female employment and training.

B. CONTRACTORS SUBJECT TO THESE BID CONDITIONS:

In regard to these Bid Conditions, if the Contractor meets the goals set forth therein or can demonstrate that it has made every good faith effort to meet these goals, the Contractor shall be presumed to be in compliance with Article III, Division 2 of Chapter 28 of the Revised Municipal Code, the implementing regulations and its obligations under these Bid Conditions. In the event, no formal sanctions or proceedings leading toward sanctions shall be instituted unless the contracting or administering agency otherwise determines that the contractor is violating the Equal Opportunity Clause.

1. Where the Office of Contract Compliance finds that a contractor failed to comply with the requirements of Article III, Division 2 of Chapter 28 of the Revised Municipal Code or the implementing regulations and the obligations under these Bid Conditions, and so informs the Manager, the Manager shall take such action and impose such sanctions, which include suspension, termination, cancellation, and debarment, as may be appropriate under the Ordinance and its regulations. When the Manager proceeds with such formal action it has the burden of proving that the Contractor has not met the goals contained in these Bid Conditions. The Contractor's failure to meet its goals shall shift to it the requirement to come forward with evidence to show that it has met the good faith requirements of these Bid Conditions.
2. The pendency of such proceedings shall be taken into consideration by the Department of Public Works in determining whether such contractor can comply with the requirements of Article III, Division 2 of Chapter 28 of the Revised Municipal Code, and is therefore a "responsible prospective contractor".
3. The Division of Small Business Opportunity shall review the Contractor's employment practices during the performance of the contract. If the Division of Small Business Opportunity determines that the Contractor's Affirmative Action Plan is no longer an acceptable program, the Director shall notify the Manager.

C. OBLIGATIONS APPLICABLE TO CONTRACTORS:

It shall be no excuse that the union with which the Contractor has a collective bargaining agreement providing for exclusive referral failed to refer minority or female employees. Discrimination in referral for employment, even if pursuant to provisions of a collective bargaining agreement, is prohibited by the National Labor Relations Act, as amended, Title VI of the Civil Rights Act of 1964, as amended, and Article III, Division 2 of Chapter 28 of the Revised Municipal Code. It is the policy of the Department of Public Works that contractors have a responsibility to provide equal employment opportunity, if they wish to participate in City and County of Denver contracts. To the extent they have delegated the responsibility for some of their employment practices to a labor organization and, as a result, are prevented from meeting their obligations pursuant to Article III, Division 2, Chapter 28 of the Revised Municipal Code, such Contractors cannot be considered to be in compliance with Article III, Division 2, Chapter 28 of the Revised Municipal Code, or its implementing rules and regulations.

D. GENERAL REQUIREMENTS:

Contractors are responsible for informing their subcontractors in writing regardless of tier, as to their respective obligations. Whenever a Contractor subcontracts a portion of work in any trade covered by these Bid Conditions, **it shall include these Bid Conditions in such subcontracts and each subcontractor shall be bound by these Bid Conditions to the full extent as if it were the prime contractor.** The Contractor

shall not, however, be held accountable for the failure of its subcontractors to fulfill their obligations under these Bid Conditions. However, the prime contractor shall give notice to the Director of any refusal or failure of any subcontractor to fulfill the obligations under these Bid Conditions. A subcontractor's failure to comply will be treated in the same manner as such failure by a prime contractor.

1. Contractors hereby agree to refrain from entering into any contract or contract modification subject to Article III, Division 2, Chapter 28 of the Revised Municipal Code with a contractor debarred from, or who is determined not to be a "responsive" bidder for the City and County of Denver contracts pursuant to the Ordinance.
2. The Contractor shall carry out such sanctions and penalties for violation of these Bid Conditions and the Equal Opportunity Clause including suspension, termination and cancellation of existing subcontracts and debarment from future contracts as may be ordered by the Manager pursuant to Article III, Division 2, Chapter 28 of the Revised Municipal Code and its implementing regulations.
3. Nothing herein is intended to relieve any contractor during the term of its contract from compliance with Article III, Division 2, Chapter 28 of the Revised Municipal Code, and the Equal Opportunity Clause of its contract with respect to matters not covered in these Bid Conditions.
4. Contractors must keep such records and file such reports relating to the provisions of these Bid Conditions as shall be required by the Office of Contract Compliance.
5. Requests for exemptions from these Bid Conditions must be made in writing, with justification, to the Manager of Public Works, 201 W. Colfax, Dept. 608, Denver, Colorado 80202, and shall be forwarded through and with the endorsement of the Director.

**CITY AND COUNTY OF DENVER
DEPARTMENT OF PUBLIC WORKS**

CONTRACT NO. 201845550

ASBURY & TEJON PARK

CONTRACT

THIS CONTRACT AND AGREEMENT, made and entered into by and between the City and County of Denver, a municipal corporation of the State of Colorado, hereinafter referred to as the "City," party of the first part, and , hereinafter referred to as the "Contractor," party of the second part,

**Iron Woman Construction & Environmental Services, LLC
2680 Emerson Street,
Denver, CO 80216**

WITNESSETH, commencing on **December 5, 2018**, and for at least three (3) days the City advertised that sealed bids would be received for furnishing all labor, tools, supplies, equipment, materials, and everything necessary and required for the following:

CONTRACT NO. 201845550

ASBURY & TEJON PARK

WHEREAS, bids pursuant to said advertisement have been received by the Manager of Public Works, who has recommended that a Contract for said work be made and entered into with the above named Contractor who was the lowest, responsive, qualified bidder therefore, and

WHEREAS, said Contractor is now willing and able to perform all of said work in accordance with said advertisement and its bid.

NOW THEREFORE, in consideration of the compensation to be paid the Contractor, the mutual agreements hereinafter contained, and subject to the terms hereinafter stated, it is mutually agreed as follows:

1. CONTRACT DOCUMENTS

It is agreed by the parties hereto that the following list of documents, instruments, technical specifications, plans, drawings and other materials which are attached hereto and bound herewith, incorporated herein by reference or otherwise referenced in these documents constitute and shall be referred to either as the "Contract Documents" or the "Contract," and all of said documents, instruments, technical specifications, Plans, Drawings and other materials taken together as a whole constitute the Contract between the parties hereto, and they are as fully a part of this agreement as if they were set out verbatim and in full herein:

*Advertisement of Notice of Invitation for Bids
Instructions to Bidders
Commitment to M/WBE Participation
Article III, Divisions 1, 2, and 3 of Chapter 28, D.R.M.C.
Bid Bond
Addenda (as applicable)*

Equal Employment Opportunity Provisions (Appendix A and Appendix F)
Bid Form
Contract Form
General Contract Conditions
Special Contract Conditions
Performance and Payment Bond
Notice to Apparent Low Bidder
Notice to Proceed
Contractor's Certification of Payment Form
Final/Partial Lien Release Form
Certificate of Contract Release
Change Orders (as applicable)
Federal Requirements (as applicable)
Prevailing Wage Rate Schedule(s)
Technical Specifications
Contract Drawings
Accepted Shop Drawings

2. **SCOPE OF WORK**

The Contractor agrees to and shall furnish all labor, tools, supplies, equipment, materials and everything necessary for and required to do, perform and complete all of the Work described, drawn, set forth, shown and included in said Contract Documents.

3. **TERMS OF PERFORMANCE**

The Contractor agrees to undertake the performance of the Work under this Contract within ten (10) days after being notified to commence work by issuance of a Notice to Proceed in substantially the form contained herein from the Manager and agrees to fully complete said Work within **250 (Two Hundred and Fifty Days)** consecutive calendar days from the effective date of said Notice, plus such extension or extensions of time as may be granted in accordance with the provisions of the General Contract Conditions and any applicable Special Contract Conditions.

4. **TERMS OF PAYMENT**

The City agrees to pay the Contractor for the performance of all of the Work required under this Contract, and the Contractor agrees to accept as the Contractor's full and only compensation therefore, such sum or sums of money as may be proper in accordance with the price or prices set forth in the Contractor's Bid Form hereto attached and made a part hereof for **bid item numbers (01-21.26.03 through 32-97.00.01 for 74 (Base Bid A) + 36 (Base Bid B) (One Hundred Ten [110]) total bid items, and twenty one (21) Add Alternate bid items (30-02 through 33-16.00.01, the total estimated cost thereof being Two Million, Six Hundred Two Thousand, One Hundred Forty-Two Dollars, and Fifteen Cents (\$ 2,602,142.15)**. Adjustments to said Contract Amount and payment of amounts due hereunder shall be made in accordance with the provisions of the General Contract Conditions and any applicable Special Contract Conditions.

5. **NO DISCRIMINATION IN EMPLOYMENT**

In connection with the performance of work under this contract, the Contractor may not refuse to hire, discharge, promote or demote, or discriminate in matters of compensation against any person otherwise qualified, solely because of race, color, religion, national origin, gender, age, military status, sexual orientation, gender identity or gender expression, marital status, or physical or mental disability. The Contractor shall insert the foregoing provision in all subcontracts.

6. **COMPLIANCE WITH M/WBE REQUIREMENT**

This Contract is subject to all applicable provisions of Divisions 1 and 3 of Article III, of Chapter 28, Denver Revised Municipal Code (D.R.M.C.), designated as Sections 28-31 – 28-36 and 28-52 – 28-90 D.R.M.C. and referred to in this Contract as the "M/WBE Ordinance". Without limiting the general applicability of the foregoing, the Contractor acknowledges its continuing duty, pursuant to Sections 28-72, 28-73 and 28-75 of the D.R.M.C., to maintain throughout the duration of this Contract, compliance with the level of minority and Woman business enterprise participation, upon which the City approved the award of this Contract to the Contractor and the Contractor further acknowledges that failure to maintain such participation commitments or otherwise comply with the requirements of the M/WBE Ordinance shall subject the

Contractor to sanctions in accordance with Section 28-77 of the D.R.M.C. Nothing contained in this provision or in the M/WBE Ordinance shall negate the City's right to prior approval of subcontractors, or substitutes therefore, under this Contract

7. WAGE RATE REQUIREMENTS

In performance of all Work hereunder, the Contractor agrees to comply with and be bound by all requirements and conditions of the City's Payment of Prevailing Wages Ordinance, Sections 20-76 through 20-79, D.R.M.C. and any determinations made by the City pursuant thereto.

8. APPLICABILITY OF LAWS

The Agreement between the Contractor and the City shall be deemed to have been made in the City and County of Denver, State of Colorado and shall be subject to, governed by, and interpreted and construed by or in accordance with the laws of the State of Colorado and the Charter, Revised Municipal Code, Rules, Regulations, Executive Orders and fiscal rules of the City. As such, the Contractor shall at all times comply with the provisions of the Charter, Revised Municipal Code, Rules, Regulations, Executive Orders and fiscal rules of the City, and those State of Colorado and Federal Laws, Rules and Regulations, which in any manner limit, control or apply to the actions or operations of the Contractor, any subcontractors, employees, agents or servants of the Contractor engaged in the Work or affecting the materials and equipment used in the performance of the Work, as the same may be, from time to time, promulgated, revised or amended. The Charter and Revised Municipal Code of the City and County of Denver, as the same may be amended from time to time, are hereby expressly incorporated into this Agreement as if fully set out herein by this reference.

9. APPROPRIATION

The amount of money, which has been appropriated and encumbered for the purpose of this contract, to date, is equal to or in excess of the Contract Amount. The Manager, upon reasonable written request, will advise the Contractor in writing of the total amount of appropriated and encumbered funds, which remain available for payment for all Work under the Contract.

The issuance of any change order or other form or order or directive by the City which would cause the aggregate payable under the contract to exceed the amount appropriated for the contract is expressly prohibited. In no event shall the issuance of any change order or other form of order or directive by the City be considered valid or binding if it requires additional compensable work to be performed, which work will cause the aggregate amount available under the Contract to exceed the amount appropriated and encumbered for this Contract, unless and until such time as the Contractor has been advised in writing by the Manager that a lawful appropriation, sufficient to cover the entire cost of such additional work, has been made.

It shall be the responsibility of the Contractor to verify that the amounts already appropriated for this Contract are sufficient to cover the entire cost of such work, and any work undertaken or performed in excess of the amount appropriated is undertaken or performed in violation of the terms of this contract, without the proper authorization for such work, and at the Contractor's own risk.

10. APPROVALS

In the event this Contract calls for the payment by the City of five hundred thousand dollars (\$500,000.00) or more, approval by the Board of Councilmen of the City and County of Denver, acting by ordinance, in accordance with Section 3.2.6 of the Charter of the City and County of Denver, is and shall be an express condition precedent to the lawful and binding execution and effect and performance of this contract.

11. ASSIGNMENT

The Contractor shall not assign any of its rights, benefits, obligations or duties under this Contract except upon the prior written consent and approval of the Manager to such assignment.

12. DISPUTES RESOLUTION PROCESS

It is the express intention of the parties to this Contract that all disputes of any nature whatsoever regarding the Contract including, but not limited to, any claims for compensation or damages arising out of breach or default under this Contract, shall be resolved by administrative hearing pursuant to the provisions of Section 56-106, D.R.M.C., or, as applicable, Section 28-33 D.R.M.C. for Minority and Woman Business Enterprise disputes. The Contractor expressly agrees that this dispute resolution process is the only dispute resolution mechanism that will be recognized by the parties for any claims put forward by the Contractor,

notwithstanding any other claimed theory of entitlement on the part of the Contractor or its subcontractors or suppliers.

13. CONTRACT BINDING

It is agreed that this Contract shall be binding on and inure to the benefit of the parties hereto, their heirs, executors, administrators, assigns and successors.

14. PARAGRAPH HEADINGS

The captions and headings set forth herein are for convenience of reference only and shall not be construed so as to define or limit the terms and provisions hereof.

15. SEVERABILITY

It is understood and agreed by the parties hereto that, if any part, term, or provision of this Contract, except for the provisions of this Contract requiring prior appropriation and limiting the total amount to be paid by the City, is by the courts held to be illegal or in conflict with any law of the State of Colorado, the validity of the remaining portions or provisions shall not be affected, and the rights and obligations of the parties shall be construed and enforced as if the Contract did not contain the particular part, term or provision held to be invalid.

16. ELECTRONIC SIGNATURES AND ELECTRONIC RECORDS:

Contractor consents to the use of electronic signatures by the City. The Agreement, and any other documents requiring a signature hereunder, may be signed electronically by the City in the manner specified by the City. The Parties agree not to deny the legal effect or enforceability of the Agreement solely because it is in electronic form or because an electronic record was used in its formation. The Parties agree not to object to the admissibility of the Agreement in the form of an electronic record, or a paper copy of an electronic document, or a paper copy of a document bearing an electronic signature, on the ground that it is an electronic record or electronic signature or that it is not in its original form or is not an original.

Contract Control Number: PWADM-201845550-00

Contractor Name: Iron Woman Construction & Environmental Services, LLC

By: 

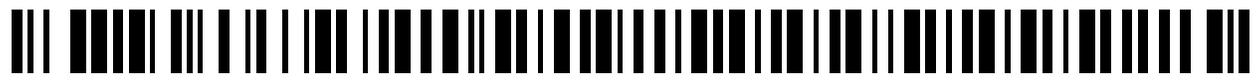
Name: Shawn S. Egan
(please print)

Title: Pres & CEO
(please print)

ATTEST: [if required]
By: 

Name: Shawn S. Egan
(please print)

Title: Secretary
(please print)



Contract Control Number:

IN WITNESS WHEREOF, the parties have set their hands and affixed their seals at Denver, Colorado as of

SEAL

CITY AND COUNTY OF DENVER

ATTEST:

By _____

APPROVED AS TO FORM:

REGISTERED AND COUNTERSIGNED:

By _____

By _____

By _____



**CITY AND COUNTY OF DENVER
DEPARTMENT OF PUBLIC WORKS**

General Contract Conditions

INDEX

TITLE 1		
DEFINITIONS		1
101	CITY	1
102	CONTRACT	1
103	CONTRACT AMOUNT	1
104	CONTRACT DOCUMENTS	1
105	CONTRACT TIME	1
106	CONTRACTOR	2
107	CONTRACTOR PERSONNEL	2
108	DAYS	2
109	DEPUTY MANAGER	2
110	DESIGNER	2
111	FINAL COMPLETION	2
112	MANAGER	3
113	PRODUCT DATA	3
114	PROJECT	3
115	PROJECT MANAGER	3
116	SAMPLES	3
117	SHOP DRAWINGS	3
118	SUBCONTRACTOR	3
119	SUBSTANTIAL COMPLETION	3
120	SUPPLIER	4
121	WORK	4
TITLE 2		
CITY ADMINISTRATIVE ORGANIZATIONS; LINE OF AUTHORITY		5
201	DEPARTMENT OF AVIATION	5
202	MANAGER OF AVIATION	5
203	DEPARTMENT OF PUBLIC WORKS	5
204	MANAGER OF PUBLIC WORKS	5
205	BUILDING INSPECTION	5
206	ZONING	5
207	DIVISION OF SMALL BUSINESS OPPORTUNITY	6
208	CITY AUDITOR	6
209	MANAGER OF FINANCE	6
210	CITY ATTORNEY	6
211	OFFICE OF RISK MANAGEMENT	6
212	CITY'S CONTRACT ADMINISTRATION LINE OF AUTHORITY	6
213	CITY'S COMMUNICATION WITH THE CONTRACTOR	7

TITLE 3		
CONTRACTOR PERFORMANCE AND SERVICES.....		8
301 CONSIDERATION		
(CONTRACTOR'S PROMISE OF PERFORMANCE).....		8
302 NOTICE TO PROCEED AND COMPLETION OF THE WORK		8
303 EXACT CONTRACTOR PERFORMANCE		8
304 SUBSTITUTED PERFORMANCE.....		8
305 WORK PERFORMED UNDER ADVERSE		
WEATHER CONDITIONS.....		9
306 WORKING HOURS AND SCHEDULE		9
307 CONTRACTOR'S SUPERINTENDENT		10
308 COMMUNICATIONS		10
309 CONTRACTOR SUBMITTALS		
AND OTHER WRITTEN COMMUNICATIONS TO THE CITY.....		10
310 COMPETENCE OF CONTRACTOR'S WORK FORCE		11
311 NO EMPLOYMENT OF ILLEGAL ALIENS		
TO PERFORM WORK UNDER THE CONTRACT		11
312 CONDUCT OF CONTRACTOR'S PERSONNEL		12
313 SUGGESTIONS TO CONTRACTOR.....		12
314 WORK FORCE		12
315 CONSTRUCTION MACHINES AND STANDBY EQUIPMENT		13
316 CUTTING AND PATCHING THE WORK		13
317 PERMITS AND LICENSES		13
318 CONSTRUCTION SURVEYS		14
319 PRESERVATION OF PERMANENT		
LAND SURVEY CONTROL MARKERS		14
320 TRADEMARKS, COPYRIGHTS AND PATENTED DEVICES,		
MATERIALS, AND PROCESSES		15
321 PROJECT SIGNS.....		15
322 PUBLICITY AND ADVERTISING.....		16
323 TAXES		16
324 DOCUMENTS AND SAMPLES AT THE SITE		17
325 CLEANUP DURING CONSTRUCTION.....		17
326 SANITARY FACILITIES.....		18
327 POWER, LIGHTING, HEATING, VENTILATING,		
AIR CONDITIONING AND WATER SERVICES		18
TITLE 4		
CONTRACT DOCUMENTS (DRAWINGS AND TECHNICAL SPECIFICATIONS)		19
401 CONTRACT DOCUMENTS - REVIEW AND INTERPRETATION.....		19
402 OWNERSHIP OF CONTRACT DRAWINGS		
AND TECHNICAL SPECIFICATIONS.....		20
403 CONTRACT DRAWINGS AND TECHNICAL SPECIFICATIONS		
ISSUED TO THE CONTRACTOR		20
404 REQUESTS FOR INFORMATION OR CLARIFICATION		21
405 SHOP DRAWINGS, PRODUCT DATA AND SAMPLES		21
406 SUBSTITUTION OF MATERIALS AND EQUIPMENT		22
TITLE 5		
SUBCONTRACTS		24
501 SUBCONTRACTS.....		24
502 SUBCONTRACTOR ACCEPTANCE		24
TITLE 6		
TIME OF COMMENCEMENT AND COMPLETION		27
601 BEGINNING, PROGRESS AND TIME OF COMPLETION		27
602 LIQUIDATED DAMAGES; ADMINISTRATIVE COSTS;		
ACTUAL DAMAGES.....		27

603	DELAY DAMAGES	28
TITLE 7		
COOPERATION, COORDINATION AND RATE OF PROGRESS		29
701	COOPERATION WITH OTHER WORK FORCES	29
702	COORDINATION OF THE WORK.....	30
703	COORDINATION OF PUBLIC CONTACT.....	30
704	RATE OF PROGRESS	30
TITLE 8		
PROTECTION OF PERSONS AND PROPERTY		32
801	SAFETY OF PERSONS	32
802	PROTECTIVE DEVICES AND SAFETY PRECAUTIONS	33
803	PROTECTION OF PROPERTY AND WORK IN PROGRESS	33
804	PROTECTION OF MUNICIPAL, PUBLIC SERVICE OR PUBLIC UTILITY SYSTEMS	34
805	PROTECTION OF STREET AND ROAD SYSTEM	35
806	PROTECTION OF DRAINAGE WAYS	36
807	PROTECTION OF THE ENVIRONMENT	36
808	HAZARDOUS AND EXPLOSIVE MATERIALS OR SUBSTANCES.....	37
809	ARCHAEOLOGICAL AND HISTORICAL DISCOVERIES	37
TITLE 9		
COMPENSATION		38
901	CONSIDERATION (CITY'S PROMISE TO PAY).....	38
902	PAYMENT PROCEDURE	38
903	SCHEDULE OF VALUES IN LUMP SUM CONTRACTS	39
904	UNIT PRICE CONTRACTS.....	39
905	PROGRESS PERIOD.....	39
906	APPLICATIONS FOR PAYMENT	40
907	RELEASES AND CONTRACTORS CERTIFICATIONS OF PAYMENT	41
908	RETAINAGE	41
909	ADDITIONAL WITHHOLDING OF PROGRESS PAYMENTS	42
910	FINAL ESTIMATE AND PAYMENT	43
911	ACCOUNTING OF COSTS AND AUDIT	43
TITLE 10		
WAGE		45
1001	PREVAILING WAGE ORDINANCE.....	45
1002	POSTING OF THE APPLICABLE WAGE RATES	45
1003	RATE AND FREQUENCY OF WAGES PAID.....	45
1004	REPORTING WAGES PAID	45
1005	FAILURE TO PAY PREVAILING WAGES	46
TITLE 11		
CHANGES IN THE WORK, CONTRACT PRICE OR CONTRACT TIME		47
1101	CHANGE ORDER.....	47
1102	CITY INITIATED CHANGES	47
1103	CONTRACTOR CHANGE REQUEST.....	48
1104	ADJUSTMENT TO CONTRACT AMOUNT	51
1105	TIME EXTENSIONS.....	54
TITLE 12		
CONTRACTOR CLAIMS FOR ADJUSTMENT AND DISPUTES.....		56
1201	NOTICE OF INTENT TO CLAIM.....	56
1202	SUBMITTAL OF CLAIMS	56
1203	WAIVER OF CLAIMS	58

TITLE 13	
DISPUTES	59
1301 DISPUTES	59
TITLE 14	
SITE CONDITIONS	60
1401 DIFFERING SITE CONDITIONS	60
1402 SITE INSPECTIONS AND INVESTIGATIONS	60
TITLE 15	
PERFORMANCE AND PAYMENT BONDS	62
1501 SURETY BONDS	62
1502 PERFORMANCE BOND	62
1503 PAYMENT BOND	62
TITLE 16	
INSURANCE AND INDEMNIFICATION	63
1601 INSURANCE	63
1602 DEFENSE AND INDEMNIFICATION	63
TITLE 17	
INSPECTION AND DEFECTS	64
1701 CONSTRUCTION INSPECTION BY THE CITY	64
1702 AUTHORITY OF INSPECTORS	64
1703 OBSERVABLE DEFECTS	64
1704 DEFECTS - UNCOVERING WORK	64
1705 LATENT DEFECTS	65
1706 REMOVAL OF DEFECTIVE MATERIALS AND WORK	65
TITLE 18	
WARRANTIES, GUARANTEES AND CORRECTIVE WORK	66
1801 CONTRACTOR'S WARRANTIES, GUARANTEES AND CORRECTION OF WORK	66
1802 PERFORMANCE DURING WARRANTY PERIOD	67
TITLE 19	
SUBSTANTIAL COMPLETION OF THE WORK	69
1901 CONTRACTOR'S NOTICE OF SUBSTANTIAL COMPLETION	69
1902 INSPECTION AND PUNCH LIST	69
1903 CERTIFICATE OF SUBSTANTIAL COMPLETION	69
1904 RIGHT OF EARLY OCCUPANCY OR USE	69
TITLE 20	
FINAL COMPLETION AND ACCEPTANCE OF THE WORK	71
2001 CLEAN-UP UPON COMPLETION	71
2002 FINAL COMPLETION AND ACCEPTANCE OF THE WORK	71
2003 FINAL SETTLEMENT	71
TITLE 21	
SUSPENSION OF WORK	74
2101 SUSPENSION OF WORK	74
2102 SUSPENSION OF THE WORK FOR THE CITY'S CONVENIENCE	74
2103 SUSPENSION BECAUSE OF ORDER OF CITY, STATE OR FEDERAL COURT OR AGENCY	75
2104 SUSPENSION RESULTING FROM CONTRACTOR'S FAILURE TO PERFORM	75

TITLE 22	
CITY'S RIGHT TO TERMINATE THE CONTRACT	76
2201 TERMINATION OF CONTRACT FOR CAUSE	76
2202 TERMINATION OF CONTRACT FOR CONVENIENCE OF THE CITY	77
 TITLE 23	
MISCELLANEOUS PROVISIONS	80
2301 PARTIES TO THE CONTRACT.....	80
2302 FEDERAL AID PROVISIONS.....	80
2303 NO WAIVER OF RIGHTS	80
2304 NO THIRD PARTY BENEFICIARY	80
2305 GOVERNING LAW; VENUE.....	81
2306 ABBREVIATIONS	81
2307 STATUTE OF LIMITATIONS IN C.R.S. § 13-80-102(1)(h)	81

CITY AND COUNTY OF DENVER
DEPARTMENT OF PUBLIC WORKS
201845550

SPECIAL CONTRACT CONDITIONS

SC-1 CONSTRUCTION SPECIFICATIONS

Except as amended herein or in the attached Technical Specifications, all Work performed under the terms of this Contract shall be governed by the applicable provisions of the following latest editions:

City and County of Denver:

Standard Specifications for Construction, GENERAL CONTRACT CONDITIONS,
2011 Edition.

Transportation Standards and Details for the Engineering Division

City and County of Denver Traffic Standard Drawings

Wastewater Management Division

– *Standard Detail Drawings*

– *Public Works Wastewater Capital Projects Management Standard Construction Specifications*

Colorado Department of Transportation:

Standard Specifications for Road and Bridge Construction
(Sections 200 through 700 of the 2011 Edition)

Federal Highway Administration:

Manual on Uniform Traffic Control Devices for Streets & Highways (MUTCD)

Building & Fire Codes:

Building Code of the City and County of Denver

(International Building Code 2015 Series, City and County of Denver Amendments 2016)

National Fire Protection Association Standards

(As referenced in the Building Code of the City and County of Denver)

The aforementioned City and County of Denver documents are available for review at the Capital Projects Management Office, 201 W. Colfax Ave., Dept. 506, (5th floor), Denver, CO 80202. The *Standard Specifications for Construction, GENERAL CONTRACT CONDITIONS* is available at: <https://www.denvergov.org/content/denvergov/en/contract-administration/contractor-resources.html>. *Transportation Standards and Details for the Engineering Division* and the Wastewater Management Division – *Standard Detail Drawings*, are available at <http://www.denvergov.org>.

The “*Colorado Department of Transportation Standard Specifications for Road and Bridge Construction*” is available for review on CDOT’s website at <http://www.coloradodot.info/> and can be purchased from the Colorado Department of Transportation.

The *Manual on Uniform Traffic Control Devices for Streets & Highways* is available for review at the Federal Highway Administration Website at: www.fhwa.dot.gov. The FHWA website also contains purchasing information.

SC-2 DEPUTY MANAGER / CITY ENGINEER

General condition 109 DEPUTY MANAGER is hereby deleted in its entirety and replaced with the following:

The “Deputy Manager” means the official who reports directly to the Manager and exercises supervisory responsibility in the City agency defined in Title 2 herein that is responsible for the Project. The Manager hereby designates the City Engineer as the Deputy Manager for purposes of this Contract. The City Engineer shall have responsibility for this Project and shall undertake all duties, responsibilities, rights and authority, including specific actions and decisions, delegated to the Deputy Manager under the various terms and conditions of this Contract.

SC-3 ENGINEERING DIVISION / CITY ENGINEER

The Engineering Division is a unit of the Department of Public Works and is supervised by the City Engineer, who is subordinate to the Manager of Public Works. This Division is responsible for the planning, design, construction, operation and maintenance of all of the City's transportation facilities and the planning, design and construction of all of the City’s wastewater facilities, except for the City's Municipal Airport System. All other references to the Transportation Division or the Deputy Manager of Public Works for Transportation are deleted and replaced with references to the Engineering Division and City Engineer, respectively.

SC-4 WASTEWATER MANAGEMENT DIVISION

The Wastewater Management Division is a unit of the Department of Public Works and is supervised by the Deputy Manager of Public Works for Wastewater Management, who is subordinate to the Manager of Public Works. This Division is responsible for the operation and maintenance of the City's wastewater facilities.

SC-5 CITY DELEGATION OF AUTHORITY

With reference to General Contract Condition 109, DEPUTY MANAGER and General Contract Condition 212, CITY’S CONTRACT ADMINISTRATION LINE OF AUTHORITY, the Manager hereby designates the City Engineer as the City official responsible for those certain actions and decisions designated as the responsibility of the Deputy Manager under the General Conditions and delegates to the City Engineer the authority necessary to undertake those responsibilities under this Contract. The Director shall have supervisory responsibility over the Project Manager. Additionally, Contractor questions concerning the Plans and Technical Specifications shall be directed to:

Denver Department of Public Works / Engineering Division,

City Project Manager
Andy Stewart

Telephone
(303) 446-3510

Design Consultant
Enginuity

Contact
Don Jacobs

Telephone
(303) 872-9106

SC-6 LIQUIDATED DAMAGES; MILESTONES; ACTUAL DAMAGES

General Condition: 602 LIQUIDATED DAMAGES; ADMINISTRATIVE COSTS; ACTUAL DAMAGES is hereby replaced in its entirety with the following:

.1 Time is of the essence in performing the Contract. In the event the Contractor fails to achieve the milestones described below or fails to meet any other time requirement or the time limit set forth in the Contract (See Milestone Schedule 602.5), after due allowance for any extension or extensions of time made in accordance with the provisions herein set forth, the Contractor shall be liable to the City for liquidated damages, and not as a penalty, in the amount stipulated therefore in the Contract Form or in the Special Conditions. Such liquidated damages shall be assessed for each and every Day that the Contractor shall be in default, as established by said time limit or limits. The City shall have the right to deduct said liquidated damages from any amount due or that may become due the Contractor, or to collect such liquidated damages from the Contractor or its surety.

.2 Liquidated damages in the amount stipulated do not include any sums of money to reimburse the City for actual damages which may be incurred between Substantial Completion and Final Completion because of the Contractor's failure to achieve Final Completion within the Contract Time. For such delay in Final Completion, the Contractor shall reimburse the City, as a mitigation of City damages and not as a penalty, those administrative costs incurred by the City as a result of such failure. Representative hourly rates for such administrative costs are set out in the Special Conditions. The Project Manager shall calculate the City's administrative costs based on such Special Conditions, as the same may be revised from time to time.

Representative hourly rates for the City administrative costs shall be as follows for this Project:

Project Manager	\$69 per hour
Project Engineer	\$63 per hour
Inspector	\$49 per hour
Surveying, if necessary	\$100 per hour

.3 Liquidated damages in the amounts stipulated do not include any sums of money to reimburse the City for extra costs which the City may become obligated to pay on other contracts which were delayed or extended because of the Contractor's failure to complete the Work within the Contract Time. Should the City incur additional costs because of delays or extensions to other contracts resulting from the Contractor's failure of timely performance, the City will assess these extra costs against the Contractor, and these assessments will be in addition to the stipulated liquidated damages.

.4 The City reserves all of its rights to actual damages from the Contractor for injury or loss suffered by the City from actions or omissions of the Contractor, including but not limited to any other breach or default of the Contract, outside of the scope of the above sections of GC 602.

.5 The Parties recognize and agree that time is of the essence on this Contract. Due to the time sensitivities, the Contract establishes multiple milestones based on the date the Notice to Proceed is issued by the City. Milestone completion shall be achieved per the Milestone Schedule listed herein. Liquidated damages will be assessed by the City to the contractor in the amount of \$1,000.00 per calendar day for each and every day each individual milestone is not adequately completed. Completion for the purposes of this section 602.5 shall include all work completed per the Contract any executed change orders and any executed amendments.

MILESTONE SCHEDULE

Milestone	Scope of Work	Start Date	End Date
1	Utility Coordination, Permits, & Submittals	NTP	NTP + 60 Calendar Days
2	Carlsonator Design & Procurement	NTP	NTP + 90 Calendar Days
3	Removals, Earthwork, Structures, Boulders & Channel Improvements	NTP + 60 Calendar Days	NTP + 180 Calendar Days
4	Seeding/Sodding & Plantings (Irrigated)	April 15	September 1
5	Seeding/Sodding & Plantings (non-irrigated)	November 15	April 15
6	Playground Equipment	NTP + 60 Calendar Days	NTP + 250 Calendar Days

SC-7 SUBCONTRACTS

In accordance with General Contract Condition 501, SUBCONTRACTS, no limit shall apply to that percentage of the Work, which may be sublet providing that the subcontractors receive prior approval in accordance with General Contract Condition 502, SUBCONTRACTOR ACCEPTANCE.

SC-8 RESERVED

SC-9 PAYMENTS TO CONTRACTORS

The application for payment shall be submitted through Textura® Corporations Construction Management Website. Contractor recognizes and agrees that it shall be required to use the Textura Construction Payment Management System for this Project to request payment from the City and to pay subcontractors. All certified subcontractors or suppliers who are listed for participation towards any assigned program goal must be paid via Textura®. Contractor further agrees that, to the fullest extent possible within Textura, the City shall be entitled to all non-Confidential records, reports, data and other information related to the project that are available to Contractor through Textura, including, but not limited to, information related to Contractor and subcontractor billings. To that end, Contractor agrees it will activate any available settings within Textura necessary to grant the City access to such non-Confidential information related to the contract and the project. Applications for payment shall be based on the Contract Unit Prices or the approved Schedule of Values described in GC 903.1

In accordance with General Contract Condition 902, PAYMENT PROCEDURE, the party(ies) responsible for review of all Pay Applications shall be:

<u>Agency/Firm</u>	<u>Name</u>	<u>Telephone</u>
Public Works/Engineering Division	Jason Wennen	(303) 446-3628

In accordance with General Contract Condition 906, APPLICATIONS FOR PAYMENT, each Application submitted shall include the following:

1. The estimate of Work completed shall be based on the approved schedule of values or unit prices, as applicable, and the percent of the Work complete.
2. Each Application for Payment shall include each and every independent subcontractor’s payroll information including pay dates and pay amounts.
3. The Contractor shall also submit to the Auditor and other appropriate officials of the City in a timely fashion, information required by General Contract Condition 1004, REPORTING WAGES PAID.
4. Applications for Payment must be accompanied by completed Partial or Final Claim Release Form, as appropriate, from EACH subcontractor and supplier, **AND** the Contractors’ Certification of Payment Form (CCP), unless an exception is approved pursuant to General contract condition 907.

The forms, Final/Partial Release and Certificate of Payment (Subcontractor/Supplier) and the Contractor’s Certification of Payment (CCP), both of which must be used are attached below. If subcontractor or supplier payments are disbursed via Textura® CPM, those systems generated Release and CCP forms are acceptable.

DEPARTMENT OF PUBLIC WORKS

FINAL/PARTIAL RELEASE AND CERTIFICATE OF PAYMENT
(SUBCONTRACTOR/SUPPLIER)

(PROJECT NO. and NAME)

Date: _____, 20__.

(NAME OF CONTRACTOR)

Subcontract #: _____.

(NAME OF SUBCONTRACTOR/SUPPLIER)

Subcontract Value: \$_____.

Last Progress Payment: \$_____.

Date: _____.

Total Paid to Date: \$_____.

Date of Last Work: _____.

Check Applicable Box:
[] MBE [] WBE

The Undersigned hereby certifies that all costs, charges or expenses incurred by the undersigned or on behalf of the undersigned for any work, labor or services performed and for any materials, supplies or equipment provided on the above referenced Project or used in connection with the above referenced Subcontract (the "Work Effort") have been duly paid in full.

The Undersigned further certifies that each of the undersigned's subcontractors and suppliers that incurred or caused to be incurred, on their behalf, costs, charges or expenses in connection with the undersigned's Work Effort on the above referenced Project have been duly paid in full.

In consideration of \$_____ representing the Last Progress Payment referenced above and in further consideration of the Total Paid to Date, also referenced above, and other good and valuable consideration received and accepted by the undersigned this _____ day of _____, 20__, the Undersigned hereby releases and discharges the City and County of Denver (the "City"), the above referenced City Project, the City's premises and property and the above referenced Contractor from all claims, liens, rights, liabilities, demands and obligations, whether known or unknown, of every nature arising out of or in connection with the performance of the work effort.

As additional consideration for the payments referenced above, the undersigned agrees to defend, indemnify and save and hold harmless the City, its officers, employees, agents and assigns and the above-referenced Contractor from and against all costs, losses, damages, causes of action, judgments under the subcontract and expenses arising out of or in connection with any claim or claims against the City or the Contractor which arise out of the Undersigned's performance of the Work Effort and which may be asserted by the Undersigned or any of its suppliers or subcontractors of any tier or any of their representatives, officers, agents, or employees.

It is acknowledged that this release is for the benefit of and may be relied upon by the City and the referenced Contractor.

The foregoing shall not relieve the undersigned of any obligation under the provisions of the Undersigned's subcontract, as the subcontract may have been amended, which by their nature survive completion of the Undersigned's work effort including, without limitation, warranties, guarantees, insurance requirements and indemnities.

STATE OF COLORADO) ss.
CITY OF _____)

(Name of Subcontractor)

Signed and sworn before me this
day of _____, 20__.

By: _____

Notary Public/Commissioner of Oaths
My Commission Expires

Title: _____



Instructions for Completing the Contractor/Consultant Certification of Payment Form

Office of Economic Development
Division of Small Business Opportunity
Compliance Unit
201 W. Colfax Ave. Dept. 907
Denver, CO 80202
Phone: 720-913-1999
DSBO@denvergov.org

Note: The attached Contractor/Consultant Certification of Payment form must be completed by the Contractor/ Subconsultant and all subcontractors/subconsultant or suppliers used on the project at **any tier** and submitted with each pay application. The Contractor/Consultant is responsible for the accuracy of all information provided and is required to have each subcontractor/subconsultant or supplier fill out the appropriate forms. Please be sure to complete all information requested at the top of the form, including the name of the person who prepared this form.

If you reproduce this form, you must continue to list each of the originally listed firms, as well as any additional firms used during the performance period of the contract. Please complete an additional CCP if there is second tier-ing involved.

If you have any questions, please call the Compliance Unit of DSBO at 720.913.1999.

Instructions for Completing the Contractor/Consultant Certification of Payment Form, per Column

Contractor/Subcontractor or Subconsultant/Supplier Name: In the space provided, list all subcontractors/ subconsultants and suppliers used on the project. For all M/W/S/E/DBEs use the exact name listed in the DSBO Directory.

M/W/S/E/DBE/NON: For each name listed, indicate whether the entity is a certified M/W/S/E/DBE.

Column A: Provide the contract amount, as listed at bid time, for the Contractor/Consultant and each subcontractor/subconsultant or supplier.

Column B: Provide the percentage portion of each listed subcontractor/subconsultant or supplier contract amount (Column A) compared to the total original contract amount in (I).

Column C: Provide the original contract amount (Column A) for each subcontractor/subconsultant or supplier plus any awarded alternate and/or change order amounts applicable. If an alternate/change order does not apply to the listed firm, re-enter the original contract amount (Column A).

Column D: Provide the percent portion of each listed subcontractor/subconsultant or supplier contract amount (Column C) compare to the current total contract amount in (II).

Column E: Provide the amount requested for work performed or materials supplied by each listed subcontractor/subconsultant or supplier for this pay application. The sum of the items in this column should equal the estimated amount requested for this pay application.

Column F: Provide the amount paid to each subcontractor/subconsultant or supplier on the previous pay application. Enter the previous pay application number in the column heading. The sum of the items listed in this column should equal the warrant amount paid to the Contractor/Consultant on the previous pay application. The amounts paid to the subcontractor/subcontractor or suppliers should be the actual amount of each check issued.

Column G: Provide the net paid to date for the Contractor/Subconsultant and each listed subcontractor/subconsultant or supplier.

Column H: Provide the percent portion of the net paid to date (Column G) for the Contractor/Subconsultant and each listed subcontractor/subconsultant or supplier of the current total contract amount in (II).

Rev: 031816

SC-10 CONTRACT FORMS

In accordance with the terms and conditions of the Contract Documents, the City requires the use of certain form documents in complying with or satisfying various obligations, notifications and conditions in contracting with the City or performing Work hereunder. These form documents are referenced by title throughout the Contract Documents for mandatory use as directed. The following are the forms that shall be detached and utilized in accordance with the Contract Documents:

1. Performance and Payment Bond
2. Performance and Payment Bond Surety Authorization Letter (Sample)
3. Final/Partial Lien Release.

The following are forms that will be issued by the City during construction:

1. Notice to Apparent Low Bidder (Sample)
2. Notice to Proceed (Sample)
3. Certificate of Contract Release (Sample)

SC-11 CONSTRUCTION INSPECTION BY THE CITY

General Condition 1701, CONSTRUCTION INSPECTION BY THE CITY, is modified as follows:

.1 Persons who are employees of the City or who are under contract to the City or the City as lessee will be assigned to inspect and test the Work. These persons may perform any tests and observe the Work to determine whether or not designs, materials used, manufacturing and construction processes and methods applied, and equipment installed satisfy the requirements of the drawings and specifications, accepted Shop Drawings, Product Data and Samples, and the General Contractor's warranties and guarantees. The General Contractor shall permit these inspectors unlimited access to the Work and provide means of safe access to the Work, which cost shall be included as a Cost of the Work without any increase to the Guaranteed Maximum Price. In addition, General Contractor shall provide whatever access and means of access are needed to off-site facilities used to store or manufacture materials and equipment to be incorporated into the Work and shall respond to any other reasonable request to further the inspector's ability to observe or complete any tests. Such inspections shall not relieve the General Contractor of any of its quality control responsibilities or any other obligations under the Contract. All inspections and all tests conducted by the City are for the convenience and benefit of the City. These inspections and tests do not constitute acceptance of the materials or Work tested or inspected, and the City may reject or accept any Work or materials at any time prior to the inspections pursuant to G.C. 2002, whether or not previous inspections or tests were conducted by the inspector or a City representative.

.2 Building Inspection will perform building code compliance inspections for structures designed for human occupancy. It is the General Contractor's responsibility to schedule and obtain these inspections. If a code compliance inspection results in identification of a condition which will be at variance to the Contract Documents, the General Contractor shall immediately notify the Project Manager and confirm such notification with formal correspondence no later than forty-eight (48) hours after the occurrence.

.3 When any unit of government or political subdivision, utility or Railroad Corporation is to pay a portion of the cost of the Work, its respective representatives shall have the right to inspect the Work. This inspection shall not make any unit of government or political subdivision, utility or Railroad Corporation a party to the Contract, and shall not interfere with the rights of either party.

SC-12 DISPOSAL OF NON-HAZARDOUS WASTE AT DADS

In accordance with the Landfill Agreement made between the City and Waste Management of Colorado, Inc., bidders will be required to haul dedicated loads (non-hazardous entire loads of waste) to the Denver-Arapahoe Disposal Site ("DADS") for disposal. DADS is located at Highway 30 and Hampden Avenue in Arapahoe County, Colorado. The City will pay all fees associated with such disposal but the bidder shall be responsible for the costs of transporting the loads. Non-hazardous waste is defined as those substances and materials not defined or classified as hazardous by the Colorado Hazardous Waste Commission pursuant to C.R.S. §25-15-101(6), as amended from time to time, and includes construction debris, soil and asbestos. Bidders shall not use Gun Club Road between I-70 and Mississippi Avenue as a means of access to DADS.

SC-13 PROHIBITION ON USE OF CCA-TREATED WOOD PRODUCTS

The use of any wood products pressure-treated with chromated copper arsenate (CCA) is prohibited. Examples of CCA-treated wood products include wood used in play structures, decks, picnic tables, landscaping timbers, fencing, patios, walkways and boardwalks.

SC-14 WAIVER OF: PART 8 OF ARTICLE 20 OF TITLE 13, COLORADO REVISED STATUTES.

The Contractor specifically waives all the provisions of Part 8 of Article 20 of Title 13, Colorado Revised Statutes regarding defects in the Work under this Construction Contract.

SC-15 ATTORNEY'S FEES

Colorado Revised Statute 38-26-107 requires that in the event any person or company files a verified statement of amounts due and unpaid in connection with a claim for labor and materials supplied on this project, the City shall withhold from payments to the Contractor sufficient funds to insure the payment of any such claims. Should the City and County of Denver be made a party to any lawsuit to enforce such unpaid claims or any lawsuit arising out of or relating to such withheld funds, the Contractor agrees to pay to the City its costs and a reasonable attorney's fee which cost shall be included as a Cost of the Work.

Because the City Attorney Staff does not bill the City for legal services on an hourly basis, the Contractor agrees a reasonable fee shall be computed at the rate of one hundred dollars per hour of City Attorney time.

SC-16 INSURANCE

General Condition 1601 is hereby deleted in its entirety and replaced with the following:

(1) **General Conditions:** Contractor agrees to secure, at or before the time of execution of this Agreement, the following insurance covering all operations, goods or services provided pursuant to this Agreement. Contractor shall keep the required insurance coverage in force at all times during the term of the Agreement, or any extension thereof, during any warranty period, and for eight (8) years after termination of the Agreement. The required insurance shall be underwritten by an insurer licensed or authorized to do business in Colorado and rated by A.M. Best Company as "A-"VIII or better. Each policy shall contain a valid provision or endorsement requiring notification to the City in the event any of the required policies be canceled or non-renewed before the expiration date thereof. Such written notice shall be sent to the parties identified in the Notices section of this Agreement. Such notice shall reference the City contract number listed on the signature page of this Agreement. Said notice shall be sent thirty (30) days prior to such cancellation or non-renewal unless due to non-payment of premiums for which notice shall be sent ten (10) days prior. If such written notice is unavailable from the insurer, contractor shall provide written notice of cancellation, non-renewal and any reduction in coverage to the parties identified in the Notices section by certified mail, return receipt requested within three (3) business days of such notice by its insurer(s) and referencing the City's contract number. If any policy is in excess of a deductible or self-insured retention, the City must be notified by the Contractor. Contractor shall be responsible for the payment of any deductible or self-insured retention. The insurance coverages specified in this Agreement are the minimum requirements, and these requirements do not lessen or limit the liability of the Contractor. The Contractor shall maintain, at its own expense, any additional kinds or amounts of insurance that it may deem necessary to cover its obligations and liabilities under this Agreement.

(2) **Proof of Insurance:** Contractor shall provide a copy of this Agreement to its insurance agent or broker. Contractor may not commence services or work relating to the Agreement prior to placement of coverage. Contractor certifies that the certificate of insurance attached as part of the Contract Documents, preferably an ACORD certificate, complies with all insurance requirements of this Agreement. The City requests that the City's contract number be referenced on the Certificate. The City's acceptance of a certificate of insurance or other proof of insurance that does not comply with all insurance requirements set forth in this Agreement shall not act as a waiver of Contractor's breach of this Agreement or of any of the City's rights or remedies under this Agreement. The City's Risk Management Office may require additional proof of insurance, including but not limited to policies and endorsements.

(3) **Additional Insureds:** For Commercial General Liability and Auto Liability, Contractor and subcontractor's insurer(s) shall name the City and County of Denver, its elected and appointed officials, employees and volunteers as additional insured.

(4) **Waiver of Subrogation:** For all coverages, Contractor's insurer shall waive subrogation rights against the City.

(5) **Subcontractors and Subconsultants:** All subcontractors and subconsultants (including independent contractors, suppliers or other entities providing goods or services required by this Agreement) shall be subject to all of the requirements herein and shall procure and maintain the same coverages required of the Contractor. Contractor shall include all such subcontractors as additional insured under its policies (with the exception of Workers' Compensation) or shall ensure that all such subcontractors and subconsultants maintain the required

coverages. Contractor agrees to provide proof of insurance for all such subcontractors and subconsultants upon request by the City.

(6) Workers' Compensation/Employer's Liability Insurance: Contractor shall maintain the coverage as required by statute for each work location and shall maintain Employer's Liability insurance with limits of \$100,000 per occurrence for each bodily injury claim, \$100,000 per occurrence for each bodily injury caused by disease claim, and \$500,000 aggregate for all bodily injuries caused by disease claims. Contractor expressly represents to the City, as a material representation upon which the City is relying in entering into this Agreement, that none of the Contractor's officers or employees who may be eligible under any statute or law to reject Workers' Compensation Insurance shall effect such rejection during any part of the term of this Agreement, and that any such rejections previously effected, have been revoked as of the date Contractor executes this Agreement.

(7) Commercial General Liability: Contractor shall maintain a Commercial General Liability insurance policy with limits of \$1,000,000 for each occurrence, \$1,000,000 for each personal and advertising injury claim, \$2,000,000 products and completed operations aggregate, and \$2,000,000 policy aggregate.

(8) Business Automobile Liability: Contractor shall maintain Business Automobile Liability with limits of \$1,000,000 combined single limit applicable to all owned, hired and non-owned vehicles used in performing services under this Agreement

(9) Additional Provisions:

- (a) For Commercial General Liability, the policies must provide the following:
 - (i) That this Agreement is an Insured Contract under the policy;
 - (ii) Defense costs in excess of policy limits;
 - (iii) A severability of interests or separation of insureds provision (no insured vs. insured exclusion); and
 - (iv) A provision that coverage is primary and non-contributory with other coverage or self-insurance maintained by the City.
- (b) For claims-made coverage:
 - (i) The retroactive date must be on or before the contract date or the first date when any goods or services were provided to the City, whichever is earlier
- (c) Contractor shall advise the City in the event any general aggregate or other aggregate limits are reduced below the required per occurrence limits. At their own expense, and where such general aggregate or other aggregate limits have been reduced below the required per occurrence limit, the Contractor will procure such per occurrence limits and furnish a new certificate of insurance showing such coverage is in force.

SC-17 GREENPRINT DENVER REQUIREMENTS

In accordance with the City and County of Denver Executive Order 123: Greenprint Denver Office and Sustainability Policy, as amended, Contractor shall adhere to sections of Executive Order 123 pertinent to the construction of the built environment. This includes but is not limited to: all construction and renovation of buildings shall follow instructions and memorandum for high performance buildings; horizontal projects shall include the use of fly ash concrete and recycled aggregate where possible; and, all projects shall recycle construction and demolition waste, and install materials that contain recycled content whenever possible using the U.S. Green Building Council Leadership in Energy and Environmental Design (LEED) as guidance. Non-hazardous solid waste that is eligible for reuse or recycling is not subject to the DADS disposal requirement defined in SC-12.

A completed "Greenprint Denver Closeout Form for Construction Projects" shall be delivered to the Project Manager as a submittal requirement of Final Acceptance.

<http://www.denvergov.org/constructioncontracts/Home/ContractorResources/tabid/443154/Default.aspx>

**CITY AND COUNTY OF DENVER
DEPARTMENT OF PUBLIC WORKS**

PERFORMANCE AND PAYMENT BOND

KNOW ALL MEN BY THESE PRESENTS, that we, the undersigned Iron Woman Construction & Environmental Services, LLC, 5680 Emerson Street, Denver, CO 80621,
a corporation organized and existing under and by virtue of the laws of the State of Colorado,
hereafter referred to as the "Contractor", and Fidelity and Deposit Company of Maryland,
a corporation organized and existing under and by virtue of the laws of the State of Illinois,

and authorized to transact business in the State of Colorado, as Surety, are held and firmly bound unto the CITY AND COUNTY OF DENVER, a municipal corporation of the State of Colorado, hereinafter referred to as the "City", in the penal sum of **Two Million, Six Hundred Two Thousand, One Hundred Forty-Two Dollars, and Fifteen Cents (\$ 2,602,142.15)**, lawful money of the United States of America, for the payment of which sum, well and truly to be made, we bind ourselves and our heirs, executors, administrators, successors and assigns, jointly and severally, firmly by these presents;

THE CONDITION OF THE FOREGOING OBLIGATION IS SUCH THAT:

WHEREAS, the above bounden Contractor has entered into a written contract with the aforesaid City for furnishing all labor and tools, supplies, equipment, superintendence, materials and everything necessary for and required to do, perform and complete the construction of **CONTRACT NO. 201845550, ASBURY & TEJON PARK**, Denver, Colorado, and has bound itself to complete the project within the time or times specified or pay liquidated damages, all as designated, defined and described in the said Contract and Conditions thereof, and in accordance with the Plans and Technical Specifications therefore, a copy of said Contract being made a part hereof;

NOW, THEREFORE, if the said Contractor shall and will, in all particulars well and truly and faithfully observe, perform and abide by each and every Covenant, Condition and part of said Contract, and the Conditions, Technical Specifications, Plans, and other Contract Documents thereto attached, or by reference made a part thereof and any alterations in and additions thereto, according to the true intent and meaning in such case, then this obligation shall be and become null and void; otherwise, it shall remain in full force and effect;

PROVIDED FURTHER, that if the said Contractor shall satisfy all claims and demands incurred by the Contractor in the performance of said Contract, and shall fully indemnify and save harmless the City from all damages, claims, demands, expense and charge of every kind (including claims of patent infringement) arising from any act, omission, or neglect of said Contractor, its agents, or employees with relation to said work; and shall fully reimburse and repay to the City all costs, damages, and expenses which it may incur in making good any default based upon the failure of the Contractor to fulfill its obligation to furnish maintenance, repairs or replacements for the full guarantee period provided in the Contract Documents, then this obligation shall be null and void; otherwise it shall remain in full force and effect;

PROVIDED FURTHER, that if said Contractor shall at all times promptly make payments of all amounts lawfully due to all persons supplying or furnishing it or its subcontractors with labor and materials, rental machinery, tools or equipment used or performed in the prosecution of work provided for in the above Contract and that if the Contractor will indemnify and save harmless the City for the extent of any and all payments in connection with the carrying out of such Contract, then this obligation shall be null and void; otherwise it shall remain in full force and effect;

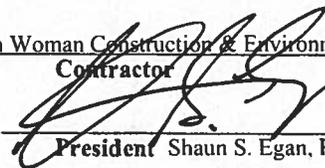
PROVIDED FURTHER, that if the said Contractor fails to duly pay for any labor, materials, team hire, sustenance, provisions, provender, gasoline, lubricating oils, fuel oils, grease, coal, or any other supplies or materials used or consumed by said Contractor or its subcontractors in performance of the work contracted to be done, or fails to pay any person who supplies rental machinery, tools or equipment, all amounts due as the result of the use of such machinery, tools or equipment in the prosecution of the work, the Surety will pay the same in any amount not exceeding the amount of this obligation, together with interest as provided by law;

PROVIDED FURTHER, that the said Surety, for value received, hereby stipulates and agrees that no change, extension of time, alteration or addition to the terms of the Contract, or to contracts with others in connection with this project, or the work to be performed thereunder, or the Technical Specifications and Plans accompanying the same, shall in any way affect its obligation on this bond and it does hereby waive notice of any change, extension of time, alteration or addition to the terms of the Contract, or contracts, or to the work, or to the Technical Specifications and Plans.

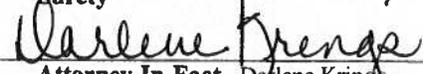
IN WITNESS WHEREOF, said Contractor and said Surety have executed these presents as of this 4th day of MARCH, 2019.

Attest: 
Secretary

Iron Woman Construction & Environmental Services, LLC
Contractor

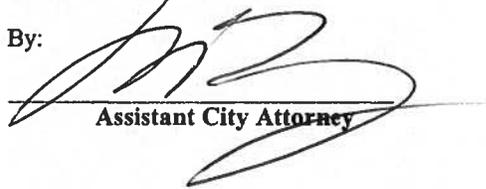
By: 
President Shaun S. Egan, President & CEO

Fidelity and Deposit Company of Maryland
Surety

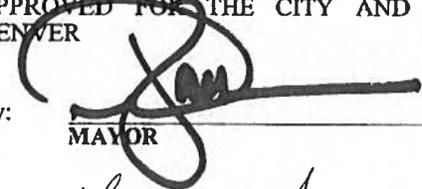
By: 
Attorney-In-Fact Darlene Krings

(Accompany this bond with Attorney-in-Fact's authority from the Surety to execute bond, certified to include the date of the bond).

APPROVED AS TO FORM:
Attorney for the City and County of Denver

By: 
Assistant City Attorney

APPROVED FOR THE CITY AND COUNTY OF DENVER

By: 
MAYOR

By: 
EXECUTIVE DIRECTOR OF PUBLIC WORKS

2

**ZURICH AMERICAN INSURANCE COMPANY
COLONIAL AMERICAN CASUALTY AND SURETY COMPANY
FIDELITY AND DEPOSIT COMPANY OF MARYLAND
POWER OF ATTORNEY**

KNOW ALL MEN BY THESE PRESENTS: That the ZURICH AMERICAN INSURANCE COMPANY, a corporation of the State of New York, the COLONIAL AMERICAN CASUALTY AND SURETY COMPANY, a corporation of the State of Maryland, and the FIDELITY AND DEPOSIT COMPANY OF MARYLAND a corporation of the State of Maryland (herein collectively called the "Companies"), by **DAVID MCVICKER, Vice President**, in pursuance of authority granted by Article V, Section 8, of the By-Laws of said Companies, which are set forth on the reverse side hereof and are hereby certified to be in full force and effect on the date hereof, do hereby nominate, constitute, and appoint **Russell D. LEAR, Kristen PEREIRO, Dulce R. HUGGINS, Darlene KRINGS, K'Anne E. VOGEL, Kelly T. URWILLER, Royal R. LOVELL, Wesley J. BUTORAC and Steve J. BLOHM**, all of GREELEY, Colorado, EACH its true and lawful agent and Attorney-in-Fact, to make, execute, seal and deliver, for, and on its behalf as surety, and as its act and deed: **any and all bonds and undertakings**, and the execution of such bonds or undertakings in pursuance of these presents, shall be as binding upon said Companies, as fully and amply, to all intents and purposes, as if they had been duly executed and acknowledged by the regularly elected officers of the ZURICH AMERICAN INSURANCE COMPANY at its office in New York, New York., the regularly elected officers of the COLONIAL AMERICAN CASUALTY AND SURETY COMPANY at its office in Owings Mills, Maryland., and the regularly elected officers of the FIDELITY AND DEPOSIT COMPANY OF MARYLAND at its office in Owings Mills, Maryland., in their own proper persons.

The said Vice President does hereby certify that the extract set forth on the reverse side hereof is a true copy of Article V, Section 8, of the By-Laws of said Companies, and is now in force.

IN WITNESS WHEREOF, the said Vice-President has hereunto subscribed his/her names and affixed the Corporate Seals of the said ZURICH AMERICAN INSURANCE COMPANY, COLONIAL AMERICAN CASUALTY AND SURETY COMPANY, and FIDELITY AND DEPOSIT COMPANY OF MARYLAND, this 31st day of January, A.D. 2018.

ATTEST:

ZURICH AMERICAN INSURANCE COMPANY
COLONIAL AMERICAN CASUALTY AND SURETY COMPANY
FIDELITY AND DEPOSIT COMPANY OF MARYLAND



By: *Dawn E. Brown*
Assistant Secretary
Dawn E. Brown

David McVicker
Vice President
David McVicker

State of Maryland
County of Baltimore

On this 31st day of January, A.D. 2018, before the subscriber, a Notary Public of the State of Maryland, duly commissioned and qualified, **DAVID MCVICKER, Vice President, and DAWN E. BROWN, Assistant Secretary**, of the Companies, to me personally known to be the individuals and officers described in and who executed the preceding instrument, and acknowledged the execution of same, and being by me duly sworn, deposed and saith, that he/she is the said officer of the Company aforesaid, and that the seals affixed to the preceding instrument are the Corporate Seals of said Companies, and that the said Corporate Seals and the signature as such officer were duly affixed and subscribed to the said instrument by the authority and direction of the said Corporations.

IN TESTIMONY WHEREOF, I have hereunto set my hand and affixed my Official Seal the day and year first above written.

Constance A. Dunn

Constance A. Dunn, Notary Public
My Commission Expires: July 9, 2019



EXTRACT FROM BY-LAWS OF THE COMPANIES

"Article V, Section 8, Attorneys-in-Fact. The Chief Executive Officer, the President, or any Executive Vice President or Vice President may, by written instrument under the attested corporate seal, appoint attorneys-in-fact with authority to execute bonds, policies, recognizances, stipulations, undertakings, or other like instruments on behalf of the Company, and may authorize any officer or any such attorney-in-fact to affix the corporate seal thereto; and may with or without cause modify or revoke any such appointment or authority at any time."

CERTIFICATE

I, the undersigned, Vice President of the ZURICH AMERICAN INSURANCE COMPANY, the COLONIAL AMERICAN CASUALTY AND SURETY COMPANY, and the FIDELITY AND DEPOSIT COMPANY OF MARYLAND, do hereby certify that the foregoing Power of Attorney is still in full force and effect on the date of this certificate; and I do further certify that Article V, Section 8, of the By-Laws of the Companies is still in force.

This Power of Attorney and Certificate may be signed by facsimile under and by authority of the following resolution of the Board of Directors of the ZURICH AMERICAN INSURANCE COMPANY at a meeting duly called and held on the 15th day of December 1998.

RESOLVED: "That the signature of the President or a Vice President and the attesting signature of a Secretary or an Assistant Secretary and the Seal of the Company may be affixed by facsimile on any Power of Attorney...Any such Power or any certificate thereof bearing such facsimile signature and seal shall be valid and binding on the Company."

This Power of Attorney and Certificate may be signed by facsimile under and by authority of the following resolution of the Board of Directors of the COLONIAL AMERICAN CASUALTY AND SURETY COMPANY at a meeting duly called and held on the 5th day of May, 1994, and the following resolution of the Board of Directors of the FIDELITY AND DEPOSIT COMPANY OF MARYLAND at a meeting duly called and held on the 10th day of May, 1990.

RESOLVED: "That the facsimile or mechanically reproduced seal of the company and facsimile or mechanically reproduced signature of any Vice-President, Secretary, or Assistant Secretary of the Company, whether made heretofore or hereafter, wherever appearing upon a certified copy of any power of attorney issued by the Company, shall be valid and binding upon the Company with the same force and effect as though manually affixed.

IN TESTIMONY WHEREOF, I have hereunto subscribed my name and affixed the corporate seals of the said Companies, this ____ day of _____, 20 ____.



Michael Bond, Vice President

TO REPORT A CLAIM WITH REGARD TO A SURETY BOND, PLEASE SUBMIT ALL REQUIRED INFORMATION TO:

Zurich American Insurance Co.
Attn: Surety Claims
1299 Zurich Way
Schaumburg, IL 60196-1056



**PERFORMANCE AND PAYMENT BOND
SURETY AUTHORIZATION
(SAMPLE)**

FAX NUMBER: 720-913-3183
TELEPHONE NUMBER: 720-913-3267

Assistant City Attorney
201 W. Colfax Ave. Dept 1207
Denver, Colorado 80202

RE: Iron Woman Construction & Environmental Services, LLC

Contract No: 201845550
Project Name: ASBURY & TEJON PARK
Contract Amount: \$2,602,142.15
Performance and Payment Bond No.: 9277440

Dear Assistant City Attorney,

The Performance and Payment Bonds covering the above captioned project were executed by this agency, through Fidelity and Deposit Company of Maryland insurance company, on February 27, 2019.

We hereby authorize the City and County of Denver, Department of Public Works, to date all bonds and powers of attorney to coincide with the date of the contract.

If you should have any additional questions or concerns, please don't hesitate to give me a call at 970-266-7102.

Thank you.

Sincerely,

Darlene Krings
Attorney-in-Fact

Denver Public Works/Office of the Executive Director
201 West Colfax Avenue, Dept 608 | Denver, CO 80202
www.denvergov.org/dpw
p. 720.865.8630 | f. 720.865.8795

311 | POCKETGOV.COM | DENVERGOV.ORG | DENVER 8 TV



**PERFORMANCE AND PAYMENT BOND
SURETY AUTHORIZATION
(SAMPLE)**

FAX NUMBER: 720-913-3183
TELEPHONE NUMBER: 720-913-3267

Assistant City Attorney
201 W. Colfax Ave. Dept 1207
Denver, Colorado 80202

RE: (Company name)

Contract No: 201845550
Project Name: ASBURY & TEJON PARK
Contract Amount:
Performance and Payment Bond No.:

Dear Assistant City Attorney,

The Performance and Payment Bonds covering the above captioned project were executed by this agency, through _____ insurance company, on _____, 20__.

We hereby authorize the City and County of Denver, Department of Public Works, to date all bonds and powers of attorney to coincide with the date of the contract.

If you should have any additional questions or concerns, please don't hesitate to give me a call at _____.

Thank you.

Sincerely,

Denver Public Works/Office of the Executive Director
201 West Colfax Avenue, Dept 608 | Denver, CO 80202
www.denvergov.org/dpw
p. 720.865.8630 | f. 720.865.8795

311 | POCKETGOV.COM | DENVERGOV.ORG | DENVER 8 TV



NOTICE OF APPARENT LOW BIDDER
(SAMPLE)

Current Date

To:

Gentlemen:

The MANAGER OF PUBLIC WORKS has considered the Bids submitted on DATE for work to be done and materials to be furnished in and for:

Contract No. 201845550 ASBURY & TEJON PARK

as set forth in detail in the Contract Documents for the City and County of Denver, Colorado. It appears that your Bid is fair, equitable, and to the best interest of the City and County; therefore, said Bid is hereby accepted at the bid price contained herein, subject to execution of the Contract Documents and your furnishing the items specified below, the total cost thereof (Contract Amount Written), (Contract Amount Numeric).

It will be necessary for you to appear forthwith at the office of the Department of Public Works, Finance and Administration, 201 W. Colfax Ave. Dept 614, Denver, Colorado 80202, to receive the said Contract Documents, execute the same and return them to the Department of Public Works, Finance and Administration, within the time limit set forth in the Bid Proposal.

In accordance with the requirements set forth in the Contract Documents, you are required to furnish the following documents:

- a. Insurance Certificates: General Liability and Automotive Liability, Workman's Compensation and Employer Liability; or any other coverage required by the contract; and
- b. One original plus four copies of the Power of Attorney relative to Performance and/or Payment Bond;

All construction Contracts made and entered into by the City and County of Denver are subject to Affirmative Action and Equal Opportunity Rules and Regulations, as adopted by the Manager of Public Works, and each contract requiring payment by the City of one-half million dollars (\$500,000.00) or more shall first be approved by the City Council acting by ordinance and in accordance with Section 3.2.6 of the Charter of the City and County of Denver.

Prior to issuance of Notice to Proceed, all Equal Opportunity requirements must be completed. Additional information may be obtained by contacting the Director of Contract Compliance at (720-913-1700).

**NOTICE OF APPARENT LOW BIDDER
(SAMPLE)**

CONTRACT NO. 201845550

Page 2

The Bid Security submitted with your Bid, will be returned upon execution of the Contract and furnishing of the Performance Bond. In the event you should fail to execute the Contract and to furnish the performance Bond within the time limit specified, said Bid Security will be retained by the City and County of Denver as liquidated damages, and not as a penalty for the delay and extra work caused thereby.

Dated at Denver, Colorado this _____ day of _____ 20____.

CITY AND COUNTY OF DENVER

By _____
Manager of Public Works

Denver Public Works/Office of the Executive Director
201 West Colfax Avenue, Dept 608 | Denver, CO 80202
www.denvergov.org/dpw
p. 720.865.8630 | f. 720.865.8795

311 | POCKETGOV.COM | DENVERGOV.ORG | DENVER 8 TV



Current Date

**NOTICE TO PROCEED
(SAMPLE)**

Name
Company
Street
City/State/Zip

CONTRACT NO. 201845550, ASBURY & TEJON PARK

In accordance with General Contract Condition 302 of the Standard Specifications for Construction, General Contract Conditions, 2011 Edition, you are hereby authorized and directed to proceed on _____ with the work of constructing contract number 201845550, as set forth in detail in the contract documents for the City and County of Denver.

With a contract time of _____ calendar days, the project must be complete on or before _____.

If you have not already done so, you must submit your construction schedule, in accordance with General Contract Condition 306.2.B, to the Project Manager within 10 days. Additionally, you must submit your tax exempt certificate, and copies of your subcontractors' certificates, in accordance with General Contract Condition 323.5, to the Project Manager as soon as possible. Failure to submit these certificates will delay processing of payment applications.

Sincerely,

Lesley B. Thomas
City Engineer

cc:

Denver Public Works/Office of the Executive Director
201 West Colfax Avenue, Dept 608 | Denver, CO 80202
www.denvergov.org/dpw
p. 720.865.8630 | f. 720.865.8795

311 | POCKETGOV.COM | DENVERGOV.ORG | DENVER 8 TV



Certificate of Contract Release
(SAMPLE)

Date

Name
Company
Street
City/State/Zip

RE: Certificate of Contract Release for
201845550, ASBURY & TEJON PARK

Received this date of the City and County of Denver, as full and final payment of the cost of the improvements provided for in the foregoing contract, _____ dollars and _____ cents (\$_____), in cash, being the remainder of the full amount accruing to the undersigned by virtue of said contract; said cash also covering and including full payment for the cost of all extra work and material furnished by the undersigned in the construction of said improvements, and all incidentals thereto, and the undersigned hereby releases said City and County of Denver from any and all claims or demands whatsoever, regardless of how denominated, growing out of said contract.

And these presents are to certify that all persons performing work upon or furnishing materials for said improvements under the foregoing contract have been paid in full and this payment to be made is the last or final payment.

Contractor's Signature

Date Signed

If there are any questions, please contact me by telephone at (720) 913-XXXX. Please return this document via facsimile at (720) 913-1805 and mail to original to the above address.

Denver Public Works/Office of the Executive Director
201 West Colfax Avenue, Dept 608 | Denver, CO 80202
www.denvergov.org/dpw
p. 720.865.8630 | f. 720.865.8795

311 | POCKETGOV.COM | DENVERGOV.ORG | DENVER 8 TV

CITY AND COUNTY OF DENVER

STATE OF COLORADO



DENVER
THE MILE HIGH CITY

DEPARTMENT OF PUBLIC WORKS

Prevailing Wage Rates

Contract Number: 201845550



Asbury & Tejon Park

December 5, 2018



DENVER
THE MILE HIGH CITY

Office of Human Resources

201 W. Colfax, Department 412

Denver, CO 80202

p: 720.913.5751

f: 720.913.5720

www.denvergov.org/humanresources

TO: All Users of the City of Denver Prevailing Wage Schedules

FROM: Susan Keller, Human Resources Technician, Classification & Compensation

DATE: Monday, October 15, 2018

SUBJECT: Latest Change to Prevailing Wage Schedules

Please be advised, prevailing wage rates for some building, heavy, highway, and residential construction trades have not been updated by the United States Department of Labor (DOL) since March 1, 2002. The Career Service Board, in their meeting held on April 21, 2011, approved the use of the attached supplemental wage rates until prevailing wage rates for these classifications of work are again published by the United States Department of Labor in accordance with the Davis-Bacon Act.

The effective date for this publication will be **Friday, October 12, 2018** and applies to the City and County of Denver for **HEAVY CONSTRUCTION PROJECTS** in accordance with the Denver Revised Municipal Code, Section 20-76(c).

General Wage Decision No. CO180012
Superseded General Decision No. CO20170012
Modification No. 8
Publication Date: 10/12/2018
(6 pages)

Unless otherwise specified in this document, apprentices shall be permitted only if they are employed pursuant to, and individually registered in, a bona fide apprenticeship program registered with the U.S. Department of Labor (DOL). The employer and the individual apprentice must be registered in a program, which has received prior approval, by the DOL. Any employer, who employs an apprentice and is found to be in violation of this provision, shall be required to pay said apprentice the full journeyman scale.

Attachments as listed above.

General Decision Number: CO180012 10/12/2018 CO12

Superseded General Decision Number: CO20170012

State: Colorado

Construction Type: Heavy

Counties: Adams, Arapahoe, Boulder, Broomfield, Denver, Douglas, El Paso, Jefferson, Larimer, Mesa, Pueblo and Weld Counties in Colorado.

HEAVY CONSTRUCTION PROJECTS

Note: Under Executive Order (EO) 13658, an hourly minimum wage of \$10.35 for calendar year 2018 applies to all contracts subject to the Davis-Bacon Act for which the contract is awarded (and any solicitation was issued) on or after January 1, 2015. If this contract is covered by the EO, the contractor must pay all workers in any classification listed on this wage determination at least \$10.35 per hour (or the applicable wage rate listed on this wage determination, if it is higher) for all hours spent performing on the contract in calendar year 2018. The EO minimum wage rate will be adjusted annually. Please note that this EO applies to the above-mentioned types of contracts entered into by the federal government that are subject to the Davis-Bacon Act itself, but it does not apply to contracts subject only to the Davis-Bacon Related Acts, including those set forth at 29 CFR 5.1(a)(2)-(60). Additional information on contractor requirements and worker protections under the EO is available at www.dol.gov/whd/govcontracts.

Modification Number	Publication Date
0	01/05/2018
1	01/12/2018
2	02/02/2018
3	02/09/2018
4	03/02/2018
5	07/13/2018
6	08/03/2018
7	08/31/2018
8	10/12/2018

ASBE0028-001 07/01/2018

	Rates	Fringes
Asbestos Workers/Insulator (Includes application of all insulating materials, protective coverings, coatings and finishings to all types of mechanical systems).....	\$ 31.73	14.23

BRCO0007-004 01/01/2018

ADAMS, ARAPAHOE, BOULDER, BROOMFIELD, DENVER, DOUGLAS, JEFFERSON AND WELD COUNTIES

	Rates	Fringes
BRICKLAYER.....	\$ 27.98	10.04

 BRCO0007-006 05/01/2018

EL PASO AND PUEBLO COUNTIES

	Rates	Fringes
BRICKLAYER.....	\$ 25.88	10.34

 * ELEC0012-004 09/01/2018

PUEBLO COUNTY

	Rates	Fringes
ELECTRICIAN		
Electrical contract over		
\$1,000,000.....	\$ 27.70	12.30+3%
Electrical contract under		
\$1,000,000.....	\$ 24.85	12.30+3%

 ELEC0068-001 06/01/2018

ADAMS, ARAPAHOE, BOULDER, BROOMFIELD, DENVER, DOUGLAS,
 JEFFERSON, LARIMER, AND WELD COUNTIES

	Rates	Fringes
ELECTRICIAN.....	\$ 35.80	15.45

 ELEC0111-001 09/01/2017

	Rates	Fringes
Line Construction:		
Groundman.....	\$ 25.68	25.25%+\$5.75
Line Equipment Operator.....	\$ 31.35	25.25% + \$5.75
Lineman and Welder.....	\$ 44.92	25.25%+\$5.75

 ELEC0113-002 06/01/2018

EL PASO COUNTY

	Rates	Fringes
ELECTRICIAN.....	\$ 31.80	15.90

 ELEC0969-002 06/01/2015

MESA COUNTY

	Rates	Fringes
ELECTRICIAN.....	\$ 24.00	7.92

 ENGI0009-001 05/01/2017

Rates	Fringes
-------	---------

Power equipment operators:

Blade: Finish.....	\$ 27.92	10.10
Blade: Rough.....	\$ 27.60	10.10
Bulldozer.....	\$ 27.60	10.10
Cranes: 50 tons and under..	\$ 27.75	10.10
Cranes: 51 to 90 tons.....	\$ 27.92	10.10
Cranes: 91 to 140 tons.....	\$ 28.55	10.10
Cranes: 141 tons and over...	\$ 29.82	10.10
Forklift.....	\$ 27.22	10.10
Mechanic.....	\$ 28.08	10.10
Oiler.....	\$ 26.84	10.10
Scraper: Single bowl under 40 cubic yards.....	\$ 27.75	10.10
Scraper: Single bowl, including pups 40 cubic yards and over and tandem bowls.....	\$ 27.92	10.10
Trackhoe.....	\$ 27.75	10.10

IRON0024-003 06/01/2018

	Rates	Fringes
Ironworkers:.....	\$ 27.45	22.11
Structural		

LABO0086-001 05/01/2009

	Rates	Fringes
Laborers:		
Pipelayer.....	\$ 18.68	6.78

PLUM0003-005 06/01/2017

ADAMS, ARAPAHOE, BOULDER, BROOMFIELD, DENVER, DOUGLAS,
JEFFERSON, LARIMER AND WELD COUNTIES

	Rates	Fringes
PLUMBER.....	\$ 39.08	16.44

* PLUM0058-002 07/01/2018

EL PASO COUNTY

	Rates	Fringes
Plumbers and Pipefitters.....	\$ 32.75	14.85

* PLUM0058-008 07/01/2018

PUEBLO COUNTY

	Rates	Fringes
Plumbers and Pipefitters.....	\$ 32.75	14.85

PLUM0145-002 07/01/2016

MESA COUNTY

	Rates	Fringes
Plumbers and Pipefitters.....	\$ 35.17	11.70

PLUM0208-004 06/01/2016

ADAMS, ARAPAHOE, BOULDER, BROOMFIELD, DENVER, DOUGLAS,
JEFFERSON, LARIMER AND WELD COUNTIES

	Rates	Fringes
PIPEFITTER.....	\$ 37.10	16.62

SHEE0009-002 07/01/2018

	Rates	Fringes
Sheet metal worker.....	\$ 34.02	17.49

TEAM0455-002 07/01/2018

	Rates	Fringes
Truck drivers:		
Pickup.....	\$ 21.41	4.32
Tandem/Semi and Water.....	\$ 22.04	4.32

SUCO2001-006 12/20/2001

	Rates	Fringes
BOILERMAKER.....	\$ 17.60	
Carpenters:		
Form Building and Setting...	\$ 16.97	2.74
All Other Work.....	\$ 15.14	3.37
Cement Mason/Concrete Finisher...	\$ 17.31	2.85
IRONWORKER, REINFORCING.....	\$ 18.83	3.90
Laborers:		
Common.....	\$ 11.22	2.92
Flagger.....	\$ 8.91	3.80
Landscape.....	\$ 12.56	3.21
Painters:		
Brush, Roller & Spray.....	\$ 15.81	3.26
Power equipment operators:		
Backhoe.....	\$ 16.36	2.48
Front End Loader.....	\$ 17.24	3.23
Skid Loader.....	\$ 15.37	4.41

WELDERS - Receive rate prescribed for craft performing
operation to which welding is incidental.

Office of Human Resources
Supplemental rates
(Specific to the Denver Projects)
(Supp #74, Date: 02-03-2012)

Classification		Base	Fringe
Ironworker	Ornamental	\$24.80	\$10.03
Laborer	Group 1	\$18.18	\$8.27
	Group 2	\$21.59	\$8.61
Laborer (Janitor)	Janitor/Yardmen	\$17.68	\$8.22
Laborer (Asbestos)	Removal of Asbestos	\$21.03	\$8.55
Laborer (Tunnel)	Group 1	\$18.53	\$8.30
	Group 2	\$18.63	\$8.31
	Group 3	\$19.73	\$8.42
	Group 4	\$21.59	\$8.61
	Group 5	\$19.68	\$8.42
Line Construction	Lineman, Gas Fitter/Welder	\$36.88	\$9.55
	Line Eq Operator/Line Truck Crew	\$25.74	\$8.09
Millwright		\$28.00	\$10.00
Power Equipment Operator	Group 1	\$22.97	\$10.60
	Group 2	\$23.32	\$10.63
	Group 3	\$23.67	\$10.67
	Group 4	\$23.82	\$10.68
	Group 5	\$23.97	\$10.70
	Group 6	\$24.12	\$10.71
	Group 7	\$24.88	\$10.79
Power Equipment Operator (Tunnels above and below ground, shafts and raises):	Group 1	\$25.12	\$10.81
	Group 2	\$25.47	\$10.85
	Group 3	\$25.57	\$10.86
	Group 4	\$25.82	\$10.88
	Group 5	\$25.97	\$10.90
	Group 6	\$26.12	\$10.91
	Group 7	\$26.37	\$10.94
Truck Driver	Group 1	\$18.42	\$10.00
	Group 2	\$19.14	\$10.07
	Group 3	\$19.48	\$10.11
	Group 4	\$20.01	\$10.16
	Group 5	\$20.66	\$10.23
	Group 6	\$21.46	\$10.31

Go to <http://www.denvergov.org/Auditor> to view the Prevailing Wage Clarification Document for a list of complete classifications used.

CITY AND COUNTY OF DENVER

STATE OF COLORADO



DENVER
THE MILE HIGH CITY

DEPARTMENT OF PUBLIC WORKS

Addenda

Contract Number: 201845550



Asbury & Tejon Park

December 5, 2018

CITY AND COUNTY OF DENVER
DEPARTMENT OF PUBLIC WORKS

CONTRACT NO: 201845550
PROJECT NAME: ASBURY & TEJON PARK

ADDENDUM NO. 1 TO CONTRACT DOCUMENTS

Bidders are hereby instructed that the drawings, specifications, and other contract documents are modified, corrected, supplemented and/or superseded for the above-mentioned project as hereinafter described in the following attachments:

POSTPONEMENT OF BID OPENING

CITY AND COUNTY OF DENVER
DEPARTMENT OF PUBLIC WORKS
Contract No. 201845550 Asbury & Tejon Park

POSTPONEMENT OF BID OPENING

Notice is hereby given that Sealed Bids for Contract No. 201845550, Asbury & Tejon Park are hereby postponed from January 17, 2019. Sealed bids will be received at 201 W. Colfax Ave., Denver, CO 80202 no later than:
11:00 a.m., Local Time
February 7, 2019
Room 6.G.7

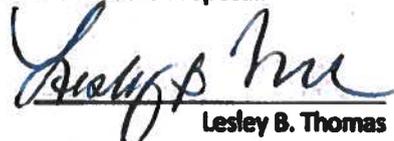
Published in the Daily Journal: January 15, 16, 17, 2019

EXTENSION OF QUESTIONS DEADLINE

Questions may be submitted in writing by bidders no later than January 18, 2019, 5:00 p.m. local time to pw.procurement@denvergov.org ; for response by means of a forthcoming Addendum.

Prior to submitting a bid, the bidder shall consult the Contractor's bulletin board, located on the 2nd floor at 201 W. Colfax Avenue, Denver, CO 80202 and www.work4denver.com.

This ADDENDUM shall be attached to, become a part of, and be returned with the Bid Proposal.


Lesley B. Thomas
City Engineer

Date: 1.10.19

The undersigned bidder acknowledges receipt of this Addendum. The Proposal submitted herewith is in accordance with the stipulations set forth herein.

**IRON WOMAN CONSTRUCTION &
ENVIRONMENTAL SERVICES LLC**
Contractor

ADDENDUM NO. 1

Date: 1/10/2019


IRON WOMAN CONSTRUCTION

CITY AND COUNTY OF DENVER

STATE OF COLORADO



DENVER
THE MILE HIGH CITY

DEPARTMENT OF PUBLIC WORKS

Technical Specifications &
Drawings Contract Number:

201845550



Asbury & Tejon Park

December 5, 2018



DENVER

PUBLIC WORKS

Wastewater Capital Projects Management

Asbury and Tejon Park

Project Technical Specifications

October 2018

TABLE OF CONTENTS

1. City and County of Denver Engineering Division, Wastewater Capital Project Management Standard Construction Specifications, dated March 15, 2016
2. Supplemental Measurement & Payment
3. Project Special Provisions
4. Supplemental Technical Specifications
 - a. 31 23 00, Earthwork
 - b. 31 23 19, Water Control and Dewatering
 - c. 31 37 00, Riprap, Boulders, Soil Riprap, Void-Filled Riprap and Bedding
 - d. 31 37 19, Grouted Boulders and Stacked Grouted Boulders
5. Denver Parks and Recreation Technical Specifications and Measurement and Payment, dated October 2018
6. Project Geotechnical Report: Geotechnical Engineering Study, Asbury & Tejon Park Improvements, dated March 24, 2017
7. Materials Management Plan: Draft Materials Management Plan, Tejon and Asbury Park Water Quality Project Denver, CO, dated December 28, 2017
8. CDPS General Permit COG070000 Construction Dewatering Discharges, Certification Number: COG076281.
9. Example Carlsonator System from High Line Canal for Contractors Reference



DENVER

PUBLIC WORKS

Wastewater Capital Projects Management

**Wastewater Capital Project Management Standard
Construction Specifications, dated March 15, 2016**

For Asbury and Tejon Park

October 2018



DENVER

PUBLIC WORKS

CITY AND COUNTY OF DENVER
ENGINEERING DIVISION

Wastewater Capital Projects Management Standard Construction Specifications

March 15, 2016



CITY AND COUNTY OF DENVER
ENGINEERING DIVISION

Wastewater Capital Projects Management Standard Construction Specifications

Table of Contents

<i>Section</i>	<i>Page</i>
1.0	Scope.....1-1
01-1416	Public Information Services011416-1
01-5213	Temporary Office Facilities015213-1
2.0	Site Preparation2-1
02-2213	Vibration Assessment022213-1
3.0	Existing Facilities3-1
4.0	Utility Trenching and Excavation4-1
5.0	Bedding and Backfilling.....5-1
6.0	Surface Restoration.....6-1
7.0	Pipe Jacking, Boring, Casing and Micro Tunneling
7.1	Tunneling, Jacking and Boring.....7.1-1
7.2	Micro Tunneling7.2-1
7.3	Shaft Excavation and Support7.3-1
7.4	Permeation Grouting.....7.4-1
7.5	Compensation Grouting7.5-1
8.0	Structural Excavation8-1
9.0	Testing, Inspection and Acceptance9-1
10.0	Storm/Sanitary Sewer Pipe and Culverts
10.1	Precast Concrete Pipe10.1-1
10.3	Precast Reinforced Box Conduits10.3-1
10.4	Reinforced Polymer Mortar Pipe10.4-1

10.5	Ductile Iron Pipe	10.5-1
10.6	Polyvinyl Chloride (PVC) Sewer Pipe	10.6-1
10.7	Cured In Place Pipe.....	10.7-1
10.20	Pipe Bursting.....	10.20-1
11.0	Structures and Appurtenances	11-1
12.0	Riprap Boulders and Slope/Channel Protection	12-1
13.0	Fencing.....	13-1
14.0	Removal and Disposal of Construction Debris and Contaminated Materials	14-1
15.0	Reserved	
20.0	Grass Sodding.....	20-1
21.0	Sprinkler Systems.....	21-1
22.0	Seeding.....	22-1
23.0	Storm Water Management.....	23-1
25.0	Hot-Mix Asphalt Pavement.....	25-1
26.0	Excavation and Embankment	26-1
31-3223.12	Soil Improvement by Compaction Grouting	31322312-1
47.0	Construction Survey and Monumentation	47-1

Supplemental Information

Measurement and Payment	Pages 1 thru 53
-------------------------------	-----------------



CITY AND COUNTY OF DENVER
ENGINEERING DIVISION

Wastewater Capital Projects Management Standard Construction Specification

01-00 Scope

These Standard Construction Specifications set forth the provisions applicable to storm, sanitary and other related construction on Wastewater Capital projects, as specified. The general contractor is responsible for all materials and equipment necessary to perform all operations in connection with the construction of the facilities as described in approved plans, the most recent edition of these Standard Construction Specifications and the Wastewater Management Division Standard Details.

END OF SPECIFICATION



CITY AND COUNTY OF DENVER
ENGINEERING DIVISION

Wastewater Capital Projects Management Standard Construction Specification

01-1416 PUBLIC INFORMATION SERVICES

PART 1- General

1.01 Description

The Work consists of providing various public involvement activities for the Project. Additional requirements may be included elsewhere within the Contract Documents.

Public information services shall include, at minimum, the following:

- a) Responding to questions concerning Project activities and schedules
- b) Participating in, and documenting meetings held with affected individuals, residents and/or business
- c) Maintaining ongoing communication with residents and businesses directly impacted by construction activities and traffic control plans for the project
- d) Maintaining a written log which documents calls and concerns. The log shall include: the nature of the concern, response(s) provided, date of completion for any required remedial action and any necessary future follow up with a frequency.

1.02 Submittals

The following shall be submitted to the Construction Project Manager:

- a) All construction notification letters intended for use on the project, shall be submitted for approval by the Construction Project Manager prior to issuance of a notice to proceed. Updated notification letters intended for distribution to the public will require re-review and approval prior to issuance and may require additional time for coordination through the district City Council office.
- b) The qualifications of the Contractor's assigned Public Information Manager shall be submitted to the Construction Project Manager prior to the preconstruction meeting for review
- c) An updated written log for calls and concerns received will be submitted on a weekly basis, unless directed otherwise

Part 2 – Product

Part 3 – Execution

3.01 Public Information Manager

A Public Information Manager (PIM) for the Project shall be designated by the Contractor at the preconstruction meeting. The PIM shall be primarily responsible for maintaining communications and providing information on a regular basis to businesses and property owners affected by and adjacent to the work. The PIM shall be available on every calendar day and at all times during the course of the project from Contract Award through issuance of Final Acceptance. Interpretation services may be necessary and must be made available to ensure appropriate assistance is provided.

The PIM shall have a minimum of two Projects of previous experience in work with communications on similar Projects.

If directed by the Construction Project Manager, the PIM shall:

- a) attend regularly scheduled meetings of local neighborhood and business associations to discuss the project and schedule
- b) provide interpretation services
- c) distribute additional notifications to the public which provide project related information, service interruptions, or general construction progress updates
- d) provide timely input and review public information intended for use in neighborhood newsletters or publications, City Council updates, and local news media interviews or articles
- e) provide information, documents, photographs, input and review for information posted on City sponsored websites
- f) coordinate and communicate with adjacent projects/work, as well as utility companies working within the project limits to ensure proper notification of effected residents and business owners occurs and does not negatively impact the project

3.02 Public Information Phone Line

The Contractor shall provide a public information, local call line for the Project which is accessible 24 hours a day, 7 days a week. The public information line shall be answered by a person with direct knowledge of the Project or by an answering machine with current Project information that is updated on a weekly basis and allows the recording of a message from the caller. Cellular phones are acceptable. All calls shall be returned by the PIM or their designee within 24 hours. This phone number shall also appear on the project signs and on all information distributed for the Project.

3.03 Construction Notification Letter

The Contractor shall be required to prepare, submit for review and distribute construction notifications a minimum of 7 calendar days prior to starting work on each block. Notification and coordination shall occur with: property owners, tenants and/or businesses directly adjacent to or affected by the work, as well as those on side streets near the work site. It is the Contractor's responsibility to maintain ongoing communication with the affected property owners, tenants and/or businesses.

The notification shall provide a brief summary of the Project scope, work activities associated with the type of construction, general safety guidelines for the public and an anticipated completion date for the Project. In addition, the notification shall provide the name of the PIM and their telephone number. Notifications shall be updated and redistributed every two to

three weeks until construction is completed. The Contractor shall allow time for the Construction Project Manager to review and approve all updated notification letters prior to distribution.

End of Specification



CITY AND COUNTY OF DENVER
ENGINEERING DIVISION

Wastewater Capital Projects Management Standard Construction Specification

01-5213 TEMPORARY OFFICE FACILITIES

PART 1- General

1.01 Description

This specification covers temporary office facilities during construction activities above that normally provided by the Contractor for use by the City and their designated personnel. This specification only applies when the corresponding bid item for temporary office facilities is included and is specifically stipulated in the contract documents.

The purpose of the temporary office facilities is to provide the necessary working area and resources for project team member meetings, City Construction Project Managers, City Construction Project Inspectors, Project Resident Engineers, or their designees.

The City and County of Denver is not responsible for the safety of the temporary office facilities and compliance with this specification does not relieve the Contractor of full responsibility for damage caused by the Contractor's operations.

1.02 Submittals

All submittals for this item shall be provided to the City Construction Project Manager for record keeping purposes and verification of conformance with the contract documents. These submittals or approval of the submittals does not shift liability or relieve the Contractor from full responsibility for adherence to specification.

Provide a detailed submittal for review and acceptance by the City Construction Project Manager detailing the product requirements described in Part 2 of this specification. Detail the location and layout of the temporary office facilities in the submittal(s).

PART 2- Product

2.01 Temporary Office Space

The Contractor shall furnish and maintain a temporary office facility at or adjacent to the work site for use by City Construction Project Managers, City Construction Project

Inspectors, Project Resident Engineers, and/or their designees. An individual desk space is required for City Construction Project Inspectors, the City Construction Project Manager, and/or Project Resident Engineer; and additional space may be needed for specialty inspectors (geotechnical, structural, etc.)

Each individual desk space shall include one standard size desk with drawers, one desk chair and one side chair, a book case, a plan rack, a waste basket, lighting (50 foot candles at desk top), a duplex electrical outlet (110-volt), access to high speed internet (minimum 20Mbps), and a printer (capable of printing and scanning standard, legal, and 11-inch by 17-inch color prints).

The temporary office shall be structurally sound, secure, vandal resistant, weather tight, with floors raised above ground and have interior and exterior lighting. The temporary office shall be provided with automatic heating and mechanical cooling equipment to maintain comfort conditions of 70 degrees Fahrenheit year round and provide convenient access to potable drinking water and toilet facilities cleaned at least twice per month.

2.02 Temporary Meeting Space

The Contractor shall furnish and maintain a temporary meeting space at the work site within the temporary office facility for use by project team members during meetings. The temporary meeting space shall be large enough to accommodate at least 8-persons, including a table and chairs. The meeting space shall have multiple wall mounted cork boards and white boards and a large wall mounted display clock for help in facilitating meetings.

PART 3- Execution

Provide the City with and maintain full access to the temporary office facilities at least two weeks prior to starting ground disturbance at the project site. Allow the City and/or their designees' full access to the temporary office facilities during the duration of the project; including weekends, nights, and holidays if warranted by the project. Provide temporary access roads and maintenance if required to maintain access to the temporary office facilities. Provide snow removal as required.

The temporary office facilities shall be removed within 30 days after they are no longer needed or as directed by the City Construction Project Manager.

END OF SPECIFICATION



CITY AND COUNTY OF DENVER
ENGINEERING DIVISION

Wastewater Capital Projects Management Standard Construction Specification

2.0 Site Preparation

2.0.1 General

The site of all trenches shall be cleared of all vegetation, stumps, roots, sod, and debris prior to excavating. Fences, walls, curbs, sidewalks, gutters, crosspans, poles, or any other structures stipulated on the drawings to be removed, or otherwise authorized by the Construction Project Manager to be removed, shall be removed and later replaced in a manner acceptable to the City and equivalent to its original undisturbed condition. Except as otherwise shown on the Drawings or otherwise specified herein all unsalvageable materials shall be removed or hauled from the site and disposed of by the Contractor at his expense. Unless otherwise specified in the Contract Documents or elsewhere in these Standard Construction Specifications, all salvageable materials and items shall become the property of the City. If, in the event it is specified that certain salvageable materials are to become property of the Contractor, no payment will be made for the removal of those items or materials.

2.0.2 Stockpiling of Excavated Materials, Pipe, Etc.

In accordance with and in addition to the requirements set forth in GC's 801-807 of the General Contract Conditions, no excavated materials, pipe, equipment, or any other items shall be stockpiled or stored on private property without the express written approval of the property owner of record. Duplicate copies of any written approval or authorization given to the Contractor shall be submitted to the Construction Project Manager and shall be so worded as to hold harmless the City of any responsibility whatsoever related to the stockpiling and storage of material and equipment. All costs incurred shall be borne by the Contractor.

2.0.3 Construction Easements

All additional temporary construction easements that the Contractor feels are necessary to perform the required work shall be coordinated, obtained and paid for by the Contractor. If these easements are granted to the Contractor, they shall be so worded as to hold harmless the City of any responsibility whatsoever related to any temporary construction easement obtained by the Contractor. Duplicate copies of the written authorization shall be submitted to the Construction Project Manager. All costs incurred under this item shall be borne solely by the Contractor.

End of Specification



CITY AND COUNTY OF DENVER
ENGINEERING DIVISION

Wastewater Capital Projects Management Standard Construction Specification

02-2213 Vibration Assessment

Part 1 - General

1.01 Description

This specification covers vibration monitoring during construction activities to include an existing condition survey, baseline equipment monitoring and the establishment of a vibration monitoring program for use during construction operations. . This specification only applies when the corresponding bid item for vibration assessment is included and is specifically stipulated in the contract documents.

The purpose of the vibration monitoring program is to assess possible impacts that construction activities might have to adjacent facilities during all phases of the work. These facilities include, but are not limited to buildings, bridges, underground utilities, surface facilities, structure foundations, and all other facilities within the proximity of the work.

The City and County of Denver is not responsible for the safety of the Work and compliance with this specification does not relieve the Contractor of full responsibility for damage caused by the Contractor's operations.

1.02 Submittals

All submittals are submitted to the Construction Project Manager for record keeping purposes and verification of conformance with the contract documents. These submittals do not shift liability or relieve the Contractor from full responsibility for damage that is deemed to be caused by the Contractor's operations.

- A. An independent vibration monitoring consultant will be used to fulfill the requirements of this section. The Contractor shall submit references for the consultant detailing at least

PWWCPM_SCS
SCS 022213-1

Revised: March 15, 2016

- two projects completed in the past five years where the vibration monitoring consultant has satisfactorily monitored construction operations by recording maximum peak particle velocities (PPVs). Include contact information for each reference. This information shall be submitted to the Construction Project Manager for acceptance prior to beginning use of the Consultant's services.
- B. The Contractor shall submit any facility condition survey that is done to the Construction Project Manager within 2 weeks of completion of the survey.
 - C. At a minimum, the Contractor shall submit any data and documentation derived from vibration monitoring along with interpretations of the results from the vibration monitoring consultant to the Construction Project Manager on a monthly basis.
 - D. The contractor shall offer formal training on how to access any web base data access site. A technical manual detailing all procedures for accessing the site shall be offered at the training session and submitted to the Construction Project Manager.

Part 2 – Product

Part 3 – Execution

3.01 Facility Condition Survey

This work shall consist of performing a facility condition survey(s) and preparing permanent records as indicated in this specification prior to the commencement of work, after completion of work, and at locations and times during construction as needed to verify that adjacent facilities have not been damaged by any element of the work.

3.02 Vibration Monitoring Consultant

- A. The Contractor shall, as specifically indicated in this specification, provide vibration monitoring to verify that construction activities will not or have not damaged adjacent facilities.
- B. The Contractor will obtain the services of an independent vibration monitoring consultant to assist in developing an existing condition survey, establish a vibration monitoring plan to include baseline and continuous monitoring, and interpret the results of the vibration monitoring as it relates to adjacent facilities.
- C. Vibration monitoring will be done near elements of the construction work which are likely to have the largest potential to damage adjacent facilities during the course of construction operations. This monitoring will be used to establish a baseline reading of these activities and will be done at a location of the work which is least likely to damage adjacent property. The vibration monitoring consultant will review the results of the

- baseline monitoring program and submit the results and their interpretation of the findings to the Construction Engineer in a report submitted on a monthly basis.
- D. Vibration monitoring will take place on a continuous basis during all construction activities. Continuous vibration monitoring will be done throughout the project at locations that are nearest the construction activities and which have the potential to damage nearby facilities. The location and number of vibration monitoring instruments will be as directed by the vibration monitoring consultant based on the results of the baseline monitoring, their interpretation of these results, and their experience based on the type of activity and proximity to nearby facilities.
 - E. The Consultant/Contractor shall provide protection for all instrumentation from vandalism or theft. Any costs associated with vandalism or theft shall be born by the general contractor. The City and County of Denver shall at no time entertain any claim for loss associated with vandalism or theft of instrumentation.
 - F. The vibration monitoring consultant will be a PE licensed in the state of Colorado, and will have performed vibration monitoring services in Colorado to include monitoring construction operations to record maximum peak particle velocities.
 - G. The Consultant/Contractor will submit monthly reports to the Construction Project Manager which detail the baseline monitoring results, a summary of the continuous vibration monitoring results at locations nearest the construction activities and include a summary interpretation of all the results collected over the past month.

END OF SPECIFICATION



CITY AND COUNTY OF DENVER
ENGINEERING DIVISION

Wastewater Capital Projects Management Standard Construction Specification

3.0 Existing Facilities

3.0.1 General

The Contractor shall at all times take extreme and proper precautions for the protection of utilities, the presence of which are known or can be determined by the examination of appropriate utility maps, use of electronic locating, exploratory excavations, etc. The Contractor shall be responsible for all costs associated with the repair of any service and/or utility damaged by construction.

The Contractor shall notify Denver Water, Xcel Energy, telephone, cable and fiber optic companies, as well as property owners and all other interested parties, prior to commencement of work in order to ensure that there will not be service interruptions during construction. Existing utility lines and utility poles, trees, shrubbery, fences, water mains, gas mains, sewers, cables, conduits, curb, gutter, walks, and other structures in the vicinity of the work not authorized to be removed, shall be supported and protected from damage by the Contractor until all construction and related work is complete. The Contractor shall be liable for all damages to existing facilities, structures, and property.

3.0.2 Utilities

Utilities, underground and above-ground, shall include but not be limited to: fiber optics (including empty ducts), gas, telephone, electric, steam, water, sanitary and storm sewers, telegraph lines, conduits, all abandoned utilities, etc., and their accessories, appurtenances and service connections. The type, size, location, and number of all known above-ground and underground utilities have been shown on the drawings, however, no guarantee is made as to the true size, location or number of such utilities. It shall be the responsibility of the Contractor to verify the existence and location (vertically and horizontally) of all underground utilities along the route of the work, to ensure construction as shown in the Contract Documents. The omission from or the inclusion of existing or abandoned utility locations on the drawings is not to be considered as the nonexistence of, or a definite location of, said utilities.

3.0.3 Exploratory Excavations

Exploratory excavations shall only be paid at locations designated in the Contract Documents or as specifically approved by the Construction Project Manager, in writing. Otherwise, all costs incurred by the Contractor in making exploratory excavations shall be considered to be

included in the unit price bid for constructing each section of sewer line, structures, laterals and/or appurtenances.

In addition to those areas as may be designated in the Contract Documents, it shall be the Contractor's responsibility to excavate and locate all utilities and appurtenances which may affect construction or require protection during construction of the project scope. All exploratory excavations shall occur far enough in advance of the sewer facility construction to permit any necessary relocation or adjustment of the sewer facility without delaying the project.

3.0.4 Relocation and Adjustment

If it is determined prior to, or during construction that any underground or aboveground utilities (as defined within this specification) are required to be relocated or adjusted, the Contractor shall notify the utility owner well in advance of the Contractor's approach of such utility so that arrangements with the owner or owners of the affected utility can be completed without delaying construction. It is the Contractor's responsibility to coordinate all utility relocations and adjustments required to complete the scope of work designated within the construction plans and documents. All utilities requiring relocation and/or adjustment shall be constructed in accordance with each specific owner's requirements, standard specifications, and applicable agreements. The costs associated with utility coordination, relocations, adjustments; and/or construction delays due to improper planning, scheduling or advance notification of utility owners by the Contractor, shall be included within the related pipe segments, structures and appurtenances. Unless otherwise provided for in the Contract Documents or specified elsewhere, the responsibility of relocating both underground and aboveground utilities within the project limits shall be borne by the Contractor. If operations by the Contractor cause damage to any utilities lying outside of the prescribed maximum trench width the utility shall be repaired at the sole expense of the Contractor. The Construction Project Manager may order such utilities to be protected or relocated at the sole expense of the Contractor.

3.0.4.1 Water Services

The type, size and location of water services are not shown on the construction plans and it shall be the Contractor's responsibility to identify and locate the services affected during construction. The Contractor is required to coordinate all water service relocations with Denver Water, well in advance of approach

The Contractor is required to maintain service and adjust all water service taps and/or connections encountered during construction. Service adjustments and reconnections for homeowners, businesses, and facilities with special circumstances will be completed during a timeframe which accommodates their needs. All work will be performed by a licensed plumber or journeyman drainlayer and shall be in accordance with Denver Water Standard Construction Specifications. No separate payment will be made for any of the work involved for this item and all costs incurred will be considered to be included in the applicable unit price bid for the associated pipe segments, structures and appurtenances.

3.0.4.2 Gas Services

The type, size and location of gas services are not shown on the construction plans, and it shall be the Contractor's responsibility to identify and locate the services affected during construction. The Contractor is required to coordinate all gas service relocations with the utility owner, well in advance of approach. All work involved and costs incurred for this item will be included within the applicable unit price bid for the associated pipe segments, structures and appurtenances.

3.0.4.3 Sewer Services

1. Adjusting

All storm and sanitary sewer services and/or connections crossed during construction shall be adjusted by the Contractor as required to maintain service. A licensed plumber or a licensed drainlayer shall perform all such work. Unless otherwise provided for in the Contract Documents, no separate payment will be made for any of the work involved for this item and all costs incurred will be considered to be included in the applicable unit price bid for the associated pipe segments, structures and appurtenances.

2. Reconnection

Where existing sanitary and/or storm sewer lines with service and/or lateral connections are being replaced, reconnection will be required at the locations shown in the contract documents, in addition to those located in the field by the Contractor and identified by the Construction Project Manager as active connections. Reconnection will also be required where a service or lateral connection was damaged as a result of work associated with this project. The contractor is also required to immediately and fully mitigate all damage to public or private property associated with the damaged service and/or lateral connection. This full and immediate mitigation shall be conducted regardless of apparent "fault" of the damage. The connections shall be reconnected by the Contractor utilizing standard tee or wye fittings, factory manufactured saddle taps, applicable pipe and reinforced concrete collars, adjustable repair couplings, etc. as specifically approved for construction by the Construction Project Manager. All service connections on PVC lines shall be constructed in accordance within these Standard Construction Specifications. Connections to sewer lines and structures shall be made using coring machines, keyhole saws, or other methods approved by the Construction Project Manager; jack-hammering or break in connections are not permitted. The Contractor will perform this work utilizing a licensed plumber or journeyman drainlayer. All connections must be reconnected to the new sewer line within twelve hours of discontinuance of service.

3. Location and Verification

All sewer services and/or lateral connections shall be located and verified by the Contractor prior to construction (both vertically and horizontally). The Contractor shall notify the owner well in advance of access to mainline sewers to allow coordination and planning with the pertinent maintenance groups. All costs associated with delays and maintenance of mainline facilities will be incurred by the Contractor. The Construction

Project Manager shall be notified immediately of any information acquired from locates and verifications which may affect the design or original scope of work.

Unless provided for elsewhere in the Contract Documents or specified elsewhere, no separate payment will be made for any of the work involved for these items and all costs incurred will be included in the applicable unit price bid for the associated pipe segments, structures and appurtenances.

3.0.5 Abandonment

All existing sewer facilities to be plugged and abandoned in place are specifically shown on the Construction Drawings. Unless otherwise specified in the Contract Documents or elsewhere in the Special Conditions, the procedures and methods for the abandonment of said facilities shall conform to the following.

3.0.5.1 Manholes/Inlets/Structures

Manholes, inlets or miscellaneous structures to be abandoned in place shall have all pipes entering or exiting the structure plugged with lean concrete. Manhole tops or cone sections shall be removed to the first full barrel diameter section, and/or to a point not less than 24-inches below final grade. The structure shall then be backfilled and compacted in accordance with Backfill Method B as specified within these Standard Construction Specifications. Backfill material may be either: select backfill, clean suitable excavated material, or controlled low strength material approved by the Construction Project Manager. Surface restoration for the surrounding area shall be done in accordance within these Standard Construction Specifications.

Manhole rings, covers, inlet grates, frames, precast flat tops, cone sections, or other salvageable items shall be salvaged, stored and delivered to such location as prescribed by the Construction Project Manager.

The payment for abandoning manholes, inlets, and/or miscellaneous structures as described above; along with the materials, equipment and labor necessary to complete all surface restoration associated with these items shall be included within the appropriate bid item (regardless of the size or depth of item abandoned). Refer to applicable Measurement and Payment description for specific item inclusions.

3.0.5.2 Sewer Lines

Sewer lines to be abandoned in place shall be plugged with lean concrete and standard manufactured plugs or caps at both upstream and downstream ends of the abandoned section. If the manholes, inlets, etc. are also abandoned in place, or if the structure is to be removed completely, all sewer lines shall be plugged upstream and downstream of the removed structure following removal.

Sewer lines with an internal diameter of 24-inches or larger shall be filled with sand, pumped grout mixtures, or flowable fill, prior to final plugging. Unless otherwise noted in the Contract Documents, sewer lines with an internal diameter of 21-inches and smaller shall be plugged at entrance and exit ends with approved grout mixtures or concrete.

Unless provided for elsewhere in the Contract Documents or specified elsewhere, no separate payment will be made for any of the work involved for these items and all costs

incurred will be included in the applicable unit price bid for the associated pipe segments, structures and appurtenances.

3.0.6 Crossing of Existing Utilities

See Wastewater Management Division Standard Detail S-350, for requirements and general notes.

End of Specification



CITY AND COUNTY OF DENVER
ENGINEERING DIVISION

Wastewater Capital Projects Management Standard Construction Specification

4.0 Utility Trenching and Excavation

4.0.1 General

All excavations, trenching, shoring and stockpiling of excavated materials shall be in strict compliance with the applicable Occupational Safety and Health Act (OSHA) rules and regulations.

Except where shown otherwise on the Drawings, and except when the Construction Project Manager provides written permission to do otherwise, all trench excavation shall be made by open cut to the depth required to construct the pipe line as shown on the Drawings and specified herein. Permission for tunnel work may be granted by the construction project manager for crossing under sidewalks, driveways, or existing utility lines. No separate payment will be made for any of the work involved for these items and all costs incurred will be included in the applicable unit price bid for the associated pipe segments, structures and appurtenances.

The length of trench permitted to be open at any one time may be limited when, in the opinion of the Construction Project Manager, such limitation is necessary for the safety and convenience of the public; however, in no case shall the length of open trench exceed 400 feet, except when the Construction Project Manager provides written permission to do otherwise. All trenches and excavations left overnight shall be protected as specified by the Construction Project Manager. This may include, but is not limited to: fencing, concrete, barriers, additional signage or any other measures required to provide public safety.

4.0.2 Subsurface Information

Whenever subsurface exploration, consisting of test holes and borings, has been made along the route of the work, the information obtained from these test holes will be included in both the Bid Submittal Package and the Contract Documents.

Subsurface information is provided for general information, and conditions may vary due to the location on jobsite and time of year. The City does not accept any responsibility for assumptions or generalizations made by the Contractor. Each bidder and Contractor must form their own opinion of the character of the work and of the materials to be excavated, and must make their own interpretations and investigations regarding all conditions affecting the work to be done.

4.0.3 Trench Width

Except as may be otherwise specified on the Drawings, the maximum clear trench width measured at a point one (1) foot above the top of the pipe barrel shall not be greater than that set forth in the most recent edition of the Wastewater Management Division Standard Detail Drawings.

The trench width shall be sufficient to permit the pipe to be placed and jointed properly and to allow for the construction of appropriate structures and appurtenances. Adequate width shall be provided to allow backfill to be placed and compacted as specified. Pipe shall not be installed in a bedding trench having a width (as measured one (1) foot above the top of the pipe) greater than the outside diameter of the pipe plus sixteen (16) inches for pipe having internal diameters of thirty-three (33) inches or less. Bedding trench shall not be greater than the outside diameter of the pipe plus twenty-four (24) inches for all pipes with internal diameters of thirty-six (36) inches or more.

If the stated maximum trench widths are exceeded either through accident or otherwise and if the Construction Project Manager determines that the design loading of the pipe will be exceeded, the Contractor will be required to either support the pipe with an improved trench bottom or to use a stronger class of pipe. The cost of such remedial measures shall be entirely at the Contractor's own expense. If deemed necessary, the Contractor shall brace or shore this portion of the trench excavation to maintain the required trench width at the top of the pipe.

4.0.4 Trench Walls

All trench sidewalls shall be properly sloped, benched, braced, shored or sheeted to assure safe working conditions and to prevent cave-ins. All trench operations including sloping or benching of the trench sidewalls and stockpiling of excavated materials shall be confined to the width of the permanent rights-of-way plus any temporary construction easements.

4.0.4.1 Sloping or Benching

Sloping or benching of the trench walls will normally be allowed, provided that such sloping or benching complies with all applicable State and Federal requirements as defined within these Standard Construction Specifications; and provided further, that such sloping or benching does not endanger adjacent utilities or structures or the public. In the event the Contractor elects to slope or bench the trench sidewalls, the sloping or benching shall terminate at a depth not less than one (1) foot above the top of the pipe barrel and, from that point to the bottom of the excavation, the trench wall shall be vertical (with adequate shoring as necessary). All additional costs for backfilling and surface restoration, for trenches which exceed the maximum width defined within the Standard Constructions shall be borne by the Contractor.

4.0.4.2 Bracing Shoring, Sheeting

The sides of the excavation shall be securely held in place with suitable bracing and shoring wherever necessary to prevent caving. In addition, bracing, shoring, sheeting, etc. shall be in accordance with all applicable State and Federal. Shoring shall be removed as the work

and backfilling operations progress, unless ordered by the Construction Project Manager to be left in place. The Contractor will be responsible for minimizing the disturbance of compacted bedding during advancement and removal of shoring within the bedding trench zone. All voids and separations shall be backfilled and recompacted with the appropriate bedding materials and in conformance with these Standard Construction Specifications. The Contractor will be paid for shoring so ordered left in place on the basis of invoiced material only. All other shoring shall be considered as incidental to construction and all costs incurred, except for materials ordered to be left in place, will be considered to be included in the unit price bid for the construction of each section of sewer, associated structures, laterals and appurtenances.

The decision to brace, shore or sheet the excavation shall be entirely the Contractor's responsibility. However, if the Construction Project Manager is of the opinion that any part of the excavation is not properly supported, the placement of additional supports or implementation of other methods by and at the expense of the Contractor may be required. Compliance with such order shall not relieve or release the Contractor from his/her responsibilities to provide a safe work zone.

4.0.5 Preparation of Foundation for Pipe Laying

When the excavation is in firm soil, care shall be taken to avoid excavation below the established grade (i.e. the specified overdepth to accommodate the particular class of bedding). The different methods and classes of bedding are described within these Standard Construction Specifications.

4.0.5.1 Dewatering

During construction, the Contractor shall provide and maintain adequate equipment to properly remove and dispose of all water entering the trench or other part of the work. In water bearing strata, well points, sub drains or any other method approved by the Construction Project Manager that may be required to provide a dry trench.

Pipe trenches shall be kept free from water during excavation, fine grading, pipe laying and jointing. Dewatering, sufficient to provide a completely dry trench, shall be maintained during all pipe laying and jointing operations. The Contractor shall be responsible for damage resulting from the dewatering operations.

The discharge from any trench dewatering operations shall be conducted to natural drainage channels or other structures as approved by the Construction Project Manager and in accordance with applicable permits. Ground water shall not be discharged into sanitary sewers.

Unless provided for in the Contract Documents, dewatering shall be considered as incidental to construction and all costs incurred will be considered to be included in the unit price bid for the construction of each section of sewer line, associated structures, laterals and appurtenances.

4.0.5.2 Overexcavation and Replacement with Select Backfill Material

If soft or otherwise unsuitable foundation material is encountered during the course of completing the work, it shall be removed and replaced with select backfill material and/or

angular rock bedding material so as to provide a suitable foundation for the pipe, structure and/or appurtenance or roadway, as determined by the Construction Project Manager.

In the event that overexcavation and replacement with select backfill material is below the water table, the sub-bedding material shall consist of 3/4 to 1-1/2-inch rock (or larger if approved). All work shall conform to the most recent edition of the Wastewater Management Division Standard Details.

If provided for in the Contract Documents, the cost of overexcavation and replacement with select backfill material will be paid for per the associated measurement and payment description. If no pay item for such work is included in the Contract Documents, the Contractor shall consider all costs incurred to be included in the unit prices bid for the construction of each section of sewer, associated structures, laterals and appurtenances.

At the option of the Construction Project Manager, select backfill material meeting the requirements of these Standard Construction Specifications may be delivered to the job site for the Contractor's use. The Contractor will be paid for placement of this material and the removal and disposal of the overexcavated material per the associated measurement and payment description.

4.0.6 Unsuitable Materials Excavation

Unsuitable material encountered within an excavated area during construction shall be excavated and disposed of by the Contractor as directed by the Construction Project Manager. Payment for excavation, disposal and replacement of unsuitable materials will not be paid for unless specifically authorized in writing by the Construction Project Manager. It may be necessary for the Contractor to rework, solely at the Contractor's own expense; dry, wet or otherwise satisfactory excavated material as necessary to obtain conformance with backfill requirements. Unsuitable materials are defined as:

1. Rock Excavation: Rock shall be defined as material consisting of igneous, metamorphic and sedimentary materials which cannot be excavated without blasting or the use of rippers, or boulders or other detached stones having a volume of ½ cubic yard or more, or having a specific gravity of at least 2.24 and weight not less than 140.4 pounds per cubic foot. The unit price bid for rock excavation will include granular bedding, select material, or any other material specifically approved in writing by the Construction Project Manager required to fill the excavated area.
2. Soil and excavated material containing rubbish, organics, frozen material, broken pavement, debris, stones larger than three (3) inches in diameter.
3. Muck, defined as an organic soil consisting of highly decomposed materials with more than 30% organic material and are generally referred to as peat or muck. These soils have bulk densities as low as 25 to 37 lb/ft³.
4. Material determined to be of such an unstable nature as to be incapable of being compacted to the specified density using ordinary methods, at optimum moisture content.
5. Material which is too wet to be properly compacted and circumstances prevent suitable in-place drying prior to incorporation into the work.

6. For backfill to be used within a street, roadway or any other area where the degree of compaction is critical, material having a plasticity index greater than twenty (20) shall be considered unsuitable.
7. Material otherwise unsuitable for the planned use per the Contract Documents.

4.0.7 Pavement and Sidewalk Cuts

Where excavation is required under concrete or asphalt paved areas, including gutters and walks, the surfacing material shall be cut or rotomilled in such a manner as to produce a smooth, structurally sound, straight cut edge and confine the excavation to a minimum practical width. All pavement removals shall be neatly cut, rectangular or trapezoidal in shape, and edges shall be parallel, perpendicular or skewed up to 45°. The pavement or concrete shall be cut or removed at least one (1) foot beyond the top width of the trench on each side. All broken pavement, asphalt, concrete or other debris resulting from this initial work shall be immediately removed from the job site or stockpiled in an approved manner so that it is kept separated from the remaining trench excavation. This debris will not be allowed to be mixed in the trench backfill material.

4.0.8 Cut-off Walls

Cut-off walls are only required as noted in the contract documents and as specifically requested by the Construction Project Manager to prevent migration of water through the pipe bedding zone. The Construction Project Manager may specify alternate locations from those shown in the plans. Concrete cut-offs are the preferred installation method. Refer to Wastewater Management Division Standard Detail S-301.1 figure 2 for typical locations and additional information.

End of Specification



CITY AND COUNTY OF DENVER
ENGINEERING DIVISION

Wastewater Capital Projects Management Standard Construction Specification

5.0 Bedding and Backfilling

5.0.1 General

This section outlines the guidelines and requirements for pipe bedding and backfilling operations required to complete construction per the Contract Documents.

5.0.2 Pipe Bedding

Unless specified otherwise on the Drawings or elsewhere in the Contract Documents, or directed otherwise by the Construction Project Manager, the Contractor shall bed all conduit according to the Class B Bedding method using a crushed granular, mineral aggregate material as noted in these Standard Construction Specifications and install the required geotextile over the pipe and/or bedding. Substitutions of recycled materials or manufactured materials in place of mineral aggregate mixtures for pipe bedding will not be allowed. If, in the course of construction, it is determined that the pipe foundation is unsatisfactory or the prescribed maximum allowable trench width is exceeded, the Construction Project Manager may require that an alternate class of bedding be installed. The Contractor shall be required to place the improved bedding class or make other remedies, at his/her expense.

No separate payment will be made for placement of the required bedding material. All costs incurred will be considered to be included in the unit price bid for each section of sewer line, associated structures, laterals and appurtenances.

5.0.2.1 Bedding Materials

1. #67 Bedding

This bedding shall consist of a durable crushed granular material with a well graded mineral aggregate mixture, which will provide good stability. This bedding shall not contain recycled or manufactured materials. The size range of the aggregate shall be from 1/4-inch minimum to 3/4-inch maximum with a maximum amount of fines passing a No. 8 sieve not to exceed 5% by weight and shall conform to ASTM C-33 or ASTM D-448, gradation size #67. At least 50% of the material greater than the 3/8-inch sieve shall contain particles having 3 or more fractured faces.

CLASS 67 GRADATION	
Nominal Size	Percent Passing by Weight
$\frac{3}{4}$	90-100
$\frac{3}{8}$	20-55
No. 4	0-10
No. 8	0-5

2. Special Bedding Material

Special bedding material shall only be used where required within the Contract Documents and as specifically approved by the Construction Project Manager. This material is intended for use on rigid pipe of sixty (60) inches or greater in diameter and shall not be used with flexible conduits. Additionally, this bedding shall not contain recycled or manufactured materials. The following gradation requirements shall apply:

SPECIAL BEDDING MATERIAL	
Nominal Size	Percent Passing by Weight
$\frac{3}{8}$	100
No. 4	80-100
No. 16	35-65
No. 50	10-25
No. 100	5-10
No. 200	3-8

3. Alternate Classes of Bedding

Alternate classes of bedding may be required within the Contract Documents or requested within the project scope. All such bedding materials must be submitted and separately approved for use by the Construction Project Manager. Recycled or manufactured materials will not be considered and alternate bedding materials used on site which have not been approved shall be rejected and the removal and replacement of these materials will be at the Contractor's expense.

5.0.2.2 Bedding Requirements

On rigid pipe of fifteen (15) inches or less in diameter and on all pipe classified as flexible, the bedding shall be continued until the bedding is filled to one foot above the top of the pipe. On rigid pipes eighteen (18) inches or greater in diameter, the bedding can be terminated at a point equal to the spring line of the pipe.

Conduit Type	Bedding Requirements*	
	≤15" Diameter	≥18" Diameter
Reinforced Concrete Pipe (RCP, HERCP, etc.)	1' Above Top of Pipe	Spring Line of Pipe
Reinforced Polymer Mortar Pipe (RPMP)	1' Above Top of Pipe	
Ductile Iron Pipe (DIP)	1' Above Top of Pipe	
Corrugated Metal Pipe (CMP, CSP, ASP, etc.)	1' Above Top of Pipe	
Polyvinyl Chloride Pipe (PVC)	1' Above Top of Pipe	
High Density Polyethylene Pipe (HDPE)	1' Above Top of Pipe	
Reinforced Concrete Box Culvert (RCB or RCBC)	6" Below Outside of Box	
* Based on internal diameter or equivalent internal diameter of conduit		

5.0.2.3 Bedding Methods

1. Class A Pipe Bedding

Class A Bedding shall be defined as that method of bedding by which additional supporting strength of the pipe is attained by supporting the lower part of the pipe with a concrete cradle or distributing trench loads on the upper portion of the pipe by means of a concrete arch.

In those instances where Class A Bedding is required, the Contractor shall construct either a concrete cradle or concrete arch as specifically noted in the Contract Documents or as directed by the Construction Project Manager. Class A Bedding shall be constructed of non-reinforced concrete with a minimum 28-day compressive strength (f'_c) of no less than 2000 psi, unless otherwise noted. Additional requirements for either type of construction are specified below. Class A Bedding will normally not be allowed for flexible type installations such as corrugated steel pipe, plastic pipe, etc.

After concrete cradle or arch bedding has been constructed, no backfilling shall be completed above the pipe until the concrete has attained the required minimum compressive strength. Where sheeting is removed or left in place, all cavities remaining, adjoining and/or behind shall be firmly filled with a suitable backfill material.

a. Concrete Cradle

This method of Class A Bedding construction shall consist of bedding the lower part of the pipe in a poured-in-place concrete cradle. The minimum thickness of concrete under and around the conduit shall not be less than that specified on the most recent edition of the Wastewater Management Division Standard Detail Drawings.

The concrete shall extend upward around the pipe a minimum distance of $\frac{1}{4}$ of the outside diameter (but not less than 4-inches), measured from the lowest portion of the pipe exterior. The width of the concrete cradle shall be at least equal to the outside diameter plus 8-inches. Blocking material required to support the pipe prior to placement of concrete shall have a minimum compressive strength of 2000 psi. The remaining excavation to a point two (2) feet above the top of pipe shall be backfilled and compacted in accordance with Backfill Method B as specified in Section 5.0 of the Standard Construction Specifications.

b. Concrete Arch

This method of Class A Bedding construction shall consist of bedding the upper part of the pipe in a poured-in-place concrete arch. The minimum thickness of concrete over and around the conduit shall not be less than that specified in the most recent edition of the Wastewater Management Division Standard Detail Drawings.

The concrete shall extend upward around the pipe a minimum distance of $\frac{1}{2}$ the outside diameter plus 4-inches, measured from the spring line of the pipe. The width of the concrete arch shall be at least equal to the outside diameter plus 8-inches. Where a concrete arch is required, the lower portion of the pipe (from spring line down) shall be bedded with Class B bedding, in accordance with this section. The remaining excavation to a point two (2) feet above the top of pipe shall be backfilled and compacted in accordance with Backfill Method B as specified in Section 5.0 of these Standard Construction Specifications.

2. Class B Pipe Bedding

Class B Bedding shall be defined as that method of bedding in which the pipe is set on an approved granular material. The trench shall be excavated to a depth below the bottom of the pipe as specified in the Wastewater Management Division Standard Details. The overexcavation shall be backfilled and compacted with a clean granular material free from organic and/or unsuitable materials. The material shall be placed under the pipe and on either side of the pipe up to depths specified within these Standard Construction Specifications. The placing shall be done in a manner which will assure no separation or change in uniform gradation.

All bedding material shall be placed under the pipe haunches, then brought up in six inch (6") lifts (maximum) and compacted by hand operated mechanical vibrators equally and thoroughly along each side of the pipe in such a manner as to avoid displacement of, or damage to the pipe. All bedding material shall be compacted to a density of at least ninety percent (90%) as determined by the Modified Proctor Method, AASHTO designation T-180, before the next lift is placed. Refer to Wastewater Management Division Standard Detail S-301.2 for additional information.

In no case will jetting or flooding be allowed as means for consolidation or compaction of the bedding material. Cut-off walls will be required to be installed as described in these Standard Construction Specifications and as shown on the Wastewater Management Division Standard Details.

5.0.3 Backfill

Excavated material will be considered suitable for backfill purposes, provided its use results in a well-compacted stable condition. All backfill material shall be free from rubbish, organics, frozen material, broken pavement, debris, stones larger than three (3) inches in diameter, or other unsuitable materials.

Material having a plasticity index greater than twenty (20) shall not be used for backfill within a street, roadway, or any other area where the degree of compaction is critical. It may be necessary for the Contractor, at his/her sole expense, to dry, wet, mix or otherwise rework satisfactory excavated material as necessary to obtain conformance with these Standard Construction Specifications.

The use of squeegee material or pea gravel will not be allowed as backfill material due to their free flowing nature if undermined. These materials may be used as pipe bedding if required by a specific utility owner, but they must be consolidated by vibration prior to backfilling operations.

When, in the opinion of the Construction Project Manager, the excavated material is unsuitable for use as backfill, or when there is a shortage of satisfactory backfill material within the project limits, the Contractor shall locate and furnish all necessary suitable backfill material and shall dispose of the unacceptable material. All excess backfill or unacceptable excavated material shall be disposed of off the rights-of-way and public property by the Contractor, unless directed otherwise by the Construction Project Manager. Backfilling shall be performed in strict conformance with these Standard Construction Specifications.

5.0.3.1 Trench Backfill

The entire area from pipe subgrade to the finished surface elevation shall make up the trench backfill zone. This zone consists of two (2) main sections described below: the Bedding Trench and the Backfill Above Bedding Trench. All areas outside of this zone will be considered Backfill Outside the Trench.

Unless otherwise set forth in the Contract Documents, the cost of the bedding and trench backfill requirements shall be included in the associated unit price bid for the respective sewer line, associated structures, laterals and appurtenances.

1. Bedding Trench

The Bedding Trench is defined as starting at the subgrade of the specified overdepth required to accommodate the particular class of bedding below the bottom of the pipe and extends vertically to a point where the bedding is terminated (as defined under Bedding Requirements above).

The bedding trench shall be backfilled with an approved bedding material, in accordance with Class A or Class B Bedding methods immediately after the pipe is laid, except where the pipe must remain exposed for leakage tests (subject to the provisions of these Standard Construction Specifications).

2. Backfill Above Bedding Trench

Backfill Above the Bedding Trench shall be considered as starting one foot above rigid pipe fifteen (15) inches in diameter or less and for all pipe classified as flexible; or at the spring-line for rigid pipe eighteen (18) inches and larger in diameter. All material below these areas shall be considered as bedding material. Refer to the Bedding Requirement table included within this section for further clarity based on pipe types.

3. Backfill Outside the Trench

All backfilling required during construction which is outside of the Trench Backfill Zone, as defined above, will be considered Backfill Outside the Trench. These materials shall meet the requirements set forth in this specification.

Backfill for cast-in-place or precast structures and appurtenances, including but not limited to: manholes, transition structures, junction structures, vaults, inlets and concrete box culverts, shall start at the subgrade for the structure, or appurtenance. As a minimum requirement all structures, inlets, manholes and appurtenances will follow Method B backfill procedures as described in this specification. All remaining operations which fall under Backfill Outside the Trench will follow method A backfill procedures as a minimum, unless specified otherwise in the Contract Documents or directed by the Construction Project Manager.

5.0.3.2 Backfilling Methods

After the specified pipe bedding has been placed, compacted and approved, and after the requirements for the bedding trench have been fulfilled and the Construction Project Manager has approved the commencement of backfilling operations, the balance of the trench shall be backfilled and compacted in accordance with one of the methods described below. The contractor shall not temporarily backfill trenches and return later to re-excavate and meet the backfill method requirements. The Contractor shall consider the minimum backfill and compaction requirements to be in conformance with Backfill Method A for pipeline trenches and Backfill Method B for pipe bedding, backfill under or around manholes, structures, inlets, utilities and appurtenances, unless specified otherwise in the Contract Documents.

The use of hand held tools or devices to meet compaction requirements shall be continued around and above the pipe section during the trench backfilling process until a minimum

vertical height above the pipe of two (2) feet is reached. Thereafter, the use of approved compaction equipment (vibratory, sheepsfoot, rubber-tire, etc.) may be utilized. Impact, free fall, stomping and jetting operations are not permitted unless specifically approved by the Construction Project Manager.

The Contractor shall exercise the utmost care during compaction by any of the methods described below, to assure that no damage will occur to the sewer, appurtenances or other existing utilities. Any damage resulting from compaction shall be repaired or replaced at the Contractors expense.

1. Backfill Method A

The backfill shall be placed in horizontal layers of such depths as are specified below for the material being placed and the type of equipment being used. Granular soils shall be compacted by vibration; whereas cohesive soils shall be compacted by a kneading action.

Material for mechanically compacted backfill shall be placed in lifts, which, prior to compaction, shall not exceed the thickness specified below for the various type of equipment:

- a. Vibratory equipment, including vibratory plates, vibratory smooth-wheel rollers, and vibratory pneumatic-tired rollers - maximum lift thickness of two (2) feet;
- b. Rolling equipment, including sheepsfoot (both vibratory and non-vibratory), grid, smooth-wheel (non-vibratory), pneumatic-tired (non-vibratory), and segmented wheels-maximum lift thickness of one (1) foot;
- c. Hand-directed mechanical tampers - maximum lift thickness of six (6) inches.

Permission to use specific compaction equipment shall not be construed as guaranteeing or implying that the use of such equipment will not result in damage to adjacent ground, existing improvements, or improvements installed under the Contract Documents. The Contractor shall make his/her own determination in this regard.

It will be the Contractors responsibility to maintain a minimum of eighty-five (85%) density from the top of bedding to a distance of two (2) feet over the top of pipe. The density from two (2) feet over the top of pipe to the subgrade surface shall maintain a minimum of ninety percent (90%) density. Regardless of facility depth, the last foot of subgrade material shall be compacted to a minimum density of ninety percent (90%). All densities shall be determined by the Modified Proctor Method, AASHTO Designation T-180. Each lift of backfill material shall have the proper moisture content and consistency to permit compaction to the designated density. The compacted material may be tested at any time for adherence to these Standard Construction Specifications.

2. Backfill Method B

This method of backfilling requires placement in six (6) inch lifts. Each lift will have the proper moisture content and consistency to permit compaction to the prescribed density. Each lift will be uniformly and completely compacted by either handheld pneumatic or mechanical tampers to a density of at least equal to ninety percent (90%) of the density

determined by the Modified Proctor Method, AASHTO designation T-180, before the next lift is placed.

3. Backfill Method C

Other methods of backfill placement and compaction to the prescribed density may be submitted to the Construction Project Manager by the Contractor. These methods will not be used without the prior written approval of the Construction Project Manager.

5.0.3.3 Select Backfill Materials

Select materials shall only be used as backfill when specifically shown in the Contract Documents or as approved and authorized by the Construction Project Manager and will only be placed to the specified depths in those areas as shown on the Contract Documents or as ordered by the Construction Project Manager. The materials listed here are only intended for backfilling purposes and shall not be used for pipe bedding at any time. Prior to using select materials onsite, the Contractor shall submit product documentation for approval. All select material placed without approval from the Construction Project Manager will be rejected and the Contractor will incur all costs associated with removal and replacement of the material.

1. Subgrade Material (Select Backfill)

Select subgrade material, which may also be specified as “select backfill material” in other locations within the Contract Documents, shall be defined as a well graded mixture of sound mineral aggregate particles containing sufficient, proper quality binding material to secure a firm, stable foundation when placed and compacted. When tested with laboratory sieves, the material shall meet the following gradation requirements:

Standard Sieve Size	% Passing (by Weight)
3 inch	100
No. 10	80 maximum
No. 200	0-15 maximum

All select subgrade material shall be of such quality that material passing a No. 40 sieve will have a liquid limit of not more than thirty five (35) and a plasticity index of not over six (6) when tested in conformity with AASHTO Designations T-89 and T-91 respectively. In addition, the City will take soil-bearing tests where necessary, to evaluate the quality of materials produced from pit sources. If the bearing value or stabilometer values of pit materials are considered to be adequate, minor deviations (less than five percent) from the liquid limit and plasticity index criteria specified shall not be considered to be a basis for rejection of the material. It shall be the responsibility of the Contractor to locate material meeting these Standard Construction Specifications and to secure approval of the Construction Project Manager before such material is delivered to the project. If at

any time during the construction, such tests reveal that the material being delivered is not of suitable quality for the purpose for which it is intended, the City reserves the right to direct the Contractor to change pit locations as necessary, at no cost to the City. If the Contractor so elects, he/she may, at his/her own expense, remove and dispose of the excavated material even if the Construction Project Manager considers it satisfactory for use as backfill, and replace it, at his/her own expense with select backfill material.

2. Structural Fill

Structural Fill shall be defined as a well graded mixture of sound mineral aggregate particles void of debris containing sufficient proper quality binding materials to secure a firm, stable foundation when placed and compacted. When tested with laboratory sieves, the material shall meet the following gradation requirements:

Standard Sieve Size	% Passing (by Weight)
2 inch	100
No. 4	30-100
No. 50	10-60
No. 200	5-20

Bearing value and or stabilometer tests by CBR or R value methods may be required to properly evaluate the quality of the material.

Colorado Department of Transportation approved class 4, 5, or 6 base course materials typically meet the above specifications. A report showing the gradation analysis and test results for the materials proposed for Structural Fill shall be required by the Construction Project Manager prior to placement and in accordance to AASHTO designations T-89 and T-91.

3. Recycled and Processed Materials

Recycled and processed materials shall include: recycled concrete, aggregates, asphalt, crushed gravel base course (road base), crusher fines or any other materials specified as such. The use of these materials within the construction site shall be limited to those areas designated within the Contract Documents or approved by the Construction Project Manager.

The following gradations are provided as a guideline for recycled and processed materials commonly used in construction and represent only a portion of those available for use. Approved submittals will be required prior to placement, to ensure that the material type and particle distribution are suitable for the intended application. All materials of this category placed without previous approval of the Construction Project Manager shall be rejected and all costs incurred for removal and replacement of these materials will be at the Contractor’s expense.

a. Crushed Recycled Concrete

Standard Sieve Size	% Passing (by Weight)
1½ inch	100
¾ inch	40-75
¼ inch	25-50
No. 40	5-20
No. 200	10 max

b. Crushed Recycled Asphalt Pavement

Standard Sieve Size	% Passing (by Weight)
1½ inch	100
¾ inch	40 minimum

c. Crushed Gravel Base Course (CDOT Class 6 Road Base)

Standard Sieve Size	% Passing (by Weight)
¾ inch	100
No. 4	30-65
No. 8	25-55
No. 200	3-12

d. Crusher Fines

Crusher fine material shall meet the gradation shown in the following table. The material shall consist of fine mineral fragments resulting from rock crushing operations.

Standard Sieve Size	% Passing (by Weight)
¾ inch	100
No. 4	90-100
No. 8	55-80
No. 16	40-70

Standard Sieve Size	% Passing (by Weight)
No. 30	25-50
No. 200	6-15

4. Controlled Low Strength Material (CLSM)

Controlled Low Strength Materials (CLSMs) consist of a well-graded mixture of mineral aggregates, cementitious materials, water and admixtures. Other common names for CLSMs include: flowable fill, flowfill, non-shrink backfill, fly ash fill and controlled density fill.

The contractor will be required to submit a mix design and test data to the Construction Project Manager for approval, prior to excavating the area for which CLSMs are proposed for use. All materials of this category placed without previous approval, or which do not perform as specified, will be rejected by the Construction Project Manager and all costs incurred for removal and replacement of these materials will be at the Contractor's expense.

All CLSMs shall adhere and conform to the following, unless noted otherwise:

- a. The mix must be capable of freely flowing to fill all voids in trenches or other areas without compaction or other additional effort,
- b. The mix must be of uniform density and low permeability to prevent migration of adjacent fines into the set mix,
- c. Must be placed in a uniform manner that will prevent voids or segregation of the backfill and shifting of pipelines, structures and appurtenances. Foreign material that falls into the trench prior to, or during placement shall be immediately removed,
- d. The CLSM shall be produced using a central-mixed concrete plant or other approved method,
- e. Chemical admixtures containing chlorides shall not be used unless approved otherwise,
- f. CLSMs will be classified as either Standard Aggregate or Fine Aggregate CLSM according to the table below. Submitted CLSMs must follow the gradation guideline provided here, unless approved otherwise:

Standard Sieve Size	% Passing (by Weight)
1 inch (For Standard Aggregate CLSM)	100
$\frac{3}{8}$ inch (For Fine Aggregate CLSM)	100
No. 8	50 minimum

No. 200	0-30 maximum
---------	--------------

- g. The 28-day compressive strength must be between 50 and 150psi, unless otherwise directed by the Construction Project Manager. Test cylinders may be required to insure that the specified strength is obtained. The compressive strength shall be determined by ASTM D4832, "Preparation of Testing of Soil-Cement Slurry Test Cylinders",
- h. The mix shall have a slump between 7 and 10 inches as per AASHTO Designation T 119-82,
- i. When CLSMs are placed within the right-of-way, or they are to be covered by paving materials, the final set product must achieve a maximum indentation diameter of 3-inches prior to covering and opening the area to traffic. Penetration resistance shall be as measured by ASTM C6024, "Standard Test Method for Ball Drop on Controlled Low Strength Material to Determine Suitability for Load Application",
- j. Final set product shall excavate easily, minimizing the risk of damage to buried utilities during future work,
- k. Must be placed within 2 hours after mixing at the batch plant, unless otherwise approved or specified by the Construction Project Manager,
- l. Delivery tags shall be collected from the delivery driver and provided to the Project Inspector or Construction Project Manager. The delivery tag shall contain the supplier name, the mix identifying name and/or number as listed in the supplier's submitted mix design. The Project Inspector or Construction Project Manager may reject any mix that does not appear to meet the requirements of this specification (segregation, insufficient slump, open graded aggregates, etc.).

5. Topsoil

Topsoil shall be defined as soil that contains the sufficient organic materials necessary to support growth of grass, which is free of all types of debris, weeds, stones or other unsuitable materials. Topsoil will be required to be placed and compacted whenever excavation occurs through parks or other landscaped areas and the excavated material is deemed to be unsuitable for growth. Placement will be required from the existing subgrade to the depth specified in the Contract Documents or as otherwise directed by the Construction Project Manager. All topsoil used within the construction site shall conform to the Contract Documents and/or the specifications set forth by the owner of property affected during construction. Topsoil may also be specified as Class B Topsoil.

Class B topsoil shall be the original top layer of the soil profile formed under natural conditions, technically defined as the "A" horizon by the Soil Society of America. It shall have demonstrated by evidence of healthy vegetation growing or having grown on it,

prior to stripping, that it is well drained and does not contain substances toxic to plant life. It shall be the responsibility of the Contractor to locate material meeting these Standard Construction Specifications and to certify that the material is suitable for the intended purpose. The contractor must also secure approval of the Construction Project Manager before such material is delivered to the project.

Topsoil shall not be placed until the areas to be covered have been properly prepared and grading operations in the area have been completed. Topsoil does not require compaction but shall be keyed to the underlying material by the use of rollers or other equipment suitable for the purpose. Water shall be applied to the surface in a fine spray by nozzles or spray bars in such a manner that the operation does not wash or erode the topsoil areas.

6. Other Classified Select Materials

Alternate select materials, stabilization materials, and angular rock bedding materials shall be considered as other classified select materials.

Whenever the excavated material is deemed to be unsuitable for backfill and there is no requirement for the placement of any of the above specified select materials, other classified select materials shall be placed and compacted. It shall be the responsibility of the Contractor to locate such material and to secure written approval of the Construction Project Manager before such material is delivered to the project.

5.0.3.4 Unsuitable Material

Unsuitable material encountered within the project boundaries during construction shall be excavated and disposed of by the Contractor. Unsuitable material is defined as:

1. Soil and excavated material containing debris, weeds, asphalt, stones or concrete (larger than 3-inches in diameter), rubbish, and frost or other frozen particles,
2. Material determined to be of such an unstable nature as to be incapable of being compacted to the specified density using ordinary methods, at optimum moisture content,
3. Material which is too wet to be properly compacted and circumstances prevent suitable in-place drying prior to incorporation into the work,
4. Material otherwise unsuitable for the planned use per the Contract Documents.
5. Any fill material or soils not meeting regulatory and City standards for contamination

The presence of excessive moisture in a material is not, by itself, sufficient cause for determining that the material is unsuitable. Additionally, material which becomes unsuitable due to negligence or the means and methods utilized by the contractor will not be considered for payment. The costs incurred to remove and replace these materials shall be included in the associated unit price bid for the respective sewer line, associated structures, laterals and/or appurtenances.

The cost of removal of unsuitable backfill material and replacement with suitable material encountered while completing the project scope and which do not meet the above, will be paid for per the applicable bid items and in accordance with the associated measurement and payment description.

End of Specification



CITY AND COUNTY OF DENVER
ENGINEERING DIVISION

Wastewater Capital Projects Management Standard Construction Specification

6.0 Surface Restoration

6.1 General

Where pavement, curb and gutter, sidewalks, drainage culverts, headwalls, or other structures or improved surfaces, landscaping, etc., have been removed during the course of the work, such items shall be restored to a condition at least equal to that prior to removal and to the same elevation and alignment. The subgrade for all restored surfaces shall be thoroughly compacted to the specified limits by mechanical or hand tampers.

6.2 Asphalt Replacement

Except as modified herein, asphaltic concrete paving material to be replaced over trench excavations shall conform to the MGPEC asphalt paving requirements.

6.2.1 Thickness

Unless otherwise stipulated in the **Proposal** or on the Plans, all asphalt pavement required to be removed for trench or structural excavation shall be replaced with a "full depth" asphaltic concrete paving section conforming to the depths specified on the Plans.

6.2.2 Materials

The materials to be used for asphaltic concrete pavement shall conform to **Item 20** of the **Standard Construction Specifications** and the herein described modifications, additions or deletions.

6.3 Gravel Surfaced Streets and Alleys

Where excavation occurs in streets, alleys, or other areas which have only a gravel surface, such surfacing shall be replaced with gravel surfacing material equal in depth to that which existed before construction but not less than 3 inches compacted depth minimum. The surface shall conform to the original finish grade.

If the Contractor so elects, the existing gravel surfacing may be excavated down to a depth and width designated by the Project Construction Engineer, stockpiled in an area separate

from the excavated trench material, and later replaced to the required depth after the trench has been properly backfilled.

No separate measurement for payment will be made of any work or material stipulated above that is necessary to remove and later replace the gravel surfacing, and all costs incurred will be considered to be included in the unit price bid for the construction of the appropriate section of sewer line or the associated structure.

6.4 Sidewalk, Curb and Gutter, Concrete Pavement

Where sidewalks, curb together, culverts and other obstacles are removed in the prosecution of the work. The Contractor shall consolidate the backfill in the same manner as specified for paved streets and shall then replace sidewalks curb and gutter, etc. in accordance with standard specifications for class of work involved. Where sod areas are encountered, the sod shall be removed and replaced with new at the original grade and elevation after consolidation of the backfill. Sprinkler systems shall be protected or removed and replaced as required.

6.5 Sod

Sod, defined as densely grassed turf, which is removed, may be put back if it has been properly stored and remains in a healthy condition. If so stipulated in the Contract, the cost of replacing sod will be paid in the manner described under Measurement and Payment. If no pay item for replacing sod is included in the Contract, the Contractor shall consider that all costs incurred in replacing sod are to be included in the unit price bid for each section of sewer line or the associated structure.

6.6 Concrete Alley Pavement Replacement

Except as modified herein, concrete alley pavement replacement over trench excavations shall conform to **Item 4** of the **Standard Construction Specifications**.

6.6.1 Materials

The materials to be used for concrete alley pavement replacement shall conform to Item 20 Grass Sodding and the herein described modifications, additions or deletions.

- a. **Wire Mesh.** Reinforcing steel (6" x 6", W1.4 x W1.4) wire mesh shall be used for reinforcement of the concrete pavement over For replacement of full width alley concrete paving, the reinforcing steel wire mesh will extend the full alley width, per Wastewater Management Division Standard Detail S-205.
- b. **Concrete Aggregates.** Concrete shall conform to Paragraph 12.2, "materials", subparagraph b(2) of the Standard Specifications.
- c. **Joint Sealer.** Silicone joint sealer shall be a one part, low modulus, silicone formulation, designed for use in highway joint sealing applications and meeting Federal Specifications TT-S-001543A and TT-S-00230C. Primer shall be used if required by the manufacturer.

Acetic acid cure sealants are not acceptable.

Test methods shall be as follows:

Flow	MIL S 8802
Extrusion Rate	MIL S 8802
Track Free Time	MIL S 8802
Specific Gravity	ASTM D 792, Method A
Durometer Hardness	ASTM D 2240
Tensile Stress	ASTM D-412 (DIE C)
Elongation	ASTM D-412 (DIE C)
Ozone & Resistance	ASTM D-793-75

Bond to concrete mortar: Briquettes molded in accordance with AASHTO T 132-74 sawed in half and bonded with a thin section of sealant and tested in accordance with AASHTO T 132-74. Briquettes shall be dried to constant weight in oven at 110 degrees C+ degrees.

GESCS4403 Highway Joint Sealant and Dow Corning 888 Silicone Joint Sealant are approved for sealing joints. "Backer Rod" used in joints for Portland Cement Concrete Pavement shall be closed cell, polyethylene form rod conforming to the following specifications:

Diameter	Joint width + 1/78"	
Density	2.0 lbs./cu. ft.	ASTM D-1622
Tensile	15 psi	ASTM D-1623
Water Absorption	0.5% by volume	ASTM C-509
Compression Reflection	25% @ 8 psi	ASTM D-1621

6.6.2 Construction Requirements

a. **Alley Paving.**

"Concrete driveways which abut the alley must be placed separately, creating a cold joint between the concrete driveway and the alley for the full depth of the alley paving."

b. **Expansion Joints.**

"Expansion joints shall be placed at the end of block property lines and where the alley changes directions. Construction of the expansion joints will be as shown on the Wastewater Management Division Standard Details. Expansion joints shall also be required at structures, vaults, retaining walls, poles, etc. or as required by the Project Construction Engineer."

c. **Dummy Groove Contraction Joints.** The Contractor has the option to use the dummy groove contraction joints as follows:

"All contraction joints will be saw cut as shown on the Wastewater Management Division Standard Details. The saw cut will be 1-1/2 inches deep by 3/8 inch minimum width to a maximum of 1/2 inch for the full width of the alley. Contraction joints will be spaced a maximum of fifteen (15) feet apart along the length of the alley and must be sawed consecutively in the direction of the pour. Only by approval of the Construction Project Manager may a joint be skipped and sawed later. Transverse contraction joints shall be placed at each utility pole, manhole, and at the ends of retaining walls, or as directed by the Project Construction Engineer. Contraction joints shall extend through any alley curbhead. Concrete joint sealer shall be a grey silicone joint sealant as manufactured by G.E., Dow-Corning or an approved equal. All joint sealers and backer rods shall be installed in accordance with the manufacture's requirements. The silicone shall meet all applicable AASHTO, ASTM and Federal Specification TT-S-0021543A and TT-S-00230C.

Saw cut joints to be sealed shall be filled with joint sealing material before the pavement is opened to traffic and as soon after completion of the curing period as is feasible. Just before sealing, each joint shall be thoroughly cleaned of all foreign material, including membrane curing compound, and joint faces shall be clean and surface-dry when seal is applied. Where cleaning of the joints is by compressed air, the compressed air shall be oil free. The sealing materials shall be applied to each joint opening in accordance with the details shown in the plans, to the manufacturer's specifications or as directed by the Project Construction Engineer. The joint filling shall be done without spilling material on the exposed surfaces of the concrete. Any excess material on the surface of the concrete pavement shall be removed immediately and the pavement surface cleaned. The use of sand or similar material to cover the seal shall not be permitted. Joint sealing material shall not be placed when the air temperature in the shade is less than 50 degrees F., unless approved by the Project Construction Engineer.

Should other cleaning methods prove unsatisfactory, the Construction Project Manager may require sandblasting or another method inside of the contraction joints to remove incompressible materials. The Contractor may wish to install the backer rod on top of the sawed joint in order to keep it clean and later depress the rod when the silicone sealant is installed. The joints shall be sealed by first priming the joint, if required by the silicone sealant manufacturer and then placing a backer rod compatible with silicone and sealing with an approved liquid silicone joint sealant. The joints should be approved by the Construction Project Manager prior to sealing."

- d. **Opening to Traffic.** Add the following after the first sentence of Paragraph 35.31: "Or until field-cured concrete cylinders have obtained a compressive strength of 3500 psi and all contraction joints have been cleaned and sealed."
- e. **Raised Lips.** No extra payment will be made for raised slope paving required to widen alleys to meet existing improvements shall be paid for as Concrete Alley Paving.
- f. **Finish.** As shown the plans, or where longitudinal slopes exceed 7%, or where required by the Project Construction Engineer, a 3/16 inch metal time finish shall be applied

perpendicular to the centerline in accordance with Colorado Department of Highway specifications.

End of Specification



CITY AND COUNTY OF DENVER
ENGINEERING DIVISION

Wastewater Capital Projects Management Standard Construction Specification

7.1 TUNNELING, JACKING AND BORING

7.1.1 Definitions

7.1.1.1 Geotechnical Data Report (GDR)

A document which presents an interpretation of the known subsurface data for the project. The purpose of the GDR is to compile all geological, geotechnical, groundwater, and other data obtained from the geotechnical investigations for use by the various participants in the project. If available, this information will be included within the contract documents as specifically applicable to the project.

7.1.1.2 Geotechnical Baseline Report (GBR)

The intent of a GBR is to clearly and contractually define the geotechnical conditions through which tunneling will occur in order to evaluate a differing site condition (if encountered) and it is used as a basis of bid for the contractor. By assessing the anticipated geotechnical conditions for a project and providing baselines in the contract, the contractor has a basis from which to prepare their bid and select their means and methods. The baseline conditions do not necessarily reflect the actual conditions; they are not geotechnical fact to be encountered. Rather, they represent the owner's assumption of existing geotechnical conditions for the project. If available, **this** information will be included within the contract documents as specifically applicable to the project. Regardless of inclusion, this information shall be investigated, interpreted, verified and/or developed by the contractor prior to commencement of the work.

7.1.1.3 Tunnel Shield

A steel shell shaped to fit the excavation line of the tunnel that provides protection at the tunnel face for the construction personnel and space for the tunnel excavation and support operations. The shield may be fitted with boom-mounted tools such as an excavator for excavating the tunnel and mechanical devices for erecting the tunnel supports, or hand mining may be performed inside the shield.

7.1.1.4 Tunnel Boring Machine (TBM)

A machine that uses a full-face cutter head to excavate a circular tunnel.

7.1.1.5 Pipe Jacking

The one-pass trenchless installation of a pipe by jacking the pipe behind a TBM or Tunnel Shield.

7.1.1.6 Permeation Grouting

The direct pressure injection of a chemical fluid grout into the ground to fill the spaces between and bind together soil particles, without causing excessive movement or fracturing of the soil formation. Permeation grouting is performed prior to commencement of tunneling operations to provide a more consistent and stable soil matrix. If applicable, the general extents of permeation grouting for a specific project may be shown in the plans.

7.1.1.7 Compensation Grouting

Compensation grouting is a grouting technique utilized to control ground settlement during soft ground tunneling. Compensation grouting involves the injection of a low slump mortar-like grout under high pressure to compact and displace the adjacent soils. The grout does not penetrate soil pores but displaces the subsurface soils by forming a homogeneous grout bulb near the grout pipe tip. Typically, compensation grouting is done after completion of tunneling to correct for settlement. Compensation grouting may also be performed concurrently with the progress of the tunnel while adjusted grouting parameters continually with reference to measured movements of the ground and/or surface structures, to keep settlement and deformations within specified limits.

7.1.1.8 Contact Grouting

The controlled injection of fluid grout at the interface between the pipeline and the ground to achieve continuous contact and fill the annular space, after pipe jacking has been completed.

7.1.1.9 Inclinator

An electronic probe lowered within a casing that senses changes in inclination along the casing axis. Inclinator are used to record the magnitude and depth of horizontal ground displacement. For tunneling purposes, they are typically installed adjacent to pit locations.

7.1.1.10 Surface Monitoring Point

A marker or point fixed to the ground surface and/or structures along a proposed alignment that is monitored by a professional land surveyor licensed in the state of Colorado using survey control to determine vertical and/or horizontal displacements that may occur during construction.

7.1.1.11 Surface Monitoring Point Array

A grouping or arrangement of surface monitoring points along the proposed tunnel alignment to determine vertical and/or horizontal displacements that may occur during construction.

7.1.1.12 Deep Settlement Monitoring Point

A sleeved rod installed to a specific depth, above the crown of the tunnel, which is used to detect ground movement directly above the tunnel. Also referred to as a single-point fixed borehole extensometer or Borros anchor.

7.1.2 Section Includes

This item includes construction via tunneling, jacking and/or boring as shown on the Construction Drawings. The work includes: excavation of the tunnel, installation of carrier pipe, pipe, contact grouting around the pipe after tunneling, installation and monitoring of geotechnical instrumentation, disposal of excavated soils and compensation grouting as necessary during tunneling operations to control settlement to within acceptable limits. If the need for permeation grouting prior to starting the tunneling is anticipated, a separate bid item will be included within the contract documents.

7.1.3 Requirements

The Contractor must adhere to all requirements contained with the Contract Documents, as well as access permits between the City and facility owners within the project limits.

A pre-excavation permeation grouting program shall be implemented prior to beginning tunnel excavation to improve ground behavior and reduce the potential for ground loss during tunneling. Requirements for this program are provided within these Standard Construction Specifications.

The Contractor shall determine tunneling and support equipment, materials, and methods subject to the limitations specified herein and elsewhere in the Construction Documents. It is the responsibility of the Contractor to safely construct the tunnel and provide the finished product within the requirements specified and shown. The Contractor shall design his tunnel means and methods to allow for performance of the work as specified herein.

The Contractor shall have the sole responsibility for maintenance and protection of existing utilities, railroad tracks, structures, and facilities within the zone of construction. Location of utilities shown on the Construction Drawings shall be considered approximate. The Contractor shall be responsible for locating each utility potentially impacted by the work to verify location prior to beginning the tunneling work.

The Contractor shall allow the Engineer, the City's Construction Project Manager, and the City's Project Management Team access to the shafts and tunnel.

7.1.4 Submittals

7.1.4.1 Preconstruction

Submit the following a minimum of 8 weeks prior to mobilization of tunneling equipment to allow for review by the City's Construction Project Manager and any other affected project stakeholders:

1. A detailed work plan including descriptions of methods and equipment to be utilized in completing the work, schedule for tunnel construction, and details of proposed tunnel construction procedures.
2. A detailed scale drawing showing tunnel layout, shaft locations and dimensions, equipment and staging areas.
3. Procedures for measuring excavation quantities versus forward progress during the tunneling operation.

4. A description and drawings of proposed methods and procedures for excavating the tunnel, including details for tunnel shield or TBM, breasting capabilities, method of controlling line and grade of the tunnel, and steering provisions for making line-and-grade corrections. Include details of provisions for supporting the face of the tunnel when tunneling operations are interrupted.
5. Contact grouting plans and procedures including: description of the grout system and grout equipment including grout pumps, mixers, delivery systems, and monitoring systems; number and spacing of grout holes; procedures for monitoring grout placement and controlling pressures; sequence of construction; grout material and properties; grout mix design including fluidizers, accelerators, and other additives; grout material properties including density, viscosity, bleeding, shrinkage, expansion, and set time.
6. Work plan and shop drawings showing: jacking frame and thrust block design, layout and details, including reaction transfer calculations. The thrust block backstop shall be normal (square) with the proposed pipe alignment and shall be designed to withstand the maximum jacking pressure to be used with a factor of safety of at least two, without excessive deflection or displacement.
7. Design calculations demonstrating that the pipe is capable of sustaining the maximum stresses to be imposed during jacking with a factor of safety of at least two. The calculations shall take into account: ground loads per the Geotechnical Data Report if available; live loads and surcharge loads from equipment; Cooper E80 loads; and jacking forces. Calculations to be performed and stamped by a professional engineer registered in the State of Colorado.
8. Submittal of a settlement control plan and applicable contingency plans prior to construction, including the proposed locations of surface monitoring points and arrays, deep settlement monitoring points, and inclinometers; equipment and materials to be used; and installation procedures.
9. Five days prior to commencement of grouting or construction of any kind, the contractor shall submit the installed location of all surface monitoring points, deep monitoring points and inclinometers. The Contractor shall submit drawings showing the surveyed location, the instrument identification number, the instrument type, the installation date and time, established elevations, initial elevations, offset and stationing, initial coordinates, boring logs, and the anchor to tip elevation and instrument length, when applicable.

7.1.4.2 During Construction

Written Daily Logs. The Daily Logs shall be recorded for each shift and shall be submitted to the City's Construction Project Manager within one working day of excavation at each location. As a minimum, the logs shall include the following:

- The station of the face of the excavation and advance distance;

- Length of pipe installed;
- The date, starting time, and finish time;
- Any unusual conditions, breakdowns, and delays;
- Excavated muck quantity;
- An accounting of volume of spoil in relation to the lineal foot advancement of the tunneling head
- Contact grouting performed;
- Results of pipe joint pressure testing; and
- Results of instrumentation monitoring.

7.1.5 Materials

7.1.5.1 Tunnel Shield or Tunnel Boring Machine (TBM)

The tunnel shield or TBM shall be designed to sustain ground loads which may be imposed upon it as well as any loads imposed by the thrust jacks, steering mechanisms, and other appurtenances. Tunnel excavation equipment shall be capable of maintaining a stable face in all expected ground conditions. The tunnel shield or TBM shall be steerable and capable of being controlled to the desired line and grade indicated on the Construction Drawings within the tolerances specified herein. Equip the tunnel shield or TBM with a laser control system to permit continuous and accurate monitoring of line and grade. The tunnel shield or TBM shall have suitable breasting tables, a closeable cutter wheel with flood doors, or such other appropriate provisions, as necessary, to support the tunnel face and minimize loss of ground. Mechanical or hydraulic excavators shall not interfere with breasting system or face support provisions. Excavator shall be capable of operation when fully retracted within the tunnel shield.

The tunnel shield or TBM shall have a propulsion system capable of moving the shield or machine forward while maintaining the construction tolerances with respect to line and grade. The propulsion system shall include a thrust ring or other provision that will distribute the jacking forces uniformly against the casing or jack pipe so the shield or machine can be advanced without damaging or distorting the pipe.

7.1.5.2 Contact Grout

Contact grout shall be a stable colloidal suspension of cement, bentonite, water, fluidifier, and admixtures. Sand may be added, provided the grout is demonstrated to have suitable flow characteristics and to adequately fill the annular space between the pipeline and the ground being tunneled through.

The grout mix shall be the responsibility of the Contractor. The Contractor shall adjust the water-solids ratio of the grout as necessary to grout effectively and to fill all voids within the zone of grout influence; however, at all times the grout shall have a water-solids ratio of between 1:1 and 3:1 by volume, and a bentonite content of no more than two percent, and no hole shall be completed with a water-solids ratio above 1:1 by weight.

7.1.5.3 Pipe

The pipe to be installed via tunneling shall be indicated within the plans and in accordance with the applicable portion of these Standard Construction Specifications.

7.1.5.4 Casing Pipe, Spacers and End Seals

Where tunneling operations are completed via boring and where specifically called out in the contract documents, a casing pipe, spacers and end seals shall be required.

The casing pipe shall be of welded steel pipe conforming to the requirements of ASTM A53 Grade B or AWWA C200, having minimum yield strength of 35,000 psi of the size and wall thickness as shown below or as otherwise noted in the Contract Documents. i.e. See wall thickness in Additional Notes ==>

Casing shall be kept on line and grade as required within this specification. Joints in the casing shall be field welded around the entire joint perimeter to produce a watertight seal. Welds shall be of a size to develop the full strength of the pipe materials.

Factory manufactured casing spacers shall be installed on all carrier pipes passing through a casing pipe. Wooden skids will not be allowed.

All casing spacers shall adhere and conform to the following:

1. All casing spacers shall be Model SSI8 or SSIM (field adjustable) for carrier pipes up to 24-inches in diameter and Model SSI12 for larger diameter carrier pipe sizes as designed and manufactured by Advance Products & Systems, Inc., Lafayette, LA., or an approved equal. The runners shall be at least 7-inches long for SSI8 and SSIM models or 11-inches long for SSI12 models and they shall be manufactured of high abrasion resistant, low coefficient of friction, glass filled polymer.
2. The casing spacers shall be center restrained to limit vertical movement of the carrier pipe in the casing.
3. Casing spacers shall be bolt-on-style with a shell made of at least two halves.
4. Spacing is approximately 3 per joint of pipe or 1 spacer per every 7 feet maximum.
5. The band material shall be manufactured of a minimum 14 gauge T-304 stainless steel and 10 gauge T-304 stainless steel risers when needed.
6. The casing spacers shall have a flexible PVC or EPDM liner having a minimum thickness of 0.090 inches with a hardness of Durometer "A" 85-90.
7. All welds are to be chemically cleaned and passivated.
8. All hardware shall be stainless steel.

After insertion of the carrier pipe into the casing, the ends of the casing shall be closed by installing $\frac{1}{8}$ " thick synthetic rubber end seals such as the Model "AC" pull-on end seal, as manufactured by Advance Products & Systems, Inc., Lafayette, LA, or an approved equal. Ends seals shall be attached using minimum $\frac{1}{2}$ " wide T-304 stainless steel bandings utilizing a worm gear mechanism.

7.1.6 Instrumentation

7.1.6.1 Surface Monitoring Point Array

Surface monitoring points shall consist of a stable non-destructive pin, nail, point, or other identifiable element with the locations clearly identified where the ground surface consists of sidewalk, curb, rail, or other structure. Where the ground surface consists of soil, vegetation, or ballast, the surface monitoring point shall consist of a minimum 1-foot long rebar anchor driven flush with the ground. The anchor shall be grouted in place. Each surface monitoring point shall have a tag or marking indicating the identification number, tunnel station, and offset from centerline.

7.1.6.2 Surface Monitoring Point Array

The surface monitoring point array shall consist of multiple surface monitoring points installed and arranged in accordance with the Contractors submitted and approved work plan, and as outlined within these specifications.

7.1.6.3 Deep Settlement Monitoring Point

Deep settlement monitoring points shall consist of a rebar anchor installed within a casing to a depth of 3 feet above the top of the tunnel, as shown on the Construction Drawings. Each point shall have a tag or marking indicating the identification number, tunnel station, and offset from centerline. Deep settlement monitoring points shall be installed in accordance with the Contractor's submitted and approved work plan and they shall be protected by traffic rated roadway boxes.

7.1.6.4 Inclinator

Inclinometers are only required if specifically called out within the contract documents.

If required, they shall consist of inclinometer casing installed and grouted within vertical boreholes in the in situ soil. A probe, lowered within the casing, senses changes in inclination along the casing axis, and is used to calculate and monitor the magnitude and depth of horizontal ground displacements. Inclinometers shall be protected by roadway boxes.

Inclinometer casing shall be approximately 70 mm (2.75 in.) standard flush coupled such as Model No. 51150210 manufactured by Slope Indicator Company, Seattle; or approved equivalent.

Inclinometer Probe and Assembly. One inclinometer assembly shall be furnished including a sensor (probe) on a minimum 100 ft long cable, a pulley assembly, and a case. This equipment shall be Model No. 50302910 (sensor), and associated pulley assembly, and case manufactured by Slope Indicator Company, Seattle, WA or approved equivalent.

Inclinometer Readout Unit. Furnish one inclinometer readout unit. The readout unit shall be model No. 50310900 manufactured by Slope Indicator Company, Seattle, WA or approved equivalent. Readout unit provided shall be compatible with inclinometer probe and shall be calibrated to probe by manufacturer prior to shipment.

Inclinometer Software. Computer software required to reduce, analyze, and plot the inclinometer data using a compatible personal computer (PC) shall be furnished. Furnish Datamate Manager Software supplied by Slope Indicator Company, Seattle, WA or approved equivalent, or software compatible with other approved readout units.

Provide a cement-bentonite grout for installing inclinometer casing within drill hole. Grout mix shall be in accordance with manufacturer's requirements, and shall have up to 20 percent bentonite content by weight of cement; add enough bentonite to create a grout with a Marsh funnel number of 55 seconds.

7.1.7 Commencement of Work

Do not begin tunneling until:

1. Required submittals have been reviewed and approved by the Engineer, applicable utility companies, and stakeholders.
2. A pre-construction meeting with the Engineer, City's Construction Project Manager, City's Project Management Team, applicable utility companies, stakeholders and Contractor has been conducted.
3. Shaft excavation and support have been satisfactorily completed in accordance with the Contract Documents.
4. Permeation grouting has been satisfactorily completed in accordance with the Contract Documents.
5. All instrumentation has been installed and initial measurements have been obtained

7.1.8 General Tunneling Requirements

Conduct all operations such that trucks and other construction vehicles do not create a dust nuisance in the streets and adjacent properties. All work shall be done so as not to disturb railroad tracks, roadways, adjacent structures, landscaped areas, or utilities other than as shown on the Construction Drawings. Any damage shall be immediately repaired to the satisfaction of the property owner, residents, agency or utility having jurisdiction, and the City at no additional cost to the City.

No gasoline-powered equipment shall be permitted. Diesel, electrical, hydraulic, and air powered equipment is acceptable, subject to applicable City, State, and Federal regulations. There will be no classification for excavated materials and the term "excavation" shall include all materials excavated or removed from the tunnel, regardless of the type, character, composition or condition of the material so excavated.

The tunnel shall be excavated to the lines, grades and dimensions required to ensure installation of the pipeline as indicated on the Construction Drawings. The tunnel excavation shall begin at the downstream end and work upstream unless approved otherwise.

Methods of construction for the tunnel shall ensure the safety of the work, the Contractor's employees, the public, and adjacent property, whether public or private. Perform all work in accordance with all current applicable permit conditions, regulations, and codes of federal, state, and local agencies. Comply with all applicable provisions of 29 CFR Part 1926, Subpart S, Underground Construction by OSHA. Comply with standards and guidelines provided by the American Railway Engineering and Maintenance-of-Way Association (AREMA), as applicable to the work. In the event of conflict, the strictest or most restrictive shall govern.

7.1.9 Tunnel Construction

Tunnel excavation shall be performed in a manner that will minimize movement of the ground in front of and surrounding the tunnel, and to minimize loss of ground, surface settlement, heave of the ground surface, and movement of railroad tracks, structures, and utilities above and adjacent to the tunnel. The Contractor shall ensure that movement (settlement or heave) at the ground surface does not exceed 0.25-inches, unless noted otherwise within the contract documents.

Support the ground continuously and in a manner that will prevent loss of ground and maintain the stability of the tunnel perimeter and face. Support the tunnel face by positive means during all shut down periods.

Maintain clean working conditions at all times inside the tunnel, and remove all excavated soil (muck), grout spills, and any other material not required for tunneling. All construction debris shall be removed from the site and disposed of daily by the Contractor at the disposal site designated elsewhere in the Construction Documents.

Provide all temporary electrical, water, telephone, and other facilities required to complete the tunnel.

Provide access for Engineer, City's Construction Project Manager and City's Project Management Team to inspect and observe the work or to perform independent line and grade surveys.

Perform tunneling work in accordance with the working hours established for the project. In case of emergency or work stoppages likely to endanger the stability of the excavation or adjacent structures, maintain a full work force 24 hours per day, including weekends and holidays, until emergency or hazardous conditions no longer jeopardize stability and safety of the work.

7.1.10 Tunnel Line and Grade

The longitudinal centerline of the tunnel shall be sufficiently true and accurate to the tunnel profile grade line to stay within the following tolerances during and upon completion of tunneling: invert of the pipe shall be within 1.5 inches horizontally and 1 inch vertically of the plan line and grade. Survey the pipe invert upon every advancement of the pipe to ensure the elevation and alignment is within the tolerances specified above.

Pipe installation shall be invert elevation controlled and reverse grades are prohibited. Deviations from the design tunnel invert shall not exceed the tolerances specified above at

any point during construction and corrections shall not exceed a rate of 3 inches per 100 feet or a lesser rate as determined by the structural characteristics of the pipe.

If the Contractor is unable to maintain these tolerances, he shall bear the full responsibility and expense for correction (redesign, easement acquisition, retunneling, etc.). If design tolerances are exceeded and redesign is required, the Contractor shall obtain the services of a professional engineer registered in the State of Colorado for the redesign. Plans showing the changes shall be submitted to the Engineer for review and approval.

7.1.11 Pipe Jacking

Immediately before joining pipe, the end of the pipe shall be thoroughly cleaned and lubricated with an approved lubricant. The axial forces from the thrust jacks shall be distributed to the pipe uniformly to prevent damage to the ends of the pipe, using pipe cushioning in accordance with approved submittals.

If any part or parts of the pipe becomes unserviceable because the pipe is chipped, gouged, or otherwise damaged before or during installation, it shall be rejected and removed from the site. The City's Construction Project Manager shall make the final determination on rejection and removal of the pipe.

After pipe installation is completed, individual joints shall be pressure tested with a portable hydrostatic tester to 13 psi, in lieu of line infiltration, exfiltration, or air testing.

7.1.12 Contact Grouting

The annulus between the pipe and the ground shall be grouted after pipe jacking is completed. Grouting shall be performed over the entire 360° circumference of the tunnel. The number and location of grout holes in each pipe shall be determined by the Contractor but a minimum of six holes per 20-foot pipe section shall be used. Rings of grout holes shall be spaced at intervals of six feet or less.

Grout shall consist of Portland cement and water or of Portland cement, sand, and water. Grout mixtures may contain bentonite or fly ash. The grout shall consist of 2 parts Portland cement, 1 part fly ash, and not to exceed 6 parts clean, dry, sand.

Contact grout shall be free of lumps when put into the mixer, and the grout mix shall be constantly agitated. Grout shall flow unimpeded and completely fill all voids. Perform the injection of grout continuously on any one pipe section. Fill spaces and voids until completed, so as to avoid disturbance of grout which has taken an initial set.

The grouting process shall be so operated and controlled that the grout will be delivered uniformly and steadily. If, during the grouting of any pipe, grout is found to flow from adjacent grout pipes, such pipes from which grout is flowing shall be closed with valves or plugged with wooden plugs. Where such closing is not essential, ungrouted pipes shall be left open to facilitate the escape of air and water from the space being grouted.

Grouting shall progress from grout pipe to grout pipe in accordance with approved submittals. In going from lower to higher grout pipes, do not make connections to the higher grout pipes until the grout has completely filled the space below the higher grout

pipes. As the grouting proceeds, the escape of grout from the upper pipes in turn shall be permitted as an indication of successive satisfactory filling of voids with grout.

Protect and preserve the interior surfaces of the pipe from damage. Minimize grout drop and proceed with cleanup immediately after grouting. Any damage to the pipe caused by or occurring during the grouting operations shall be repaired. The interior lining of the pipe shall be smooth and free from defects.

Maintain and submit records of grouting operations for each shift, including the location and a detailed log of each grout hole, time of each change of grouting operations, pressures, rates of pumping, grout mix, and grout take at each grout hole hook-up.

After grouting, holes shall be filled with dry packed cement mortar grout. Threaded plugs shall be installed flush with the inside face and the remaining void shall be filled with a non-shrink grout rated to 4000 psi.

7.1.13 Installation of Instrumentation

Instrumentation shall be installed at the locations shown on approved shop drawings. Instruments shall be installed in accordance with the approved installation schedule. All instruments shall be clearly marked, labeled, and protected to avoid being obstructed or otherwise damaged by construction operations, the general public, or railroad operations.

Locate conduits and underground utilities in all areas where subsurface geotechnical instrumentation is to be drilled and installed. Subsurface geotechnical instrumentation locations shall be modified, as approved by the City's Construction Engineer, to avoid interference with existing conduits, railroad tracks, utilities, and foundation elements. Repair damage to existing utilities resulting from instrument installations at no additional cost to the City.

Surface monitoring points and arrays shall be installed over the centerline of the tunnel and at offsets as shown in the Contractor's approved submittals to determine the lateral and longitudinal extent of ground movement. The longitudinal spacing of the points shall be a minimum of one every 25 feet along tunneled portions of the project, as allowable based on surface features. The longitudinal spacing of the arrays shall be a minimum of one every 75 feet along tunneled portions of the project, as allowable based on surface features. The arrays shall be centered across the proposed tunnel(s).

Individual surface monitoring points shall be placed along each side of each shaft, a distance of 5 feet and 10 feet from the shaft wall; a minimum of 6 points per shaft shall be installed.

Deep settlement monitoring points shall be installed in accordance with approved shop drawings. The bottom of the instrument shall be located 3 feet above the crown of the tunnel.

Immediately following installation, the location of the top of all instruments shall be surveyed to provide horizontal and vertical coordinates. Data shall be provided to the City's Construction Project Manager in accordance with the submittal requirements specified herein. Re-surveying from control points shall be required a minimum of every two weeks or more frequently as required to address potential disturbances or resolve conflicting data.

7.1.14 Installation of Inclinometers

Inclinometers, if required within the contract documents, shall be installed within 5 feet of each shaft as shown on the plans and/or as approved in the submitted shop drawings. Inclinometer casing shall extend from the ground surface to a depth at least 15 feet below the base of the shaft excavation.

Conduct drilling operations using appropriate methods that are consistent with geologic conditions presented in the Geotechnical Baseline Report. Provide drill casing if required to hold drill hole open. Drill hole or inside of casing, if applicable, shall provide a clear opening (6 inches) in diameter or greater. A log of the soils encountered during drilling shall be accurately maintained, and a copy shall be provided to the City’s Construction Project Manager in accordance with the time restrictions stated herein.

Install inclinometer casing in accordance with the manufacturer’s recommendations and approved shop drawings. Grout the annulus between the inclinometer casing and the ground using a non-shrink cement grout.

Install protective housing with locking cap and padlock. Protective housing shall be installed within an approved flush-mounted traffic rated roadway box or vault so as not to obstruct vehicle or foot traffic.

7.1.15 Instrumentation Monitoring and Reporting

The Contractor shall take initial readings of all instruments to establish a baseline and provide the City’s Construction Project Manager with this data, in accordance with the requirements specified herein. The Contractor will read required instrumentation and provide the City’s Construction Project Manager with these data. Surface monitoring points and arrays and deep settlement monitoring points within 50 feet of the working face of the tunnel shall be surveyed daily. Inclinometers shall be monitored daily. The frequency of monitoring may be modified by the Engineer or the City’s Construction Project Manager.

The Contractor shall provide data from readings of all instruments to the City’s Construction Project Manager within one working day of obtaining the information. The data shall include a copy of the data sheets containing a cumulative history of readings, including weather conditions, temperature, and proximity of the excavation to the instrument location itself, at the time of each reading.

The Contractor shall abide by the following Response Values:

Instrument	Threshold Value	Shutdown Value
Surface Monitoring Points and Arrays	1.5-inch H or V for Shafts 0.13-inch H or V for Tunnels	3-inch H or V for Shafts 0.25-inch H or V for Tunnels
Inclinometer	1.5-inch H or V for Shafts	3-inch H or V for Shafts
Deep Settlement Monitoring Points	2-inch V	4-inch V

If a threshold response value is reached, the Contractor shall meet with the City's Construction Project Manager to discuss his/her means and method to determine what changes, if any, shall be made to better control movement. If a shutdown response value is reached, the Contractor shall stop all work immediately. The Contractor shall meet with the City's Construction Project Manager, the Engineer, and the City's Project Management Team to develop a plan of action before work can be resumed. All costs associated with shutdown due to reaching maximum limits shall borne by the Contractor.

Remove all instrumentation during the cleanup and restoration work or as required by the City's Construction Project Manager. All roadway boxes shall be removed. At a minimum, fill the inclinometer casing and deep settlement point casing with a lean cement grout and cut off the upper 3 feet of the instrument and casing which extend below grade.

7.1.16 Cleanup and Restoration

Remove all equipment, unused materials, and debris from the site at the end of the job. Restoration shall follow construction as the work progresses and shall be completed as soon as possible and to the satisfaction of the applicable utility owners and stakeholders. Restore and repair any damage resulting from surface movement caused by the work. Any property or improvements damaged or destroyed, shall be restored to a condition equal to or better than existing prior to construction at no additional cost to the City. Restoration shall be completed immediately if a third party or the City is inconvenienced by the damage, and in no case later than thirty (30) days after the damage is discovered. This provision for restoration shall include all property which was affected by the construction operations.

END OF SPECIFICATION



CITY AND COUNTY OF DENVER
ENGINEERING DIVISION

Wastewater Capital Projects Management Standard Construction Specification

7.2 MICRO TUNNELING

7.2.1 General

Where indicated on the Drawings, or where field conditions dictate that open trenching for the pipeline across railroad tracks, highways, or other obstructions is prohibited, the pipe shall be installed by jacking, tunneling, boring and casing methods, or micro tunneling.

Should the General Contractor, in the process of Project construction, elect to propose that a portion of the pipe be installed by micro tunneling, rather than by jacking, boring or trenching operations, the subject cost shall not total more than the aggregate sum of the removal and replacement costs that such an activity would replace.

7.2.2 Shop Drawings

Detailed shop drawings will be required for all pipe jacking, tunneling and boring installations.

7.2.3 Construction

Work specified in this Section describes the construction of sanitary sewers by jacking fiberglass reinforced polymer mortar (RPM) behind a remotely operated, steerable, micro-tunneling boring machine (MTBM), with RPM serving as both the primary tunnel liner during construction and sanitary sewer pipe (secondary tunnel liner) after completion of construction. The General Contractor shall select and utilize methods and equipment compatible with the selected dimensions of the tunnel and with the anticipated geologic conditions described in the Geotechnical Report (GR).

The micro-tunneling boring machine (MTBM) may be either of the following:

1. Slurry Shield

An MTBM in which the tendency of soil at the excavation face to run or flow uncontrollably into the MTBM is prevented by the counterbalancing force of bentonite slurry contained at the face of the MTBM. During boring, the excavated material is mixed with the bentonite slurry and pumped through a pipe for disposal.

2. Earth Pressure-Balance Shield

An MTBM in which the tendency of the soil at the excavation face to run or flow uncontrollably into the MTBM is prevented by the counterbalancing force of the excavated material which is contained, under pressure, at the face of the MTBM. During boring, the excavated material is mixed with water or bentonite slurry and pumped through a pipe for disposal or by a balanced screw auger or screw conveyor system.

During tunneling and construction operations, the following shall be followed:

- a. Control groundwater in accordance with specified requirements during all micro-tunnel excavation.
- b. Perform micro-tunneling operations in a manner that will minimize loss of ground and minimize settlement of the ground surface, structures, and utilities above and adjacent to the tunnel.
- c. The General Contractor shall perform pre-construction and post-construction surveys of all structures, residences, and other facilities adjacent to the areas of the tunnel.
- d. Maintain clean working conditions at all times inside the tunnel and pits. All muck, slush, grout spills, ponded water, and any other material not required for tunneling shall be removed from the excavations in a timely manner.
- e. All work of excavating, lining, grouting and construction of the jacking operation shall be so executed that ground settlement or loss will be minimized; the completed sewer pipe shall have full bearing against earth, and no voids or pockets will be left in any portion of the Work. The peripheral space between the support elements and the excavated surface (i.e., the diameter of the excavated hole is no larger in diameter than 3/4 inch more than the pipe outside diameter) shall be filled with the bentonite lubricating material. If the diameter of the excavated hole is greater than 3/4 inch more than the outside diameter of the pipe, it shall be promptly filled with suitable material, such as grout, as accepted by the Construction Project Manager. This may require jacking or the pipe be discontinued and additional access pits installed at no extra cost to the City.
- f. The General Contractor shall be aware that various existing soil borings, piezometers or instrument wells coincide with the proposed sewer pipe alignment. These may or may not have been backfilled with grout and therefore caution should be used in tunneling through these existing borings. General Contractor shall take mitigating measures at no additional cost to the CITY to counter any effect these bore holes, piezometers or instrument wells may have on tunneling operations.
- g. All excavations shall remain within the easements and rights of way indicated on the Drawings, to the lines and grades designated on the Drawings, and use methods which include due regard for safety of workmen, adjacent structures, utilities, and the public. Methods of excavation shall be at the General Contractor's option, subject to the review of the Construction Project Manager. Shape the excavation to

fit the sewer pipe section and of sufficient size to allow the construction of the sewer pipe to the lines and grades indicated on the Drawings.

7.2.3.1 Casing Pipe Installation Method

The General Contractor shall have the option to select the method of micro-tunneled casing pipe installation, subject to approval by the Construction Project Manager.

The excavated size of the tunnel shall be determined by the General Contractor based on construction requirements for the secondary lining system, and is subject to the limitations shown on the Drawings.

7.2.4 References

All work shall be performed in accordance with applicable regulations of all federal, state, and local regulations, codes, and standards.

7.2.5 Existing Conditions

7.2.5.1 Restrictions

The General Contractor shall comply with all restrictions set as conditions under which the easement or permission was granted to the Owner to perform the work of this Contract. These restrictions are included with these Specifications. The General Contractor is presumed to have fully determined all special requirements that pertain to each length of sewer in tunnel constructed under this Section.

7.2.5.2 Preliminary Inspections

The General Contractor shall inspect the locations where the access pits and tunnels are to be built to familiarize himself with the conditions under which the Work will be performed and with all necessary detail as to the orderly prosecution of the work in conformance with Instructions for Bidders. The omission of any details necessary for the satisfactory prosecution of the WORK in its entirety, which may not appear herein, shall not relieve the General Contractor of his full responsibility.

7.2.5.3 Soil, Rock and Groundwater

The General Contractor acknowledges that certain soils reports, borings, and other Geotechnical data, more particularly described or referenced in the Standard Construction Specifications of the Contract, have been made available for inspection and review. The borings were made for the use of the City in the design of the Project and are not intended to be interpreted for use in temporary construction facilities designed by the General Contractor.

7.2.5.4 Utilities

The General Contractor shall be responsible for the protection of all utilities encountered during the Work of this Contract. The known utilities are shown on the Contract Drawings and the General Contractor shall take every precaution when working near the utility to locate and protect these utilities. All damage to the existing utilities shall be the sole

responsibility of the General Contractor. The General Contractor shall replace, repair, remedy, or compensate for all damages at no additional cost to the Owner.

7.2.5.5 Structures

The General Contractor shall be responsible for the protection of all structures, roads and railroads above or adjacent to the tunnel, within the framework and criteria set forth in the Contract Documents.

7.2.6 Definitions

1. Micro Tunneling

Shall be defined as a method of installing pipe, by jacking the pipe behind a remotely controlled, steerable, guided articulated Micro-Tunneling Boring Machine (MTBM). The MTBM, which is connected to and followed by the pipe being installed, shall ensure that the soils being excavated are fully controlled at all times.

2. Jacked Pipe

Shall be defined as the General Contractor's sewer pipe that serves as initial construction lining and tunnel support, installed by the General Contractor for stability and safety during construction, and as the sewer line or permanent secondary liner.

3. Jacking System

A system of jacks which pushes the sewer pipe. Capacity of jacks and extension rate is synchronized with excavation rate of the machine.

4. Intermediate Jacking Station

Hydraulic jacks installed at intermediate locations in the pipe string to allow selective shoving of discrete segments of the total pipe.

5. Slurry System

Transportation of excavated material in slurry flow matched to excavation rate. System balances groundwater pressures and separates soil from slurry at end of process. Soil separation methods are not limited to mechanical means. Soil separation method may be chemical in nature.

6. Laser

An optical system projecting a beam to a target to provide guidance for the micro-tunnel excavation.

7. TV

A television system which monitors the progress and alignment of the micro-tunneling machine and pipe.

8. Controls

The system which synchronizes excavation, removal of the excavated material, and jacking of pipe to maintain overall balance to provide complete and adequate ground support at all times.

7.2.7 Quality Assurance

7.2.7.1 General Contractor

The General Contractor must provide proof of successful experience with micro tunnel excavation and support at the depths shown, in the soil and groundwater conditions expected, with the lining systems shown and with the General Contractor's proposed equipment.

7.2.7.2 Project Superintendent

The project superintendent shall have at least five years of tunneling experience and shall have worked on at least two micro-tunneling projects in similar ground conditions using equipment similar to the equipment required for this project. The machine operator shall have at least three years of micro-tunneling experience and shall have worked on at least one tunnel project using the same equipment required for this project.

7.2.8 Quality Control

General Contractor shall establish and maintain quality control for operations under this Section to assure compliance with contract requirements and maintain records of his quality control for materials, equipment, and construction operations including but not limited to the following:

7.2.8.1 Preparatory Inspection

Preparatory inspection shall be conducted prior to commencing work and should include the following as a minimum requirement:

1. Check pipe for conformance to approved certified tests.
2. Check pipe for proper storage and handling.
3. Discuss and review pipe installation procedure with the Construction Project Manager. Discussion shall include placement of pipe, joint preparation and application of each pipe used.

7.2.8.2 Initial Inspection

Initial inspection shall be conducted after a representative sample of the work is complete and should include the following as a minimum requirement.

1. Check for proper depth and grade for pipe.
2. Check method of joining pipes.
3. Check the pipe for proper alignment.

7.2.9 Tolerances

Excavation and jacking of the sewer pipe shall be controlled by the General Contractor to allow construction of the sewer to a true circular shape and to within 1.5 inches on line and 1 inch on grade. Variations from line and grade tolerances listed herein may be allowed

provided the line and grade variation is regular and only in one direction, and that the final grade of flow line is in the direction indicated on the Drawings. When the excavation is off line and grade, the General Contractor shall make corrections to plan line and grade at the rate of 3 inches per 100 feet.

The General Contractor shall survey the tunnel at 50-foot intervals or a minimum of once per tunnel drive to ensure the alignment is within the tolerances specified. The survey shall be conducted immediately behind the tunnel excavation to allow immediate correction of misalignment. Tunnel excavation shall not precede surveyed verification of the alignment by more than 100 feet, or more frequently if line and grade tolerances have been exceeded. The tunnel guidance system may be used; however, the General Contractor shall select times to measure and record this information after the air temperatures have stabilized throughout the pipe to ensure accurate readings.

If the General Contractor is unable to maintain these tolerances, he shall bear full responsibility and expense for correction (redesign, easement acquisition, etc.) If these tolerances are exceeded and redesign of structures is required, the General Contractor shall obtain the services of an independent professional engineer registered in the State of Colorado for the redesign. Plans showing the changes shall be submitted to the Construction Project Manager for review.

7.2.10 General Contractor Submittals

The Construction Project Manager will base the review of submitted details and data with consideration of requirements for the completed work, utilities, and the possibility of unnecessary details in the execution of the work to be constructed under this Contract. Review of the General Contractor submittals by the Construction Project Manager shall not be construed in any way as relieving the General Contractor of his responsibilities under this Contract.

The General Contractor shall submit the following to the Construction Project Manager for approval and/or examination:

1. Working Drawings

Complete working drawings showing details of the proposed method of construction and the sequence of operations to be performed during construction shall be submitted. Working drawings shall show the method of micro-tunneling, including the micro-tunneling system to be used, location of access pits including method of excavation, shoring and bracing appurtenance installation, and dewatering techniques that are proposed to be used. The following shall be included as the minimum level of detail required:

- a. A detailed description of the micro tunneling procedure including construction techniques to provide the access required to install pipe in conformance with the Contract Documents.
- b. Manufacturer's literature describing in detail the micro-tunneling system to be used. Detailed description of projects on which this system has been successfully used

- including the names, addresses and telephone numbers of owner's representatives for these projects as well as length, diameter, and pipe material used.
- c. Calculations and drawings indicating limits of access pits and any ground support to be utilized.
 - d. Method of spoils disposal.
 - e. A groundwater stabilization scheme covering the excavations for starter and receiver pits. Verify this plan to stabilize anticipated unstable soil conditions. Such verification shall include all calculations and detail drawings for methods of controlling groundwater.
 - f. Certification by the machine manufacturer of the thrust, torque, condition, and operational characteristics of all equipment to be used for installing the specified pipes. The micro-tunneling equipment shall employ a spoil removal system with a pressure balance system that is capable of equalizing pressures between the tunnel face and the micro-tunneling machine head in order to prevent caving beyond the outside diameters of the pipe.
 - g. Layout of tunneling and ancillary equipment at each jacking and receiving (access) pit location.
 - h. Tunnel machine shop drawings including configuration of cutter head and over cut.
 - i. Ventilation system details.
 - j. Pipe lubrication system details.
 - k. Electrical system and lighting details.
 - l. Grade and alignment control system details.
 - m. Tunneling machine groundwater control provisions.
 - n. Gas monitoring system.
 - o. Details of mucking system and soil separation methods including proposed slurry formulations and calculations of the system capacity to handle flows at all distances and changes of elevation to and from the tunnel machine.
 - p. Details of jacking system, intermediate jacking stations and their proposed spacing, method of operation, and thrust capacity. Include calculations of anticipated jacking forces required to advance the pipe. Include sleeve details and supporting gasket compression calculations for joints and gaskets used with intermediate jacking stations. Describe controls to prevent the maximum jacking force from being exceeded.
 - q. Details of grouting the annulus space after pipe has been installed including injection pressure and method of controlling grout pressures.
 - r. Grouting techniques to be used for over excavation if any, including equipment, pumping procedures, pressure grout types and mixtures.

- s. Procedures for measuring excavation quantities versus forward progress during the tunneling operation.
- t. Calculations demonstrating that the pipe selected has been designed to support the maximum anticipated earth loads and superimposed live loads, both static and dynamic, which may be imposed on the pipe. Determine the additional stresses imposed on the pipe during jacking operations and upgrade the quality and strength of the pipe and pipe joints to the extent necessary to withstand the additional stresses imposed by the jacking operation. The details shall be submitted for approval.
- u. Complete information on General Contractor's safety plan for personnel conducting the micro-tunneling operations and appurtenance installation. The plan shall include provisions for lighting, ventilation, and electrical safeguards.
- v. Keep and maintain at the construction site a complete set of field drawings for recording as-built conditions. It shall have marked or noted thereon all field information, properly dated, recording as-built conditions. This set of field drawings shall be kept up to date.
- w. Pipe certification of compliance.
- x. Pipe jointing methods and details.
- y. All General Contractor submittals requiring structural design shall be signed by a professional civil or structural engineer registered in the State of Colorado.
- z. Written documentation summarizing the qualifications of the project superintendent, machine operators, and site safety representative.

2. Log of the Jacking Operations

The General Contractor shall submit a log of jacking operations; the log shall be taken at intervals of no more than 10 minutes apart and a minimum of four readings per pushed 10 foot and accomplished by digital video recording of the TV image at the operator's console. Video shall show a real-time clock that matches the time scale used in the log. Indicators in the tunneling machine being viewed by the digital recorder shall indicate when the tunneling machine is excavating and the number of the pipe joint that is being pushed. The log shall be submitted to the Construction Project Manager each day. The digital video shall be submitted to the Construction Project Manager each week. As a minimum, the log shall consist of the following:

- a. The position of the tunneling machine in relation to the design line and grade.
- b. The jacking forces exerted on the pipe at each jacking station.
- c. The date, the starting time, and the finish time.
- d. The position of the steering jacks.
- e. Inclination.
- f. Cutter head torque.

- g. Slurry flow rates in both the supply and return lines (if slurry is used).
- h. Face pressure.
- i. Hydraulic pressure (on hydraulic motor machines).
- j. LEL gas readings.

3. Pipe Lubricant

Submit a separate log tracking pipe lubricant used in gallons, its viscosity, and pumping pressure. Log shall be submitted to the Construction Project Manager each day

4. Muck Removal

Submit a separate log tracking the volume of muck removed from the site. Log shall be submitted to the Construction Project Manager each day.

5. Survey Records

Submit survey records of the horizontal and vertical positions of surface control points and other instrumentation within 24 hours of measurements as required herein.”

6. Inclinometer Data

Inclinometer data shall be plotted on a cumulative time-deflection plot, using commercial software from the manufacturer, with past readings shown together with most current so that trends can easily and quickly be established by the Construction Project Manager and General Contractor.

7.2.11 Products

7.2.11.1 Equipment

No gasoline powered equipment shall be permitted in the tunnel operation. Diesel, electrical or air-powered equipment will be acceptable, subject to applicable federal and state regulations. Diesel engines equipped with scrubbers are acceptable only when jacking in free air. Provide compressed air and electricity for General Contractor’s operations from a source outside the pipe.

1. Micro Tunnel Boring Machine (MTBM)

The General Contractor shall employ MTBM that is capable of handling the various anticipated ground conditions. In addition, the MTBM shall:

- a. Have a “closed” face which is capable of minimizing loss of ground ahead of and around the machine and providing satisfactory support of the excavated face at all times and shall have the capability of setting a calculated earth balancing pressure and positively measuring the earth pressure at the face.
- b. Provide a system to indicate whether the amount of earth material removed is equivalent to that displaced by the advance of the machine such that the advance rate may be controlled accordingly.
- c. Conform to the shape of the tunnel with a uniform perimeter that is free of projections that could produce over excavation or voids.
- d. Be articulated to enable remote steering of the system.

- e. Have a display available to the operator, at an operation console, showing the position of the shield in relation to a design reference together with other information such as face pressure, roll, pitch, steering attitude and valve positions.
- f. Incorporate a seal in the tail of each MTBM shield to prevent leakage of lubricating liquid or grout, into the tunnel space, between the MTBM shield and lining.
- g. Have a cutter head powered by electric or hydraulic motors and have motors and operating controls protected against water inflows.
- h. Provide a bi-directional drive on the cutter head wheel.
- i. Provide means for maintaining the tunnel face under wet and adverse soil conditions. Use closure doors on the cutter wheel or other means acceptable to the Construction Project Manager.

2. Automated Spoil Transportation

The General Contractor shall provide a MTBM which includes an automated spoil transportation system which shall:

- a. Match the excavation rate to the rate of spoil removal thereby maintaining settlement or heave within tolerances specified.
- b. Balance ground water pressures by the use of a slurry pressure balance system which shall be capable of any adjustment required to maintain face stability for the particular soil condition encountered on the Project and shall monitor and continuously balance the ground water pressure to prevent loss of slurry and or ground water.
 - In a slurry spoil transportation system the ground water pressure shall be managed by use of the slurry pumps, pressure control valves, and a flow meter.
 - A slurry bypass unit shall be included in the system to allow the direction of flow to be changed and isolated, as necessary.
 - A separation process shall be provided when using the slurry transportation system which shall be designed to provide adequate separation of the spoil from the slurry so that the clean slurry can be returned to the cutting face for reuse. Spoil shall be appropriately contained at the site prior to disposal.
 - The type of separation process used shall be dependent upon the size of the tunnel being constructed, the soil type being excavated, and the work space available at each work area for erecting the plant.
 - The composition of the slurry shall be carefully monitored for specific gravity and viscosity.
- c. Balance ground water pressures by the use of an auger earth pressure balance system which shall be capable of any adjustment required to maintain face stability for the particular soil condition to be encountered on the Project and shall monitor and continuously balance the ground water pressure to prevent loss of ground water.

- If an auger spoil transportation system is utilized, the ground water pressures shall be managed by controlling the volume of spoil removal with respect to the advance rate (Earth Pressure Balance Method) and the application of compressed air. The speed of rotation of the auger flight, the addition of water, and/or compressed air shall be monitored.
- The Construction Project Manager's approval will be required where an auger soil transportation system is proposed for use by the General Contractor in the presence of ground water. Such approval will be based on an evaluation of the equipment's ability to balance soil and water pressures at the face, stability of the soils, and the significance of the ground water present.

3. Pipe Jacking Equipment

The General Contractor shall provide a MTBM which includes a pipe jacking system which shall:

- a. Have the main jacks mounted in a jacking frame located in the starting pit.
- b. Have a jacking frame which shall successively push the MTBM along with a string of connected pipes toward a receiving pit.
- c. Have sufficient jacking capacity to push the MTBM and the string of pipe through the ground.
 - Calculations shall be made to determine the face excavation forces, frictional factor, and weight of the MTBM and pipes.
 - The jacking equipment installed must have a capacity at least 20 percent greater than the calculated theoretical jacking load.
- d. Have hydraulic cylinder extension rates which are synchronized with the excavation rate of the MTBM, which shall be determined by the soil conditions.
- e. Have intermediate jacking stations which shall be provided when the calculation of the total jacking force needed to complete the installation exceeds 80 percent of the capacity of the main jacks or the designed working compressive loads (including safety factor) allowed for the pipe.
- f. Develop a uniform distribution of jacking forces on the end of the pipe by use of spreader rings and packing.
- g. Provide for a pipe lubrication system which shall be used if the calculated jacking forces are expected to exceed the pipe design strength (including the 2.5 to 1 safety factor) or if the actual jacking forces encountered exceed 80 percent of the pipe design strength (including the 2.5 to 1 safety factor). Should either of these conditions occur, an approved lubricant shall be injected to lower the friction developed on the surface of the pipe during jacking.

4. Remote Control System

The General Contractor shall provide a MTBM which includes a remote control system which shall:

- a. Allow for the operation of the system without the need for personnel to enter the micro-tunnel. In man entry sized pipes, intermittent entry of personnel will be permitted for maintenance and removal of equipment once the pipe installation is complete, provided that all safety precautions specified elsewhere and required by law are in place and functional.
- b. Integrate the system of excavation and removal of soil and its simultaneous replacement by pipe. As each pipe section is jacked forward, the control system shall synchronize all of the operational functions of the system.
- c. Provide complete and adequate ground support at all times.

5. Active Direction Control

The General Contractor shall provide a MTBM which includes an active direction control system which shall:

- a. Control line and grade by a guidance system that relates the actual position of the MTBM to a design reference (e.g., by a laser beam transmitted from the jacking pit along the center line of the pipe to a target mounted in the shield).
- b. Be capable of maintaining grade to within plus or minus one inch and line to within plus or minus 1.5 inches.
- c. Provide active steering information which shall be monitored and transmitted to the operation console.
- d. Provide minimum steering information available to the operator on the control console which includes the position relative to the reference, role, inclination, attitude, rate of advance, installed length, thrust force, and cutter head torque.

6. Ventilation and Monitoring

Equipment shall be provided to adequately ventilate the entire micro-tunneling operation at all times during construction.

- a. Portable testing equipment shall be provided for carbon monoxide gas, hydrogen sulfide gas, oxygen deficiency and explosive gases.
- b. An automatic gas alarm to detect explosive gases shall be provided on the Micro-Tunnel Boring Machine. The audible alarm shall be located in the jacking pit and shall be active at all times.

7. Electrical Systems

All electrical systems utilized on the Micro-Tunnel Boring Machine shall be equipped with appropriate ground fault systems. All electrical systems are to be insulated, not permitting any bare wire exposures. Motors and controls shall be equipped with an automatic shutoff such as MSA Methane Monitoring System VI or equal.

8. Additional Safety Equipment

Necessary equipment for tunnel excavation shall include signal systems, fire extinguishers, safety equipment, and other equipment required by the General Contractor's method of construction. Such equipment shall be maintained in good repair.

7.2.11.2 Jacked Pipe

Pipe for jacking shall be designed to carry all jacking loads. Refer to individual pipe specification sections.

7.2.11.3 Pipe Joints

The outside walls shall be straight without bell modifications. All joints shall be watertight.

7.2.12 Design

The General Contractor shall be responsible for the design of the fiberglass reinforced polymer mortar pipe to carry the loads imposed on it during construction, including the jacking forces.

7.2.13 Excavation

7.2.13.1 General Tunnel Requirements

Tunnel excavation shall not begin until:

- a. The work Plan and all required submittals have been submitted by the General Contractor and reviewed and returned approved by the Construction Project Manager.
- b. The required Pre-Construction Surveys have been completed.
- c. All instrumentation along the tunnel alignment is in place, stable, and baselines have been established.
- d. All pre-job safety meetings required by OSHA and/or General Contractor's Safety Plan have been held.

7.2.14 Micro-Tunneling

The General Contractor shall conduct all micro-tunneling operations in accordance with all applicable safety rules and regulations. The following shall apply to micro tunneling operations:

1. No work shall commence until the design and construction procedure has been approved in writing by the Construction Project Manager. The General Contractor is totally responsible for the performance of the equipment and methods selected for this phase. The Construction Project Manager's approval signifies only that the construction process is compatible with the overall objectives of the project.
2. The pipe used for jacking shall be round, have a smooth, even outer surface, and have joints that allow for easy connections between pipes. Pipe ends shall be square and smooth so that jacking loads are evenly distributed around the entire pipe joint and such that point loads will not occur when the pipe is jacked in a reasonably straight alignment. Pipe used for jacking shall be capable of withstanding all forces that will be imposed by the process of installation, as well as the final in place loading conditions. The driving ends of the pipe and intermediate joints shall be protected against damage.

3. The pipe, insofar as practical, shall be micro-tunneled from the downstream end.
4. A jacking frame shall be provided for developing a uniform distribution of jacking forces around the periphery of the pipe. Special care shall be taken by the General Contractor to ensure that the thrust reaction backstop is properly designed and constructed. The backstop shall be square with the proposed pipe alignment and shall be designed to support the maximum obtainable jacking pressure with a factor of safety of at least 2.0. The jacking system shall be capable of continuously monitoring the jacking pressure and rate of advancement. Special care should be taken when setting the pipe guard rails in the pit to ensure correctness of the alignment.
5. The General Contractor shall maintain an envelope of bentonite slurry, or other similar material, around the exterior of the pipe during the jacking and excavation operation to reduce the exterior friction and the possibility of the pipe freezing in place. Water jetting of the pipe bedding or backfill shall not be permitted.
6. The pipe freezes and the General Contractor is unable to move it again, the General Contractor may be permitted to construct an intermediate access pit, with the location subject to review by the Construction Project Manager . The General Contractor shall be solely responsible for making arrangements for such an intermediate pit and shall be solely responsible for any and all costs associated with the location and construction of the pit and for maintaining traffic in the area.
7. In the event a section of pipe is damaged during the jacking and excavation operation, one of the following procedures shall be used to correct the damage, as directed by the Construction Project Manager.
 - a. Slightly damaged pipe which passes leakage test and maintains pipe barrel and joint structural integrity shall be repaired in place with a method approved by the manufacturers.
 - b. Severely damaged pipe shall be removed from the excavation by jacking it through the excavation and removing it at an access pit.
8. The joints shall be made watertight by using rubber gaskets.
9. The pipe joints shall be cushioned by a plywood ring between the joints, or by other methods, to transmit the jacking forces without damage to the pipe or pipe joints.
10. After the pipe is in place and the jacking and excavation operation is complete from one access pit to the next; any over excavation greater than the pipe outside diameter plus 3/4 inch shall require the pipe to be grouted in place.

7.2.15 Grouting

The General Contractor shall furnish and operate suitable equipment for all grouting operations.

After completion of the jacking operation, the lubricate material shall be displaced from between the pipe exterior and surrounding ground by a cement grout. Pressure and the amount of grout shall be controlled by the General Contractor to avoid pipe damage and

displacement of the pipe and soil beyond specified tolerances. Grouting shall be accomplished as soon as possible after pipe installation has been completed to prevent any surface settlement due to movement of soil material into the void space or loosened zone around the pipe.

All voids outside the limits of the excavation created by caving or collapse of earth cover over the excavation, or by other cause shall also be completely filled with pea sized gravel or sand cement grout. Pressure-injected grout shall be placed at the same frequency as required when placing grout behind the pipe.

Pressure-injected grout used in conjunction with pea gravel shall be placed behind the pipe if required to minimize ground loss. General Contractor shall provide seals on the tail of the tunnel boring machine which will prevent the pea gravel or grout from moving into the shield.

7.2.16 Jacking Pits

Construction techniques required to provide access for micro-tunneling shall be such as to ensure the safety of the work. Acceptable excavation methods include the use of interlocked steel sheetpiling or open excavation. Final dimensions of access pits selected by the General Contractor shall conform as a minimum with dimensions required to permit installation of the work.

The General Contractor shall be required to properly support all excavations and to prevent all movement of the soil, pavement, utilities or structures outside of the excavation. All pits shall conform to applicable Local Safety Standards, OSHA Standards, trenching, and shoring standards.

If at any time the method being used by the General Contractor for supporting any material or structure adjacent to any excavation is not safe in the opinion of the Construction Project Manager or applicable federal, state or local inspection authorities, the Construction Project Manager may require and the General Contractor shall provide additional bracing and support necessary to furnish the added degree of safety required by the Construction Project Manager. The General Contractor shall provide such added bracing and support by such method approved by the Construction Project Manager as he may elect to use but the taking of such added precautions shall in no way relieve the General Contractor of his sole final responsibility for the safety of lives, work, and structures. The use of such additional bracing and support shall be without additional cost to the City. The absence of an order from the Construction Project Manager for the aforementioned additional bracing shall in no way relieve the General Contractor of his sole final responsibility.

Pits shall be constructed to accommodate the installation of pipe casings, slurry shield, and jacking device. Install thrust block as required and consolidate the ground where the casings enter and exit the ground.

All work of excavating shoring and bracing shall be so executed that settlement is minimized, the in-place casing shall have full bearing against earth, and no voids or pockets are left in any portion of the work.

Before beginning construction, the General Contractor shall adequately protect existing structures and other permanent objects. The repair of or compensation for damage to permanent facilities due to negligence or lack of adequate protection on the part of the General Contractor will be at no cost to the City.

The General Contractor shall provide surface drainage during the period of construction to protect the work. Provide all dewatering and test any groundwater discharges. All discharge limits and reporting requirements shall be the responsibility of the General Contractor.

Size and locate pits and their work areas so as to avoid interference with traffic.

Blasting will not be permitted.

7.2.17 Line and Grade

The Construction Project Manager has established the baselines and benchmarks as indicated on the Contract Drawings. The General Contractor shall check these baselines and benchmarks at the beginning of the contract period and report any errors or discrepancies to the Construction Project Manager.

The General Contractor shall use the baselines and benchmarks to furnish and maintain all reference lines and grades for the micro-tunnel construction. These lines and grades shall be used to establish the exact location of all micro-tunneling, excavations and structures.

The General Contractor shall establish and be fully responsible for the accuracy of his own control for the construction of the entire project, including access shaft locations, structures, excavation, pipe alignment and grade. The General Contractor shall submit copies of field notes used to establish all lines and grades.

The General Contractor's control points shall be established sufficiently far from the tunnel operation not to be affected by ground movement.

The General Contractor shall maintain daily surveying records of alignment and grade and shall submit three copies of these records to the Construction Project Manager . The General Contractor, however, remains fully responsible for the accuracy of his work and the correction of it, as required.

The General Contractor shall check his control for his excavation against an above ground undisturbed reference at least once each week and once for each 250 feet of tunnel constructed, or more often as needed or directed by the Construction Project Manager .

After installation of the sewer pipe, the General Contractor shall provide the Construction Project Manager with access to the tunnel for visual inspection of the line and grade of the completed in place sewer pipe.

Guidance laser system shall be mounted in a manner that isolates it from effects of movement by the jacking forces.

7.2.17 Earth Movement

The General Contractor shall be responsible for all damages due to settlement from any construction induced activities or occurrences.

The General Contractor is advised of the proximity of buildings, structures, roads, and utilities to the work. Precautions shall be taken to avoid damage or settlement to any of these. Such precautions shall include the use of construction methods and equipment to minimize loss of earth at the excavation face and settlement of earth around the sewer pipe.

In the event any movement of earth is detected, the Construction Project Manager may order the work stopped and secured. Before proceeding, the General Contractor shall correct any problems causing or resulting from such movement.

The General Contractor should be aware that if settlement of the ground surface should occur during construction, which will affect the accuracy of the temporary benchmarks established by the Construction Project Manager, it shall be the General Contractor's responsibility to detect and report such movement. The locations of the permanent City monumentation benchmarks (BM) and temporary benchmarks (TBM) are indicated on the Drawings; the General Contractor may use these to verify temporary benchmark accuracy. Advise the Construction Project Manager and the City of any settlement affecting the permanent monumentation benchmarks. Upon completion, the field books pertaining to monitoring of the permanent monumentation benchmarks shall be submitted to the City.

7.2.18 Excavated Material

Remove and dispose of all excavated materials from jacking pit and tunnel excavations in accordance with the requirements of State of Colorado.

7.2.19 Infiltration Leakage Test

The tests shall be performed by the General Contractor under the observation of the Construction Project Manager. A test section is defined as the length of tunnel between manholes or structures.

Leak testing shall be by television inspection after dewatering operations have been discontinued a minimum of 48 hours and until groundwater has been allowed sufficient time to reach its natural elevation. Any leakage found during this operation shall be corrected.

Each joint shall also be tested in place by exerting a pressure of 11.2 psi absolute on it in accordance with ASTM D 3754. The internal test pressure, which is 3.5 psi lower than normal atmospheric pressure, shall be in addition to the normal external hydrostatic pressure exerted on the pipe by the groundwater above the pipe. Each joint when tested in this manner shall exhibit no infiltration of groundwater into the pipe. The General Contractor may at his option, test sections of the sewer using this method instead of individual joints. If this method is selected each section shall exhibit no infiltration of ground water into the section. The General Contractor shall isolate any joints which are found to leak during this test and jack such joints through until all joints between manholes are found to be watertight under these conditions.

One hundred percent of the sewer and sewer joints shall be tested.

The General Contractor shall repair all visible leaks in manholes, structures, and joints even if the leakage test requirements are met.

Adequate bulkheads, or plugs, shall be installed at each end of the sewer pipe in preparation for testing. The General Contractor shall submit the type of bulkhead, or plug, to be used to the Construction Project Manager for review. After testing, the bulkheads or plugs shall remain in place until the sewer is put into service, at which time the General Contractor shall remove the bulkheads or plugs.

7.2.20 Restoration

The General Contractor shall promptly restore to their original condition any streets, curbs, sidewalks, or any other facilities which are damaged, moved or disturbed as a result of tunneling operations or jacking pit construction. Any surface or subsurface settlement shall be restored to pre-construction conditions.

End of Specification



CITY AND COUNTY OF DENVER
ENGINEERING DIVISION

Wastewater Capital Projects Management Standard Construction Specification

7.3 SHAFT EXCAVATION AND SUPPORT

7.3.1 Definitions

7.3.1.1 Geotechnical Data Report (GDR)

A document that presents an interpretation of the known subsurface data for the project.

The purpose of the GDR is to compile all geological, geotechnical, groundwater, and other data obtained from the geotechnical investigations for use by the various participants in the project. If available, this information will be included within the contract documents as specifically applicable to the project.

7.3.1.2 Geotechnical Baseline Report (GBR)

The intent of a GBR is to clearly and contractually define the geotechnical conditions through which tunneling will occur in order to evaluate a differing site condition (if encountered) and it is used as a basis of bid for the contractor. By assessing the anticipated geotechnical conditions for a project and providing baselines in the contract, the contractor has a basis from which to prepare their bid and select their means and methods. The baseline conditions do not necessarily reflect the actual conditions; they are not geotechnical fact to be encountered. Rather, they represent the owner's assumption of existing geotechnical conditions for the project. If available, this information will be included within the contract documents as specifically applicable to the project. Regardless of inclusion, this information shall be investigated, interpreted, verified and/or developed by the contractor prior to commencement of the work.

7.3.2 Section Includes

The work specified in this section includes requirements for design, excavation, and support of the entry shaft(s), jacking pit(s), exit shaft(s), and receiving pit(s) for all tunneling operations required within the Contract Documents. The Contractor shall design, furnish, install, and maintain a system of supports, including all bracing and associated items, to retain excavations in a safe manner and to control ground movements as specified herein. Acceptable means of shaft support include: pre-fabricated systems such as slide-rail; rib and lagging; sheet pile; or liner plate. The means and methods utilized to accomplish the project scope are the Contractor's responsibility. All costs incurred for completion of this item shall be included within the applicable bid item(s) for construction of the associated facility.

7.3.3 Requirements

The Contractor shall have the sole responsibility for maintenance and protection of existing utilities, structures, railroad tracks, and facilities within the zone impacted by shaft construction.

The Contractor shall have the sole responsibility for sizing the shafts within the site boundaries shown on the Construction Drawings. The size of the excavations shall be adequate to construct all structures required and to gain access to tunneling and contact grouting operations.

Shaft support systems shall be in accordance with OSHA Health and Safety Standards for Excavations, 29 CFR Part 1926. Shaft support systems shall also meet the standards and guidelines of all **applicable utility companies, and stakeholders**.

The Contractor shall allow the Engineer, City's Construction Project Manager and City's Project Management Team access to the shafts, and to use the shafts to access tunnel operations.

7.3.4 Submittals

7.3.4.1 Preconstruction

Submit the following shop drawings and plans a minimum of 8 weeks prior to beginning shaft construction to allow for review by the City's Construction Project Manager, utility owners, and stakeholders:

1. Detailed description of the procedures, equipment, and methods proposed to conduct the shaft excavations.
2. Shop drawings of shafts including locations, dimensions, and support elements.
3. Shop drawings and descriptions of the procedures and methods proposed for the construction shoring system(s), including a minimum: erection scheme; support element descriptions, sizes, spacings, and strengths; design calculations; plan for removal of shoring. Shafts shall be designed and constructed to withstand all imposed loads, including soil conditions, **Cooper E80 loads**, dynamic loads from
4. Equipment and surcharge loads from materials. Calculations shall include loads, methods, assumptions, results, and safety factors. Shop drawings and calculations shall be signed and stamped by a professional engineer registered in the State of Colorado.

7.3.5 Materials

7.3.5.1 Structural Steel

Structural steel members, such as fabricated connections and accessories, steel W shapes, and other structural steel shall conform to the requirements of ASTM A 572 or ASTM A 36, unless otherwise approved.

7.3.5.2 Slide-Rail

Pre-engineered system of panels, corner slide-rails, linear slide-rails, and cross braces as manufactured by Speed Shore Corporation or equivalent.

7.3.5.3 Lagging

Timber lagging shall be of construction grade and shall be any species that provides a minimum allowable bending stress of 1,100 psi.

7.3.5.4 Lagging Backfill

Backfill sand shall conform to ASTM C 778 for 20-40 sand. Plugging material such as Excelsior or dry pack shall be used to prevent backfill sand from running.

7.3.5.5 Sheet Piles

Steel sheet piling shall be continuous interlocking made in accordance with ASTM A 328 or ASTM A 857 or from steel meeting the requirements of ASTM A 570 or ASTM A 36.

7.3.5.6 Liner Plate

Steel for liner plate shall be ASTM A 569 with a minimum yield of 28 ksi and a minimum ultimate strength of 42 ksi.

7.3.6 General Shaft Requirements

Commence shaft excavations only after submittals have been reviewed and approved by the Engineer, applicable utility companies, and stakeholders, and a pre-construction meeting has been conducted.

Provide all excavations with a gravel pad or concrete working slab equipped with a sump to pump out water.

No gasoline-powered equipment shall be permitted. Diesel, electrical, hydraulic, and air powered equipment is acceptable, subject to applicable City, State, and Federal regulations.

7.3.7 Utilities

All utilities shall be preserved without interruption.

Location of utilities shown on the Construction Drawings shall be considered approximate. Field locate each utility potentially impacted by the work to verify location prior to beginning underground construction at each location.

Coordinate with each utility agency as necessary prior to relocation, hanging, or upgrade of utilities in the vicinity of shafts, pits, and excavations.

7.3.8 Slide-Rail

The slide-rail system shall be installed simultaneous with soil excavation in accordance with manufacturer recommendations.

7.3.9 Soldier Pile and Lagging

Install piles in predrilled holes to the tip elevations shown on approved submittals. Provide casing or drilling mud as needed to prevent caving of holes and loss of ground in predrilled holes.

After soldier pile has been seated plumb in the drill hole, encase it with concrete from the tip to the bottom level of the final excavation. Concrete strength shall be in accordance with approved submittals, and shall be placed by means of a tremie system. Apply vibration through the pile.

Provide timber lagging of sufficient strength to withstand lateral earth pressures. Install lagging with no gap between adjacent boards. As installation progresses perform the following as selected by the excavation and support designer: 1) backfill the voids between the excavation face and the lagging with sand or pea gravel packed into place, 2) pack voids with materials such as straw, burlap, or geotextile fabric, or 3) grout voids with cementitious materials. Where necessary, allow drainage of groundwater without loss of ground due to piping.

7.3.10 Steel Sheet Piling

Drive in plumb position with each sheet pile interlocked with adjoining piles for its entire length so as to form a continuous diaphragm throughout the length of each run of wall, bearing tightly against original ground.

Drive to the depth indicated on approved shop drawings; exercise care in driving to avoid damaging adjacent utilities and structures, and so that interlocking members can be extracted without damaging adjacent structures or utilities.

7.3.11 Liner Plate

Install liner plate around the full perimeter of the shaft excavation. The unsupported height of soil at the base of the shaft shall be no greater than the height of one course of liner plate. Upon completion of liner plate installation, backfill the annulus between support elements and the ground with excelsior and/or grout as needed to prevent inflow of soil or groundwater.

7.3.12 Internal Bracing System

The internal bracing support system shall include wales, struts, and/or shores as applicable.

Provide web stiffeners, plates, angles, and struts with intermediate bracing as needed to prevent rotation, crippling, or buckling of connections and points of bearing between structural steel members. Allow for eccentricities caused by field fabrication and assembly.

Install and maintain all bracing support members in tight contact with each other and with the surface being supported.

7.3.13 Disposal of Excess Excavated Material

Excess excavated material shall be disposed of in accordance with the Contract Documents.

7.3.14 Removal of Support System

Temporary shoring systems shall be removed completely at the end of the job. If the Contractor intends to leave any portion of the support system in the ground permanently, he must first get the approval of the property owner where the support elements are located. In the event that the support system is not fully removed, all shoring elements within 5 feet (minimum) of the ground surface, including soldier piles, wales, struts, lagging, sheet piles, and shores shall be removed. Removal of the support system shall be performed in a manner that will not disturb or harm adjacent construction or facilities and only after backfill has been fully compacted. All voids created by the removal of the construction shoring system(s) shall be immediately filled with controlled density fill, lean concrete, or cement grout, as approved by the City's Construction Project Manager.

END OF SPECIFICATION



CITY AND COUNTY OF DENVER
ENGINEERING DIVISION

Wastewater Capital Projects Management Standard Construction Specification

7.4 PERMEATION GROUTING

7.4.1 Definitions

7.4.1.1 Geotechnical Data Report (GDR)

A document that presents an interpretation of the known subsurface data for the project. The purpose of the GDR is to compile all geological, geotechnical, groundwater, and other data obtained from the geotechnical investigations for use by the various participants in the project. If available, this information will be included within the contract documents as specifically applicable to the project.

7.4.1.2 Geotechnical Baseline Report (GBR)

The intent of a GBR is to clearly and contractually define the geotechnical conditions through which tunneling will occur in order to evaluate a differing site condition (if encountered) and it is used as a basis of bid for the contractor. By assessing the anticipated geotechnical conditions for a project and providing baselines in the contract, the contractor has a basis from which to prepare their bid and select their means and methods. The baseline conditions do not necessarily reflect the actual conditions; they are not geotechnical fact to be encountered. Rather, they represent the owner's assumption of existing geotechnical conditions for the project. If available, this information will be included within the contract documents as specifically applicable to the project. Regardless of inclusion, this information shall be investigated, interpreted, verified and/or developed by the contractor prior to commencement of the work.

7.4.1.3 Permeation Grouting

The direct pressure injection of a chemical fluid grout into the ground to fill the spaces between soil particles, without causing excessive movement or fracturing of the soil formation. Permeation grouting is performed prior to commencement of tunneling operations to provide a more consistent and stable soil matrix.

7.4.1.4 Chemical Grout

A chemical fluid grout that sets and alters the physical properties of a geologic mass, typically composed of (1) matrix forming base materials, (2) reactants and, (3) accelerators or retarders.

7.4.2 Section Includes

This item includes pre-excavation ground stabilization as required within the Contract Documents by permeation grouting. Permeation grouting shall be performed in accordance with these specifications. If applicable, the general extents of permeation grouting for a specific project may be shown in the plans.

7.4.3 Requirements

The purpose of the grouting program is to stabilize non-cementitious granular soil and fill as shown on Construction Drawings. The permeation grouting program is to be completed prior to beginning tunnel construction.

The effectiveness of the grouting program shall be verified in accordance with requirements specified herein.

Restricted work hours and permits are as specified in the Contract Documents. The Contractor shall coordinate all work with affected utility companies, and stakeholders and comply with the requirements outlined within any access and/or construction permit obtained by the City.

7.4.4 Quality Control

Before the Contractor begins tunnel construction, demonstrate to the City's Construction Project Manager, using either drilling and sampling methods, geophysical methods, data records during grouting operations, or other acceptable means as stated in the approved quality control program, that the grouting zones have been thoroughly impregnated and stabilized with chemical grout. If grouting zones are found to be inadequately treated, the Contractor shall perform additional chemical grouting as needed and at no additional expense to the City.

The Contractor shall obtain samples of grout used for chemical grouting for gel time checks: at least one for every half-hour of pumping or for every 250 gallons of grout, whichever is more frequent. The gel samples shall be labeled and stored in accordance with manufacturer recommendations until completion of the project.

7.4.5 Submittals

7.4.5.1 Preconstruction

Submit the following shop drawings and plans a minimum of 8 weeks prior to mobilization of grouting equipment for review by the City's Construction Project Manager, utility owners and stakeholders:

1. Certificates of compliance for materials specified herein. Certificate of origin for reactant materials.
2. Proposed grout mix, gel time, and certified laboratory testing results documenting the required strength of soil samples injected with the proposed chemical grout mix,

at least 45 days prior to beginning grouting operations.

3. Detailed chemical grouting work plans and shop drawings, describing the grouting approach, the chemical grout to be used, grout hole locations and orientations, grout pipe installation procedures, locations and arrangement of injection points, grouting equipment, injection procedures and sequences, proposed injection pressures, recording equipment, data reporting methods, work sequences, schedules, method of monitoring and protecting existing utilities; testing methods to be used to verify the effectiveness of grouting with respect to strength and acceptance criteria; quality assurance program and methods for determining that grouted zones are effectively stabilized; and any other information necessary to demonstrate compliance with the specified purpose of this grouting work. Also show grout target volumes at each proposed grout injection point including assumptions with respect to porosity and target volumes. Indicate cure time required for chemically grouted soil to obtain required strength prior to tunneling.

7.4.5.2 During Construction

Submit records of grouting operations to the City's Construction Project Manager on a daily basis. Include grout mix, gel time, injection date and time, injection pressure and rate, injection volumes and exact injection locations. Provide data in an acceptable chart-type format that facilitates rapid visual evaluation of the results of the work, and update daily.

Submit results of surface monitoring point and settlement monitoring point array monitoring on a daily basis.

Submit test results by the end of the day in which they were taken, and with frequency as specified herein.

Within one week of completion of the grouting program, submit an as-built sketch showing locations, depths and orientations of drilled holes and any grout pipes left in place.

7.4.6 Materials

7.4.6.1 Chemical Grout

Chemical grout shall consist of a liquid sodium silicate base, reactant, water, accelerator, and other admixtures as required. The Contractor shall design the chemical grout mix so that when injected into standard medium dense sand (Ottawa 20-30) specimens, the unconfined compressive strength of the grouted test sample is no more than 200 psi and no less than 100 psi. The Contractor shall design the trial mix and conduct laboratory tests to verify trial mix meets strength requirements in accordance with ASTM D4219 and D4320.

7.4.6.2 Base Material

The base material for the grout shall be liquid sodium silicate with a specific gravity of 1.4 to 1.5 and a silicate-to-soda ratio of 3.20 to 3.35. The minimum sodium silicate concentration shall be 50 percent of the mix by volume. Sodium silicate shall be delivered in sealed containers, or a certified tank truck, accompanied by the supplier's certificate of origin.

7.4.6.3 Reactant

The reactant shall be an organic base type which, when properly mixed with other grout components, provides a permanent, irreversible gel with controllable gel times. The resulting gels shall exhibit less than 15 percent syneresis in 30 days when mixed with appropriate amounts of sodium silicate, water and accelerator, and shall not exhibit objectionable odors such as ammonia. Sodium bicarbonate, sodium aluminate and other reactants that produce a temporary grout are not allowed. Reactant shall be delivered in sealed containers, accompanied by the supplier's certificate of origin.

7.4.6.4 Water

Water shall be potable and free of impurities that will deleteriously affect the grout gelling characteristics and strength development of the grouted soil.

7.4.6.5 Accelerator

An accelerator may be utilized if required. It shall be technical grade, water soluble calcium chloride or other approved salt, containing a minimum amount of insolubles.

7.4.6.6 Drilling Equipment

Drilling equipment shall be of the type and capacity suitable for drilling the required hole diameters to the tolerances identified or established by the Contractor through evaluating the potential ground conditions from the Geotechnical Data Report and/or Geotechnical Baseline Report, as applicable. Drilling equipment shall also be able to drill at the approved inclinations and depths for installing grout pipes.

7.4.6.7 Grouting Equipment

Chemical grouting equipment shall have the capacity and mechanical capability to do the work as described herein. The equipment shall be maintained in good operating condition at all times. If grout holes are lost or damaged due to mechanical failure of the equipment, inadequacy of grout supply, or improper injection procedure, the Contractor shall backfill these holes and replace them at no additional cost to the City.

The chemical grout plant shall be a continuous mixing type capable of supplying, proportioning, mixing and pumping the grout with a gel time as specified. Batch-type systems are not permitted. The main pumps shall be equipped with recording, positive displacement meters that will accurately measure the volumes of the various components pumped. Meters shall also be provided at the injection point and at each material line ahead of mixing. The meters shall act independently of the viscosity of the metered fluid. The accuracy of the meters shall be checked at least twice daily.

The pumping unit shall be equipped with piping and/or hoses of adequate capacity to carry the base grout and reactant solutions separately to the point of mixing. The hoses shall be joined using a 'Y' fitting containing check valves to prevent backflow, followed by a baffling chamber. A sampling valve shall be placed beyond the point of mixing and the baffling chamber. The pumping unit shall allow distribution of proportioned grout, under pressure, to the grouting locations monitored by separate, automatic real-time display, flow rate indicators and gauges.

Chemicals shall be stored in metal tanks, suitably protected from accidental discharge. The Contractor shall maintain storage tank capacity sufficient to supply at least one day's worth of grouting materials so as to not interrupt the work if chemical delivery delays occur.

The Contractor shall provide the required chemical quality control testing apparatus on site including, but not limited to: hydrometers, balance scales, graduates, viscometers and other devices required to conduct chemical material acceptance tests, chemical proportioning tests, and grout quality tests for proper quality control of the work.

7.4.7 Grout Pipes

Grout pipes shall be installed horizontally, inclined, or vertically to obtain the specified minimum grout coverage. Grout pipes shall be re-groutable sleeve-port type grout pipes, with grout ports at maximum 15-inch centers covered by expandable rubber sleeves. After being placed in a borehole, the sleeve-port grout pipes shall be encased in a continuous brittle mortar sheath. An internal double packer shall be used to inject grout at a specific sleeve-port.

7.4.8 Preparation

Permeation grouting operations shall not begin until geotechnical instrumentation has been installed as required in Section 7.1 of these Standard Construction Specifications.

Coordinate with all affected utility companies as applicable. Coordinate the sequence of operations taking into consideration: a) means of access to the area; b) permitted areas of operations; c) time restrictions for the performance of the Work; and d) maintenance and adherence to utility traffic requirements.

7.4.9 Installation of Grout Pipes

The Contractor shall locate, protect, support and maintain, without interruption, all utility facilities, equipment and services. Before beginning grout pipe installation from the surface, the proposed grout hole locations shall be marked by the Contractor and cleared by the "on-call" utility notification system. If existing utilities are within 5 feet of proposed grout pipes, the Contractor shall pothole the utilities before installing grout pipes.

Close coordination with the affected utility companies and/or property owners will be necessary when installing grout pipes, in terms of both grout pipe location and the timing of installation.

The minimum extents of the soil zones to be grouted are shown on the Construction Drawings. The intent of the grouting program is to treat granular soil and fill. During drilling, the Contractor should be able to distinguish these granular soils from cohesive soil and fill by drilling action and return of cuttings. Grout pipes shall be installed to the elevations shown on the Construction Drawings or until drilling action indicates that the grout pipes have fully penetrated through the depth of granular soil and fill, whichever is greater.

7.4.10 Grouting Procedures

Using double packers or other approved suitable measures, inject chemical grout into the selected zones through ports in the sleeve pipes. The Contractor shall use soils information gained while drilling grout pipes to manage the grout plan accordingly. The grouting pressure for any one pipe shall not be more than 2 psi per foot of overburden. Adjust injection procedures as required to prevent surface heave. Temporary high injection pressures are permitted to crack open sleeve-ports, but these pressures are not allowed for longer than one minute.

The Contractor shall conduct a surface pressure test of sleeve port grout tube from manifold to injection point (equivalent to maximum depth) to ascertain system pressure loss. This measured pressure is used for estimating appropriate grouting pressures for production grouting. Inject grout at rates not greater than 10 gpm.

The Contractor shall survey surface monitoring points and arrays each day after grouting operations are completed. Ground heaving and settlement shall not exceed monitoring criteria as specified in Section 7.1 of these Standard Construction Specifications.

7.4.11 Leakage Monitoring

The Contractor shall closely monitor the rate of grout take during grout injection, and ascertain the cause of sudden drops in grout injection pressures following initial start-up pressure adjustments. Regularly monitor the ground surface adjacent to the grouting site for leakage. In the event that serious grout leaks are observed, the Contractor shall temporarily terminate injection and plug leaks before resuming pumping. The City's Construction Project Manager shall be informed immediately of such leakage.

If excessive grout take is experienced that is not attributable to leakage, the Contractor shall adjust injection pressure, pumping rates, gel or setting times, or grout composition, subject to the acceptance of the City's Construction Project Manager, to reduce grout use to acceptable levels.

7.4.12 Clean Up and Site Restoration

Remove all equipment, unused materials, and debris from the site at the end of the job. Spilled materials and ground shall be cleaned-up. After tunneling is completed, grout pipes shall be filled with lean cement and cut off within one foot of the ground surface.

Restoration shall follow construction as the work progresses and shall be completed as soon as possible. Restore and repair any damage resulting from heave or spills caused by the work. Any property or improvements damaged or destroyed, shall be restored to a condition equal to or better than existing prior to construction at no additional cost to the City. Restoration shall be completed immediately if a third party or the City is inconvenienced by the damage, and in no case later than thirty (30) days after the damage is discovered. This provision for restoration shall include all property which was affected by the construction operations.

END OF SPECIFICATION



CITY AND COUNTY OF DENVER
ENGINEERING DIVISION

Wastewater Capital Projects Management Standard Construction Specification

7.5 COMPENSATION GROUTING

7.5.1 Definitions

7.5.1.1 Geotechnical Data Report (GDR)

A document that presents an interpretation of the known subsurface data for the project. The purpose of the GDR is to compile all geological, geotechnical, groundwater, and other data obtained from the geotechnical investigations for use by the various participants in the project. If available, this information will be included within the contract documents as specifically applicable to the project.

7.5.1.2 Geotechnical Baseline Report (GBR)

The intent of a GBR is to clearly and contractually define the geotechnical conditions through which tunneling will occur in order to evaluate a differing site condition (if encountered) and it is used as a basis of bid for the contractor. By assessing the anticipated geotechnical conditions for a project and providing baselines in the contract, the contractor has a basis from which to prepare their bid and select their means and methods. The baseline conditions do not necessarily reflect the actual conditions; they are not geotechnical fact to be encountered. Rather, they represent the owner's assumption of existing geotechnical conditions for the project. If available, this information will be included within the contract documents as specifically applicable to the project. Regardless of inclusion, this information shall be investigated, interpreted, verified and/or developed by the contractor prior to commencement of the work.

7.5.1.3 Compensation Grouting

Compensation grouting is a grouting technique utilized to control ground settlement during soft ground tunneling. Compensation grouting involves the injection of a low slump mortar-like grout under high pressure to compact and displace the adjacent soils. The grout does not penetrate soil pores but displaces the subsurface soils by forming a homogeneous grout bulb near the grout pipe tip. Typically, compensation grouting is done after completion of tunneling to correct for settlement. Compensation grouting may also be performed concurrently with the progress of the tunnel while adjusted grouting parameters continually with reference to measured movements of the ground and/or surface structures, to keep settlement and deformations within specified limits.

7.5.2 Section Includes

This item includes settlement mitigation by compensation grouting. All costs for compensation grouting shall be included within the cost of the associated pipeline and no separate measurement for payment will be made. Within the compensation grouting plan, the Contractor is responsible for design of controls such that bondage between the tunnel pipeline and the compensation grout does not occur and hinder tunnel progression.

7.5.3 Requirements

This work shall consist of installation, monitoring and testing of compensation grouting. It shall be used to mitigate areas of settlement which exceed the limits specified within the Contract Documents.

The Contractor shall provide all labor, materials and equipment to accomplish this work. In addition, the Contractor shall be responsible for all associated costs to comply with City held permits, obtaining additional permits, working within restricted hours and ensuring that all work is coordinated with affected utility companies and stakeholders.

Prior to beginning grout pipe installation, the Contractor shall perform a subsurface investigation to verify the ground conditions above and within the tunnel footprint.

7.5.4 Quality Control

The Contractor shall obtain compensation grout cylinders daily or when the mix design changes. Cylinders shall be 3-inch by 6-inch. Three cylinders shall be taken and marked with the date and time of day collected. Cylinders shall be broken at 7 and 28 days with the remaining cylinder held. Testing shall be performed at a certified laboratory.

The Contractor shall perform slump tests on grout and take measurements of grout mix quantities to verify the grout mix at least twice every shift.

Results of these tests shall be submitted in accordance with these specifications.

7.5.5 Submittals

7.5.5.1 Preconstruction

Submit the following a minimum of 8 weeks prior to mobilization of grouting equipment to allow for review by the City's Construction Project Manager, utility companies and stakeholders:

1. Description of plant, equipment, and materials, including manufacturer's product data
2. The proposed grout mix design, including: the proposed proportions or range of proportions of each constituent including cement, water, fly ash, sand, bentonite and additives; anticipated characteristics when mixed including density, slump or viscosity as appropriate; expected working time after mixing, time to initial set, and time to achieve 75 percent of design strength; and anticipated properties when set including compressive strength and shrinkage. Include field test data from previous projects

including the compressive strength and slump achieved.

3. Grouting work plan and shop drawings, describing: the grouting approach; the grout mix design; grout pipe locations, spacing, depth, and orientation; grout pipe installation procedures; grouting equipment including pump and pressure capacity; injection procedures and sequences; proposed injection pressures; recording equipment; data reporting methods; work sequence; schedule; method of monitoring and protecting existing utilities; testing methods to be used to verify the effectiveness of grouting with respect to strength and acceptance criteria; and any other information necessary to demonstrate compliance with the specified purpose of this grouting work.
4. Work plan for grouting operations to be performed within affected property owner or utility company corridors.
5. If applicable: Layout and location plan of deep settlement monitoring points used to detect settlement above the crown of the tunnel. Include a description of the instrument type and method of installation. Also, proposed method to monitor the ground surface for heave during grouting.
6. If applicable: Layout and location of boreholes for subsurface investigation.

7.5.5.2 During Construction

Record and maintain accurate daily records of all grout pipe installation and grouting quantities, including:

- type of drill rig and drilling method used;
- grout pipe locations and tip elevations;
- grout mix;
- grout quantity injected per stage;
- rate of pumping; and
- beginning and final grouting pressure obtained in each stage

The Contractor shall perform slump tests on grout and take measurements of grout mix quantities to verify the grout mix at least twice every shift. These records shall be submitted on a daily basis within one day of the work being performed. The grout cylinder break results shall be submitted 5 days after test results are available.

Within one week of completion of the grouting program, the contractor will submit an as-built sketch showing locations, depths and orientations of drilled holes.

7.5.6 Materials

7.5.6.1 Cement

Type I or Type II Portland cement (per ASTM C150) free of contamination.

7.5.6.2 Sand

Per ASTM C-33. The fines content shall be greater than 10 percent and less than 30 percent. Natural fines may be supplemented with flyash or bentonite.

7.5.6.3 Flyash

Class C or Class F per ASTM C-618

7.5.6.4 Water

Water shall be potable and free of impurities that will deleteriously affect the grout characteristics.

7.5.6.5 Compensation Grout Mix

A low mobility, viscous grout with a slump between 1-2 inches. Grout shall be a mixture of cement and water, with the potential addition of sand, which will displace soil under pressure but will not penetrate between soil particles. Bentonite, fly ash, and additives may be included. Slump achieved shall be between 1-2 inches.

7.5.7 Equipment

7.5.7.1 Grout Pipe Drilling Equipment

Furnish drilling equipment as required to install grout pipes at locations, depths, and inclinations indicated on the approved work plan in the soil conditions as described in the Geotechnical Baseline Report or as determined via subsurface investigation by the contractor. Use duplex rotary (self-casing) drills to install all grout pipes, or other system(s) as approved by the City's Construction Project Manager. The system must prevent flow of water from the top of the borehole and prevent ground losses as a result of installation. The use of wash boring techniques is not acceptable.

7.5.7.2 Subsurface Investigation Drilling Equipment

If necessary, the Contractor shall furnish geotechnical drilling equipment as required to advance soil borings along the tunnel alignment to confirm ground conditions prior to compensation grouting.

The geotechnical rig shall be a CME55 or similar, or other equipment approved by the City's Construction Project Manager, such that Standard Penetration N-values and split spoon barrel soil samples can be obtained by the Engineer. The rig shall be equipped with hollow stem augers to facilitate sampling and maintain borehole stability.

7.5.7.3 Hydraulic Jacking System

Provide suitable hydraulic jacking system for withdrawing grout pipes in a controlled manner after completion of compensation grouting.

7.5.7.4 Grouting Pipes

Grout pipes and connections shall be steel casing of adequate strength to maintain the hole and to withstand the required jacking and pumping pressures. The pipes shall be at least 2-inches inside diameter to adequately transmit the specified low slump material without

plugging. All casing shall be flush joint threaded or a single piece tubing to provide a smooth inner wall and unobstructed inside diameter. It shall be the Contractor's responsibility to install casing that does not detrimentally impact the grouting procedure.

7.5.7.5 Grouting Equipment

Equipment used shall be specifically designed for compensation grouting. Because of the high pressure involved, all equipment, including hoses, couplings, gauges and pipes, shall be able to safely operate at the maximum grouting pressures as included in Contractor submittals. The mixing and grout pump system shall be designed to provide continuous flow of the grout mixture at variable flow rates and pressures without interruption during any single hookup or stage due to inadequate batching or pump feed capacity.

7.5.7.6 Grout Mixers

The mixer shall be a continuous auger type to ensure complete uniform mixing of the materials used and shall be of sufficient capacity to continuously provide the pumping unit with mixed grout at its normal pumping range. The mixer must be capable of volumetrically proportioning the grout materials. Ready mixed grout is also acceptable with an approved mix design.

7.5.7.7 Grout Pumps

Provide positive displacement grout pump(s) capable of continuously delivering grout at pressures of at least 700 psi or at pressures sufficient to penetrate through previously grouted zones, whichever is larger. Pumping rate shall be readily controllable down to 0.2 cfm. Each grout pump shall be capable of displaying both pressure and injection volume.

7.5.7.8 Grout Delivery System

The grout delivery system shall consist of hoses, couplings, and pipes compatible with the equipment used for this work and shall be capable of withstanding the pressures delivered by the pump. Pressure gauges shall be provided at the pump discharge and at the top of the injection pipe to monitor pressure.

7.5.8 Utility and Stakeholder Coordination

Coordinate with all affected utility companies, stakeholders and property owners within the project limits, as applicable. The Contractor shall locate, protect, support and maintain, without interruption, all utility facilities, equipment and services. Coordinate the sequence of operations taking into consideration: a) means of access to the area; b) permitted areas of operations; c) time restrictions for the performance of the Work; and d) maintenance of traffic requirements.

7.5.9 Installation of Grout Pipes

Before beginning grout pipe installation from the surface, the proposed grout hole locations shall be marked by the Contractor and cleared by the utility notification system. If existing utilities are within 3 feet of proposed grout pipes, the Contractor shall expose the utilities by hand excavation before installing grout pipes. Vacuum excavation may be permitted to expose existing utilities, subject to City's Construction Project Manager's approval.

7.5.10 Compensation Grouting Procedures

The grouting process shall progress in stages within each pipe starting at the bottom of the pipe, progressing upward at 2-foot intervals. The ground surface and adjacent structures will be monitored by the Contractor during grouting, in accordance with the approved work plan. Heave shall not exceed 1/8 inch. Grout injection shall cease at any given stage when surface heave is detected, when the maximum grouting pressure is reached, or when a sudden drop in pressure is noted.

7.5.11 Clean Up and Site Restoration

Remove all equipment, unused materials, and debris from the site at the end of the job. Spilled materials and ground shall be cleaned-up. Grout pipes shall be removed from the ground or filled with lean cement and cut off within one foot of the ground surface in accordance with the requirements of the City, utility owner or stakeholder. Restoration shall follow construction as the work progresses and shall be completed as soon as possible. Restore and repair any damage resulting from heave or spills caused by the work. Any property or improvements damaged or destroyed, shall be restored to a condition equal to or better than existing prior to construction at no additional cost to the City. Restoration shall be completed immediately if a third party or the City is inconvenienced by the damage, and in no case later than thirty (30) days after the damage is discovered. This provision for restoration shall include all property which was affected by the construction operations.

END OF SPECIFICATION



CITY AND COUNTY OF DENVER
ENGINEERING DIVISION

Wastewater Capital Projects Management Standard Construction Specification

8.0 Structural Excavation

8.0.1 General

All excavation for the construction of structures shall be in conformance with the applicable provisions of CDOT Section 206 except as modified herein.

Unless otherwise stipulated in the Contract Documents, no separate payment will be made for structural excavation, except for overexcavation as directed by the Construction Project Manager, and all costs incurred will be considered to be included in the unit price bid for the associated structure or appurtenance. The cost of overexcavation will be paid for as specified below.

8.0.2 Over Excavation

In locations where soil with unsuitable bearing characteristics are encountered, the Construction Project Manager may order that the unsuitable material be removed and be replaced with granular and/or rock backfill material to provide suitable bearing for the structure.

The overexcavation will be paid for in accordance with the unit price set forth in the Contract Documents for excavation and replacement with an approved granular material; provided, however, no measurement for payment will be made of any material required to fill overexcavated areas: outside of specified pay limits (if applicable), that were for the Contractor's convenience, beyond the limits required for structural excavation, or where excavations for footings, slabs, etc., are made below the required elevations without specific authorization from the Construction Project Manager. Under these circumstances, the excess excavation and backfill required for over excavated area(s) shall be filled in a manner satisfactory to the Construction Project Manager by the Contractor at their expense.

8.0.3 Removal of Water

All water encountered in excavations shall be removed as required within these Specifications.

8.0.4 Backfill

Backfill around structures shall be per the requirements set forth within these Standard Construction Specifications.

8.0.5 Site Grading

The entire site shall be graded using suitable materials from the excavation. Grading shall be for the purpose of providing a neat and pleasing appearance and for facilitating positive drainage. Compaction of all grading material shall be as specified within these Specifications.

End of Specification



CITY AND COUNTY OF DENVER
ENGINEERING DIVISION

Wastewater Capital Projects Management Standard Construction Specification

9.0 Pipe Testing, Inspection and Acceptance

9.1 General

In addition to any other testing or inspection requirements set forth elsewhere in these Specifications, all testing, inspection and acceptance of the completed work will be as specified herein.

Test for water-tightness of sanitary sewers shall be conducted by the Contractor at his own expense, except as noted, with the assistance and under the direction of the Construction Project Manager prior to final acceptance.

Unless otherwise specified, storm sewer systems normally will not be required to be tested for leakage. All leakage tests shall be completed and approved prior to placing of permanent resurfacing. Where the difference in elevation between the inverts of adjacent structures (manholes) exceeds 20 feet, no exfiltration leakage tests will be required.

9.2 Testing and Inspection

9.2.1 Exfiltration Test

Unless otherwise noted on the plans, each section of sewer will be tested between successive manholes by closing the lower end of a sewer reach by plugging the pipe at the inlet to the lower manhole and then by filling the sewer and the upper manhole(s) to the proper level with water. The water level in the upper manhole shall be a minimum of 4 feet above the level of the ground water. The maximum exfiltration rate for any section of sewer line shall not exceed the limits specified below:

Pipe Material	Maximum Rate of Exfiltration
Clay, Concrete	200 gal per day/inch diam/mile
PVC, RPMP	50 gal per day/inch diam/mile

For the purposes of exfiltration leakage, manholes shall be considered to be concrete pipe of the same diameter as the manhole i.e. 48, 60 or 72 inch diameter. Air pocket entrapment shall be avoided when filling the line with water. Once filled with water, the system shall be allowed to stabilize for a period of one or two hours before starting the test. Exfiltration leakage rate is determined by measuring the amount of water required to maintain a constant level in the upper manhole. Test duration is to be no less than two hours.

If the leakage, as shown by the test, exceeds the allowable value, the Contractor shall make the necessary corrections at his expense to reduce the exfiltration to within the permissible limits. The Contractor shall furnish all water, material and labor required to perform the test. All tests shall be made in the presence of the Construction Project Manager.

9.2.2 Infiltration Test

If the Construction Project Manager determines that excessive ground water is encountered during construction of a sanitary sewer section, the infiltration test for leakage shall be used. The maximum allowable infiltration for sanitary sewers shall not exceed the following limits for the type of projects specified:

Type of Pipe	Max. Allowable Infiltration
Clay, Concrete	200 gal per day/inch diam/mile (3.8 d/inch/100 ft)
PVC, RPMP	50 gal per day/inch diam/mile (0.95 gpd/inch/100 ft)

Unless otherwise specified, infiltration will be measured by the Construction Project Manager, using measuring devices furnished by the City.

If the infiltration is found to exceed the prescribed amount, the Contractor shall make the appropriate repairs as approved by the City and shall continue to test the sewer until it meets requirements.

9.2.3 Air Pressure Test

When directed by the Construction Project Manager and prior to acceptance of any segment of newly constructed sanitary sewers, the pipe will be subjected to an air pressure test, which will be conducted after densification of the backfill and prior to installation of any sanitary taps. The test shall conform to the recommended practice and calculations established by the ASTM C-828. After a manhole to manhole reach of pipe has been backfilled, the line should be flushed and cleaned with the interior walls moist. Plugs shall be placed in the line at each manhole and low pressure shall be introduced into this sealed line until the internal pressure reaches 4 psig (pounds per square inch gage) greater than the average back pressure of any ground water that may be surrounding the pipe. At least two minutes shall be allowed for the air pressure to stabilize. The test shall then be run with the drop in pressure from 3.5 to 2.5 psig. The calculations generated by ASTM C-828 shall then be used to check the adequacy of the pipe installation. If the installation fails to meet the requirements, the Contractor shall at his own expense determine the source of leakage

and then shall repair or replace all defective materials and/or workmanship at his own expense to the satisfaction of the Construction Project Manager.

Safety precautions shall be used at all times. It is extremely important that the plugs be installed and braced to prevent blowouts. No one shall be allowed into the manholes during testing.

9.2.4 Television Inspection

Prior to acceptance of any segment of newly-constructed sewers, all pipes will be televised and physically inspected by the City for any observable defects. This requirement will apply to sanitary sewers and to small storm sewers which are too small to be physically inspected will also be televised. Any defects discovered during this inspection shall be corrected prior to acceptance of the sewer.

The Contractor shall request these televised inspections through the City Construction Project Manager with at least 48 hours advance notification. The cost of initial inspection and the first re-inspection to confirm correction of previously identified deficiencies will be borne by the City. If additional inspections are required due to inadequate or otherwise unacceptable repairs, the costs for such inspections shall be charged to the Contractor.

9.2.5 Deflection Test (Flexible Pipe)

The City shall conduct deflection tests of all flexible pipes after completion of the work and again 30 days prior to the end of the guarantee period. The Contractor shall, at his expense, furnish a multiarmed test mandrel having an odd number of arms, nine or more in number. The mandrel will be pulled through the lines to be tested by City personnel using the ASTM testing procedure. The Contractor may witness the tests and may receive a copy of the test logs and reports if desired. All test equipment, calibration data, procedures, etc. shall be subject to approval by the Construction Project Manager.

The maximum allowable deflection after installation and backfilling shall not exceed that specified elsewhere in these Specifications for the particular pipe installed. Any segments of the pipe deemed necessary to be unsatisfactory shall be replaced or reworked by the Contractor in accordance with the requirements of the Construction Project Manager. Such repair shall be at the Contractor's expense.

9.2.6 Hydrostatic Test

Cast Iron, Ductile Iron, PVC Pressure Mains and Force Mains

9.2.6.1 Hydrostatic Tests

Hydrostatic tests consisting of a Pressure Test and a Leakage Test shall be performed prior to final backfilling. Thrust blocks, anchors, and partial backfill sufficient to anchor the pipeline in place but leaving joints, valves and fittings exposed for inspection shall be performed before testing.

9.2.6.2 Pressure Test

After the pipe has been laid and partially backfilled, all newly laid pipe, or any valved section thereof, shall be subjected to a pressure test. The test pressure shall be determined by the Engineer. For PVC Pressure mains and Force Mains the test pressure shall be defined in

general accordance with the requirements of AWWA-900 or UNI Bell B-3-77. The duration of the pressure test shall be at least one hour with no discernable loss of pressure.

- a. **Procedure.** Each valved section of pipe shall slowly be filled with water to the specified test pressure, based on the elevation of the lowest point of the line or section under test and corrected to the elevation on the test gage. Air shall be applied by means of a pump connected to the pipe in a satisfactory manner satisfactory to the Engineer. The pump, pipe connections, gages and all necessary test equipment shall be furnished by the Contractor who will make all taps into the pipe. The Contractor shall furnish all necessary assistance for conducting the tests.
- b. **Air Removal.** Before applying the specified air pressure, all air shall be expelled from the pipe. If permanent air vents are not located at all high points, the Contractor shall install corporation cocks at such points so the air can be expelled as the line is filled with water. After the air has been expelled, the corporation cocks shall be closed and the test pressure applied.
- c. **Examination Under Pressure.** All exposed pipe fittings, valves and joints shall be carefully examined prior to placement of backfill. Any cracked or defective pipe, pipe joints, fittings, or valves discovered in consequence of the pressure test shall be removed and replaced by the Contractor, and the test shall be repeated to the satisfaction of the Construction Project Manager.

9.2.6.3 Leakage Tests

A leakage test shall be conducted after the pressure test has been satisfactory completed. The Contractor will furnish the gage, measuring device, pump, and pipe connections, other necessary apparatus and the necessary assistance to conduct the test. The duration of each leakage test shall be two hours with an average test pressure determined by the Engineer being maintained during this period.

Leakage shall be defined as the quantity of water that must be supplied into the newly laid pipe, or any valved section thereof, to maintain the specified leakage test pressure after the air in the pipeline has been expelled and the pipe has been filled with water.

No pipe installation will be accepted if the leakage is greater than that determined by the following formula:

$$L = \text{NDVP divided by } 3700$$

For mechanical joints and push-on joints, where L is the allowable leakage in gallons per hour, N is the number of joints in the length of pipeline tested, D is the nominal diameter of the pipe in inches, and P is the average test pressure applied during the test in pounds per square inch gage.

The allowable leakage for 1,000 feet of 18-foot length of mechanical joint or push-on joint pipe at various pressures and diameters is shown in Table 1 of this section.

- a. **Variation from Permissible Leakage.** If any pipe laid discloses leakage greater than that specified above, the Contractor shall, at his own expense, locate and repair the defective joints until the leakage is within the specified allowance.

- b. **Pressure and Leakage Tests after Backfilling.** After the trench has been completely backfilled, the test connections made, and the main filled with water, the pipe shall be subject to a final pressure and leakage test as specified above. If defects are found, the Contractor shall immediately make the repairs and the test repeated until satisfactory to the Engineer.

A final leakage test shall then be conducted after satisfactory completion of the pressure tests. Should any section fail to meet the final leakage test, the Contractor shall make the necessary repairs at his expense.

The duration of the final pressure test and leakage test shall be a minimum of one hour each.

9.2.6.4 Test Report

The Construction Project Manager shall be furnished a written report of the reports of the Hydrostatic Tests performed; identifying the specific length of the pipe tested, the pressure, the duration of the test and the amount of leakage.

9.2 Acceptance

Portions of the work completed may be placed in operation after all cleaning, and inspection requirements have been fulfilled. Final acceptance of the work will not be made until all requirements set forth in the Contract documents have been completed. Any items of work which the Contractor considers as extra shall be reported to the Construction Project Manager during the progress of the testing and inspection. No consideration of any work items will be made unless substantiating records of the work exist. Any work which the Contractor considers to be extra shall be considered in accordance with General Condition 1101, "Change Order".

END OF SPECIFICATION



CITY AND COUNTY OF DENVER
ENGINEERING DIVISION

Wastewater Capital Projects Management Standard Construction Specification

10.1 PRECAST CONCRETE PIPE

10.1.1 General

This section covers material requirements, inspection, marking, delivery, installation, field performance and acceptance of reinforced concrete pipe for storm drainage systems. This shall include circular, elliptical and arch pipe along with all associated special pipe sections.

10.1.2 Referenced Standards

This section references American Society for Testing and Materials (ASTM) Specifications, which are made a part hereof by such references, and shall be the latest edition and revision thereof. All material, manufacturing, operations, testing, inspection and production of concrete pipe shall conform to the following Referenced Standards:

ASTM C14	Concrete Sewer, Storm Drain and Culvert Pipe
ASTM C33	Specification for Concrete Aggregates
ASTM C76	Reinforced Concrete Culvert, Storm Drain and Sewer Pipe
ASTM C150	Standard Specification for Portland Cement
ASTM C361	Reinforced Concrete Low-Head Pressure Pipe
ASTM C443	Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
ASTM C497	Standard Test Methods for Concrete Pipe, Manhole Sections or Tile
ASTM C506	Reinforced Concrete Arch Culvert, Storm Drain and Sewer Pipe
ASTM C507	Reinforced Concrete Elliptical Culvert, Storm Drain and Sewer Pipe
ASTM C655	Standard Specification for Reinforced Concrete D-Load culvert, Storm Drain and Sewer pipe
ASTM C822	Standard Terminology Relating to Concrete Pipe and Related Products
ASTM C985	Standard Specification for Non-reinforced concrete Specified Strength Culvert, Storm Drain and Sewer pipe

ASTM C1417 Standard Specification for Manufacture of Reinforced Concrete Sewer,
Storm drain and Culvert pipe for Direct Design

10.1.3 Diameter of Pipe

The diameter indicated on the Contract Documents shall mean the inside diameter of the pipe.

10.1.4 Wall Thickness and Class of Pipe

The wall thickness and reinforcing steel shall comply with the appropriate ASTM Specification and the designated class of pipe as indicated in the Contract Documents. For jacked pipe, the pipe manufacturer shall supply allowable jacking force calculations for each size of pipe supplied for the project. The Contractor is responsible for ensuring that the allowable jacking force is sufficient to install the product based on anticipated site conditions and the forces that the pipe may be subjected to during jacking operations.

10.1.5 Submittals

10.1.5.1 Supplier Certification

A letter from the supplier to the Construction Project Manager shall be submitted certifying that all Precast Reinforced Concrete Pipe is manufactured in accordance with the applicable ASTM specification.

10.1.5.2 Design Calculations

All designs shall be per the applicable ASTM designation, except where pipe sizes and or special load conditions are not covered in the specifications. All special designs and load conditions shall require the submittal of design calculations through the Construction Project Manager for approval.

10.1.5.3 Shop Drawings

Shop drawings showing a laying diagram and the location of all closure pieces shall be submitted. Drawings shall include: proposed lifting anchors, lugs and any other features pertinent to the manufacture of special sections.

10.1.5.4 Gasket Deformation

Calculations showing the gasket deformation(s) shall be submitted to the Construction Project Manager.

10.1.5.5 Lifting Anchors

The lifting mechanisms proposed for handling and placement of conduit shall be submitted to the Construction Project Manager for approval.

10.1.5.6 Maximum Allowable Joint Gap

The manufacturer shall provide the Construction Project Manager with the maximum allowable joint gaps on all conduit sizes for the project. The maximum allowable joint gap is determined as that point where the bevel of the bell and the shoulder of the spigot are vertically aligned and the rubber gasket has achieved the minimum compression necessary to ensure a water tight seal per these Standard Construction Specifications.

10.1.6 Materials

All precast reinforced concrete pipe shall be manufactured in accordance with the applicable ASTM designation or as specified in the Contract Documents.

The Construction Project Manager shall be provided a production schedule at least three working days in advance of when the various types of pipe will be cast so the casting operation may be inspected and appropriate specimens may be selected for testing in accordance with the Contract Documents.

10.1.6.1 Cement

Unless otherwise specified by the Construction Project Manager, or within the Contract Documents, Type II Portland Cement complying with the requirements of ASTM C150 will be used in the production of concrete pipe.

10.1.6.2 Lifting Anchors

Lifting anchors shall be used on all precast concrete pipe. Lifting holes are only permitted on jack pipe and will require metal sleeves cast through the pipe wall which are capable of accepting threaded caps that are flush with the pipeline interior after installation. Lift hole sleeves shall be filled with a non-shrink grout prior to installing threaded caps.

10.1.6.3 Fittings and Specials

Details of all fittings and specials shall be submitted for approval to the Construction Project Manager prior to construction. Fittings and specials shall be made up of pipe segments having the same structural qualities as the adjoining pipe and shall have the interior treated the same as the pipe, except that epoxy coatings shall be allowed.

10.1.6.4 Joints and Gaskets

Pipe joints for all reinforced concrete pipes shall be formed using rubber gaskets that provide a watertight seal, in accordance with ASTM C443. The joints shall be of such design that they will withstand the forces caused by the compression of the gasket when joined.

- A separate submittal package specific to each pipe size and unique project scenario shall be required for approval by the Construction Project Manager prior to product procurement by the Contractor. At a minimum, this submittal shall include jacking force calculations (see 7.1.4), joint design, and a special pipe detail for each situation.

The joint design of concrete pipe shall be a bell and spigot or a tongue and groove style joint. The spigot or tongue shall be grooved to properly contain and seat the rubber gasket. The joint assemblies shall be accurately formed so that when each pipe section is forced together in the trench the assembled pipe shall form a continuous watertight conduit with a smooth and uniform interior surface, and shall provide for slight movement of any piece of the pipeline due to expansion, contraction, settlement or lateral displacement. The gasket shall be the sole element of the joint providing water tightness. The ends of the pipe shall be perpendicular (90° angle) to the longitudinal centerline of the pipe, except where bevel-end pipe is required. The ends shall be finished so that they are uniform and smooth.

Rubber gaskets for bell and spigot pipe shall consist of an o-ring rubber gasket, rubber profile gasket, or another gasket specifically approved, in writing, by the Construction Project Manager.

Gaskets may be either isoprene or neoprene conforming to ASTM C443. All gaskets shall be stored in a cool place, preferably at a temperature of less than 70 degrees Fahrenheit (F), and in no case shall the gaskets be stored in the open, or exposed to direct sunlight. No gaskets which show signs of deterioration, such as surface cracking or checking, shall be installed in a pipe joint. When the air temperature is 10 degrees F or lower, the gaskets shall be warmed to temperature of 60 degrees Fahrenheit for a period of 30 minutes before being placed on the pipe.

10.1.6.5 Joint Gap

For reinforced concrete pipe 30-inches (or equivalent diameter for arch and elliptical pipes) and larger, if the end face joint gap is greater than or equal to 65% of the maximum allowable joint gap, as submitted by the manufacturer for each specific pipe size and less any factors of safety, the gap shall be grouted with an approved non-shrink grout product around the entire internal joint perimeter. If the end face joint gap is greater than the maximum allowable joint gap submitted by the manufacturer, at any point around the internal joint perimeter, the adjoining pipe sections will be rejected and no payment will be made.

10.1.6.6 Jacking and/or Microtunneling Pipe

All other Requirements set forth in this specification shall apply to reinforced concrete pipe being installed via tunneling, in addition to the following:

2. All RCP shall have a flush joint design.
3. The class of pipe shall be as defined in the drawings:
 - Where steel joint rings are specified, they shall conform to ASTM C361, joint type R-2 and shall include steel joint rings on the bell and spigot
 - Where steel bell bands are specified, the pipe shall include a ¼" thick steel bell band which is at least 12" wide or twice the manufactured pipe joint depth, whichever is greater. A separate submittal package specific to each pipe size and unique project scenario shall be required for approval by the Construction Project Manager prior to product procurement by the Contractor. At a minimum, this submittal shall include jacking force calculations, additional reinforcement required to meet the site conditions, and a special pipe detail for each situation.
4. Concrete used in Pipe production shall have a minimum 28-day compressive strength of 6,000 psi, regardless of the class of pipe specified.
5. Grouting nipples shall be spaced no more than 8 feet apart on the installed pipeline.

10.1.7 Acceptance

In addition to any deficiencies not covered by the applicable ASTM specifications, individual concrete pipe sections shall be subject to rejection due to any of the following:

1. Surface defects indicating honeycombed or open texture that would adversely affect the function of pipe sections. Repairs may be made, if approved by the Construction Project Manager.
2. Damaged ends, where such damage would prevent making a satisfactory joint.
3. Pipe which has been excessively patched or repaired. The manufacturer may request that the Construction Project Manager perform an inspection at the plant, prior to delivery, to assess patching and/or repair work on conduits. Pipe damaged during shipment or construction may be repaired with the approval of the Construction Project Manager.
4. Exposure of the reinforcement. The exposure of the ends of longitudinals, stirrups and spacers used to position reinforcement shall not be cause for rejection and may be repaired with the approval of the Construction Project Manager, in writing.
5. Concrete pipe that has been delivered to the jobsite prior to being at least 5 days (120 hours) old, except in cases when evidence that design strengths can be met earlier has been submitted and approved by the Construction Project Manager.
6. Broken bells or spigots on installed pipeline
7. Joint gaps greater than maximum allowable submitted by manufacturer

Acceptance of the pipe at point of delivery will not relieve the Contractor of full responsibility for any defects in materials due to workmanship.

10.1.8 Marking

The following shall be clearly marked on both the interior and exterior surface of the pipe:

1. ASTM specification designation
2. Class and size
3. Date of manufacture
4. Name or trademark of manufacturer

10.1.9 Protective Coatings

Whenever adverse corrosive conditions warrant additional interior protection, those pipe segments noted in the Contract Documents shall be lined as specified elsewhere in these Standard Construction Specifications.

10.1.10 Installation

Reinforced concrete pipe shall be constructed continuously, from downstream to upstream, except when otherwise approved by the Construction Project Manager, in writing. The General Contractor is responsible for matching line and grade as shown within the Contract Documents. Bedding material shall be placed in accordance with these Contract Documents

and all applicable Wastewater Management Division Standard Details to provide uniform and continuous support.

Pipe shall be placed with the grove or bell end upstream. Each conduit section shall be set into position and checked for line and grade prior to continuing placement. The manufacturers' recommendations shall be closely followed during installation.

The General Contractor shall ensure that all reinforced concrete pipe is kept clean and free from gravel, dirt and debris during and after installation. Precautions shall be taken by the General Contractor to eliminate soil and debris from being washed into the sewer prior to completion of the entire system and its appurtenances. The General Contractor shall incur all costs associated with street failures, cave-ins, system washouts and settlements, and conduit cleaning as a result of carelessness during this timeframe.

End of Specification



CITY AND COUNTY OF DENVER
ENGINEERING DIVISION

Wastewater Capital Projects Management Standard Construction Specification

10.3 Precast Reinforced Box Conduits

10.3.1 General

The work of this section includes furnishing and installing all precast reinforced concrete box conduits for storm drainage systems. This shall include all associated special pieces, except inlets and manholes.

10.3.2 Related Sections

Section 4.0, Utility Trenching and Excavation (Wastewater Capital Projects Management Standard Construction Specifications).

10.3.3 Referenced Standards

This section references American Society for Testing and Materials (ASTM) Specifications, which are made a part hereof by such references, and shall be the latest edition and revision thereof. All material, manufacturing, operations, testing, inspection and production of precast reinforced box conduits shall conform to the following standards.

ASTM C150	Standard Specification for Portland cement
ASTM C497	Standard Test Methods for Concrete Pipe, Manhole Sections, or Tile
ASTM C822	Terminology Relating to Concrete Pipe and Products
ASTM C1433	Standard Specification for Precast Reinforced Concrete Box Sections for Culverts, Storm Drains and Sewers
ASTM C443	Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets

10.3.4 Submittals

10.3.4.1 Supplier Certification

A letter from the supplier to the Construction Project Manager shall be submitted certifying that all Precast Reinforced Box Conduits are manufactured in accordance with ASTM C1433.

10.3.4.2 Design Calculations

All designs shall be per the tables of ASTM C1433 except where box sizes and or special load conditions are not covered by these tables. All special designs and load conditions shall

require the submittal of design calculations through the Construction Project Manager for City and County of Denver approval.

10.3.4.3 Shop Drawings

Shop drawings showing laying diagram and location of all closure pieces shall be submitted. Drawings shall include: proposed lifting anchors, lugs and any other features pertinent to the manufacture of special sections.

10.3.4.4 Gasket Deformation

Calculations showing the gasket deformation(s) shall be submitted to the Construction Project Manager.

10.3.4.5 Lifting Anchors

The lifting mechanisms proposed for handling and placement of box conduit shall be submitted to the Construction Project Manager for approval.

10.3.4.6 Maximum Allowable Joint Gap

The manufacturer shall provide the Construction Project Manager with the maximum allowable joint gaps on all box conduit sizes for the project. The maximum allowable joint gap is determined as that point where the bevel of the bell and the shoulder of the spigot are vertically aligned and the rubber gasket has achieved the minimum compression necessary to ensure a water tight seal per these Standard Construction Specifications.

10.3.5 Materials

10.3.5.1 Box Conduits

All precast reinforced concrete box conduits shall be manufactured in accordance with ASTM C1433.

The Construction Project Manager shall be provided a schedule at least three working days in advance of when the various types of box conduit will be cast so the casting operation may be inspected and appropriate specimens may be selected for testing in accordance with the Contract Documents.

10.3.5.2 Box Joints

Box joints for reinforced concrete box conduits shall be formed using either o-ring or profile rubber gaskets that provide a watertight seal. The gasket shall be properly placed on the spigot using an adhesive, as necessary along the joint perimeter, to maintain the correct position of the gasket. Joints for box conduits shall comply with the requirements set forth in ASTM C443, with the following revisions.

- A separate submittal package specific to each pipe size and unique project scenario shall be required for approval by the Construction Project Manager prior to product procurement by the Contractor. At a minimum, this submittal shall include jacking force calculations (see 7.1.4), joint design, and a special pipe detail for each situation.

1. Gasket Deformation

The joints shall be of such design that they will withstand the forces caused by the compression of the gasket when the joint is in the assembled and homed position, as well as when the box joint is fully off-centered and the maximum dimensional tolerances are applied.

2. Hydrostatic Testing and Requirements

One box joint per size, for each project, shall be hydrostatically tested at the place of manufacture to verify water tightness and joint integrity. Hydrostatic pressure tests on joints shall be made on an assembly of two sections of box, properly connected in accordance with the joint design. Suitable means shall be provided that allows pressure to be applied to the joint, either external or internal of the two joined box sections. When infiltration is a concern, the joint shall be tested using external pressure only.

Assembled joints shall pass the following performance tests without leakage at the joints. Moisture or beads of water appearing on the surface of the joint will not be considered as leakage.

Box in straight alignment

Concrete box conduit shall be subjected to a hydrostatic pressure of 5psi (11.5 ft of pressure head) for 10 minutes in straight alignment. If leakage of joints should initially occur, the manufacturer shall have the option to extend the test period up to 24 hours.

Box in maximum deflected position

Upon completion of the test for box in straight alignment, the test section shall be deflected to create a position ½ inch wider than the assembled position on one side of the outside perimeter of each joint and shall be subjected to a hydrostatic pressure of 3psi (6.9 ft of pressure head) for 10 minutes.

3. Joint Gap

If the end face joint gap is greater than or equal to 65% of the maximum allowable joint gap, as submitted by the manufacturer for each specific box size and less any factors of safety, the gap shall be grouted with an approved non-shrink grout product around the entire internal joint perimeter.

10.3.5.3 Closure Pieces

All pieces required for closure between precast and cast-in-place elements shall be fabricated with protruding dowels or exposed reinforcing steel, as shown in the Contract Documents, and as approved by the Construction Project Manager. All dowels and/or exposed reinforcing shall be fully developed.

10.3.5.4 Special Pieces

Special pieces shall be fabricated as shown on the Contract Documents and shall be approved by the Construction Project Manager prior to fabrication.

10.3.5.5 Lifting Anchors

Lifting anchors shall be used on all box conduits. Lifting holes will not be allowed.

10.3.6 Acceptance

In addition to deficiencies covered by applicable ASTM specifications, individual precast reinforced concrete box conduits shall be subject to rejection due to any of the following:

1. Surface defects indicating honeycombed or open texture that would adversely affect the function of box sections. Onsite repairs may be made, if approved by the Construction Project Manager.
2. Damaged ends, where such damage would prevent making a satisfactory joint.
3. Conduit which has been excessively patched or repaired. The manufacturer may request that the Construction Project Manager perform an inspection at the plant, prior to delivery, to assess patching and/or repair work on conduits. Conduit damaged during shipment or construction may be repaired with the approval of the Construction Project Manager.
4. Exposure of the reinforcement. The exposure of the ends of longitudinals, stirrups and spacers used to position reinforcement shall not be cause for rejection.
5. Box conduit that has been delivered to the jobsite prior to being at least 5 days (120 hours) old.

Acceptance of the conduit shall not relieve the General Contractor of full responsibility for defects in material or workmanship on the completed boxlines.

10.3.7 Marking

The following information shall be legibly marked on each box section by indentation, waterproof paint or other approved means:

1. ASTM specification designation
2. Date of manufacture
3. Name or trademark of manufacturer

10.3.8 Testing

The Construction Project Manager or other identified representatives shall be permitted to visit the manufacturing facility of the General Contractor's supplier to observe compliance with all applicable testing provisions. These visits may be scheduled or random.

10.3.9 Shipping and Handling Box Conduit and Fittings

All conduits, fittings, and specials shall be hauled, unloaded, stockpiled, distributed, handled and installed as recommended by the manufacturer and in such a manner as to prevent damage to the product.

10.3.10 Installation

Box conduit lines shall be constructed continuously, from downstream to upstream, except when otherwise approved by the Construction Project Manager. The General Contractor is responsible for matching line and grade as shown within the Contract Documents. Bedding

material shall be placed in accordance with the Contract Documents and applicable Wastewater Management Division Standard Details to provide uniform and continuous support.

Box conduits shall be placed with the grove end upstream. Each conduit section shall be set into position and checked for line and grade prior to continuing placement. The manufacturers' recommendations shall be closely followed during installation.

The General Contractor shall ensure that all reinforced concrete box conduits are kept clean and free from gravel, dirt and debris during and after installation. Precautions shall be taken by the General Contractor to eliminate soil and debris from being washed into the sewer prior to completion of the entire system and its appurtenances. The General Contractor shall incur all costs associated with street failures, cave-ins, system washouts and settlements, and conduit cleaning as a result of carelessness during this timeframe.

End of Specification



CITY AND COUNTY OF DENVER
ENGINEERING DIVISION

Wastewater Capital Projects Management Standard Construction Specification

10.4 Reinforced Polymer Mortar Pipe

10.4.1 General

This section covers material requirements, inspection and testing, marking and delivery, installation, and field performance and acceptance tests of Reinforced Polymer Mortar Pipe (RPMP), for use in gravity, storm and sanitary sewer installations.

10.4.2 Referenced Standards

This section references American Society for Testing and Materials (ASTM), which are made part hereof by such references, and shall be the latest edition and revision thereof. All material, manufacturing, operations, testing, inspection and production of Reinforced Polymer Mortar Pipe (RPMP) shall conform to the following referenced standards:

- ASTM D3262 Standard Specification for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer Pipe
- ASTM D4161 Standard Specification for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe Joints Using Flexible Elastomeric Seals.
- ASTM D2412 Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading.
- ASTM D3681 Standard Test Method for Chemical Resistance of "Fiberglass" Pipe in a Deflected Condition.
- ASTM D638 Test Method for Tensile Properties of Plastics.

10.4.3 Diameter of Pipe

The diameter indicated on the Contract Documents shall mean the inside diameter of the pipe.

10.4.4 Wall Thickness

The wall thickness and reinforcements shall comply with the appropriate ASTM Specification as indicated in the Contract Documents.

10.4.5 Submittals

10.4.5.1 Supplier Certification

1. A letter from the supplier to the Construction Project Manager shall be submitted certifying that all Reinforced Polymer Mortar Pipe and associated appurtenances are manufactured in accordance with the applicable ASTM specifications.
2. The manufacturer shall provide the Construction Project Manager with the manufacturer's recommended maximum allowable joint gaps and tolerances on all conduit sizes for the project.
3. If the project contains tunneling or boring, please refer to additional submittal requirements elsewhere in this specification.

10.4.6 Materials

10.4.6.1 Pipe

The pipe shall meet the ASTM D3262 standard specification Cell Limit Type 1, Liner 1 or 2, and Grade 1 or 3, with a minimum SN of 46 psi and PN of 25psi, unless otherwise indicated on the plans.

10.4.6.2 Joints

The joints must meet the performance requirements of ASTM D4161. Unless otherwise specified, the pipe shall be field connected with sleeve couplings that utilize elastomeric sealing gaskets made of EPDM rubber compound as the sole means to maintain joint water tightness as otherwise approved by the Construction Project Manager.

The measured pipe joint gap shall not be equal to or larger than 65% of the manufacturer's recommended maximum allowable joint gap.

10.4.6.2.1 Manhole Connection

Unless otherwise specified the connection at the manhole must be a waster stop gasket or approved equal.

- **A separate submittal package specific to each pipe size and unique project scenario shall be required for approval by the Construction Project Manager prior to product procurement by the Contractor. At a minimum, this submittal shall include jacking force calculations (see 7.1.4), joint design, and a special pipe detail for each situation.**

10.4.6.3 Fittings

Flanges, elbows, reducers, tees, wyes, laterals and other fittings shall be capable of withstanding all operating conditions when installed. They may be contact molded or manufactured from mitered sections of pipe joined by glass-fiber-reinforced overlays. Properly protected standard ductile iron, fusion-bonded epoxy coated steel and stainless steel fittings may also be used.

10.4.6.4 Resin Systems

The manufacturer shall use only polyester resin systems with a proven history of performance in this particular application. The historical data shall have been acquired

from a composite material of similar construction and composition as the proposed product.

10.4.6.5 Glass Reinforcements

The reinforcing glass fibers used to manufacture the components shall be of highest quality commercial grade E-glass filaments with binder and sizing compatible with impregnating resins.

10.4.6.6 Silica Sand

Sand shall be minimum 98% silica with a maximum moisture content of 0.2%.

10.4.6.7 Additives

Resin additives, such as curing agents, pigments, dyes, fillers, thixotropic agents, etc., when used, shall not detrimentally affect the performance of the product.

10.4.6.8 Elastomeric Gaskets

Gaskets shall be supplied by qualified gasket manufacturers and be suitable for the service intended.

10.4.7 End Squareness

Pipe ends shall be square to the pipe axis with a maximum tolerance of 1/8".

10.4.8 Packaging, Handling, Shipping

The Contractor shall follow the procedures and recommendations for packaging, handling, and shipping, in accordance with the manufacturer's instructions.

10.4.9 Jacking and/or Microtunneling Pipe

All other Requirements set forth in these specifications shall apply to reinforced polymer mortar pipe being installed via tunneling, in addition to the following:

1. All RPMP utilized for Jacking and or Microtunneling shall have a flush joint design.
2. A separate submittal package specific to each pipe size and unique project scenario shall be required for approval by the Construction Project Manager prior to product procurement by the Contractor. At a minimum, this submittal shall include jacking force calculations, joint design, and a special pipe detail for each situation.
3. The pipe manufacturer shall supply allowable jacking force calculations for each size of pipe supplied for the project.
4. The Contractor is responsible for ensuring that the allowable jacking force is sufficient to install the product based on anticipated site conditions and that the forces the pipe may be subjected to during jacking operations do not damage the product.

10.4.4.9 Testing

1. All pipes shall be manufactured and tested in accordance with ASTM D3262
2. All joints shall meet the requirements of ASTM D4161.
3. Stiffness shall be tested in accordance with the test method of ASTM D2412.

10.4.5 Inspection of Product During Manufacturing

10.4.5.1 Customer Inspection

The owner or other designated representative shall be entitled to inspect pipes or witness the pipe manufacturing.

10.4.5.2 Manufacturers Notification to Customer

Should the Owner request to see specific pipes during any phase of the manufacturing process, the manufacturer must provide the Owner with at least 48-hours advance notice of when and where the production of those pipes will take place.

10.4.6 Installation

10.4.6.1 Trenching and Excavation

Trenching and excavation shall be performed in accordance with Section 4.0 of these Standard Construction Specifications.

10.4.6.2 Bedding and Haunching

The bedding shall be Class B as defined in these Standard Construction Specifications. The bedding material shall conform to ASTM C33 or ASTM D448 gradation No. 67 shall be brought to proper grade and elevation prior to installation of pipe and assembly of joints. Depressions for pipe bell shall be provided. Additional bedding material shall then be placed according to Wastewater Management Division Standard Detail S-301, "Standard Detail for Trenching and Bedding".

10.4.6.3 Pipe Handling

Use textile slings, other suitable materials or a forklift. Use of chains or cables shall not be permitted.

10.4.6.4 Jointing

1. Clean ends of pipe and coupling components.
2. Apply joint lubricant to pipe ends and elastomeric seals of coupling. Use only lubricants approved by the pipe manufacturer.
3. Use suitable equipment and end protection to push or pull the pipes together.
4. Do not exceed forces recommended by the manufacturer for coupling pipe.
5. Join pipes in straight alignment then deflect to required angle. Do not allow the deflection angle to exceed the deflection permitted by the manufacturer.

10.4.6.5 Minimum Cover

Minimum cover depth of compacted fill above the top of the pipe is three (3) feet. If this minimum cover requirement is not attainable, pipes with higher stiffness (SN 72) shall be used for installation.

10.4.7 Field Testing

10.4.7.1 Infiltration/Exfiltration Test

Maximum allowable leakage shall be per local specification requirements.

10.4.7.2 Low Pressure Air Test

See section 9.2.3

10.4.7.3 Individual Joint Testing

For pipes large enough to enter, individual joints may be air pressure tested with a single or double bladder tester to 5 psi for 1 minute. If the joint fails then the joint shall be repaired per City approved manufacturer's recommendation.

10.4.7.4 Deflection Testing

A deflection test shall be performed according to section 9.2.5 of these Standard Construction Specifications. The maximum allowable deflection limits after construction shall be 5% of the initial diameter.

END OF SPECIFICATION



CITY AND COUNTY OF DENVER
ENGINEERING DIVISION

Wastewater Capital Projects Management Standard Construction Specification

10.5 Ductile Iron Pipe

10.5.1 General

This section covers material requirements, fittings, field joints and protective coatings for ductile iron pipe.

10.5.2 Referenced Standards

This section references American Society for Testing and Materials (ASTM), American National Standards Institute (ANSI), and American Water Works Association (AWWA), which are made a part hereof by such references, and shall be the latest edition and revision thereof. All material, manufacturing, operations, testing, inspection and production of ductile iron pipe shall conform to the following standards;

ASTM A746	Standard Specification for Ductile Iron Gravity Sewer Pipe
AWWA C110/ANSI A21.10	Standard for Ductile-Iron and Gray Iron Fittings, 3 in. – 48 in
AWWA C111/ANSI A21.11	Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C151/ASA A21.51	Standard for Ductile-Iron Pipe, Centrifugally Cast, for Water
AWWA C153/ANSI A21.53	Standard for Ductile-Iron Compact Fittings

10.5.3 Pipe Diameter

The diameter indicated on the drawings shall represent the nominal diameter of the pipe. The inside diameter of the pipe after protective lining has been applied shall not be less than that required for cast iron pipe.

10.5.4 Wall Thickness

The minimum wall thickness and /or pressure class of each section of the pipeline shall conform to that indicated on the Contract Documents, and shall be subject to the approval of the Construction Project Manager.

10.5.5 Grade of Iron

The grade of iron shall be 60-42-10 having a minimum tensile strength of 60,000 psi, minimum yield strength of 42,000 psi, and a minimum percent of elongation of 10 percent.

10.5.6 Fittings and Specials

Fittings and specials shall be ductile iron at least Class 54 thickness and shall be in accordance to the requirements of either AWWA C153/ANSI A21.53 or AWWA C110/ANSI A21.10. Fittings shall be lined as specified in Section 10.5.7a and coated as specified in Section 10.5.7b below.

10.5.7 Field Joints

Mechanical joints shall conform to AWWA C111/ANSI A21.11.

10.5.8 Protective Coatings

Unless otherwise specified. The interior and exterior surfaces shall conform to the following.

1. Interior surfaces shall be lined with calcium aluminates mortar made of fused calcium aluminates cement and fused calcium aluminates aggregates. The thickness of the lining shall be a minimum of 0.125" for 6" through 12" and 0.1875" for 14" through 24" diameter pipe.
2. The lining shall be Sewpercoat® as manufactured by Lafarge Calcium Aluminates or approved equal.
3. Exterior coating shall be a minimum of 1 mil bituminous paint according to AWWA C151/ASA A21.51 - Section 51-8.1.

End of Specification



CITY AND COUNTY OF DENVER
ENGINEERING DIVISION

Wastewater Capital Projects Management Standard Construction Specification

10.6 Polyvinyl Chloride (PVC) Sewer Pipe

10.6.1 General

This section covers material requirements, inspection and testing, marking and delivery, installation, and field performance and acceptance tests of Polyvinyl Chloride (PVC) Sewer Pipe and Fittings for use in gravity, non-pressure, storm or sanitary sewer installations.

10.6.2 Referenced Standards

This section references American Society for Testing and Materials (ASTM), American National Standards Institute (ANSI), and American Water Works Association (AWWA), UNI-Bell PVC Pipe Association (UNI), which are made part hereof by such references, and shall be the latest edition and revision thereof. All material, manufacturing, operations, testing, inspection and production of Poly (Vinyl Chloride) (PVC) sewer pipe shall conform to the following referenced standards:

ASTM C33	Standard Specification for Concrete Aggregates
ASTM D448	Standard Classification for Sizes of Aggregate for Road & Bridge Construction.
ASTM F477	Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
ASTM F679	Standard Specification for Poly (Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings.
ASTM F789	Standard Specification for Type PS-46 and Type PS-115 Poly (Vinyl Chloride) (PVC) Plastic Gravity Flow Sewer Pipe and Fittings.
ASTM F794	Standard Specification for Poly (Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter.
ASTM D2321	Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.
ASTM D3034	Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.

10.6.3 PVC Sewer Materials

The following described materials are approved for use in PVC pipe sewer construction.

10.6.3.1 Pipe and Fittings

Sanitary sewer pipes shall be PVC and conform to: ASTM D3034 SDR 35 for sizes 8 inches to 15 inches in diameter; ASTM F789 for sizes 8 inches to 18 inches (Solid Wall); ASTM F679 for sizes 18 inches to 36 inches (Solid Wall); ASTM F949 for sizes 8 inches to 36 inches (Profile Wall); ASTM F794 for sizes 8 inches to 48 inches (Profile Wall); ASTM F1803 for sizes 18 inches to 60 inches (Profile Wall).

10.6.3.2 Gaskets

Gaskets shall comply with ASTM F477. It shall consist of a properly vulcanized high grade elastomeric compound. The basic polymer shall be natural rubber, synthetic elastomer, or a blend of both. The gasket shall be the only element depended upon to make the joint flexible and water-tight.

10.6.3.3 Lubricant

The lubricant used for assembly shall have no detrimental effect on the gasket or on the pipe. Lubricants shall be in accordance with the manufacturer's recommendations.

10.6.4 Acceptance

Acceptance of the pipe, fittings, and other associated sewer material shall be based on full compliance with these Standard Construction Specifications.

10.6.4.1 Certification

A manufacturer's certification that the material was manufactured and tested in accordance with these Standard Construction Specifications together with a report of all test results shall be furnished at the time of shipment.

10.6.5 Receiving, Storage and Handling

The Contractor shall follow the procedures and recommendation for receiving, storage, and handling contained in the Uni-Bell Plastic Pipe Association, "Handbook of PVC Pipe", and as recommended by the manufacturer.

10.6.5.1 Receiving

Pipes not conforming to the requirements of these Standard Construction Specifications and pipes damaged in transit shall be rejected by the Construction Project Manager. Acceptance of pipes at the time of delivery does not preclude rejection of the installed sewer pipe which do not conform to these Standard Construction Specifications.

10.6.5.2 Storage

Pipe shall be stored in unit packages provided by the manufacturer. The unit packages shall be supported by racks to prevent damage to the underside of the pipe. Supports shall be spaced to prevent pipe bending. Stored pipe shall be covered with an opaque material to

prevent exposure to direct sunlight while permitting adequate circulation of the air above and around the pipe to prevent excessive heat accumulation. Pipe determined to have been damaged in storage shall be rejected.

10.6.5.3 Handling

Construction equipment shall be operated in a safe and cautious manner so as to prevent damage to the pipe. Blows to the pipe causing impact damage shall be prevented. Pipe and fittings shall not be thrown, dropped, or dragged.

10.6.6 Installation

Installation of PVC pipe shall be in conformance with ASTM D2321, except where modified by these Standard Construction Specifications.

10.6.6.1 Trenching and Excavation

Trenching and excavation shall be performed in accordance with Section 4.0 of these Standard Construction Specifications.

10.6.6.2 Bedding and Haunching

The bedding shall be Class B as defined in Section 4.0 of these Standard Construction Specifications. The bedding material shall conform to ASTM C33 or ASTM D448 gradation No. 67 as modified and shall be brought to proper grade and elevation prior to installation of pipe and assembly of joints. Depressions for pipe bell shall be provided. Additional bedding material shall then be placed according to Wastewater Management Division Standard Detail S-301, "Standard Detail for Trenching and Bedding".

10.6.6.3 Jointing Pipe

Assembly of all joints shall be in accordance with the recommendations of the manufacturer. Proper jointing may be verified by rotation of the spigot or with a strap wrench. If unusual joining resistance is encountered or if the insertion mark does not reach the flush position, the joint shall be disassembled, inspected for damage, the joint components re-cleaned and the assembly steps repeated.

10.6.6.4 Cutting and Beveling Pipe

For shorter than standard pipe lengths, field cuts may be made with plastic pipe cutters. Ends shall be cut square and perpendicular to the pipe axis. Spigots shall have burrs removed and ends smoothly beveled by a mechanical beveler or by hand with a rasp or file. Field spigots shall be stop-marked with felt tip marker or wax crayon for the proper length of assembly insertion. The angle and depth of field bevels and length to stop-mark shall be comparable to factory pipe spigots.

10.6.6.5 Sanitary Sewer Connections

On all new PVC sewer construction, connections shall be made with Wye's or Tee's conforming to ASTM D3034 or F679 whichever is applicable. Only gasketed fittings will be used. Saddle Wye's and Tee's with gaskets for the saddle and joints are approved for sanitary sewer service connection to existing PVC sanitary sewers only. Stainless steel straps shall be used to secure the saddle fittings to the main pipe.

10.6.6.6 Water Stops

Whenever the PVC sewer pipe joints a manhole and is encased by the concrete manhole base or a cutout in precast manhole base, waterstops or seals shall be used. See City and County of Denver, Wastewater Management Division Standard Detail No. S-550.

- A separate submittal package specific to each pipe size and unique project scenario shall be required for approval by the Construction Project Manager prior to product procurement by the Contractor. At a minimum, this submittal shall include jacking force calculations (see 7.1.4), joint design, and a special pipe detail for each situation.

10.6.6.7 Trench Backfill

Backfilling of the trench shall as specified in Section 5.0 of these Standard Construction Specifications except that no wheeled vehicles shall be used for compaction or other purpose over the installed pipe until the backfill is at least 30 inches thick measured from the top of the pipe to the backfill surface. Mechanical tampers shall not be used until the backfill is at least 48 inches thick. Direct dumping of material over the top of uncovered pipe will not be allowed.

10.6.7 Field Performance and Acceptance Tests

10.6.7.1 Television Inspection

The City will perform a television inspection to verify accuracy of alignment, freedom from debris or obstructions, displacement of gaskets or joints and leaks at joint and service connections. Any of the above discrepancies observed shall be rectified by the Contractor at no cost to the City.

The cost of the initial inspection and the first re-inspection to confirm correction of previously identified deficiencies will be borne by the City. In the event additional inspections are necessary due to inadequate or otherwise unacceptable repairs, the costs for such inspection shall be charged to the Contractor.

10.6.7.2 Air Pressure Test

An air pressure test using the most recent version of UNI-Bell's UNI-B-6 shall be made. The air pressure test outlined in paragraph 9.2.3 of Section 9.0 of these Standard Construction Specifications will not apply to PVC sewer air testing. The Contractor shall secure adequate copies of UNI-B-6, as published by the Uni-Bell Plastic Pipe Association, and provide at least one copy to the Construction Project Manager.

10.6.7.3 Infiltration Test

If the ground water level is above the top of the pipe throughout the length being tested, an infiltration test shall be performed. See paragraph 9.2.2 of Section 9.0 of these Standard Construction Specifications.

10.6.7.4 Deflection Test

A deflection test shall be performed according to paragraph 9.2.5 of Section 9.0 of these Standard Construction Specifications. The allowable deflection limits shall be a maximum of 5% after construction and 6% at the end of the guarantee period. The allowable deflection shall be based on the base inside diameter of the PVC pipe.

10.6.7.5 Reports

Copies of all certified reports and logs of all tests and inspections conducted shall be submitted to the Construction Project Manager.

End of Specification



CITY AND COUNTY OF DENVER
DEPARTMENT OF PUBLIC WORKS, ENGINEERING DIVISION

Wastewater Capital Projects Management Standard Construction Specification

10.7 Cured In Place Pipe

10.7.1 General

This section outlines the guidelines & requirements for the rehabilitation of pipelines and conduits by the Cured in Place Pipe Method (CIPP). CIPP is the installation of a resin-impregnated flexible tube which is inserted into an existing conduit and cured by the use of pressurized steam or circulated water under a hydrostatic head. When complete, the CIPP is continuous and fits tightly to the existing pipe.

10.7.2 Referenced Standards

This section references American Society for Testing and Materials (ASTM) standards, which are made a part of this specification by such reference. All standards shall be the latest edition and revision. The materials, manufacturing, operations, testing, inspection and production of cured in place pipe shall conform to the following standards.

- | | |
|---------------|---|
| ASTM D638 | Standard Test Method for Tensile Properties of Plastics |
| ASTM D790 | Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials |
| ASTM D2122 | Determining Dimensions of Thermoplastic Pipe & Fittings |
| ASTM D2990 | Standard Test Methods for Tensile, Compressive, and Flexural Creep and Creep-Rupture of Plastic |
| ASTM D5813 | Standard Specification for Cured-In-Place Thermosetting Resin Sewer Piping Systems |
| ASTM F1216-09 | Standard Practice and Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin-Impregnated Tube |
| ASTM F1743 | Practice of Rehabilitation of Existing Pipelines and Conduits by Pulled-In-Place |

10.7.3 Submittals

Unless otherwise specified, the Contractor is responsible to have all submittals transmitted to the Construction Project Manager in sufficient time to allow two weeks for review and acceptance prior to starting the construction or any work by the Contractor. These include, but are not limited to:

- CIPP Health and Safety Plan
- Confined Space Entry Permits
- Corrosion Testing.
- Employee Certifications (NASSCO, OSHA, etc.)
- Felt Certification
- Fire Department Permit
- Installation Procedures
- Laboratory Designation and Accreditation
- Laboratory Testing Results
- Liner and Resin Long Term Performance Studies in Post-installation
- Service Open Notice
- Pre-cleaning (and TV) Notice
- Pre-lining Notice
- Pulling force gauge
- Structural Requirements
- Technical Supervision
- Tube Compliance
- Unanticipated Cancellation Notice
- Video/log sheet sample

10.7.3.1 Installation

Prior to installation by Inversion or the Pulled-in-Place method, the Contractor shall provide the Construction Project Manager with the following as applicable to the specific installation method:

- a. The minimum pressure required to hold the tube tight against the existing conduit and the maximum allowable pressure so as not to damage the tube. A complete log of the pressure (or head level) shall be maintained on the site and be furnished to the Construction Project Manager after each installation.
- b. The maximum allowable force that can be used in pulling the tube into the existing pipeline for each size of line. A complete log of the pulling force used for each line shall be maintained on site by the Contractor and be furnished to the Construction Project Manager after each installation.
- c. Minimum temperature and time required for cure on each size of line, based on installation method.
- d. For CIPP segments which are wet out on site, the Contractor must also submit (in spreadsheet form) information on allowable head pressure, roller spacing and gallons of resin to felt length with respect to diameter so the procedure can be verified on site.

10.7.3.2 Health and Safety Plan

Prior to site work, the Contractor shall provide the Construction Project Manager, for review, a Health and Safety Plan which includes (at a minimum) the following:

I) Introduction

- a. Provide project description, the work location and summary of key work activities to be performed.

II) Scope and Applicability

- a. Describe the scope of work for the General Contractor and 1st tier subcontractors performing the work
- b. Detail the planned site activities
- c. Describe who must adhere and abide by the Health and Safety plan
- d. Detail how site visitors will be addressed

III) Key Personnel, Responsibilities and Authority

- a. In relation to Health and Safety, describe the role of project managers, health and safety managers, technical supervisors (10.7.3.4), and other contractor and subcontractor staff.
- b. Provide resumes of Key Personnel, including background and training history.
- c. Identify the name, title, and contact information (phone, email, address) for key personnel.
- d. Identify the name, location, and contact numbers for ambulance, fire, police, hospital, Health and Safety managers (contractor and/or subcontractors), and other key personal or support contacts.

IV) Task/Operation Health and Safety Risk Analysis

- a. Identify, on a task specific basis the individual hazard elements that are present including chemical, physical, and biological.

V) Qualifications and Training Requirements for all Personnel

- a. Detail specific qualifications and training that are required.
- b. Discuss the frequency of safety and training refreshers.
- c. Detail the requirement for site personnel to read and acknowledge, in writing, their understanding of the Health and Safety plan.

VI) Engineering and Administrative Controls

- a. Describe in detail how engineering and administrative controls will be used to protect worker and public safety by preventing chemical exposure, injury, or illness.

- b. List controls in conjunction with each activity identified in the Task/Operation Health and Safety Risk Analysis section above.

VII) Personal Protective Equipment (PPE) Requirements

- a. PPE requirements should be listed in conjunction with each activity identified in the Task/Operation Health and Safety Risk Analysis.
- b. Detail applicable standards (e.g., ANSI, NIOSH, ACGIH, OSHA etc)

VIII) Health and Safety Monitoring

- a. Detail instruments, samples, and monitoring that will occur both on the jobsite and in response to complaint(s) or inquiries.
- b. Detail who is responsible for performing monitoring
- c. Detail frequency of monitoring
- d. Define the appropriate action levels and thresholds
- e. Describe standard operating procedures for Health and Safety monitoring

IX) Site control

- a. Describe work zones, buddy systems, and site security.
- b. Address policies including drug and alcohol policies, personal hygiene requirements, heat and cold stress prevention
- c. Describe task specific site control (e.g., confined space entry protocol, worker photo ID program, etc.)

X) Decontamination plan

- a. Eye and hand wash (if applicable)
- b. Site cleanup

XI) Emergency Contingency Plan

- a. Medical services
- b. Emergency phone numbers
- c. Personnel Injury
- d. Fire/Explosion
- e. Hazardous Material spill response and onsite location of spill kit
- f. Evacuation
- g. Emergency signals and communication
- h. First aid
- i. Emergency equipment list
- j. Map(s), addresses, and phone numbers of nearest medical facilities

XII) Appendices

- a. Safety forms (as needed)
- b. Supporting documentation and information
- c. Material safety data sheets (MSDS)

10.7.3.3 Weekly Installation Schedule

The Contractor shall submit a weekly construction schedule, 7 calendar days in advance of the work, to the Construction Project Manager and the Denver Fire Department to include the following information:

1. The specific line number and related manhole numbers as designated in the project plans. The line length and service connection count information must also be included from the preliminary video investigation.
2. The specific date and timeframe each installation will occur. Night and weekend work must be approved by the Construction Project Manager a minimum of 10 days prior to the proposed commencement of the work.
3. The Technical Supervisor's name for the crew(s) that will be doing each specific installation.
4. The method of installation planned for each line in accordance with ASTM F1216 or F1743.
5. The location and schedule of the "wet-outs" in order to permit inspection of the materials and procedures. This information may be submitted separately.

10.7.3.4 Technical Supervision

Due to the technical aspects and complexity of the products used during the installation of CIPP, the Contractor is required to maintain a full time employee with a minimum of five years experience in the CIPP process of rehabilitation. This employee should be at the superintendent level or higher. This employee must be the direct, first line contact for all aspects of the project construction management. Resume and references, and copies of applicable required NASSCO, OSHA, etc. training certificates of this employee shall be submitted to the Construction Project Manager for review and acceptance prior to the start of the project.

10.7.3.5 Test Results and Performance Studies

CIPP sample test results as well as long term performance studies, from an industry recognized independent laboratory, must be submitted for the materials from the specific supplier(s) to be used on the project in accordance with applicable ASTM standards. The CIPP liner material must meet the requirements of ASTM F1216 or F1743 and ASTM D5813 Sections 6 and 8 (Appendix X.1). The resin shall produce CIPP, which will comply with the structural and chemical resistance requirements of ASTM F1216 or F1743. It is required that CIPP samples with and without polyethylene coating meet these chemical testing requirements. The long term performance studies must show the proposed material

consistently meets the required thickness and strength requirements per the Contract Documents.

The Long Term Performance Studies must be submitted and accepted prior to bidding to pre-qualify the prospective bidder. The CIPP liner material used for the project must be the exact same composition of the material used in the Long Term Performance Studies as outlined in this Section. Any deviation in the composition will require that a new Long term Performance Study is completed, submitted and accepted prior to installation.

10.7.3.6 Street Occupancy Permits

The Contractor shall submit, to the Construction Project Manager, copies of the street occupancy permits, including the approved traffic control plans prior to beginning work.

10.7.3.7 Digital Video and Log Sheets

Prior to commencing any site work, the contractor shall submit video quality samples as well as log sheet samples for review and acceptance by the Construction Project Manager. These samples must be in accordance with the following specifications.

10.7.3.8 Digital Video and Log Sheets Specifications

1. After cleaning and lining, the manhole sections shall be visually inspected by means of closed-circuit television. The inspection will be done one manhole section at a time and the flow in the section being inspected will be suitably controlled as specified elsewhere in these Standard Construction Specifications. CCTV inspections shall be performed in accordance with PACP standards including indications of the specific date and time of inspection.
2. The closed-circuit television camera used for the inspection shall be one specifically designed and constructed for such inspection. Lighting for the camera shall be suitable to allow a clear picture of the entire periphery of the pipe. The camera shall be operative in 100% humidity conditions. The camera, television monitor, and other components of the video system shall be capable of producing picture quality to the satisfaction of the Owner's Representative; and if unsatisfactory, equipment shall be removed and no payment will be made for an unsatisfactory inspection.
3. The camera shall be moved through the line upstream to downstream at a moderate rate, stopping when necessary to permit proper documentation of the sewer's condition. In no case will the television camera be pulled at a speed greater than 30 feet per minute. Manual winches, power winches, TV cable, and powered rewinds or other devices that do not obstruct the camera view or interfere with proper documentation of the sewer conditions shall be used to move the camera through the sewer line. If, during the inspection operation, the television camera will not pass through the entire line section, the Contractor shall set up his equipment so that the inspection can be performed from the opposite manhole. If, again, the camera fails to pass through the entire manhole section, the inspection shall be considered complete noted as Survey Abandoned. The contractor is required to notify the Construction Project Manager and further direction will be provided.
4. When manually operated winches are used to pull the television camera through the line,

telephones or other suitable means of communication shall be set up between the two manholes of the section being inspected to insure good communications between members of the crew.

5. The importance of accurate distance measurements is emphasized. Measurement for location of defects shall be above ground by means of a meter device. Marking on the cable, or the like, which would require interpolation for depth of manhole, will not be allowed. Accuracy of the distance meter shall be checked by use of a walking meter, roll-a-tape, or other suitable device, and the accuracy shall be satisfactory to the Construction Project Manager.

6. Documentation of the television results shall be as follows:

- (6.1) Television Inspection Logs: Electronic media location records shall be kept by the Contractor and will clearly show the location, by distance in 1/10 of a foot or nearest cm, from the upstream manhole wall, in relation to an adjacent manhole of each infiltration point observed during inspection. In addition, other points of significance such as locations of building sewers (taps), unusual conditions, roots, storm sewer connections, cracks, fractures, broken pipe, presence of scale, calcium deposits and corrosion (with estimated thicknesses), and other discernible features, as defined in the PACP defect codes, will be recorded on electronic media, and a copy of such records will be supplied to the Construction Project Manager.
- (6.2) Digital photographs of the pipe condition and all defects and service connections (taps) shall be taken by the Contractor. Photographs shall be located by distance in 1/10 of a foot or nearest mm, from the manhole wall, in relation to an upstream manhole.
- (6.3) Electronic media recordings: The purpose of electronic media recording shall be to supply a visual and audio record of problem areas of the lines that may be replayed by the Owner. Each original electronic media recording of conditions and defects will be delivered to the Project Construction Manager upon completion of a specific line section.
- (6.4) All CCTV Inspection shall be performed by CCTV personnel who are trained and certified in the use of NASSCO's Pipeline Assessment and Certification Program (PACP)©.

10.7.3.9 Digital Video and Log Sheets Submittal Naming Convention

The Contractor shall submit all log sheets and digital video files for pre and post installation, together, the week immediately following completion of each work segment. All digital video and log sheets must be submitted electronically, *on a USB Plug and Play device (flash drive or hard drive)*. *Video shall be in MP4 format and logs shall be in .pdf format* All video and logs shall be submitted utilizing the following naming convention:

- a. Video Files and Log Sheets
 - i. Named using the following items sequentially, followed by a space

1. City of Denver Contract Number
2. Line Number From Plans
3. GIS Facility ID From Plans (for each line segment.)
4. Type Of File ('Pre' or 'Post' for Video, 'Pre Log' or 'Post Log' for applicable log sheets)
5. Extension of file (.mp4 or .pdf)

ii. Examples:

1. 2012XXXXX Line72 31814SAGM Post Log.pdf
2. 2012XXXXX Line72 31814SAGM Post.mp4
3. 2012XXXXX Line72 31814SAGM Pre Log.pdf
4. 2012XXXXX Line72 31814SAGM Pre.mp4
5. 2012XXXXX Line73 31825SAGM Post Log.pdf
6. 2012XXXXX Line73 31825SAGM Post.mp4

10.7.4 Materials

10.7.4.1 Textile Tube

1. The tube shall meet the requirements of ASTM F1216 or F1743 and ASTM D5813 Sections 6 and 8. The finished CIPP shall be fabricated from materials which when cured will be chemically resistant to withstand internal exposure to all types of sewage being conveyed. The textile tube shall be continuous in length for the associated run. The wet-out textile tube shall meet ASTM F1216 or F1743, as applicable, have sufficient strength to bridge missing pipe segments and have a uniform thickness that when compressed at installation pressure will equal the specified nominal tube thickness, with a -5% manufacturing tolerance allowed. The tube shall be fabricated to a size that when installed will tightly fit the internal circumference and length of the original pipe. Allowance should be made for circumferential stretching during installation. The minimum length shall be that deemed necessary by the Contractor to effectively span the distance between respective access points, unless otherwise specified. It is the Contractor's responsibility to verify the CIPP lengths and diameters in the field before fabricating the tube.
2. Prior to installation the outside layer of the tube shall be coated with a translucent plastic coated flexible material that clearly allows inspection of the resin impregnation, or wet-out procedure. The plastic coating shall not be subject to delamination after curing of the CIPP. The tube shall be homogenous across the entire wall thickness containing no intermediate or encapsulated elastomeric layers. No materials shall be included in the tubes that are subject to delamination from the cured CIPP.
3. The wall color of the interior pipe surface of the CIPP after installation shall be notably colored as seen in the field install to insure that the resin has been fully impregnated so that a clear and detailed examination with closed circuit television inspection equipment may be made.

- The wet-out textile tube shall meet ASTM F1216 or F1743, as applicable, shall have a uniform thickness and 5% to 10% excess resin distribution that when compressed at installation pressures will meet or exceed the design thickness after the cure.

10.7.4.2 Resin

- The resin/liner system shall conform to ASTM D2990 and ASTM D5813 Section 8.2.2 – 10,000-hour test.
- The resin shall be a general purpose, unsaturated, styrene-based, thermoset resin and catalyst system or epoxy resin and hardener that are compatible with the inversion or pulled in place process as per the requirements of ASTM F1216 or F1743. The resin shall be tinted so that adequate saturation can be readily observed. Only resin with a minimum long term (50 years) Modulus of Elasticity of 48% of the initial Modulus of Elasticity will be accepted.
- The tube shall be impregnated with sufficient amount of resin to insure that the resin will be observed on the outer surface of the tube when squeezed. After the tube is cured, it shall show satisfactory evidence of a fully impregnated tube or the existence of excess resin on the outer surface.

10.7.4.3 Calibration Hose

If a calibration hose is required to be used during the process of the installation of the CIPP, the hose shall be wet and vacuum impregnated with sufficient amount of resin prior to inversion to prevent delamination after the curing of the CIPP. Delaminating or failure of the calibration hose will be cause for rejection or complete removal of the CIPP section at the discretion of the Construction Project Manager.

10.7.4.4 Structural Requirements

- The CIPP shall be designed as per ASTM F1216, Appendix X.1. The CIPP design shall assume no bonding to the original pipe wall, a fully deteriorated condition, 5% ovality and a conservative groundwater presence over the pipeline. The CIPP cured thickness must meet the required minimum cured nominal thicknesses specified in the table below, or for pipe larger than 18-inches in diameter as specified within the Contract Documents.

Internal Pipe Diameter (inches)	CIPP Minimum Cured Nominal Thickness (mm) Based on Modulus of Elasticity Values	
	Modulus of Elasticity (E) 250,000 psi	Modulus of Elasticity (E) 400,000 psi
8	6	5
10	7.5	6
12	9	7.5
15	10.5	9
18	12.5	10.5
For pipe larger than 18-inches in diameter, the CIPP minimum nominal thickness is specified within the Contract Documents		

2. The layers of the cured CIPP shall be uniformly bonded. It shall not be possible to separate any two layers with a probe or point of a knife blade so that the layers separate cleanly or the probe or knife blade moves freely between the layers; nor shall separation of the layers occur during the required testing.
3. The cured pipe material (CIPP) shall conform to the minimum structural standards, as listed below:

Flexural Stress	ASTM D790	4,500 psi
Modulus of Elasticity	ASTM D790	250,000 or 400,000 psi
Tensile Strength	Pressure Pipe - ASTM D638	3,000 psi

Either of the listed Modulus of Elasticity values noted may be used as long as minimum nominal thicknesses are adhered to in accordance with the table or as noted within the Contract Documents.

10.7.5 Quality Control

It shall be the contractor’s responsibility to ensure that the CIPP installed on the project meets all requirements of the Contract Documents and that the final product provided to the City meets all of the City and County of Denver Specifications and is of the highest quality possible.

10.7.5.1 Testing

In the event that the results of any tests do not meet the requirements of the Contract Documents and/or referenced ASTM standards, the Contractor may proceed with the work at his/her own risk and will be required to submit to the Construction Project Manager the proposed changes in the process to meet the required properties of the CIPP.

If any lined pipe segment fails to meet the required properties, the Contractor's attention is directed to General Condition 304 – “Substituted Performance”. At the discretion of the Construction Project Manager and at the Contractor’s own expense, the Contractor will be required to remove and replace any lined pipe segment, without damaging the host pipe, or install another liner inside of the liner that failed in order to meet the specified requirements of the Contract Documents

The City may elect at any time to decrease or increase the frequency of these sample and testing requirements.

10.7.5.1.1 On-Site Thickness Testing

A minimum of 2 (two) samples will be collected or 2 locations tested using ultrasonic methods, for on-site thickness at each installation by the contractor. All samples collected for testing shall be restrained with equivalent diameter pipe to match the actual field installed liner. A minimum of eight measurements at evenly spaced intervals around the circumference (internal or external based on method) of the pipe will be made to ensure that

minimum and maximum thicknesses have been achieved. For pipe diameters fifteen inches or greater, a minimum of sixteen evenly spaced measurements shall be recorded. Any plastic coatings or CIPP layers not included in the structural design of the CIPP must be deducted from the measured thickness value. The average thickness will be calculated using all measured values and shall meet or exceed the minimum required design thickness. Additionally, the minimum wall thickness measured at any one point around the circumference shall not be less than 87.5% of the specified design thickness as specified within the Contract Documents.

The wall thickness will be measured in accordance with the applicable sections of ASTM D2122 or ASTM E797 and shall incorporate the following, as applicable:

1. For onsite samples collected for testing: A cylindrical anvil tubing micrometer accurate to +0.02 mm (+0.001 inch) will be used. The minimum wall thickness tests will be performed by the Construction Project Manager (or assigned field representative) from the two samples at each installation. All costs associated with providing the required samples shall be borne by the Contractor.
2. For onsite testing using Ultrasonic methods: Testing will be performed by the ultrasonic pulse echo method, in accordance to ASTM E797. Measurements will be taken and calculated at both ends of the pipe run, around the internal circumference of the installed CIPP and at a distance of 12 to 18 inches from the end of pipe, as noted in item 1 above. The ultrasonic method will utilize a flaw detector with A-scan display and a direct thickness readout as defined in 6.1.2 of ASTM E797. A calibration block shall be manufactured from the identical materials used in the installed CIPP to calibrate sound velocity through the liner. Calibration of the transducer shall be performed daily in accordance with the equipment manufacturer's recommendations.

If the deviation in thickness of any one sample is less than 5% (five percent), no payment adjustment will be required. If the deviation in thickness is measured to be between 5%-10% (five percent and ten percent) an adjustment of 10% (ten percent) reduction of the liner unit bid cost will be applied. If the deviation in thickness is greater than 10% (ten percent), the entire run will be rejected and removed and replaced solely at the Contractor's expense.

10.7.5.1.2 Allowable Pulling Force

Prior to installation, the Contractor shall submit to the Construction Project Manager the maximum allowable force, per the material manufacturer, that can be used in pulling the tube into the pipe without rupturing or diminishing the diameter and/or the thickness of the tube. Such pulling force shall be monitored at all times during the installation operation with a gauge that is available for viewing by the City and the tube shall be rejected and removed if the allowable pulling force is exceeded.

10.7.5.1.3 Allowable Elongation of Flexible Tube

Prior to installation, the flexible tube shall be measured and marked equal to the installation run (distance between manholes less one manhole diameter). After the completion of installation, the length of the flexible tube outside of the installation run (face of the manhole to the mark) shall be measured. This length or elongation shall not exceed

3% (three percent) of the original length of measured flexible tube. In the event that this length is exceeded, the entire run length may be rejected and permanently discarded, the Construction Project Manager may order an additional tube to be inserted at no cost to the City, or may accept the elongated tube, but reduce the price paid for the work by 5% (five percent) for every percent elongation above the 3% (three percent) allowable tolerance, as provided by General Condition 304, Substituted Performance. Acceptance will be at the sole discretion of the Construction Project Manager.

10.7.5.1.4 Laboratory Testing

At the start of construction, at least two restrained CIPP field samples will be taken and submitted for laboratory testing. CIPP samples shall be prepared and tested in accordance with ASTM F1216. These samples will be taken by the approved independent lab, with chain of custody documentation regarding each sample.

A CIPP sample is required to be prepared for each installation segment, using one of the following two methods (depending on the size of the host pipe):

1. For pipe sizes of 18 inches or less: the sample will be cut from a section of cured CIPP at an intermediate manhole or at the termination point. If the sample is taken at a termination point the CIPP must have been inverted through a restrained, like diameter pipe which has been held in place by a suitable heat sink, such as sandbags.
2. For pipe sizes greater than 18 inches and areas with limited access: the sample must be fabricated from material taken from the tube and the resin/catalyst system used. This fabricated sample must be cured in a clamped mold which is placed in the down tube (when curing using circulating hot water) or in the silencer (when curing using steam). If approved by the Construction Project Manager, this method can be used for preparing a test sample on any size of CIPP in situations where preparing samples in accordance with section F1216-09, sec. 8.1.1 is not possible due to physical constraints.

Samples must identify the City contract number, project name, line number, date sample was taken and the specified thickness requirement. Testing for cured liner thickness, modulus of elasticity, flexural stress and tensile strength shall be performed by a Certified Independent laboratory approved by the Construction Project Manager. Test results are to be submitted to the Construction Project Manager and all costs of tests shall be included in the related bid price unless specified elsewhere in the Contract Documents. The Contractor shall take samples from the first week's installation and have the short term tests completed and results to the Construction Project Manager prior to application for the first pay estimate. Additional testing will commence at intervals required by the Construction Project Manager.

Additional laboratory testing, at the City's expense, may be requested as frequently as every CIPP installation, at the discretion of the Construction Project Manager. The Contractor will be reimbursed for additional testing at the Contract unit bid price. At the option of the Construction Project Manager any sample taken by the Contractor may be sent to an independent laboratory for similar testing.

10.7.5.1.5 Infiltration Test

If the ground water level is above the top of the pipe throughout the length being reconstructed, the Construction Project Manager, at his/her discretion, may order that an infiltration test be performed. The maximum allowable infiltration shall be 50 gal per day/inch dia/mile (.95 gpd/inch/100 ft.). If the infiltration is found to exceed the prescribed amount, the Contractor shall make the appropriate repairs as approved by the Construction Project Manager. Additional infiltration tests will be performed until acceptable results are obtained.

Unless otherwise specified, infiltration will be measured by a subcontractor specializing in CIPP testing who is mutually agreed upon by the City and Contractor. Payment for this testing is at the City's expense and will be handled by change order.

10.7.5.1.6 Exfiltration Test

In the absence of ground water, the Construction Project Manager, at his/her discretion, may order an exfiltration test be performed in accordance with these specifications. The allowable rate of exfiltration shall be equal to the limits of infiltration stated above. Each section of CIPP will be tested between successive manholes by closing the lower end of a sewer and the upper manhole(s) to the proper level with water. The water level in the upper manhole shall be a minimum of 4 feet above the level of the ground water.

For the purposes of exfiltration leakage, manholes shall be considered to be equivalent length of pipe equal to the diameter of the manhole (i.e. 48, 60 or 72 inch diameter). Air pocket entrapment shall be avoided when filling the line with water. Once filled with water, the system shall be allowed to stabilize for a period of two hours before starting the test. Exfiltration leakage rate is determined by measuring the amount of water required to maintain a constant level in the upper manhole. Test duration is to be no less than two hours.

If the leakage, as shown by the test, exceeds the allowable value, the Contractor shall make the necessary correction at his expense to reduce the exfiltration to within the permissible limits. The Contractor shall furnish all water, material and labor required to perform the test. All tests shall be made in the presence of the Construction Project Manager.

10.7.6 Public Information and Notification

All written notices shall be issued on current City and County of Denver letterhead templates, prepared in a professional manner and must be approved by the Construction Project Manager prior to distribution. All contact with the Public shall be executed in a business professional manner, including adhering to professional standards regarding courtesy, grooming and maintaining visible/legible photo identification.

1. The Public Information and Notification program shall at a minimum, require the Contractor to be responsible for contacting each home or business affected by the sewer construction and informing them of the work to be done in all of the following ways: Written notice shall be delivered a minimum of 48 hours in advance of the Pre-clean and Video; and again on the day of installation, to each home or business describing the work, schedule, how the construction affects them, and a local

- telephone number of the Contractor they can call to discuss the project or any problems that may arise.
2. Personally contacting each home and business owner on the day of pre-installation inspection of the sewer and coordinating with that owner the verification of their existing service connection. If the owner is unavailable, other arrangements shall be made for existing service connection verification.
 3. In the event that a written notice cannot be left at the home or business, the contractor shall personally contacting each home or business owner the day prior to beginning work on the section of sewer to which they are connected.
 4. Personally contacting any home or business owner which cannot be reconnected within the time stated in the Written Notice. Anticipated service tap reconnection time shall be noted within another notice.
 5. Provide written notice with the time of reactivation posted on the front door of a residence or business.
 6. Upon request by residents and businesses affected by the work, portable toilets shall be furnished and serviced by the Contractor. Reimbursement for the costs of these items will be covered through change order with the Construction Project Manager.
 7. Businesses which require special accommodations, such as night or weekend work, must be identified at least 10 days prior to the proposed scheduled work. The Construction Project manager shall be notified and kept apprised of the coordination to meet these special accommodations.

10.7.7 Installation

10.7.7.1 Access Points

The City has shown all existing manhole access points on the Contract Documents, to the best of its knowledge. It is the Contractor's responsibility to fully examine the project site to verify the location of existing manholes and to determine if all manholes are accessible, as necessary for completion of the work. It will be the Contractor's responsibility to notify the Construction Project Manager far enough in advance of the CIPP lining process to allow time for the City to make necessary repairs and provide access to the manholes that are not accessible. The Contractor will reschedule the work as needed so that repair work, either by the City or by the Contractor, can be completed.

10.7.7.2 Pre-Installation Inspection

Inspections of pipelines shall be performed by experienced personnel trained in locating and identifying defects, breaks, obstacles, and service connections by closed circuit television. Certification by NASSCO, PACP program is preferred for inspection personnel. The pre-inspection of pipelines shall also determine active service connections, the addresses served (both visible on the digital recording and audible), as well as which service

connections are opened, capped or misaligned. Only active service connection and laterals shall be re-established unless directed otherwise by the Construction Project Manager.

The interior of the pipeline shall be carefully inspected to determine the location of any conditions which may prevent proper installation of the CIPP. It is the Contractor's responsibility to notify the Construction Project Manager of any conditions which may prevent proper installation of the CIPP. These types of conditions shall be recorded and submitted digitally, as described elsewhere in these specifications, to the Construction Project Manager within 5-calendar days of observance, to allow for remedial action and rescheduling of installation for that section of CIPP.

10.7.7.3 Bypassing Sewage

The Contractor shall provide for the flow of sewage around the section or sections of pipe designated for reconstruction. All costs incurred for bypass pumping are included within the "Cured-In-Place-Pipe" bid item within the contract, except when otherwise noted. The bypass shall be made by plugging the line at an existing upstream manhole or adjacent system. The pump and bypass lines shall be of adequate capacity and size to handle the flow with backup pumps onsite. Bypass pumps must be monitored at all times. Leaking equipment will not be permitted. Bypass pumping must be provided for all mainline and service line flows affected by construction. Wastewater shall not be allowed to spill into storm drains, street gutters, or open excavations. Any spills that occur must be addressed immediately and in full conformance with local regulations and requirements. The Construction Project Manager shall be notified immediately and the Contractor shall bear all costs associated with any spills.

10.7.7.4 Cleaning of the Sewer Line

The Contractor shall be required to remove all existing internal debris from the sewer line with the use of water jet, and/or grinding equipment that is accepted by the Construction Project Manager. The cleaning operation shall remove any and all existing debris so that each pipe joint can be thoroughly inspected and successfully reconstructed or rehabilitated. Excessively hard deposits that cannot be removed by regular cleaning equipment or grinding which require special tools to remove will be paid for negotiated separately by the City.

All sludge, dirt, sand, rocks, grease, and all other solid or semi-solid material resulting from the cleaning operation shall be removed at the downstream manhole of the section being cleaned. Passing material from one manhole section to another shall not be permitted.

All such debris resulting from cleaning operations shall be removed from the site and disposed of in a proper manner. The Contractor shall bear all costs associated with testing of debris and proper dumping. Dumping of the debris shall be in accordance with all local, state, and federal regulations. The City will negotiate for costs associated with material disposal if Hazardous Wastes are encountered during testing.

At the end of each work day, all debris shall be removed from the downstream manhole and from the construction site. No debris shall be left at the construction site unattended by the Contractor. Under no circumstances will the Contractor be allowed to accumulate

debris beyond the stated time limit. In the event the Contractor leaves debris unattended at the construction site beyond the stated time, the Contractor will not be allowed to proceed with the work until the debris is properly removed.

During all sewer cleaning operations, precautions shall be taken to protect the sewer lines from damage that might be inflicted by improper use of cleaning equipment. Precautions shall be taken to ensure that the cleaning operation will not cause any damage or flooding to public and/or private property being served by the sewer line section involved. The Contractor shall bear all costs associated with flooding, damage to basements or structures, adjacent utilities and the City's sewer.

10.7.7.5 Line Obstructions

It shall be the responsibility of the Contractor to clear the line of obstructions such as solids and roots that will prevent the installation of the CIPP. If the pre-installation inspection reveals an obstruction such as a protruding service connection, dropped joint, collapse or obstruction that will prevent the rehabilitation process and cannot be removed by conventional sewer cleaning equipment, grinding or extended tap cutting, then the Contractor shall notify the Construction Project Manager immediately. These conditions shall be recorded and a digital video file and log sheet must be submitted to the Construction Project Manager so that the existing conditions are documented and may be reviewed to determine the extent of repair required prior to CIPP installation. The Construction Project Manager will notify the Contractor upon completion of required repair(s), at which time the Contractor shall perform sewer line cleaning and a pre-installation inspection prior to CIPP installation.

10.7.7.6 Methods

All bidders proposing to use the CIPP process for a project must use a method that has been approved by the City prior to bid opening. All approved CIPP methods must meet these Standard Construction Specifications. Any proposed deviation from these Standard Construction Specifications must be submitted in writing for acceptance at least eight calendar days prior to the bid opening. CIPP installation shall be in accordance with ASTM F1216, Section 7 for the Inversion Method, or Section 6 of ASTM F1743 for the Pulled-In-Place Installation Method, with the following requirements:

1. The Contractor shall designate a location where the tube will be impregnated prior to installation. The Contractor shall notify the Construction Project Manager of proposed "wet-outs" in order to inspect the materials and procedure. A resin and catalyst system compatible with the requirements of this method shall be used.
2. Once inversion has started, the pressure shall be maintained between the minimum and maximum pressures, as set by the liner's manufacturer, until cure completion. A continuous, constant pressure must be maintained for all air inversion steam cure (AISC) installations. If pressure is lost at any time during installation/cure (for inversion or pulled in place methods), the City may request that the CIPP product be removed and the line segment re-inspected, at the contractor's expense, prior to allowing re-installation and curing.

3. The Contractor shall pull or invert the flexible tube through the existing sewer line in a method which has been reviewed and approved by the Construction Project Manager. The Contractor will not be allowed to use water to float the inserted flexible tube into the existing sewer line. Immediately after installation of the tube, a heat source will be applied to start the curing process. Constant pressure shall be maintained until the tube has completely cured out with continuous monitoring of the confined space during the curing procedure to ensure that the LEL is not exceeded.
4. The heat source shall be fitted with suitable monitors to gauge the temperature of the incoming and outgoing heat supply. Another such gauge shall be placed at the remote manhole to determine the temperature at that location during cure. The Contractor must maintain an on-site written log during the CIPP curing process for each installation, tracking temperature, pressure (for steam cure) and curing time. This log must be available for review at any time by the Construction Project Manager. If air pressure and steam are used, a Safety Gas Detector shall be used to ensure that it does not reach the explosive limit.
5. As noted within the submittals portion of this specification, before the installation process begins, the Contractor shall submit to the Construction Project Manager, the minimum pressure required to hold the tube tight against the existing conduit (including considerations for external ground water pressure, if present) and the maximum allowable pressure to avoid damaging the tube. This data shall be obtained by the Contractor from the tube manufacturer.

If the CIPP is installed via inversion, the pressure shall be maintained between the minimum and maximum pressures until the entire operation has been completed (inversion and cure). If the CIPP is installed using the pulled-in-place method, the pressures shall be maintained, after initial inflation, between the minimum and maximum pressures until the entire operation has been completed (inflation and cure).

If the pressure drops below the recommended minimum at any time during installation or curing of the CIPP, the liner should be removed and the host pipe re-inspected for dislodged pipe fragments or fallen debris which may cause bulging or protrusions within the cured CIPP. In addition, under the above circumstances, the CIPP product should be inspected for lifts or delaminations and evaluated for its ability to fully meet the applicable ASTM F1216 and F1743 requirements. Should the pressure deviate from within the range of minimum and maximum pressures, the installed tube may be rejected and the Contractor will be responsible for the removal of the CIPP without damage to the host pipe and replacement with new CIPP at no additional cost to the City.

Once the cure has started and dimpling for laterals is completed, the required pressures shall be sustained until the cure has been completed. A complete log of the pressures shall be maintained on the site and furnished to the Construction Project Manager after each installation.

6. The plastic coating of the tube shall be translucent to allow visual proof that the resin has wet out the entire tube and that there are no dry areas.

7. The Contractor shall maintain a log on site for each installation section documenting elongation, thickness and pulling force. These logs shall be submitted weekly to the Construction Project Manager.
8. The finished CIPP shall be continuous over the entire length of an installation run between two manholes and be free, as commercially practicable, from visual defects such as foreign inclusions, dry spots, pinholes, folds and delamination.
9. If the CIPP fails to make a tight seal at each manhole, the Contractor shall apply Hydrophilic Seals. The Contractor shall provide a submittal to the Construction Project Manager for approval on either a gasket or a non cementitious (epoxy) grout.
10. Individual installation runs can be made over one or more manhole sections as determined in the field by the Contractor. The maximum allowed installation run is 1,200 feet. Intermediate manholes will be reopened as directed by the Construction Project Manager.

10.7.7.7 Sewer Service Connection and Reactivation

The Contractor shall determine if a service connection is active prior to rehabilitation of the sewer. Only active service connections and laterals shall be re-established. All costs incurred to verify active service connections are included within the "Cured-In-Place-Pipe" bid item within the contract. No additional payment for verification shall be considered.

After the curing of the CIPP has been completed, the Contractor shall reopen and restore the existing active service connections and branch connections. It is the intent of these Standard Construction Specifications that the active service connections and branch connections be reopened without excavation. When the pipe size is too small to facilitate direct manned reactivation, a remotely controlled cutting device, monitored by a close circuit television camera shall be used. The cutting device is required to re-establish service connections to not greater than 100% (one hundred percent) capacity, and not less than 95% (ninety five percent) capacity, while conforming to the shape of the existing opening. A smooth, or brushed, surface is required to prevent debris or solids from accumulating at the opening. Perforated services connections will be considered damaged and will need to be repaired. The Contractor shall be responsible for completing point repairs of any active service connections that are damaged or misaligned during reactivation procedures. These point repairs shall be completed as directed and approved by the Construction Project Manager and all costs shall be borne by the Contractor.

The Contractor shall certify he/she has a minimum of 2 (two) complete working cutting devices, plus spare key components on the site before each installation.

All solid or semi-solid material resulting from reactivation of the service connection or manhole cut outs shall be removed at the downstream manhole of the section being reactivated. Passing material from one manhole section to another shall not be permitted.

Service connections shall not remain out of service for more than 12 hours at a time, without the Contractor providing some means of temporary facilities or hotel accommodations for the affected residents or property owners.

10.7.8 Post Installation Inspection

Post installation video inspection of all CIPP line segments shall be completed by the contractor and recorded using closed circuit television in accordance with ASTM F1216 or F1743. The post inspection of pipelines shall be performed in a manner which allows the invert to be clearly viewed and inspected (i.e. no water flow). The recorded video must show that all active service connections have been reactivated, the addresses served (both visible on the digital recording and audible), as well as any inclusions or visual defects present. All service connections and laterals which are not plugged or capped shall be re-established unless directed otherwise by the Construction Project Manager. The contractor shall review all post inspection videos and notify the City immediately of any visual defects, inclusions, or issues with the installation. Digital video records shall be submitted, as specified elsewhere in these standards.

10.7.9 Clean-Up

The Contractor shall reinstate all project areas affected by their operations to an equal or better condition than existing upon completion of the CIPP installation. All restoration must be completed prior to submitting that section of CIPP for consideration for payment.

10.7.10 Record Documentation

1. Digital Video and Log Sheets

The Contractor is required to provide pre and post video files, as well as associated log sheets, for all pipe segments rehabilitated under the contract. All video and log sheets must be submitted to the City and County of Denver. All digital video files shall be submitted in .mp4 format and log sheets shall be submitted in .pdf format. All files will be labeled in accordance with the instructions provided by the Construction Project Manager.

Pre and post inspection log sheets and digital video should be submitted together the week immediately following completion of each work segment, unless the contractor is submitting pre-inspection results separately to convey potential problem areas to the Construction Project Manager. Log sheets and digital video files not submitted at least 5 business days prior to a pay estimate cut-off date will not be considered for payment until the following month. It is the Contractor's responsibility to submit digital video media and log sheets in a timely fashion and as outlined in these specifications.

2. Redline Drawings

A final set of red-lined drawings shall be submitted by the Contractor on a clean, full size set of project plans for As-Built creation purposes prior to processing final

payment and releasing remaining retainage. A .pdf copy of a clean set of project plans may be obtained from the Construction Project Manager upon request.

The red-lined drawings shall include the following: location and size of all pipe segments rehabilitated, the location of all restored service connections (showing distances from the downstream manhole), and the field recorded length of each rehabilitated segment (face of manhole to face of manhole). Providing inaccurate or incomplete record information is reason for withholding of progress payment as outlined in the General Contract Conditions.

10.7.11 Patents

The Contractor and the Contractor's suppliers shall warrant and save harmless the City against any and all claims, potential litigation involving patent infringement, copyright violations and any loss thereof.

End of Specification



CITY AND COUNTY OF DENVER
ENGINEERING DIVISION

Wastewater Capital Projects Management Standard Construction Specification

10.20 Pipe Bursting

10.20.1 Intent

It is the intent of this specification to provide for the replacement of existing pipelines and conduits by bursting or crushing the existing pipeline and replacing it with either the same size or larger diameter pipe.

10.20.2 Methods

All bidders on this project must construct the Trenchless Replacement of Sanitary Sewers with a process that has been approved by Wastewater Capital Projects Management prior to bid opening.

All approved methods must meet these Standard Construction Specifications. Any proposed deviation from these Standard Construction Specifications must be submitted in writing for acceptance at least ten (10) calendar days prior to the bid opening. Any and all departures from these Standard Construction Specifications must be pointed out and shown on the material submitted.

Special Condition SC-8, **Substitution** of these Specifications refer to substitution of processes other than herein approved.

10.20.3 Inspection of Pipelines

Inspections of pipelines shall be performed by experienced personnel trained in locating breaks, obstacles, and service conditions by closed circuit television. The inspection of pipelines is also to determine active service connections and the addresses which they serve. A videotape and suitable log shall be kept for later reference by Wastewater Capital Projects Management.

10.20.4 Public Relations

The Public Information and Notification program shall as a minimum require the Contractor to be responsible for contacting each home or business connected to the sanitary sewer and informing them of the work to be done, and when the sewer will be off-line and the following:

10.20.4.a

Written notice to be delivered to each home or business describing work, schedule, how it affects them, and a local telephone number of the Contractor they can call to discuss the project or problems.

10.20.4.b

Personal contact on the day of pre-installation inspection of the sewer. Each lateral shall be verified by having the homeowner run water down their drain. If the homeowner is unavailable, other arrangements shall be made to drain water through the lateral.

10.20.4.c

Personal contact and written notice the day prior to beginning work on the section of sewer to which they are connected.

10.20.4.d

Personal contact with any home or business which cannot be reconnected within the time stated in the written notice.

10.20.4.e

If so required by a served business, portable toilets for their use by their employees will be furnished and serviced by the Contractor. The costs of these items are considered to be included in the cost of CIPP. No additional payment will be made by the City.

10.20.4.f

The Public Information and Notification Program shall include the minimum of the above. A complete program shall be submitted in writing to the Construction Project Manager.

10.20.5 Approved Material for Trenchless Replacement of Sanitary Sewers

10.20.5.a Materials

High Density Polyethylene Pipe (HDPE) shall conform to requirements of Type III, Class C, Category 5, Grade P34 as defined in the latest revision of ASTM D-1248. All solid wall HDPE pipe and fittings shall be manufactured in accordance with ASTM F-714. Pipe and fittings shall be made from virgin high density plastic compounds, with no rework compound except that obtained from the manufacturer's own production of the same formulation, which comply with the requirements for a minimum cell classification of PE 345434C as defined by ASTM D-3350. HDPE pipe shall have an inside surface in light color (e.g. natural, white, green, etc.) to allow light reflection for television inspection.

10.10.5.b Physical Properties

Pipes, fittings and joints shall meet the following minimum requirements at the time of installation:

Density	0.941 gm/cc	ASTM D-1505
Melt Index	< 0.15 gm/10 min.	ASTM D-1238
Initial Flexural Modulus	110,000 psi	ASTM D-790
Long-Term Flexural Modulus	28,200 psi	Continuous load duration of 50 years at design load conditions, certified by manufacturer.
Initial Flexural Strength	3,000 psi	ASTM D-790
Long-Term Flexure Strength	1,500 psi	Continuous load duration of 50 years at design load conditions, certified by manufacturer.
Environmental Stress Cracking Resistance	F20=192	ASTM D-1693, Test Condition C (failure % = hours).
Hydrostatic Design Basis	1,600 psi	ASTM D-2837
Color & Ultraviolet Stabilizer	Black, with 2% carbon black	ASTM D-3350

Certification

Manufacturer shall provide certification that the pipe and fittings meet the minimum specified physical properties, and has sufficient ultraviolet stabilizer for a minimum two (2) years storage life.

Workmanship

The pipe and fittings shall be homogeneous throughout and free of any blemishes, wrinkles, ribs, protrusions, holes, visible cracks, foreign materials, blisters or other deleterious faults or any defects.

10.20.5.c Joints

Sections of HDPE pipe shall be assembled and joined on the job site. Jointing shall be accomplished by the heating and butt-fusion method in strict conformance with the manufacturer's printed instructions. It is the sole responsibility of the Contractor to provide an acceptable water-tight butt-fusion joint. Joint strength shall be equal to or greater than the pipe and shall indicate a ductile rather than brittle fracture when tested. If sectional HDPE pipe is used, it shall be joined in accordance with the manufacturer's recommendation for a leakproof, stab joint method using EPDM O-ring synthetic elastomer gaskets.

Where excavations for HDPE pipe installation are made between manholes, pipe ends shall be jointed by butt-fusion joints, or when recommended by the pipe supplier, with a full circle seal clamp made of stainless steel hardware and a rubber sleeve. Seal clamps shall be manufactured by Rockwell, Dresser, or approved equal. The minimum clamp length shall be fifteen inches (15”).

10.20.5.d Saddles

Reconnection of service laterals to installed HDPE pipe shall be accomplished using heat fusion saddles. Heat fusion saddles shall be made of polyethylene pipe that meets the minimum specified physical properties and is suitable for fusion welding. Fusion saddles shall be Branch Saddle as manufactured by Driscopipe®, Miller®, Dupont®, or approved equal.

10.20.5.e Flexible Couplings

Connections to existing service laterals shall be made using flexible couplings. All flexible couplings shall conform to ASTM C-425 and shall be as manufactured by Fernco® Joint Sealer Co., DFW® Plastics, Inc., or approved equal.

10.20.5.f Restrained Joint Polyvinyl Chloride (PVC) Pressure Pipe

10.20.5.g Material

Restrained Joint PVC Pressure Pipe shall conform to the requirements of the latest revision of ASTM D-2241. All restrained joint PVC pipe and fittings shall be manufactured from a specially formulated PVC compound which contains impact modifiers and ultraviolet inhibitors. In accordance with ASTM D-1784, all pipe and fittings shall be made from a compound utilizing Type 1, Grade 1, 2000 psi hydrostatic design stress material, Class 12454-B.

10.20.5.h Physical Properties

Pipe, fittings and joints shall meet the following minimum requirements at the time of installation:

Izod Impact	1.15 ft-lb./in. of notch	ASTM D-256
Tensile Strength	7,000 psi	ASTM D-638
Modulus of Elasticity	40,000 psi	ASTM D-638
Deflection Temperature	158° F	ASTM D-648
Chemical Resistance	B	ASTM D-543
Elongation	150%	ASTM D-638
Flammability	Self-Extinguishing	ASTM D-635

Certification

Manufacturer shall provide certification that the pipe and fittings meet the minimum specified physical properties.

Workmanship

The pipe and fittings shall be homogeneous throughout and free of any blemishes, wrinkles, ribs, protrusions, holes, visible cracks, foreign materials, blisters or other deleterious faults or any other defects.

10.20.5.i Joints

Sections of PVC pipe shall be assembled and permanently joined on the job site. Jointing shall be accomplished by use of machined grooves on the pipe and in the joining coupling which, when aligned, allow a spline to be inserted, resulting in a fully circumferential restrained joint that locks the pipe and couplings together. A flexible elastomeric seal (O-ring) in the coupling provides a hydraulic pressure seal.

Joints shall meet the requirements of ASTM D-3139, and the O-rings shall meet the requirements of ASTM F-477. Couplings shall be provided with factory installed O-rings.

10.20.6 Bypassing Sewage

The Contractor shall provide for the flow of sewage around the section or sections of pipe designated for reconstruction. The bypass shall be made by plugging the line at an existing upstream manhole or adjacent system. The pump and bypass lines shall be of adequate capacity and size to handle the flow. Bypassing includes all mainline and service line bypassing required. Wastewater shall not be allowed to spill into storm drains, street gutters, or open excavations. Any spills that occur must be taken care of properly and immediately. The City shall be notified immediately and the Contractor shall bear all costs associated with any spills.

10.20.7 Service Connections

After the trenchless replacement of the pipe has been completed, the Contractor shall reopen / restore the existing active service connections and branch connections. No service connection shall remain out of service for more than twenty-four (24) hours at a time without the Contractor providing some means of temporary facilities or hotel accommodations for the residents.

No additional payment will be made for excavations for the purpose of reopening connections and the Contractor will be responsible for all costs and liability associated with such excavation and restoration work.

10.20.8 Reports

The Contractor will provide the Construction Project Manager with a color videotape. The tape will include both the before and after conditions, and restored connections with addresses each connection serves, in audio, and on the videotape. Copies of all certified reports and logs off all tests and inspections conducted shall be submitted to the Construction Project Manager.

10.20.9 Clean-up

Upon acceptance of the installation work and testing, the Contractor shall reinstate the project area affected by this operation.

10.20.10 Payment

Payment for work included in this section will be in accordance with the prices set forth in the proposal for the quantity of work performed. Progress payments will be made monthly based on the work performed during that period.

10.20.11 Patents

The Contractor and the Contractor's supplier shall warrant and save harmless the City and Wastewater Management Division against any and all claims and potential litigation involving patent infringement and copyright violations and any loss thereof.

End of Specification



CITY AND COUNTY OF DENVER
ENGINEERING DIVISION

Wastewater Capital Projects Management Standard Construction Specification

11.0 Structures and Appurtenances

11.0.1 General

Except where otherwise indicated in these Standard Construction Specifications, manholes, special structures, box culverts, vaults, storm inlets, and other miscellaneous structures and appurtenances shall conform to the details included in these Specifications or as shown on the drawings. All concrete and reinforcing for structures shall conform to the requirements set forth in the most recent Standard Specifications for Road and Bridge Construction, by the Colorado Department of Transportation, as described below, or otherwise modified herein.

1. CDOT Section 601 Structural Concrete

CDOT Section 601 Structural Concrete shall be utilized and revised as follows:

Class D Concrete will be utilized for all structural concrete work; using $\frac{3}{4}$ " nominal sized aggregate (100% passing the 1" sieve and 90% to 100% passing the $\frac{3}{4}$ " sieve).

Type II Portland Cement will be used.

Subsection 601.05 shall be revised to include:

The concrete used in upper deck slabs shall have a maximum substitution of fly ash for Portland cement of 10% by weight.

CDOT Subsection 601.19 shall be revised as follows:

Method of measurement shall be deleted. Method utilized will be as specified elsewhere in the Contract Documents.

Subsection 601.20 shall be revised as follows:

Basis of payment will be deleted. Basis of payment utilized will be as specified elsewhere in the Contract Documents.

2. CDOT Section 602 Reinforcing Steel

CDOT Section 602 Reinforcing Steel shall be utilized and revised as follows:

Subsection 602.02 shall be revised as follows:

Epoxy coated reinforcing steel will not be utilized unless otherwise specified in the Contract Documents.

Subsection 602.07 shall be revised as follows:

Method of measurement will be deleted. Method utilized will be as included otherwise in the Contract Documents.

Subsection 602.08 shall be revised as follows:

Basis of payment will be deleted. Basis of payment will be as included otherwise in the Contract Documents.

2. Special Design

All special structures in the City and County of Denver that deviate from the standard details shall be submitted in writing, to the City Construction Project Manager. This includes items such as inlets, oversize structures, and/or precast vaults. If the Construction Project Manager will allow the special design a structural design is required by a Professional Engineer licensed in the state of Colorado. At a minimum the design loading and load factors shall comply with the following:

Live Load - AASHTO LRFD, HL-93 Tandem, and Colorado Permit Truck

Dead Load - vertical earth load = 120 lbs/cu.ft., horizontal earth load = 60 lbs/cu.ft.

Wearing Surface – 12 in. thick concrete pavement

Live Load Surcharge on Exterior Walls = 2 ft. of Earth (120 psf)

Load Factors - Latest edition of AASHTO Bridge Design Specifications

Environmental engineering durability factor (Sd) per ACI 350-06

11.0.2 Manholes

Except where otherwise specified or indicated on the drawings, storm and sanitary sewer manholes shall conform to the requirements as set forth below. Manholes 6' (six foot) in diameter or smaller shall be constructed of precast concrete or cast-in-place concrete as outlined in the Wastewater Management Division Standard Detail Drawings or within the Contract Documents. Type B and Type P manholes shall be cast in place only, unless specified otherwise in the contract documents. All manholes and related component items shall be designed for AASHTO HS20 loading.

11.0.2.1 Size

The minimum internal diameter of the manhole barrel shall be as follows for both storm and sanitary sewer installations (please refer to the Wastewater Management Division Standard Detail Drawings).

Pipe Size	MH Barrel I.D.	Standard Top Section	Standard Detail
30" dia. and smaller	4'-0"	Concentric Cone	S501.1
30" to 36"	5'-0"	Concentric Cone	S501.1
42" and larger	Type B or P or Special Detail	As detailed	S503 S504

Note: Standard ring and cover is 24 inch diameter.

11.0.2.2 Materials

The materials to be used in the construction of sewer manholes shall conform to the following requirements:

1. Precast Reinforced Concrete Manhole Sections

Precast manhole sections including barrels, cones, flat tops, etc. shall be manufactured in accordance with ASTM C-478, Precast Reinforced Concrete Manhole Sections. All cones furnished shall be concentric except for manholes with less than 4 feet of cover, which shall be flat top. Concrete used in precast manhole bases shall have a minimum 28 day compressive strength of 5000 psi, and shall be constructed of Type II, Portland cement. Welded wire fabric used in precast manhole sections shall be as specified in ASTM C-478. These precast manhole elements are intended to be utilized as components of non-pressurized sewer and manhole systems only. Pressure systems were warranted and authorized by the Division will require special design pressure manholes, joints, and other appurtenant items.

2. Cast-in-Place Concrete Manholes

All concrete used in construction of cast-in-place manholes and bases shall be CDOT Class D. Construction shall be in conformance with the Wastewater Management Division Standard Detail Drawings.

3. Structural Reinforcement

All structural reinforcement shall be placed in accordance with the Wastewater Management Division Standard Detail drawings and in conformance with this specification.

4. Frame and Cover

Unless otherwise noted on the drawings, frame and covers for manholes and special structures shall be the current Denver Standard pattern, manufactured by an approved foundry. Castings shall, at the minimum, meet the requirements of ASTM A48, Class 35B, and other Agency requirements as a condition of approval. Horizontal bearing surfaces of all rings and covers shall be machined to eliminate any rocking action or non-uniform bearing. Castings shall not be dipped or painted prior to field inspection and acceptance. Refer to the Wastewater Management Division Standard Detail Drawings for additional requirements.

5. Manhole Steps

Manhole steps shall be required for all new manholes greater than 4 feet in depth, from the rim to the top of the bench, unless otherwise specified within the Contract Documents.

6. Flexible Plastic Joint Sealing Compound

All joints in the manhole barrel, cone and/or flat top sections including the joint between the cast-in-place base and the bottom barrel section, shall be sealed with an approved preformed, flexible plastic gasket conforming to the following requirements:

- a. The flexible plastic gasket shall be in conformance with ASTM C-990-91, AASHTO M198-B, and ASTM C-990, latest versions.
- b. The plastic sealing compound shall be packaged in extruded pre-formed rope-like shapes of proper size to completely fill the joint when completely compressed, as per the pipe manufacturer's recommendations. The material shall be protected by a suitable, removable two-piece wrapper that may be removed as the compound is applied to the joint surface without disturbing the other wrapper, which remains attached to the compound for protection. The sealing compound shall be impermeable to water, have high immediate bonding strength to the concrete surface and shall maintain permanent plasticity, as well as resistance to water, acids, and alkalis inherent in sewer systems.
- c. All lifting holes shall be permanently and properly sealed with the plastic sealing compound or an approved concrete grout.

7. Adjustment

Grade rings shall be used to adjust and set final rim elevations, brick is not allowed. A 3-inch cast iron riser shall be used in conjunction with grade rings on all construction within streets. Cast iron shall conform to ASTM C62, Grade SW [AASHTO M114].

8. Mortar and Grout

Mortar and grout used in the shaping of inverts, grade ring gaps, setting and anchoring cast iron street fabrications, etc., shall consist of one part Type II Portland Cement and two parts of fine, clean sand. Only sufficient water shall be added to provide a stiff, workable cement mixture for proper troweling. Hydrate lime or masonry cement shall not be used. Where relatively thin portions of grout are to be applied to the flow channel, top of bench, etc., and approved epoxy bonding coat shall be applied to the exposed concrete surfaces prior to grouting.

11.0.2.3 Bases and Inverts

Except as otherwise shown on the drawings, manhole bases shall be constructed of cast-in-place or precast concrete, as shown in the Wastewater Management Division Standard Detail Drawings, and as otherwise described in these Standard Construction Specifications. Inverts may be cast separately, but shall be constructed of cast-in-place concrete. All concrete used for these applications shall meet the requirements set forth in section 11.0.2.2 of these Standard Construction Specifications.

1. Sanitary Sewer Manholes

Sanitary Sewer manholes are normally designed and constructed such that inverts of the influent and effluent sewers are at the same relative elevation with sufficient drop to compensate for pressure head losses occurring in the manhole. Therefore except for special cases, the bench around the flow channel shall be constructed to the outside top of the largest pipe in the manhole. The top of the bench shall be poured with a slope towards the flow channel with an overall cross slope not exceeding $\frac{1}{2}$ inch. Flow channels shall have smooth, rounded inverts shaped to match the lower half of the pipe. Proper shaping shall be accomplished by forming or shaping with a proper cement grout mixture. Changes in direction of flow through the manhole shall be made with a smooth continuously-curved channel utilizing the maximum radius possible. Changes in the size of channels, multiple flow channels, or changes in invert slopes, shall be made gradually and evenly, and shall be formed directly in the concrete.

- a. Outside Drops. Whenever specified on the Drawings, directed by the Construction Project Manager, or where the elevation difference between the incoming sewer inverts and the outgoing invert is 18 inches or greater, an outside drop shall be constructed. The diameter of the drop shall not be less than the diameter of the incoming sewer pipe to be dropped. A concrete encasement will be required around the drop pipe as shown and detailed within the Wastewater Management Division Standard Details, S-530.

Quantities and costs for the outside drop configuration shall be measured and paid for separately from the manhole unless otherwise specified.

2. Storm Sewer Manholes

Flow channels in storm sewer manholes shall be as shown in the Wastewater Management Division Standard Detail Drawings for the particular type of manhole base utilized. Except for special situations, and where specifically noted, outside manhole drops will not be required. All exposed channel edges and cut pipe edges shall be grouted smooth. The minimum thickness of the cast-in-place concrete at any point shall not be less than 6-inches. The construction of the manhole base and shaping of inverts, including all pipes within the dimensions of the manhole, will be considered to be incidental to the construction of the manhole and all costs shall be included in the unit price bid for the manhole structure.

11.0.2.4 Stub-Outs and Block-Outs

Block-outs are the preferred method of construction for future connections. These shall be constructed as specified within the Contract Documents.

Where stub-outs are specifically indicated on the drawings and where a specified pipe size for future connections is to be constructed, the pipe used for stubbing shall extend a nominal 2 feet beyond the outside of the manhole barrel, unless otherwise noted, and shall terminate with a bell end [or spigot end if applicable]. The pipe end shall be sealed with an approved, pre-fabricated plug or cap conforming to the joint detail of the pipe supplied. For

pipe greater than or equal to 30-inches in diameter, a full section of pipe shall be installed as the manhole stub. Shop drawings shall be submitted for approval.

The use of brick or concrete fill as a means of plugging will only be permitted on sewers that are to be abandoned. Unless otherwise stated in the contract documents, stub-outs and plugs or caps will be considered to be incidental to the construction of the associated manholes, and all costs incurred shall be included in the unit price bid for the manhole structure.

11.0.2.5 Flexible Booted Connections

Flexible watertight rubber boots for the jointing of any sewer pipe to any precast manhole base, barrel section, inlet box, or vault shall conform to the Specifications contained herein and to the Wastewater Management Division Standard Detail Drawings. Flexible connectors shall meet the requirements of ASTM C923.

- A separate submittal package specific to each pipe size and unique project scenario shall be required for approval by the Construction Project Manager prior to product procurement by the Contractor. At a minimum, this submittal shall include jacking force calculations (see 7.1.4), joint design, and a special pipe detail for each situation.

11.0.3 Structures

11.0.3.1 Concrete

All structural concrete shall be CDOT Class D, with the revisions noted within this section.

11.0.3.2 Reinforcement

All structures shall be reinforced as shown on the Drawings or within the Wastewater Management Division Standard Details. All reinforcing steel shall be ASTM A-615, Grade 60 with deformed bars.

11.0.4 Concrete Flatwork

11.0.4.1 Concrete

All flatwork shall be CDOT Class D, unless otherwise approved by the Project Engineer.

11.0.4.2 Reinforcement

All required reinforcement shall be in accordance with the Contract Documents.

11.0.5 Storm Inlets

The work under this subsection shall consist of furnishing all materials and constructing concrete catch basins, including excavation, concrete removal and backfill. Work shall be done at the locations designated on the project plans and in accordance with the Wastewater Management Division Standard Detail Drawings and other requirements of the Contract Documents. All inlet structures and related components shall be designed for AASHTO HS20 loading conditions.

11.0.5.1 Concrete

Concrete shall be Class D, with a minimum 28-day strength of 4500 psi. Cement used in concrete shall conform to ASTM Designation C-150 Type II cement. All concrete used for these applications shall be meet the requirements set forth within these Standard Construction Specifications.

11.0.5.2 Masonry Mortar

Masonry mortar (grout) shall be composed by volume of one part Portland cement, two parts fine aggregate, one fifth part hydrated lime and sufficient water to provide a plastic mixture. Mortar in concrete fill shall obtain a 28 day strength of 2000 psi.

11.0.5.3 Reinforcement

All inlets shall be reinforced as shown on the Drawings or Wastewater Management Division Standard Details. All reinforcing steel shall be ASTM A-615, Grade 60 with deformed bars. The diameter of bend measured on the inside of the bar shall be 6 bar diameters. All reinforcing steel shall be 2" clear minimum from formed surfaces and 3" clear against earth unless otherwise noted. Splicing of reinforcing steel shall be permitted only where detailed on the Drawings.

11.0.5.4 Connectors

Connectors for single inlets shall be 15" diameter (min.) with desired slope of 1 percent, for double inlets connectors shall be 18" diameter with desired slope of 1.8 percent and for triple inlets connectors shall be 21" with a desired slope of 1.8 percent. All connections to main line storm sewers shall be cored and collared in accordance with the Wastewater Management Division Standard Detail Drawings. Saw cutting and/or jack hammering will not be permitted.

11.0.5.5 Castings (No. 16 Inlets)

Frame shall be Denver Standard Pattern and grate where required shall be No. 16 Grate (Wastewater Management Division Standard Detail-S-716). All castings shall conform to ASTM A-48 (Class 35b) with a minimum tensile strength of 35 ksi. Castings shall not be dipped or painted prior to field inspection; once castings are approved by the Division for project usage, they shall be coated with an approved material. All castings shall be heavy duty and capable of withstanding AASHTO H-20 loadings. Horizontal bearing surfaces of all frames and grates shall be machined to eliminate any rocking action or non-uniform bearing.

11.0.5.6 Steps

Manhole steps shall be required for all new inlets greater than 4' in depth, , unless otherwise specified within the Contract Documents. Single Type 16 inlets are exempt from this requirement.

11.0.5.7 Construction Requirements

All storm inlets shall be constructed of cast-in-place concrete, unless specifically approved for precast construction by the City. Precast inlets shall meet the requirements of 11.0.1 (revised 602.08 Special Design)

1. Bedding and Backfill

All catch basins/inlets shall be cast in place. Subgrade shall be Class B Bedding compacted to 90% maximum dry density (AASHTO designation T-180). Backfill shall be hand tamped in 6" lifts, Backfill Method B.

2. Inlet Depths

Desired depths for single inlets shall be 3.5 feet (flow line to floor), for double inlets depth shall be 4 feet and for triple inlets depth shall be 4.5 feet. Inlets are designed to allow for 6 foot depth maximum; for depths greater than 6 feet, shop drawings and design analysis shall be submitted for approval by the Construction Project Manager.

3. Forming

Inlets shall be formed both inside and out; casting of sidewalls against earth walls or other structures is not permitted. No formwork shall remain inside structure when complete.

11.0.6 Backfill Requirements

The following outlines backfill requirements around manholes, structures, inlets, utilities and appurtenances. Structures shall include but not be limited to: type B manholes, type P manholes, box culvert and special structures noted within the Contract Documents. All structures shall be constructed in accordance with the most recent addition of the Wastewater Management Division Standard Detail drawings, and/or in conjunction with special details provided within the Contract Documents.

Method B backfilling, as described within these Standard Construction Specifications, is required around manholes, structures, inlets, utilities and appurtenances, unless otherwise specified or directed by the Construction Project Manager. The following backfilling constraints and requirements shall apply for all such facilities:

1. Cast-in-place: Inlets ($\leq 6'$ deep), Manhole Bases and Structure Bases

May be backfilled and compacted around, once the concrete has achieved 80% of the required 28-day compressive strength indicated in the Contract Documents.

For inlet depths larger than six (6) feet, from top of base slab to the top of wall at flow line of the lip, shop drawings and a design analysis must be submitted to the Construction Project Manager for approval. These submittals shall address the backfilling constraints during and after inlet placement.

2. Cast-in-place: Structure Walls

Shall not be backfilled or compacted against until the deck (top) slab has been placed, the walls have attained 80% of the required 28-day compressive strength, and the deck (top) slab has attained 80% of its required 28-day compressive strength as indicated in the Contract Documents.

3. Cast-in-place: Structure Decks or Top Slabs

May only be backfilled and compacted over once the concrete has attained the required 28-day compressive strength indicated in the Contract Documents.

4. Precast: Structures, Manhole Bases, Barrels, Cone Sections and Inlets

All precast components may be backfilled and compacted against, if manufactured a minimum of 28-days prior to placement, or if concrete test results demonstrate that the required 28-day compressive strength indicated in the Contract Documents has been achieved.

Precast barrels and cone sections may only be placed on cast-in-place manhole bases after 80% of the required 28 day compressive strength indicated in the Contract Documents has been attained.

Alterations and special allowances to these criteria may be granted at the discretion of the Construction Project Manager on a case by case basis.

End of Specification



CITY AND COUNTY OF DENVER
ENGINEERING DIVISION

Wastewater Capital Projects Management Standard Construction Specification

12.0 Riprap, Boulders and Slope/Channel Protection

12.1 General

This work consists of furnishing all labor, equipment and materials necessary to place riprap, soil riprap, grouted riprap, and erosion resistant materials where detailed on the Plans or as directed by the Construction Project Manager. The work includes water control, excavation and backfill, grading, sub-grade preparation, materials and installation of bedding, rock, riprap, boulders and grout as indicated herein and in the Contract Documents.

12.2 Submittals and Testing

In accordance with the Special Conditions submit documentation indicating source of stone and certifying materials for all types of rock will meet the requirements of this section. Include test results for specific gravity, abrasion, gradation and freeze thaw on samples of rock to be supplied on this project. Submit design mix for grout. In advance of delivery of rock to the work site an inspection of the quarry shall be arranged by the Contractor and shall include the Contractor, Construction Project Manager, and Quarry Representative. The quarry will identify the rock source and procedures that will be used to stockpile, mix and grade the types of riprap and boulders specified. The Construction Project Manager, following receipt and review of current gradation test results, may waive the requirement for field gradation tests at his discretion. If gradation tests are determined to be necessary by the Construction Project Manager, the following procedures shall be used.

For each type of riprap specified a random sample will be selected by the Construction Project Manager. The objective is to obtain a sample as it would be handled for normal delivery to the work site. It will then be placed in an approved area at the quarry and sized and sorted to identify and weigh the individual pieces as directed by the Construction Project Manager. The Contractor and Quarry Representative shall apply all labor and equipment to sort and weigh the riprap. Submit weight data of individual pieces and summary gradation curve. The approved sample shall then be hauled to the work site and stockpiled for comparison of future riprap deliveries. If the riprap being delivered appears to be outside of the specified gradation, or does not resemble the same stockpiles, the Contractor shall make appropriate adjustments at the quarry to ensure riprap meets the requirement of the Specification.

Boulders shall be visually checked by the Contractor at the quarry or work site as required for size, elongation, cracks, deterioration and other defects visible on the entire surface of the stone. If cracks are observed, the Contractor shall notify the Construction Project Manager to re-inspect and retest the rock. Stone with cracks or defects that are detrimental to a long lasting product shall not be shipped to the work site.

12.3 Riprap and Boulders

Only quarry rock that is sound and durable against disintegration under conditions to be met in handling and placing, and is hard and tenacious and otherwise of suitable quality to ensure permanency in the specified kind of work, shall be used.

All rock shall be angular, each piece having its greatest dimensions greater than 3 times its least dimensions and shall conform to the following requirements and testing standards:

1. The riprap designation and total thickness of riprap shall be as shown in the contract documents. The maximum stone size shall not be larger than the thickness of the riprap.
2. The specific gravity of the riprap shall be two and one-half (2.5) or greater.
3. Neither width nor thickness of a single stone of riprap shall be less than one-third ($\frac{1}{3}$) of its length.
4. Broken concrete or asphalt pavement shall not be acceptable for use in any portion of the Project.
5. Rounded riprap (river rock) is not acceptable unless specifically designated in the Contract Documents.
6. The color of the riprap shall be gray with gray/blue hues or other acceptable colors approved by Construction Project Manager prior to delivery to the Project site. Color shall be consistent on the entire Project and shall match the color of rock to be used for all other portions of the Project Scope.
7. Minimum density for acceptable riprap shall be one hundred sixty five (165) pounds per cubic foot. The specific gravity shall be according to the bulk-saturated, surface-dry basis, AASHTO T85.
8. The riprap shall have a percentage loss of not more than forty percent (40%) after five hundred (500) revolutions when tested in the Los Angeles machine in accordance with AASHTO Test T96.
9. The riprap shall have a percentage loss of not more than ten percent (10%) after five (5) cycles when tested in accordance with AASHTO Test T104 for ledge rock using sodium sulfate.
10. The riprap shall have a percentage loss of not more than ten percent (10%) after twelve (12) cycles of freezing and thawing when tested in accordance with AASHTO Test T103 for ledge rock, procedure A.

11. Rock shall be free of calcite intrusions.
12. Each load of riprap shall be reasonably well graded from the smallest to the largest size specified. Stones smaller than the two-to-ten percent (2-10%) size will not be permitted in an amount exceeding ten percent (10%) by weight of each load. Control of gradation shall be by visual inspection. However in the event Construction Project Manager determines the riprap to be unacceptable, the Construction Project Manager shall pick two (2) random truckloads to be dumped and checked for gradation. Mechanical equipment and labor needed to assist in checking gradation shall be provided by Contractor at no additional cost.

12.3.1 Types, Sizes and Classifications

The types, size, or classification of riprap to be placed will be noted on the Plans. Unless otherwise specified in the Plans or the Contract Documents riprap placed in accordance with the requirements for "dumped riprap" will be considered satisfactory. All riprap shall be placed on a prepared slope on a prepared filter media consisting of either a heavy duty plastic filter cloth or a free draining granular bedding media as described in the materials section of this specification. If the existing soils conditions meet the requirements for filter media the filter media will not be required.

Riprap used shall be the type designated within the contract documents and shall conform to **the table on the following page:**

Riprap Designation	% Smaller Than Given Size By Weight	Intermediate Rock Dimension (inches)	d ₅₀ * (inches)
Type VL	70 - 100	12	6
	50 - 70	9	
	35 - 50	6	
	2 - 10	2	
Type L	70 - 100	15	9
	50 - 70	12	
	35 - 50	9	
	2 - 10	3	
Type M	70 - 100	21	12
	50 - 70	18	
	35 - 50	12	
	2 - 10	4	
Type H	70 - 100	30	18
	50 - 70	24	
	35 - 50	18	
	2 - 10	6	
Type VH	70 - 100	41	24
	50 - 70	33	
	35 - 50	24	
	2 - 10	9	

* d₅₀ = Mean Particle Size

12.3.1.1 Dumped Riprap

This type of riprap shall consist of angular or fractured rock dumped in place on a prepared slope and filter media to form a well graded mass with a minimum of voids. Asphalt, broken concrete and other materials not classified as rock will not be allowed for use as riprap.

12.3.1.2 Soil Riprap

The soil material shall be native or topsoil and mixed with sixty five percent (65%) riprap and thirty five percent (35%) soil by volume. Soil riprap shall consist of a uniform mixture of soil and riprap without voids. Bedding material is not required for soil riprap. This type of riprap shall consist of angular or fractured rock mixed with 35% soil by volume dumped in place on a prepared slope to form a uniform mixture of soil and riprap without voids per Section 12.2.1C.

12.3.1.3 Grouted Riprap

This type of riprap shall consist of rock with all parts of the interstices filled with Portland cement mortar. The finished product shall be aesthetically pleasing resembling hand placed stone or fireplace rockwork. Colored concrete grout may be specified as defined elsewhere within these Standard Construction Specifications.

12.3.1.4 Feature Boulders

Feature Boulders shall consist of the same material as riprap, differing only by size. Feature Boulders shall have a minimum dimension of four (4) feet, or as shown on the Plans.

12.3.1.5 Boulders

Boulders shall consist of the same material as riprap, differing only by size. Boulders shall have a minimum dimension of two (2) feet, or as shown on the Plans.

12.3.2 Bedding

The granular bedding designation and total thickness of bedding shall be as shown in the Contract Documents. Granular bedding shall meet the same requirements for specific gravity, absorption, abrasion, sodium sulfate soundness, and freeze-thaw durability as required for riprap and as follows:

1. Broken concrete asphalt pavement or sledge, shall not be acceptable for use in any project. Rounded river rock is not acceptable unless specifically designated in the Contract Documents.
2. Shall conform to the quality requirements of AASHTO M197.
3. The requirements for the wear test in AASHTO T96 shall not apply.

4. Gradation for Granular Bedding:

U.S. Standard	Percent by Weight Passing	Square Mesh Sieves
<u>Sieve Size</u>	<u>Type I</u>	<u>Type II</u>
3 inch		90 - 100
1-½ inch		
¾ inch		20 - 90
⅝ inch	100	
No. 4	95 – 100	0 - 20
No. 16	45 - 80	
No. 50	10 - 30	
No. 100	2 - 10	
No. 200	0 - 2	0 - 3

12.4 Excavation

The excavations shall be finished to smooth and uniform surfaces conforming to the line and grade specified. Variation from the finished grade elevations specified shall not be more than 1.0 inch. Materials shall not be wasted without written permission of the Construction Project Manager. Excavation operations shall be conducted so material outside of the slope limits will not be disturbed. Prior to beginning grading operations, all necessary clearing and grubbing in that area shall have been performed. The top six (6) inches of material from all areas to be excavated shall be designated as topsoil and shall be removed and stockpiled in the designated location on the plans. Following removal of topsoil, in the designated excavation areas, the remaining material shall be removed and stockpiled separately for use as sub-grade material in the designated location on the plans. Unclassified excavation shall consist of the excavation of all materials of whatever character required for the work, obtained within the project limits, including surface boulders, masonry, organics, muck, and slag that are not removed under some other item. The work will also include hauling of unsuitable unclassified excavation materials off the site.

12.4.1 Unclassified Excavation

All excavation from six (6) inches below existing grade to the top of sub-grade for the associated boulders and/or riprap shall be designated as Unclassified Excavation.

Unless otherwise stipulated in the Contract Documents, no separate payment will be made for unclassified excavation and all costs incurred will be considered to be included within the unit price bid for the associated work.

12.4.2 Overexcavation

In locations where soil with unsuitable bearing characteristics are encountered, the Construction Project Manager may order that the unsuitable material be removed and be replaced with granular and/or rock backfill material to provide suitable bearing for the structure. At least eight (8) inches of acceptable material must be present below the proposed riprap, soil riprap, grouted riprap or boulders within two (2) feet of existing grade.

The overexcavation will be paid for in accordance with the bid items included within the Contract Documents, regardless of soil classification. No measurement for payment will be made of any material removed or necessary to fill overexcavated areas: outside of the limits for structure excavation, outside of limits defined within the Contract Documents, beyond the limits required for structure excavation performed for the Contractor's convenience or, where excavations for footings, slabs, etc., are made below the required elevations without specific authorization from the Construction Project Manager. In these situations, excess excavation and backfill shall be at the Contractor's expense and the areas shall be filled in a manner satisfactory to the Construction Project Manager.

12.4.3 Removal of Water

During construction, the Contractor shall provide and maintain adequate equipment to properly remove and dispose of all water entering the work area. In water bearing strata, well points, sub drains or any other method approved by the Construction Project Manager may be required to provide a dry trench.

The discharge from any dewatering operations shall be conducted to natural drainage channels or other structures as approved by the Construction Project Manager and in accordance with applicable permits. Ground water shall not be discharged into sanitary sewers.

Excavation work areas shall be kept free from water during excavation, fine grading, pipe laying and grouting. Dewatering, sufficient to provide a completely dry work area, shall be maintained during all excavation, construction and grouting operations. The Contractor shall be responsible for damage of any nature resulting from the dewatering operations.

Unless provided for in the Contract Documents, dewatering shall be considered as incidental to construction and all costs incurred will be considered to be included in the unit price bid for the construction of each section of sewer line, associated structures, laterals and appurtenances.

12.5 Backfill

Backfill around riprap or boulder structures shall be performed in accordance with these Standard Construction Specifications. Backfill shall be placed only after walls or other constructed items have been inspected and the approval of the Construction Project Manager to commence backfilling has been obtained. Backfilling against riprap or boulder structures is allowed only after the concrete has properly cured for not less than seven days, or until other testing procedures (concrete test cylinders) indicate that the concrete has attained sufficient strength so as not to be damaged by the backfilling operation.

12.6 Topsoil

Top soil material shall be taken from the topsoil stockpile and placed to a minimum depth of six (6) inches to the limits shown on the plans. Additional topsoil material, if necessary, shall be obtained from the sub-grade stockpile as approved by the Construction Project Manager. The topsoil shall be placed uniformly and compacted to a minimum of 85% Standard Proctor density ASHTO T-99. The intent is to provide a suitable medium for revegetation activities.

12.7 Unsuitable Materials

Materials encountered during construction that are deemed by the Construction Project Manager to be unsatisfactory as structure sub-grade shall be removed to a maximum depth as approved by the Construction Project Manager, and replaced with stabilization material including, rock, or other materials approved by the Construction Project Manager. The source of stabilization material shall be approved by the Construction Project Manager prior to placement. Excavated muck shall be removed and hauled off the site.

12.8 Construction Requirements

Channel slopes, bottoms, or other areas that are to be protected with riprap, soil riprap, or boulders shall be free of brush, trees, stumps, and other objectionable material and be graded to a smooth compacted surface. Contractor shall excavate areas to receive riprap or boulders to the sub-grade for granular bedding or for soil riprap to the specified depth (bedding material is not required for soil riprap). The sub-grade materials shall be stable. If unsuitable materials are encountered, they shall be removed and replaced in accordance with these Standard Construction Specifications for sub-grade that has been excavated in undisturbed soil. Additional compaction shall not be required unless specified by Construction Project Manager. When sub-grade is built up with embankment material it shall be compacted to ninety five percent (95%) optimum density (ASTM D698). After an acceptable sub-grade is established, the soil riprap or bedding shall be immediately placed and leveled to the specified elevation. Immediately following the placement of the bedding material, the riprap shall be placed. If bedding material is disturbed for any reason, it shall be replaced and graded at Contractor's expense. In-place bedding materials shall not be contaminated with soils, debris or vegetation before the riprap is placed. If contaminated, the bedding material shall be removed and replaced at Contractor's expense.

12.8.1 Placement

For the purposes of the following, boulders, riprap and rock are used interchangeably.

When riprap is placed on slopes, placement shall commence at the bottom of the slopes working up the slope. Place the riprap in a stepped fashion with the bottom of the uphill riprap below the top of the downhill riprap by one half ($\frac{1}{2}$) of the height of the riprap minimum.

The entire mass of riprap shall be placed on either channel slopes or bottoms so as to be in conformance with the required gradation mixtures and to lines, grades, and thickness shown on the plan set. Riprap shall be placed to its full course thickness at one operation and in such a manner as to avoid displacing the underlying bedding material. Placing of riprap in layers, or by dumping into chutes, or by similar methods shall not be permitted.

All material going into riprap protection for channel slopes or bottoms shall be so placed and distributed that there shall be no large accumulations of either the larger or smaller sizes of stone. Some hand placement may be required to achieve this distribution.

It is the intent of these Standard Construction Specifications to produce a fairly compact riprap protection in which all sizes of material are placed in their proper proportions. Unless otherwise authorized by Construction Project Manager, the riprap protection shall be placed in conjunction with the construction of embankments or channel bottoms with only sufficient delay in construction of the riprap protection, as may be necessary, to allow for proper construction of the portion of the embankment and channel bottom which is to be protected. Contractor shall maintain the riprap protection until accepted. Any material displaced for any reason shall be replaced to the lines and grades shown in the Contract Documents at no additional cost to City and County of Denver. If the bedding materials are removed or disturbed, such material shall be replaced prior to replacing the displaced riprap.

The basic procedure shall result in larger materials flush to the top surface with faces and shapes arranged to minimize voids, and smaller material below and between larger materials. Surface grades shall be a plane or as indicated, but projections above or depressions under the finished design grade more than ten percent (10%) of the rock layer thickness shall not be allowed. Smaller rock shall be securely locked between the larger stone. It is essential that the material between the larger stones not be loose or easily displaced by flow or by vandalism. The stone shall be consolidated by the bucket of the backhoe or other means that will cause interlocking of the material. All rock is to be placed in a dewatered condition beginning at the toe of the slope or other lowest point.

Riprap shall be rejected, which is either delivered to the job site or placed, that does not conform to this section. Rejected riprap shall be removed from the Project site by the Contractor at his/her expense.

Following acceptable placement of granular bedding, riprap placement shall commence using one of the following methods:

Machine Placed Riprap

Riprap shall be placed using appropriate construction equipment on the prepared slope or channel bottom areas in a manner which will produce a reasonably well-graded mass of stone with the minimum practicable percentage of voids. Riprap shall be machine placed, unless otherwise stipulated in the Contract Documents.

Hand Placed Riprap

Hand placed riprap shall be performed during machine placement of riprap and shall conform to all the requirements outlined above. Hand placed riprap shall also be required when the depth of riprap is less than two (2) times the nominal stone size, or when required by the Contract Documents.

After the riprap has been placed, hand placing or rearranging of individual stones by mechanical equipment shall be required to the extent necessary to secure a flat uniform surface and the specified depth of riprap, to the lines and grades as shown in the Contract Documents.

12.8.1.1 Types

Buried Riprap

Where riprap is designated to be buried, place onsite excavated material that is free from trash and organic matter in riprap voids by washing and rodding. Prevent excessive washing of material into stream. When voids are filled and the surface accepted by the Construction Project Manager, place a nominal six (6) inches of soil over the area, or as designated in the Contract Documents. Fine grade, seed, and mulch per the Contract Documents.

Soil Riprap

Adjacent stockpiles of riprap and soil shall be created and mixing done at the stockpile location, not at the location where soil riprap is to be placed. Mix thirty five percent (35%) soil by volume with stockpiled riprap, using additional moisture and control procedures that assure a homogenous mixture, where the soil fills the inherent voids in the riprap without displacing riprap.

Place a first layer of smaller soil riprap of approximate d_{50} thickness. Then place the top layer with surface rocks that are largely d_{50} or greater, filling voids as necessary with smaller planted riprap. Create a smooth plane as described in Paragraph A. The mixture shall be consolidated by large vibratory equipment or backhoe bucket to create a tight, dense interlocking mass. The soil shall be further wetted to encourage void filling with soil. Any large voids shall be filled with rock and small voids filled with soil. Excessively thick zones of soil prone to washing away shall not be created (e.g., no thicknesses greater than six (6) inches). For buried soil riprap, the top surface shall be covered with four (4) inches of topsoil such that no rock points are protruding. The final surface shall be thoroughly wetted for good compaction, smoothed and compacted by vibrating equipment; the surface shall then be hand raked to receive planting or seeding. With prior approval of Construction Project Manager, layering the riprap and soil instead of premixing may be allowed if the native soil is granular.

Feature Boulders

Feature Boulders serve an aesthetic function and as such shall be placed and rotated into final position as directed by the Construction Project Manager in order to achieve the desired result.

Grouted Boulders

Grouted riprap and boulder lined channel edge shall be placed at the locations as shown in the Construction Documents and installed with the following requirements:

1. The sub-grade to receive each boulder shall be excavated and any unstable material shall be removed. Approved material shall be placed and compacted in a maximum of four-inch (4") lifts to ninety five percent (95%) of Maximum Standard Proctor Density (ASTM D698) to re-establish the sub-grade of each boulder. Unstable material shall be removed from the Project site and disposed of by Contractor. Removal and replacement of unstable material shall only be completed at the direction of Construction Project Manager and shall be paid for under Muck Excavation. Backfill behind boulders shall be compacted to ninety five percent (95%) Maximum Standard Proctor Density (ASTM D698). Care shall be taken during compaction to avoid disturbing and/or damaging the integrity of the boulder channel edge.

The top of all boulders shall be as indicated in the Construction Documents. Finished grades and sub-grades for boulders will be determined from the height of each boulder used.

2. The boulders shall be carefully picked and arranged so that adjacent rock surfaces match within two (2) inches in top elevation and two (2) inches along the vertical exposed face or channel side of rock. Boulders shall be placed such that adjacent boulders "touch" each other and voids do not exceed four (4) inches. It is the intent of construction to minimize voids and grout placed between boulders.
3. Smaller rocks shall be "chinked in" to fill all voids behind the boulders. Placement shall be approved by Construction Project Manager prior to grouting.
4. Prior to placing the grout, any type of debris, fines, smaller rock, or silt shall be removed from around or under the boulders.
5. Dewatering shall be implemented to guarantee that the grout will not be placed in water and for a period of twenty four (24) hours after the grout has been placed.
6. Keep boulders receiving grout wet at all times prior to receiving grout. The concrete grout shall be placed by injection methods by pumping under low pressure, through a two-inch (2") maximum diameter hose to ensure complete penetration of the grout into the void area as detailed in the Contract Documents. Grout will be placed up to eight (8) inches from the top of boulders, or as directed by the Construction Project Manager. The Operator shall be able to stop the flow and will place grout in the voids and not on the surface of the rocks.
7. Grout shall be troweled out and finished to minimize visibility. Clean and wash any spillage before the grout sets. The visual surfaces of boulders will be free

of grout to provide a clean, natural appearance. If washing does not clean off grout residue, Contractor shall wash off any grout residue with muriatic acid and water, using a brush to scrub off the residue. A "pencil" vibrator shall be used to make sure all voids are filled between the boulders. The intent is to fill all voids from the sub-grade level around the boulders to a depth as shown in the Contract Documents. The "pencil" vibrator may be used to smooth the appearance of the surface, but Contractor shall use a wood float to smooth and grade the grout around the boulders. The grout mix shall be stiffened and other measures taken to retain the grout between the boulders.

8. Contractor shall, if deemed necessary, support the boulders from falling over before and during the placement of rock, grout, backfill, and compaction work on either side of the boulder.
9. Grout shall receive cold weather protection and curing in accordance with the most recent version of CDOT Standard Specifications for Road and Bridge Construction (section 601.13) as applicable.

12.9 Grouted Rock Retaining Walls

Grouted rock retaining walls shall be placed at locations as shown in the Contract Documents and installed with the following requirements:

1. The grouted rock walls shall be constructed to the dimensions in the locations shown in the Contract Documents. The walls shall be constructed with a one (1) horizontal to four (4) vertical batter on the front and back face, with a minimum width of one (1) foot at the top of the wall.
2. The stone of the wall shall be laid to form substantial masonry, presenting a neat, finished appearance. Headers shall hold the heart of the wall to the face. Headers shall occupy at least twenty percent (20%) of the area and they shall be evenly distributed. The length of stretchers shall not exceed three (3) times their rise. Face stones shall be laid to break joint. Rock shall be hand graded so that only the larger stones are used in the face. Face stones shall be laid to break joint so that each rock laid rests on two beneath it. Spalls and pinners will not be allowed in the face and shall be used in the backing only where necessary.
3. All face stones shall be pitched to a string line on straight walls or laid to batter stakes for curved walls. The batter shall be consistent with respect to all parts of the wall and shall meet the minimum requirements set forth in the detail. The degree of roughness on the exposed face shall be measured with a six-foot (6') straightedge supported between adjacent projections and stone face. Variations in excess of 3 inches, measured from the straight edge to the extreme depression in the stone, will not be permitted. Rear faces shall present approximately plane surfaces and shall in general conform to the detail.
4. Grout shall be placed to fill all voids between the rocks throughout the walls. Any "loose" rocks shall be re-grouted by machine or hand methods. Grout shall

be recessed approximately two (2) inches from the face of the wall in order to give a "dry stacked" appearance.

5. Prior to placing the grout, any type of debris, fines, smaller rock, or silt shall be removed from around the rocks.

Dewatering shall be implemented to guarantee that the grout will not be placed in water and the area will remain dewatered for a period of ten (10) hours after the grout has been placed.

The surface of the rocks receiving grout shall be wet at all times prior to receiving grout.

6. Clean and wash any spillage before the grout sets on the outside face and top of walls. The visual surfaces of the rocks will be free of grout to provide a clean natural appearance. If washing does not clean off grout residue, then Contractor shall wash off any grout residue with muriatic acid and water, using a brush to scrub off the residue.
7. Grout shall receive cold weather protection and curing in accordance with the CDOT Standard Specifications for Road and Bridge Construction (section 601.13) as applicable.

End of Specification



CITY AND COUNTY OF DENVER
ENGINEERING DIVISION

Wastewater Capital Projects Management Standard Construction Specification

13.0 Fencing

13.1 Description

This item shall consist of furnishing and installing new fencing and/or removing and salvaging the existing fencing and restoring the same in conformance with the lines, grades and/or alignment shown on the Plans. Wherever the materials to be removed are not in good condition, as judged by the Construction Project Manager, or wherever the Contractor has damaged the materials during the process of removal, equal or better quality fencing materials than the existing will be furnished and installed by the Contractor. Relocated and/or new fencing will be chain link, heavy construction type. The fence heights shall be as noted on the Plans.

13.1.1 Chain Link Fence

Where specified on the plans or directed by the Construction Project Manager, chain link fencing shall be constructed as detailed on the drawings and as specified herein.

13.1.2 Security Fence

Where specified on the plans or directed by the Construction Project Manager, security fencing shall be constructed as detailed on the drawings and as specified herein. The fencing shall be topped with 3-strand barbed wire which will extend the overall height of the fence by one (1) foot.

13.1.3 Shop Drawings and Data

Complete detail drawings and specifications for the fence, gates and accessories shall be submitted in accordance with the procedure set forth in the Special Contract Conditions.

13.2.4 Removal of Existing Fencing

All ties and clamps shall be removed to free the fabric from posts, rails, braces, tension bars and the like. The fabric shall be removed and stored appropriately to be reused. All rails, braces, barbed wire, tension bars and the like shall be removed from posts to a sufficient degree that will allow the removal of the posts.

The post footings shall be excavated and the concrete shall be broken until the post is free. Posts higher than ten (10) feet may be cut in segments or left intact for relocation at the option of the Contractor and as approved by the Construction Project Manager.

13.3 Materials

Materials for all fencing shall conform to the standards of the existing fence or to the minimum standards as outlined herein. All new steel or malleable iron parts and accessories shall be hot dip galvanized after fabrication.

13.3.1 Posts

All posts shall be steel pipe, ASTM A120, standard weight, Schedule 40. Post diameters shall be as follows.

a. Line Posts

- (1) Up to ten (10) foot high fence inclusive, line posts shall be 2-1/2 inch O.D. pipe, 3.65 lbs. per ft.
- (2) Over ten (10) foot to eighteen (18) foot high fence inclusive, line posts shall be 3 inch O.D. pipe, 5.79 lbs. per ft.
- (3) Over eighteen (18) foot to thirty (30) foot high backstop fence inclusive, line posts shall be 4 inch O.D. pipe 9.1 lbs. per ft.

b. Terminal End. Corner and Pull Posts

- (1) Up to eighteen (18) foot high fence inclusive; terminal, end, corner and pull posts shall be 3 inch O.D. pipe, 5.79 lbs. pr ft.
- (2) Over eighteen (18) foot to thirty (30) foot high backstop fence inclusive; terminal, end, corner and pull posts shall be 4 inch O.D. pipe, 9.1 lbs. Per ft.

c. Gate Posts. Pipe, 9.1 lbs. per ft. and 4 inch O.D.

- (1) **Top Rail** shall be 1-5/8 inch O.D. pipe, 2.27 lbs.
- (2) **Post Tops** shall be pressed steel or malleable iron designed to prevent entry of moisture into tubular posts and/or for barbed wire installation.
- (3) **Stretcher Bars** shall be steel, 3/16 inch by 3/4 inch, or equivalent area.
- (4) **Fabric** shall be No.9 wire woven into a 2" mesh; galvanized AS~M A392, Class II.
- (5) **Fabric Ties** shall be No.7 aluminum wire or 12 gauge galvanized steel wire.
- (6) **Concrete Collars** around posts: f'c -2000 psi, 5 sack mix, with Type r or Type II cement conforming to ASTM C-150.

13.3.8 Gates

Materials for gates shall conform to the

- a. **Fabric** shall be the same as fence fabric.
- b. **Frames** shall be 2 inch O.D. pipe, 2.72 lbs. per ft.
- c. **Hinges** shall be heavy pattern with large bearing surfaces and shall not twist or turn under the action of the gate.

- d. **Latches** shall be forked type and shall be arranged for padlocking, with the padlock accessible from both sides of the gate.
- e. **Stops** shall consist of a roadway plate with anchor set in concrete and arranged to engage the plunger.

13.3.9 Security Fence

Materials for security fencing shall conform to the contract specific specifications and the following special items.

- a. **Barbed Wire Support Arms** shall be galvanized steel and shall extend at an angle of approximately 45°, and shall be fitted with clips or other means for attaching three strands of barbed wire. The top wire shall be approximately twelve inches horizontally from the fence line and the other wires spaced uniformly between the top of the fence fabric and the outside strand. The barbed wire support arm shall be of sufficient strength to withstand a weight of 200 lbs. applied at the outside strand of barbed wire.
- b. **Barbed Wire** shall consist of two strands of 12-1/2 gage steel wire with 14 gag; 4 point barbs spaced not more than 5 inches apart. All wire shall be zinc coated with a minimum coating of .80 ounces per square foot of surface area on 12-1/2 gage wire and .60 ounces per square foot of surface area on 14 gage wire.

13.4 Installation or Replacement of Fence

13.4.1 General Constructions

The Contractor shall perform such clearing and grubbing as may be necessary to construct or replace the fence to the required grade and alignment as shown on the Plans. Where specified on the plans or ordered by the Construction Project Manager, a one (1) foot wide concrete mowing strip shall be provided for the entire length of the fence. The fence shall be located along the center line of the mowing strip.

At locations where breaks in a run of fencing are required, appropriate adjustments in fence alignment and/or post spacing shall be made to satisfy requirements of conditions encountered.

13.4.2 Posts

Posts shall be held in proper position by secure bracing until such time as the concrete has set sufficiently to hold the posts. Materials shall not be installed on posts, or stress placed on guys nor bracing set in concrete until the concrete has developed enough strength to withstand the stress.

All line, terminal, corner and gate posts shall be of the size specified. Posts shall be of the proper length to accommodate full height of fabric as shown on the Plans and provide for footing to the depth required. All posts shall be set plumb and firmly in concrete footings with a maximum spacing of 10 feet between posts. Concrete footings shall be domed to shed water. All terminal, corner and gate posts shall be braced with horizontal braces and diagonal truss rods.

All posts shall have a post cap of heavy galvanized malleable iron or pressed steel.

The tops of all posts shall be set to the required grade and alignment.

13.4.3 Fabric

Fabric shall be firmly attached to the posts and braces. All wire shall be stretched taut and be installed to the required spacing. The completed fence shall be plumb and in straight alignment, firmly wired to prevent sag or looseness.

The fabric shall be the full height as shown on the Plans. Fabric shall be attached to the inside of posts with the wires or fabric clips, spaced at one (1) foot intervals on all posts and six (6) ties to each horizontal rail. Top and bottom selvages shall be knuckled for residential chain link fences and security fences.

13.4.4 Top Rails, Braces, Fittings, Ties, Tension Wire, Tension Bars

These items shall be the same lengths, dimensions and quantities as those of the existing fence or as shown on the Plans. The existing items shall be removed and replaced and where new items need to be purchased, the quality shall be equal to or better than the existing. The top rail shall extend through all line posts to form a continuous brace from end to end of each stretch of fence, be securely fastened at the end of each run, and have joints made with expansion sleeve couplings not less than 5 inches long.

13.4.5 Gates

Gates shall be constructed at or relocated to locations shown on the plans. Any materials not up to standard shall be replaced with materials of equal or better quality than the existing. Gates shall be installed to swing horizontally in true vertical plane and shall be provided with offset hinges to permit 180 degree swing.

Gates shall be installed so that they cannot be removed without disassembly of the hardware. Hardware attachment bolts shall be preened so that removal will be difficult.

Gates shall have all necessary latches, straps, locking bars and locking devices. Fabric shall be tightly stretched and securely fastened to gate frame with the proper number of bands, clips or tie wires and stretch bars shall be installed one (1) inch shorter than the full height of the fabric. Gates shall be free from sag or twist. Joints between frame members shall be made by welding or by means of heavy fittings and shall be rigid and water tight.

If welding is employed, it shall conform to the requirements of the American Welding Society. All welds shall be ground smooth. When the spelter coating has been burned by welding, the surface of the welded connection shall be thoroughly cleaned by wire brushing and all traces of the welding flux and loose or cracked spelter removed. The cleaned areas shall then be painted with two coats of zinc oxide-zinc dust paint conforming to the requirements of Federal Specification MIL-P-15145, latest revisions. The paint shall be properly compounded in a suitable vehicle in the ratio of one part zinc oxide to four parts zinc dust, by weight.

A method to padlock all gates shall be provided. Each padlock shall be provided with two keys.

End of Specification



CITY AND COUNTY OF DENVER
ENGINEERING DIVISION

Wastewater Capital Projects Management Standard Construction Specification

14.0 Removal and Disposal of Construction Debris and Contaminated Materials

14.0.1 General

The Contractor shall be required to transport all non-hazardous solid waste and construction debris to the Denver Arapahoe Disposal Site (DADS) landfill, in accordance with Executive Order 115. Only approved haul routes around DADS may be used (Contractor must contact landfill directly for these routes). Landfill fees, gate fees and applicable State surcharges will be paid for by the City and County of Denver, Wastewater Capital Projects Management. The Contractor is responsible for any special handling charges imposed by Waste Management at DADS.

All costs associated with loading, hauling, and disposal of construction debris and/or contaminated soils at DADS shall be considered included within the unit price bid for construction of each section of sewer, the associated structures, laterals and appurtenances unless provided for elsewhere in the Contract Documents. The City and County of Denver, Wastewater Capital Projects Management will not provide hauling tickets nor cover the fees associated with disposal of recyclable materials at the DADS landfill. Recyclable materials shall include: concrete, asphalt, clean soil, and any other materials generated onsite with a monetary value. No payment will be made for the loading, hauling and/or processing of recyclable materials.

If the excavated soil appears to be re-usable, and the Contractor wishes to dispose of this material at a location other than DADS, then the Contractor shall obtain City Project Manager approval, obtain an environmental consultant approved by the City and County of Denver Department of Environmental Health at the Contractor's expense, and follow the minimum recommendations below or as required by the City Project Manager.

The Contractor shall analyze the following list of constituents as a means of determining whether the soil is suitable for re-use: Volatile Organic Constituents (VOCs), Semi-Volatile Organic Constituents (SVOCs), Pesticides, Herbicides, PCBs, Total Petroleum Hydrocarbons (TPH), 8 RCRA Metals, and Asbestos. Depending on the location of the project, additional constituents may be required for testing.

Soil samples shall be collected from the stockpiles every 500 cubic yards. Samples shall be collected by environmental professionals, evaluating the results with respect to

residential standards, and only re-using soil that meets residential standards. Depending on the location of the project, a more strict sampling/testing frequency may be required. If the soil is determined to be re-usable, the Contractor transferring the soil and the non-City entity which takes possession of the soil must sign an agreement, approved by the City Attorney's Office which will release the City from liability.

If the waste material cannot be accepted at DADS, the Department of Environmental Health has contact information regarding landfills which may accept the waste material. Landfill fees at these facilities will be paid for by the Contractor.

The work required for this section shall consist of exploratory investigation, testing, identification, removal and disposal of construction debris and contaminated materials associated with the construction of pipelines, box culverts, gulches, open channels, ponds and associated structures and appurtenances.

14.0.2 Contaminants

The contaminants required to be removed or treated may or may not be known at the time of award of the work. Contaminated soils may be encountered and have to be identified on the job site. Potentially and/or suspected contaminated sites of known and unknown origin may be listed at the end of the Contract Documents and are identified on the plans.

14.0.3 Environmental Consultant

The City and County of Denver, Wastewater Capital Projects Management will provide an Environmental Consultant to help identify, monitor and document and provide other assistance as required.

14.0.4 Contaminated Soil Identification

1. Remediation of soils with unknown contaminants will be performed by the Contractor as described herein or as directed by the Construction Project Manager with recommendations by the Environmental Consultant. Materials visibly contaminated or having field instrument (e.g. PID, FID, OVA, etc.) readings above established action levels will be excavated, or otherwise loaded for transport to an approved disposal facility or to a temporary storage area designated by the Construction Project Manager. Appropriate safeguards will be utilized to prevent or limit exposures to stored materials.
2. The stored material will be tested at the contractor's expense for contaminants. As dictated by the proposed disposal facility the parameters to be tested for will be based on the historical use of the area and the requirements of the facility used for disposal. The material will not be stored for more than 90 days.
3. Material identified as hazardous or non-hazardous will be disposed of in a manner consistent with current established federal, state and local regulations for waste material. A hazardous waste contractor shall be required for handling of hazardous material.

4. Materials with contaminants below action levels may be used for fill on-site or transported off-site. Materials with contaminants not specifically regulated will be disposed of as directed by the Construction Project Manager.
5. The owner of any contaminated material will be the City and County of Denver, for the purposes of permits and disposal only.

14.0.5 Submittals

The Contractor will submit the following information for approval prior to beginning work or as otherwise specified:

1. **Health and Safety Plan** meeting OSHA requirements of CFR 1910.120. The Health and Safety Plan for remediation work shall address the protection of health, safety and response to contingencies which could occur during remediation. It shall describe known and potential hazards related to remediation work activities. It shall include descriptions of construction and decontamination procedures for personnel and equipment. The plan will only be implemented if contaminated materials are encountered.

The contractor shall provide a project Health and Safety Officer. The project Health and Safety Officer shall be qualified by certification or training in the area of Industrial Hygiene or Hazardous Waste Health and Safety. The officer will have the authority and knowledge to design and implement a site-specific Health and Safety Plan and Hazardous Communication Program and to verify compliance with applicable safety and health requirements.

All persons working in and entering the areas designated by the Health and Safety Officer to be hazardous due to the presence or potential of contacting hazardous substances shall have previously received training according to the requirements in the Hazardous Waste Operation Regulations (OSHA 1910.120).

General site workers involved in construction activities in the designated areas shall receive 40 hours minimum training in the health and safety of hazardous waste; site workers and workers who are on-site occasionally to perform a single specified task shall receive 24 hours minimum of training. Personnel overseeing the health and safety of other workers shall receive an additional eight hours of supervisor training in that capacity. Documents certifying that the training requirements have been met and that all personnel are current on their refresher training shall be present at the project office or trailer or otherwise be made available to the project Health and Safety Officer and/or the Construction Project Manager.

In addition to the personnel working in the designated hazardous waste sites, all personnel working on this construction project shall be involved in the communication and understanding of potential hazards through a Hazardous Communication Program in accordance with the provisions of OSHA regulation 29 CFR 1910.12. This program shall include all elements of the regulations including training of personnel, compilation of Material Safety Data Sheets (MSDS), labeling, and placarding of hazardous chemicals, hazard identification of the construction area and monitoring of all activities to determine if new hazards are posed to the employees.

Reduced levels of training are to be identified for persons performing short duration or non-intrusive activities in areas in which the concentrations of or the potential for exposures to hazardous chemicals are reduced or shown to be minimal in the designated areas.

The training of employees in the non-designated areas are covered in the Hazard Communication Program for this phase of construction activities. This training shall include the following elements:

1. Methods of detecting hazardous chemicals.
2. Physical and health hazards of chemicals in the area.
3. Personal protective measures that are implemented to protect the employees.
4. Details of the Hazardous Communication Program such as emergency response procedures and location of the Material Safety Data Sheet.

2. Material Management Plan

A. Sampling and Analysis Plan (SAP) which describes methods of sampling, testing and analysis to obtain additional data on chemical constituents of the various materials. The Environmental Consultant will prepare this plan which shall be reviewed by all parties prior to the commencement of this aspect of construction. The purpose of the SAP will be to provide a basis for classifying a material as hazardous or non-hazardous and to provide confirmation and documentation of completed remediation work as it relates to project construction.

B. Product Data: Submit the following as part of a Pre-Construction Submittal Package.

1. Material list for items proposed to be provided under this section.
2. Certificates signed by the materials producer and the subcontractor stating that all material, meet or exceed the specified requirements.
3. **Materials Samples:** Submit adequate and representative samples of the backfill material to the Testing Laboratory for pre-construction tests.
4. **Test Reports:** Submit at least one week prior to beginning of the work of this section the test reports for the pre-construction testing performed by the Testing Laboratory.
5. **Disposal Profile Sampling:** If contaminated soil is known or believed to exist in the project alignment, the contractor shall be responsible for waste classification, profiling and manifesting. This shall be done in advance of the construction phase.

The material management plan is a dynamic document. It shall be the contractor's responsibility to coordinate revisions as necessary based upon changing site conditions.

14.0.6 Materials

14.0.6.1 Backfill Materials

Materials generated on-site or if imported shall be predominantly granular non-expansive soil free from roots and other unsuitable material meeting the requirements of Section 5.0 of these Standard Construction Specifications. The Contractor shall try to generate all backfill materials on-site. Imported fill materials will only be allowed in cases where sufficient quantities of suitable backfill material cannot be generated on-site.

14.0.6.2 Backfill of Excavated Areas

Excavated areas outside the vertical limits of construction will be backfilled and regraded using uncontaminated soils. Compaction requirements are described in Section 5.0. The fill materials will be from on-site stockpiles as described above. The surface will be regraded to match natural contours and drainage patterns and the areas to be reseeded or otherwise restored to match existing conditions prior to the contaminated material excavation.

14.0.7 Execution

14.0.7.1 Removal

1. Contaminated materials will be removed to a depth of 3 feet below construction within the horizontal limits of construction at the direction of the Construction Project Manager. If the contamination extends less than three (3) feet, a minimum thickness of three (3) inches of soils below the contaminated materials will be removed, loaded, transported, and disposed of.
2. Upon completion of initial contaminated material removal, the excavated area will be inspected by the Construction Project Manager and or the Environmental Consultant and additional materials will be removed as deemed necessary based on visual observations, instrument readings, and the results of initial and confirmatory laboratory testing.

14.0.7.2 Disposal

The contaminated soils requiring disposal will be transported to a land fill approved to accept the waste. The landfill will be approved by the Construction Project Manager prior to transport and landfill fees will be paid for by the Contractor. A payment item is provided for this in the Bid Form and Submittal Package. The Denver Arapahoe Disposal Site (DADS) and the Conservation Services Inc. facilities are licensed to accept non-hazardous waste. Facilities in Utah and Texas are licensed to accept hazardous waste.

14.0.7.3 Confirmation Sampling

1. Upon completion of the contaminated material removal in each area, a confirmation soil sample will be collected by the Environmental Consultant in accordance with a Sampling and Analysis Plan (SAP) and the samples shipped to an approved testing laboratory for analysis.

2. The SAP will be prepared by the Environmental Consultant prior to construction and should contain methods of sampling and analysis to confirm if a material is hazardous or non-hazardous and that remediation work has been completed. The sampling will either be from a discrete location or composited, if appropriate. Duplicate and blank samples will be collected for laboratory quality assurance at the frequency described in the SAP. All samples will be labeled and sealed and appropriate chain-of-custody and shipping procedures followed.

14.0.7.4 Field Testing

1. The Testing Laboratory as designated by the Environmental Consultant, will perform tests and report results as approved by City's Department of Environmental Health (DEH) and the City and County of Denver, Wastewater Capital Projects Management on soil samples obtained by the Construction Project Manager. The City's Department of Environmental Health may act as internal consultant to the City and County of Denver, Wastewater Capital Projects Management as needed.
2. Obtain the Construction Project Manager's approval of subgrade materials with respect to the City and County of Denver, Wastewater Capital Projects Management requirements before subsequent construction is performed.
3. Notify the City and County of Denver, Wastewater Capital Projects Management and the Environmental Consultant of conditions contrary to accepted requirements.
4. The Colorado Department of Hazardous Wastes Management Division (CDHWMD) is the state's agency for reviewing cleanup measures. Since the contaminants and their levels are unknown and the Colorado Department of Hazardous Wastes Management Division does not have specific regulations for cleanup of materials that may be found, they will only "suggest" or review cleanup measures. They will in some cases provide a letter suggesting that they concur with the levels selected but make no commitments regarding long-term liabilities. They will maintain a file on each project if the information is provided to them. The following cleanup levels will be used for the site, but may be modified by CDEVS or CDHWMD.
 - Petroleum Product – 100 ppm TPH, 20 ppm BTEX (RACI)
 - Metals (CERCLA, Ep-Tox or TCLP levels)
 - Volatile and semi-volatile organics – 10 ppm total
 - PCB's – 10 ppm (TSCA regulation)

Cleanup levels are determined on a case-by-case basis for contaminants not specifically regulated under Resource Conservation Recovery Act or Toxic Substances Control Act. The cleanup will be implemented using visual observation of stained areas and an established action level for PID readings in a headspace test of 50 ppm for petroleum contaminated soils and 10 ppm for organic contaminants. If either of these conditions are met, the material will be considered contaminated and stockpiled for sampling, analysis and appropriation of disposal or potential reuse.

5. Test Report: At least once a week prior to the work of this Section, submit test reports for the pre-construction testing performed by the Testing Laboratory.

14.0.7.5 Protection of Storm and Sanitary Sewers

1. Concrete Cut-off Walls as shown in figure 2 of the City and County of Denver, Wastewater Management Division, Standard Detail for Trenching and Bedding (S-301.1) shall be constructed upstream and downstream of the contaminated area to prevent migration of hazardous material from off-site areas.

End of Specification



CITY AND COUNTY OF DENVER
ENGINEERING DIVISION

Wastewater Capital Projects Management Standard Construction Specification

20.0 Grass Sodding

20.0.1 General

This item shall consist of placing grass sodding and fertilizing in conformity with the lines, grades and cross sections shown on the plans, stakes established by the Construction Project Manager, and in accordance with these Standard Construction Specifications.

The equipment and methods described in these Standard Construction Specifications may be modified where it is established to the satisfaction of the Construction Project Manager that the resultant product is equivalent to that specified herein.

20.0.2 Materials

20.0.2.1 Sod

Sod shall be Kentucky bluegrass and shall be approved by the Parks and Recreation Department before placement. At least 99% of the plants in the sod shall be of the variety specified. The sod shall be materially free from weeds or undesirable plants and stones larger than 1 inch in diameter. Sod shall be nursery grown and shall be mowed to a height not to exceed 2 inches before lifting and shall be of a uniform thickness with not over 1-1/2 inches soil or less than 1 inch of soil.

Delivered sod shall not contain more than 5% broken rolls. Sod shall be laid within 24 hours from the time it is lifted from the field.

Sod that has become moldy, withered, or yellow from storage or white from drying will be rejected at the time of planting. Rejected sod will not be counted for payment.

20.0.2.2 Fertilizers

The area to be sodded shall be fertilized as follows:

- a. Well rotted cow manure shall be roto-tilled into the topsoil prior to sod placement.
- b. In general commercial fertilizer consisting of 20% nitrogen, 20% available phosphoric acid and 10% water soluble potash is acceptable. Commercial fertilizers shall be applied after the sod is laid and shall be a complete formulation or organic base, granular and free flowing.

20.0.2.3 Topsoil

Topsoil may be selected from the material excavated at the job site by the Construction Project Manager and placed where needed to provide a 4inch minimum friable, fertile loam root-moisture zone. During the excavation operation, the acceptable on-site topsoil shall be removed and stockpiled in the area. Upon completion of the construction, the topsoil shall be placed to the correct line and grade in all areas requiring sodding and seeding. Topsoil will not be required in areas of special slope protection noted on the plans, in paving areas or other structures.

In the event the topsoil available from project excavation is insufficient, in the judgement of the Construction Project Manager, the Contractor shall import suitable topsoil in conformance with the select material requirements in section 5.0 of these Standard Construction Specifications. Payment for on-site or imported topsoil shall be as noted in the Measurement and Payment Section of these Standard Construction Specifications.

20.0.3 Construction

20.0.3.1 Time

The Contractor shall place the sod between March 1 and November 1 of the Calendar year of construction. No sod shall be laid on frozen soil.

20.0.3.2 Site Preparation

The area to be sodded shall be cleared of all stones, roots, wood, weeds, and any other materials that may hinder proper grading, tilling, sodding, or subsequent maintenance, operations and shall be smooth before any sod is laid.

After the cow manure has been roto-tilled into the topsoil as specified in Subsection 20.3.4 below, fine grading shall be performed to insure reasonable grades and alignments per the grade stakes. Where no grade stakes are shown, areas shall be smooth and of continual grade between control points, such as walks and curbs. Areas of settlement shall be filled with topsoil and properly rolled to insure a firm bed true to the proposed grades. Areas of compacted soil, which are, in the judgment of the Construction Project Manager, too hard to serve as suitable subgrade, shall be scarified to a depth of six inches, and leveled and rolled.

After the fine grading operations have been completed, the entire area to be sodded shall be rolled with a 100 pound roller prior to sod placement.

20.0.3.3 Sod Placement

Sod shall be laid on a smooth, firm earth bed with staggered, tight joints. Care should be" exercised to avoid air voids along the joints and at end sections. Sections of sod that leave more than 1/2 inch joints opening shall be filled with a screened topsoil. Exposed edges shall be mounded with topsoil.

The sod shall be laid with staggered joints and shall run parallel to a 90-degree angle to the slope of the ground. If the slope is steeper than 2:1, the prepared sod bed shall be lightly and sufficiently watered prior to placement of the sod.

All sod laid slopes within 4 vertical feet of the flow line of open channels, gulches, etc. shall be held in place with 12 gauge u-shaped metal pins, minimum one inch in width, eight inches long driven flush with the top of the root zone. Prior to pinning, a 12" wide strip of 20 gauge 2" galvanized wire netting shall be placed at each corner and one in the center of each perpendicular edge (3 pins/1e" wide roll). Care shall be taken to insure that each pin will secure the wire netting to the sod. Pins shall be driven at intervals not greater than one foot from beginning to end of the roll and at each grade change in the slope. All sod shall be laid parallel to the center line of the channel.

20.0.3.4 Fertilizer Placement

Fertilizing accomplished in a two step operation as follows:

- a. Cow manure shall be spread over the surface of the ground of the areas to be covered at the minimum rate of one (1) cubic yard per thousand (1,000) square feet. The areas shall then be thoroughly roto-tilled to a depth of from a minimum of 4 inches to a maximum of 6 inches until no manure appears on the surface.
- b. Commercial Fertilizer shall be uniformly applied after the sod has been laid at the rate of 10-pounds per 1,000 square feet of coverage or as recommended by the fertilizer manufacturer. The method of application shall be subject to approval by the Construction Project Manager.

20.0.3.5 Maintenance

The Contractor shall be responsible for watering and mowing the sodded areas. Watering shall be performed periodically to insure a uniform root extension into the bed root--moisture zone. Mowing shall be performed to limit maximum grass height to three (3) inches and cut length of one and one-half (1-1/2) inches.

The maintenance period for sod shall continue for 90 days after notification in writing to the Construction Project Manager of the completion of sodding and the owner's initial approval. During this 90-day period the sod shall be kept growing and in place, and any movement or dead grass shall be replaced to the satisfaction of the Construction Project Manager. During this period, the sod's condition shall show normal to good progress so as to constitute an acceptable planting by the owner's representative. Watering shall be as required. If the planting within the reasonable care of the contractor does not show acceptable progress during this period, the areas affected shall be resodded, fertilized as required and growth progress repeated until results are obtained. This reworking shall be at the contractor's expense. If the planting is damaged or otherwise hindered due to causes beyond the contractor's control such as inclement weather or vandalism, the contractor shall rework the planting according to the item in the Measurement and Payment Section of these Standard Construction Specifications.

End of Specification



CITY AND COUNTY OF DENVER
ENGINEERING DIVISION

Wastewater Capital Projects Management Standard Construction Specification

21.0 Sprinkler Systems

21.0.1 General

This section outlines the guidelines and requirements required to construct irrigation distribution lines and sprinkler systems required to complete construction per the Contract Documents.

The work shall include the installation of all line pipes, fittings, valves, and blow-offs, drain valves, controllers, electrical control and supply wires, all fittings and tapped couplings necessary for the connection of the lateral sprinkling system lines to the distribution system lines, etc. Also included will be the plugging and blocking of the cut ends of disconnected existing lines if any, connection to existing park water lines and/or city water mains, meter installation, and all fittings, valves, accessories, etc. necessary for these connections.

The pipe shall be installed to the prescribed lines and grades. All work required for the construction of the water lines, accessories and appurtenances thereto, including excavation, trenching, concrete work, pressure tests and miscellaneous items of work covered by the Plans and these Standard Construction Specifications shall be preformed.

21.0.2 Proposed Substitutions

Substitutions which will result in any changes in layout, installation, or coverage as designed and shown on the Plans and specified herein shall be accompanied by plans clearly showing the proposed installation including but not limited to materials, spacing, precipitation and scheduling. Such plans must be approved by the Construction Project Manager before work is to start.

21.0.3 Qualifications of Installers

The sprinkler system contractor shall have had considerable experience and demonstrated ability in the installation of sprinkler irrigation systems of this type. All work shall be installed by skilled persons proficient in the trades as required, in a neat, orderly and responsible manner with recognized standards of workmanship. At least one person shall be present at all times during the execution of this work who shall be thoroughly familiar with the type of materials being installed and the material manufacturers' recommended methods of installation and who shall direct work performed under this section.

21.0.4 Staking

All necessary staking for construction of the sprinkler system shall be done by the Contractor and checked by the City before excavation or installation is begun.

21.0.5 Material

Unless otherwise noted or approved, all materials shall be of the type as shown on the Plans and shall conform to the following specifications. Asbestos Cement Pipe shall not be used.

21.0.5.1 Plastic Pipe

1. Rigid Plastic Pipe

Shall be polyvinyl chloride (PVC) and shall conform to all requirements of Product Standard PS-22 or ASTM D-2241 or PVC 1120 (Type I), SDR-21 (Class 200). Pipe shall be National Sanitation Foundation (NSF) approved. Fittings shall be socket type PVC schedule 40 meeting all requirements of ASTM D-2466 and D-1784. Solvent used for joining pipe & fittings shall meet all requirements of ASTM D-2564 Rigid plastic pipe shall not be threaded except as noted below.

2. Riser and Swing Joint Nipples

Shall be PVC Schedule 80 threaded pipe and shall conform to all requirements of Product Standard PS-21 or ASTM D-1785. Fittings shall be threaded PVC Schedule 40 meeting all requirements of ASTM D-2466 and D-1784. Use Teflon tape on all threaded joints.

3. Flexible Plastic Pipe

Shall be polyethylene (PE), 80 psi rated and shall conform to all requirements of Product Standard PS-11 or ASTM D-2239 or PE-2306, SDR-15. Pipe shall be National Sanitation Foundation (NSF) approved. Fittings shall be insert type PVC meeting requirements of ASTM D-2609. Clamps shall be all stainless steel. Flexible plastic pipe shall not be used in any continuous pressure application.

4. Markings

All plastic pipe shall be continuously & permanently marked with the manufacturers name, pipe size, schedule number or SDR number, type of material and code number.

21.0.5.2 Copper Pipe

Copper pipe shall be type K copper, ASTM B-88. Fittings for copper pipe shall be wrought copper or cast bronze, 150 psi class. Joints shall be solder joints with 95-5 tin-antimony.

21.0.5.3 Galvanized Steel Pipe

Galvanized Steel Pipe shall be schedule 40 steel. Fittings shall be malleable galvanized iron, screwed pattern, 150 psi class. Galvanized pipe and fittings shall conform to ASTM A-120. Buried galvanized pipe except risers and casing shall be wrapped with heavy craft paper applied with hot asphalt. Wrap on fittings shall be glass cloth. Use Teflon tape on all threaded joints.

21.0.5.4 Gate Valves

Gate Valves shall be Class 125 (200 psi w.o.g.), shall open by turning to the left, shall have non-rising stems and shall have a clear waterway equal to the full nominal diameter of the valve. Gate valves (not buried) shall have solid wedges, union bonnets and shall comply with the following materials specifications: Handwheel Nut -Bronze ASTH B-16. Stem -Silicon Bronze ASTH B-371 Alloy A (Rod) or ASTH B-198 Alloy 13B; Packing -Teflon impregnated Asbestos; Packing Gland -Bronze ASTM B-62 or B16 ; Packing Nut, Stuffing Box, Bonnet, Union Nut, Body Wedge and Wedge Holder- Bronze ASTH B-62. These valves shall conform to Federal Specification WW-V-54C Class A, Type I. Buried gate valves 2 and larger shall conform to AWWA C-500, with double-disk wedges and O-ring seals.

21.0.5.5 Valve Boxes

Unless shown or noted otherwise, all underground valves not located in pits shall have cast iron boxes with flared bases. Valve boxes shall be 2 piece screw type.

21.0.5.6 Angle Valves

Angle Valves shall be rated at 150 psi or more, and shall open by turning to the left. Angle valves shall be designed for above or below ground installation with suitable cross wheel for operation with key. Valves shall have removable bonnet and stem assembly with packing gland nut and with replaceable seat washers. Angle valves shall be heavy pattern brass construction of the make and size shown on Plans or approved equal.

21.0.5.7 Drain Valves

Drain Valves shall be rated at 150 w.o.g. or more, shall open by turning to the left, and shall be the make and size as shown on Plans or approved equal. Unless shown or noted otherwise, drain valves shall be 3/4". If valve discharge is not downward, valves shall be provided with elbow for downward discharge.

21.0.5.8 Quick Coupler Valves

Quick Coupler Valves shall be 2 piece all brass construction of the make and size as shown on Plans or approved equal. Quick coupler keys and hose swivels shall be provided as shown on the Drawings.

21.0.5.9 Manual Control Valves

Manual Control Valves shall be either angle valves as described herein or Class 125 bronze globe valves meeting requirements of Federal Specification WW-V-51d Class A, Type I. They shall be of the make and size as shown on Plans or approved equal. Valves shall be key operated.

21.0.5.10 Electric Control Valves

Electric Control Valves shall be brass construction, normally closed, 24 volt AC electrically operated globe valves with slow-opening and slow-closing devices. They shall be of the make, model numbers, and size as shown on the Plans or approved equal.

21.0.5.11 Valve Keys

Two valve keys shall be provided for each type key operated valve installed.

21.0.5.12 Unions

Brass unions shall be provided where shown and/or required to allow removal of all control valves.

21.0.5.13 Valve Pits

Valve Pits shall be constructed as shown in the Valve Pit and Piping Detail. of these Standard Construction Specifications. Concrete shall conform to the requirements of Item 12 of the Standard Construction Specifications. Precast concrete rings or fiberglass pits and their respective covers may be submitted for approval by the Construction Project Manager.

21.0.5.14 Automatic Controllers

Automatic Controllers shall be 110 volt input, 24 volt AC valve output with both controller and control valves of the same manufacturer, designed to operate as a unit or as otherwise shown on the Plans. Controllers shall be capable of operating the number of valves shown on the Plan and shall be pedestal mounted unless shown otherwise on the Plans.

Controllers shall have a 2 hour clock, 14 day calendar wheel and individual station timers from 0 to 30 minutes. Manufacturer and model numbers shall be as shown on the Plans or approved equal. Unless located inside of a building, the controller shall be enclosed in an approved separate weatherproof, vandal resistant cabinet. A lock and 3 keys shall be furnished with each unit.

21.0.5.15 Sprinkler Heads

Sprinkler Heads of the type and size as shown on the Plans shall be furnished and installed as herein specified.

21.0.5.16 Electric Control Wiring

Electric Control Wiring shall be No.14 direct burial type U.F. cable or larger if required to operate the system as designed. Follow the recommendations of the controller manufacturer for sizing wire.

21.0.6 Installation

21.0.6.1 General

Prior to any work described in this section, the Contractor shall carefully inspect the installed work of all other trades and verify that all such work is complete to the point where this installation may properly commence. The Contractor shall verify that the irrigation system can be installed in strict accordance with all pertinent Permits, codes and regulations, the original design, the referenced standards and the manufacturer recommendations. All necessary field measurements shall be made by the Contractor to ensure precise fit of items in accordance with the original design.

21.0.6.2 Excavation

Plastic pipe up to 2" in diameter may be direct bore if approved by the Construction Project Manager. All other lines shall be installed in open cut trenches. The width of the trench in which the pipe will be placed shall be sufficient to allow thorough tamping of suitable backfill material under, around and over the pipe. All excavated material shall be deposited at least two feet away from any trench side. Tunneling will be permitted only where pipe

must pass under any obstruction which cannot be removed. In backfilling the tunnel, the final density of the backfill must match that of the surrounding soil. It shall be acceptable to use a casing of suitable diameter which shall be installed first by tunneling or jacking, and the pipe shall then be laid through the casing, observing the same precautions as though it were installed in open trench. Any trench deeper than 6 feet shall be adequately shored and/or braced for safety considerations. If ground water is encountered during trench excavation above the elevation of the bottom of the pipe bell, such water shall be removed until the pipe has been installed and the trench backfilled. The Contractor shall take all necessary measures to insure that no ground water enters the pipe.

21.0.6.3 Piping and Control Wiring Depth

All lines shall be installed with the following minimum depths of cover unless noted otherwise on the drawings:

- a. Pressure Lines 30"
- b. Distribution Lines (Laterals) 6" to 18"
- c. Lines to Drinking Fountains 30"
- d. Lines to Quick Couplers 30"
- e. Electrical Lines 24"

21.0.6.4 Piping

All pipes shall be installed according to the following specifications.

1. Rigid Plastic Pipe

Exercise care in handling, loading unloading and storing plastic pipe and fittings; store plastic pipe and fittings under cover until ready to be installed; transport plastic pipe only on a vehicle with a bed long enough to allow the pipe to lay flat to avoid undue bending and concentrated external load. Repair all dented and damaged pipe by cutting out the dented or damaged section and rejoining with a coupling. In jointing, use only the specified solvent and make all joints in strict accordance with the manufacturer's recommended methods; give solvent welds at least 15 minutes set-up time before moving or handling; and 24 hours curing time before filling with water. If manufacturer's recommendations do not cover all aspects of jointing, the recommendations of Plastics Pipe Institute Technical Report TR10 shall be followed. Piping shall be snaked in the trench, centerload the pipe with a small amount of backfill to prevent arching and deflection under pressure. All piping shall be sloped to drain and shall not be installed when air temperature is below freezing.

2. Flexible Plastic Pipe

Shall be installed in strict accordance with the manufacturer's recommendation. If the manufacturer's recommendation does not cover all aspects of installation the recommendations of the Plastics Pipe Institute Technical Report TR8 shall be followed. Piping shall be sloped to drain. Saddle tee connections shall not be used. Pipe shall not be installed when air temperature is below freezing.

3. Copper Pipe

Shall be installed according to manufacturer's recommendations. When copper pipe is jointed to any metal pipe or equipment other than copper it shall be by means of dielectric unions. Pipe shall be sloped to drain.

4. Galvanized Steel Pipe

Make all cuts in galvanized pipe square. Cuts shall be thoroughly reamed with all rough edges and burrs removed. Use joint tape on male threads only. Pipe shall be sloped to drain.

21.0.6.5 Valves and Valve Boxes

Installation of Valves and Valve Boxes shall be in accordance with the following:

1. Gate Valves

Shall be installed where shown on the Plans and shall be set plumb. Gate valves 6" and larger shall be anchored to a block of concrete to insure stability of the valve in an upright position. Anchor valve in such a manner that it may be removed and re-installed without breaking the concrete block.

2. Valve Boxes

Shall be installed where shown on the Plans and shall be set plumb. Gate valves 6" and larger shall be anchored to a block of concrete to insure stability of the valve in an upright position. Anchor valve in such a manner that it may be removed and re-installed without breaking the concrete block.

3. Angle Valves and Drain Valves

Shall be installed where shown on the Plans and also at other low points in the system as necessary to insure complete drainage of the system. Each valve not in a valve pit shall be provided with a C.I. Valve box with the lid set flush with the ground. Drain valves set below valve pits shall have PVC sleeves for key operation. Sleeves shall project a minimum of 12" from the pit bottom and shall have removable caps. A drainage sump shall be provided for each drain valve and shall contain a minimum of 4 cubic feet of gravel. See "Valve & Pit Piping Detail" of these Standard Construction Specifications.

4. Quick Coupler Valves

Shall be installed where shown on the plans and as shown in "Valve Pit & Piping Detail". Risers for quick couplers shall be schedule 40 galvanized. In lawn areas install quick coupling valves using a double swing joint top flush to final grade. In planting areas install with top 2" above grade.

5. Manual Control Valves

Shall be installed where shown on the Plans and in accordance with manufacturer's recommendations. All manual control valves shall be in valve pits or valve boxes.

6. Electric Control Valves

Shall be installed as shown in "Valve Pit & Piping Detail". Valves shall be installed in such a way that they are accessible for repairs and/or removal.

21.0.6.6 Valve Pits

Install valve pits where shown on the Plans and as shown in "Valve Pit & Piping Detail".

21.0.6.7 Automatic Controllers

Install controllers where shown on the Plans and in accordance with the manufacturer's recommendations and, if pedestal type, as shown on "Controller Pedestal Detail" of these Standard Construction Specifications.

21.0.7 Flushing

Before sprinkler heads are set, the lines shall be thoroughly flushed in order to make sure that there is no foreign matter in lines which could cause stoppage of the sprinklers. When the system has been fully completed, it shall be tested and the operation thereof demonstrated to the City.

21.0.8 Inspection

No work shall be covered up or enclosed until it has been inspected, tested and approved by the City. The Contractor shall thoroughly clean, adjust and balance all systems. The Contractor shall demonstrate the entire system to the City proving that all remote control valves are properly balanced, that all heads are properly adjusted for radius and arc of coverage and that the installed system is workable, clean and efficient.

21.0.9 Testing

The Contractor shall furnish all necessary testing equipment and personnel and test the system as follows:

- a. make all necessary provisions for thoroughly bleeding the line of air.
- b. Before testing, fill the line with water for a period of at least 24 hours.
- c. After valves have been installed, test all live water lines for leaks at a hydrostatic pressure of 150 psi for a period of two hours with all couplings exposed and with all pipe sections center loaded.
- d. Correct all leaks, and replace damaged or faulty pipe and retest until accepted by the City.

21.0.10 Backfilling

Trenches shall be carefully backfilled with suitable materials free from clods of soil or stones larger than three inches (3.) in maximum dimension. Deposit the backfill materials equally on both sides of the pipe in 6" layers and compact thoroughly. Puddling or "ponding" shall be required. An excess of water shall be avoided in order to prevent disturbance of the earth under and around the pipe and also to prevent undue pressure upon the pipe. Likewise, the amount of water used shall be controlled so as not to risk "floating" the pipe out of position. Adequate dikes shall be constructed along the trench to retain and guide the water.

When jetting is used, jets shall be of an approved design and of sufficient length to reach the bottom of each layer and the water supply shall be continuous. All costs incurred in

getting the water to the point of use for the above purposes shall be borne by the Contractor. Excavated material will generally be considered satisfactory for backfill purposes. All backfill material shall be free from rubbish, vegetable matter, frozen materials, or stones larger than three inches (3.) in maximum dimension. Any material not suitable for backfill or not used shall be removed from site by the Contractor. Backfill shall not be done in freezing weather except with written approval from the City. All trenches shall be left slightly mounded to allow for settlement after the backfilling is completed. The site of the work shall be continuously cleaned up of excess and/or waste materials as the backfilling progresses and shall be left in a neat and workmanlike condition to the satisfaction of the City. Any undue settling which results within one year after final acceptance of work shall be corrected by the Contractor and at the Contractor's expense including resurfacing as required.

21.0.11 Area Restoration

Where trenches and lines cross existing roadways, paths, curbing, etc., damage to these shall be kept to a minimum and they shall be restored to as near original condition as possible. Match existing road section for blacktop paving thoroughly compacted sub-base, base course, bituminous course matching grades of existing paving. Blacktop curbs hot mix bituminous course material tamped and shaped to match adjoining curbs. Concrete paving or curbs concrete to match adjoining concrete work. The quality of the materials used in this restoration shall be equal to or better than the material which was removed, or as shown on the Plans or specified

21.0.12 Water Service

21.0.12.1 Scope

This work consists of providing water service for the sprinkler system by connecting the system to existing park water lines and/or city water mains. The work includes the furnishing of all labor, supervision, construction equipment and materials including piping, valves, meters, meter pits and backflow prevention devices. All work required to complete the water service in conformance to the Plans and Specifications including excavation, trenching, concrete work pressure tests, and miscellaneous items of related work shall be preformed.

21.0.12.2 Workmanship

All materials and equipment shall be installed in a first class, workmanlike manner using workmen who are skilled and certified in their respective trades.

21.0.12.3 Building Code

All work shall be in accordance with the Denver Building Code, latest revision.

21.0.12.4 Connection to Existing Park Water Lines

Connection to Existing Park Water Lines shall be made by tapping sleeves, tees or crosses. All fittings shall have a design working pressure of 150 psi; all material shall conform to the requirements herein specified

21.0.12.5 Connections to City Water Mains

Connections to City Water Mains shall be done in accordance with Denver Water Board Requirements and regulations.

21.0.12.6 Materials

Unless otherwise noted or approved, all material shall conform to the following Specifications .

1. Copper Pipe

Shall be Type k copper, ASTM B-88. Fittings for copper pipe shall be wrought copper or cast bronze, 150 psi class. Joints shall be solder joints with 95-5 tin -antimony.

2. Cast Iron Pipe

Shall meet the requirements of AWWA Standards C-101 and C-106 for 150 psi working pressure. Unless otherwise noted, cast iron pipe shall have push on type joints approved by the Construction Project Manager and installed in strict accordance with manufacturers recommendations. Cement lining shall conform to AWWA Standard C-104. Rubber gasket joints shall conform to AWWA Standard C-111.

3. Curb Valves

All curb valves between the main and the meter shall be rated at 175 psi w.o.g., and shall open by turning to the right. Curb valves shall be all bronze with "O" ring seals. Curb valves shall have cast iron curb boxes complete with lid and foot piece designed for use with the curb valve. Make and size shall be as shown on the Plans. Curb valves must be approved by the Denver Water Board.

4. Gate Valves

All gate valves used in conjunction with water meters shall be as approved by the Denver Water Board.

5. Water Meter

The size shall be as shown on the Meter and shall be of the type approved by the Denver Water Board.

6. Backflow Preventer Device

Shall be of the type as shown on the Plans. The backflow prevention device must be approved by the Denver Water Board and shall be furnished with inlet and discharge shut-off valves.

7. Pit for Water Meter

Shall be as per Denver Water Board requirements. Water Service installation shall conform to the following specifications.

- a. Excavation.** The width of the trench in which the pipe will be placed shall be sufficient to allow thorough tamping of suitable backfill material under, around and over the pipe. All excavated materials shall be deposited at least two feet away from any trench side.

Any trench deeper than 6 feet shall be adequately shored and/or braced for safety considerations. If ground water is encountered during trench excavation above the elevation of the bottom of the pipe bell all water shall be removed until the pipe has been installed and the trench backfilled.

b. Cast Iron Pipe shall be installed in accordance with the recommendations of the manufacturer. Unless noted otherwise or approved by the Construction Project Manager, cast iron pipe shall be embedded in and covered by a minimum of 6 inches of pea gravel; max. 3/8" dia.

c. Copper Pipe shall be installed in accordance with the manufacturer's recommendations. When copper pipe is jointed to any metal pipe or equipment other than copper, brass or bronze, it shall be by means of dielectric unions.

d. Testing required for this portion of the system shall be the same as that described in Section 21.3 of these Standard Construction Specifications.

e. Backfilling requirements shall be the same as those described in Section 21.3 of these Standard Construction Specifications.

f. Restoration. Requirements for restoring area shall be the same as those described in Section 21.3 of these Standard Construction Specifications.

21.0.13 Electrical Service

21.0.13.1 Scope

This work consists of providing electrical service to the automatic sprinkler controllers. The work includes the furnishing of all labor, supervision, construction equipment and materials including wire, conduit, devices and appurtenances. All work required to complete the electrical service in conformity with the Plans and specifications including excavation, trenching and miscellaneous items of related work shall be performed.

21.0.13.2 Workmanship

All materials and equipment shall be installed in a first class, workmanlike manner, using workmen who are skilled and certified in their respective trades.

21.0.13.3 Code

All work shall be done in accordance with the Denver Building Code and the National Electrical Code, latest edition.

21.0.13.4 Materials and Installation

Material and Installation shall conform to the following specifications.

1. Wire

Shall be as shown on the Plans.

2. Sleeves

Shall be Schedule 40 galvanized steel. All wires buried in roadways shall have sleeves.

3. Service Connections

Coordinate with Public Service Company, Street Lighting Division for electrical service connection.

End of Specification



CITY AND COUNTY OF DENVER
ENGINEERING DIVISION

Wastewater Capital Projects Management Standard Construction Specification

22.0 Seeding

22.1.1 General

This work shall consist of furnishing and drilling in seed or hydromulch seeding in accordance with these Standard Construction Specifications and as shown on the Plans. The work shall also include soil preparation, furnishing and spreading fertilizer and installation of mulch and erosion control blanket.

All areas shall be seeded by drilling. In areas where access is a problem, seeding shall be conducted by hydromulch seeding as directed by the Construction Project Manager. Mulch shall be required in all areas that are drilled.

Seeding and the installation of erosion control in certain areas designated by the Construction Project Manager may be permitted before the construction of certain areas to take advantage of growing conditions.

Seeding shall not be accomplished when the ground is frozen or otherwise unillable.

Seeded areas damaged due to circumstances beyond the Contractor's control shall be repaired and reseeded as ordered. Payment for this corrective work shall be at the contract price.

22.1.2 Grading

All areas requiring seeding shall be cleared of vegetation, roots, oversized materials and all other material which is objectionable in the opinion of the Resident Engineer and shall be disposed of as specified in Section 2.0, Site Preparation.

22.2 Materials

22.2.1 Seed

All seed shall be furnished in bags or containers clearly labeled to show the name and address of the supplier, the seed name, the lot number, net weight, the percentage of purity and germination. All brands furnished shall be free from such noxious seeds such as Russian or Canadian Thistle, European Bindweed, Johnson Grass and Leafy Spurge. All seed furnished shall be from a lot that has been tested by a recognized laboratory for seed

testing within six months prior to the date of delivery. Seed which has become wet, moldy, or otherwise damaged in transit or in storage will not be acceptable.

Seed Type. The seeds acceptable for drilling and hydromulch seeding are: (1) White Dutch Clover, (2) Fairway Wheatgrass, (3) Perennial Rye, (4) "Sodar" Streambank Wheatgrass, and (5) Luna Pubescent or Western Wheatgrass.

Seeding Mixture. The seeding mixture shall be applied at a bulk rate per acre as follows for hydromulch seeding:

	Pounds	Purity	Germination
(1) White Dutch Clover	1.1	96%	90%
(2) Fairway Wheatgrass	2.9	95%	85%
(3) Perennial Rye	3.5	98%	90%
(4) Sodar Streambank Wheatgrass	5.2	97%	92%
(5) Luna Pubescent Wheatgrass	8.9	93%	85%
(6) Western Wheatgrass	10	80%	80%

The seeding rate per acre for drilling shall be one-half the rate of hydromulch seeding.

- c. Seed Purity. Seed and seed labels shall conform to all current State and Federal regulations and will be subject to the testing provisions of the Association of Official Seed Analysis.

If seed available on the market does not meet the minimum purity and germination percentages specified, the Contractor must compensate for a lesser percentage of purity of germination by furnishing sufficient additional seed to equal the specified product. Product comparison shall be made on the basis of pure live seed in pounds. The formula used for determining the quantity of pure live seed (PLS) shall be:

$$\text{Pounds of Seed} \times (\text{Purity} \& \text{Germination}) = \text{Pounds of Live Seed (PLS)}$$

21.2.2 Fertilizers

Fertilizers shall consist of a standard brand fertilizer having a minimum content of 18% available nitrogen. The percentage of nitrogen content shall be certified at the time of use.

Super Phosphate (45% minimum Phosphate when called for on the Plans) will be used on subsoil where all topsoil has been removed. The rate of application shall be approximately 250 pounds per acre.

22.2.3 Erosion Control Blanket

Erosion Control Blanket. The blanket shall consist of a material or combination of materials that are biodegradable after a sufficiently long enough period of time to insure germination and rooting of grass seeds. The blanket shall have uniform openings and consist of knitted

yarn in a material that has enough strength and flexibility that allows it to be placed over uneven ground surfaces. The erosion control blanket shall be furnished in rolls that have a width of 4' minimum to 10' minimum. Length and weight of the rolls may vary depending on the manufacturer and the blanket material.

Pins and Staples. Pins or staples shall be made of wire .091" or larger in diameter. "U" shaped staples shall have legs 6" long and 1" crown." T" shaped pins shall have a minimum length of 8" after bending. The bar of the "T" shall be at least 4" long with the single wire end bent downward approximately ¾".

22.2.4 Tackifier

A tackifier will be required with all hydromulch seeding.

22.2.5 Hydromulch

Wood cellulose fiber for hydromulch seeding shall not contain any substance or factor, which might inhibit germination or growth of grass seed. It shall be dyed an appropriate color to allow metering of its application.

The wood cellulose fibers shall have the property of becoming evenly dispersed and suspended when agitated in water. When sprayed uniformly on the surface of the soil, the fibers shall form a blotterlike ground cover, which readily absorbs water, and allows infiltration to the underlying soil. Weight specifications from suppliers, and for all applications, shall refer only to air dry weight of the fiber, a standard equivalent to ten (10%) percent moisture. The mulch material shall be supplied in packages having a gross weight not in excess of one hundred (100) pounds, and shall be marked by the manufacturer to show the air dry weight content. Suppliers shall certify that the laboratory and field testing of their product has been accomplished and that it meets all of the foregoing requirements pertaining to wood cellulose fiber mulch.

22.2.6 Mulch

Materials for straw mulch shall consist of straw of oats, barley, wheat, or rye and shall not contain seed of noxious weeds.

Straw or hay in such an advanced stage of decomposition as to smother or retard the normal growth of grass will not be accepted. Old dry straw which breaks in the crimping process in lieu of bending will not be accepted.

22.3 Construction

22.3.1 Grade Preparation

Prior to seeding, the top 4 inches of the surface shall be tilled and brought to the desired line and grade, except where seeding follows so closely behind the initial grading as to make special seeding preparation unnecessary. Areas to be seeded shall be tilled or handworked into a reasonably even and loose sandbed immediately in advance of the seeding.

22.3.2 Seeding

Hydromulch Seeding. As required, cellulose fiber mulch shall be added with the proportionate quantities of water and other approved materials in the slurry tank. All ingredients shall be mixed to form a homogeneous slurry. Using the color of the mulch as a metering agent, the operator shall spray-apply the slurry mixture uniformly over the designated seeded area. Unless otherwise ordered for specific areas, wood cellulose fiber mulch shall be applied at the rate of 1500 pounds per acre or 35 pounds per 1,000 square feet.

Hydromulch seeding shall not be done in the presence of free surface water resulting from rains, melting snow or other causes.

Drilling. Seeding shall be accomplished by means of an approved mechanical power drawn drill, followed by packer wheels or drag chains. Seed shall not be drilled during windy weather or when the ground is frozen or otherwise untillable.

Mechanical power drawn drills shall have depth bands set to maintain a planting depth recommended for the type of seed being drilled and shall be set to space the rows not more than 7 inches apart.

If the inspections indicate the stripe wider than the specified space between the rows planted have been left or other areas skipped, the Construction Project Manager shall require immediate re-sowing of seed in such areas at the Contractor's expense.

All seeding shall be done between September 1 to September 15 and March 2 to April 15 of the Calendar year of construction.

The Contractor shall be responsible for maintaining and watering areas seeded for a period of 7 weeks after the time of seeding. Areas in which there is not a satisfactory stand at the expiration of this 7-week period shall be re-seeded. Sprinkling of the seeded areas shall be carefully done in such a manner as to avoid standing water, surface wash or scour. Areas seeded and so maintained shall be protected against damage by vehicle or pedestrian traffic by the use of barriers and appropriate warning signs. Areas shall be re-seeded as many times as is required to establish a significant growth of grass seedlings (a minimum of 25 plants per square feet).

22.3.3 Mulch

After seeding has been completed, a rate of 11/2 tons of hay or straw per acre, or as directed, shall be applied uniformly, crimped in with a crimper or other approved equipment. The Construction Project Manager may order the employment of hand crimping operations on such areas where excessive ground slopes or confined areas would cause unsatisfactory crimping by mechanical methods.

The seeded area shall be mulched and crimped within 24 hours after seeding. Areas not mulched and crimped within this 24-hour period must be reseeded with the specified seed mix at the Contractor's expense prior to mulching or crimping.

On steep slopes or other specific areas as shown on the plans, which are difficult to mulch or crimp by conventional methods, burlap or other blanketing materials properly anchored or secured may be used when approved by the Construction Project Manager.

22.3.4 Fertilizer

Fertilizer shall be spread uniformly at the rate specified and washed into the soil by the application of water or tilled into the top two inches of soil. Sufficient fertilizer shall be evenly distributed to provide 50 pounds of free nitrogen per acre.

22.3.5 Erosion Control Blanket (Channels, Etc.)

Erosion control blanket shall be installed on each side and bottom of the low flow channel as shown on the drawings and as directed by the Construction Project Manager. An additional row of blanket (approximately 4' to 5' wide) may be required in areas of steep slopes or southern exposures.

The area to be covered shall be properly prepared, fertilized and seeded before the erosion control blanket is applied. The blanket shall be placed in accordance with the manufacturer's recommendations and in such a manner to insure contact with the ground creating maximum protection for the newly planted seed. In the low flow channel, the erosion control blanket shall be applied in the direction of the flow of the water, butted snugly at the sides and lapped approximately one foot. On slopes the blankets may be applied either horizontally or vertically to the slope as directed by the Construction Project Manager. Ends and sides shall be butted snugly. The blanket shall be stapled down at intervals in accordance with the manufacturer's specifications.

The Contractor shall also be responsible for maintaining and caring for the erosion control blanket for a 7-week period. All blankets that are disturbed during this period will be replaced and restapled by the Contractor.

End of Specification



CITY AND COUNTY OF DENVER
ENGINEERING DIVISION

Wastewater Capital Projects Management Standard Construction Specification

23.0 Storm Water Management

23.0.1 Definitions

Definitions used for this Section shall consist of those listed in Title 1 of the City and County of Denver "Standard Specifications for Construction, General Contract Conditions" as referenced within the Contract Documents, those listed within the City and County of Denver Construction Activities Stormwater Manual (CASM), and the following:

23.0.1.1 Basis of Payment

The terms under which Work is paid, as a designated Pay Item, in accordance with the quantity measured and based upon the associated Measurement and Payment description.

23.0.1.2 Best Management Practices (BMPs)

Schedules of activities, prohibitions of practices, installation of devices, maintenance procedures, and other management practices deployed to stabilize the construction site to prevent or reduce the pollution of State Waters (see definition below). Stormwater BMPs can be classified as "structural" (i.e., devices installed or constructed on a site) or "non-structural" (procedures, such as modified landscaping practices).

23.0.1.3 Colorado Department of Health and Environment (CDPHE)

State of Colorado, Water Quality Control Division responsible for issuance of State Construction Stormwater Permit.

23.0.1.4 Construction Activities Stormwater Discharge Permit (CASDP)

Permit issued by the City for compliance with City & County of Denver Revised Municipal Code and Department of Public Works Rules & Regulations concerning the discharge of pollutants in storm generated runoff from construction sites to Municipal Separate Storm Sewer System (MS4, see definition below) or State Waters, via the Municipal Separate Storm Sewer System (MS4).

23.0.1.5 Construction Activities Stormwater Manual (CASM): City and County of Denver Construction Activities Stormwater Manual (CASM), current edition.

23.0.1.6 Colorado Department of Transportation (CDOT)

State agency that has published standards for Erosion Control with accompanying Erosion Control Supervisor certification courses.

23.0.1.7 Erosion Control Supervisor (ECS)

The Contractor's Erosion Control Supervisor, to perform duties as described in this Section. The ECS shall be properly trained in BMPs per requirements of Part V below, and shall be under the direction of a Professional Engineer licensed in the State of Colorado when performing any modifications to the Project Stormwater Management Plan (SWMP).

23.0.1.8 Final Stabilization

Point of construction when all ground surface disturbing activities at the site have been completed and uniform vegetative cover has reached 70% of pre-disturbance vegetative cover, or equivalent permanent features have been employed. At this point, all temporary BMPs can be removed, all construction and equipment maintenance wastes have been disposed of properly; and all elements of the Stormwater Management Plan have been completed.

23.0.1.9 Major SWMP Modification

Changes to the original SWMP that removes or adds additional area to the Project, or modifies the final hydrology or drainage of the Project. A Major SWMP Modification requires the submission of revised Storm water Management Plan (SWMP) elements to the Permit Authority for review and approval. Any adjustments to a SWMP must be performed either by or under the direction of a Professional Engineer licensed in the State of Colorado.

23.0.1.10 Minor SWMP Modification

Modification to the SWMP that does NOT increase the scope or change hydrology of the Project but: modifies/improves specific BMPs in use at site, indicates progression in phasing of the Project, or specifies relocation of previously approved BMPs within the Project. Any adjustments to a SWMP must be performed either by or under the direction of a Professional Engineer licensed in the State of Colorado.

23.0.1.11 Municipal Separate Storm Sewer System (MS4): A conveyance or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, man-made channels, or storm drains):

- a) owned or operated by a State, city, town, county, district, association, or other public body (created by or pursuant to State law) having jurisdiction over disposal of storm water or other wastes, including special districts under State law such as a sewer district, flood control district or drainage district, or similar entity, or a designated and approved management agency under Section 208 of the Federal Clean Water Act that discharges to State Waters;
- b) designed or used for collecting or conveying storm water;

- c) which is not a combined sewer; and
- d) which is not part of a Publicly Owned Treatment Works (POTW).

23.0.1.12 Permit Authority

The Department authorized by the City to review and process CASDP Applications for Capital and/ or governmental sponsored Projects. The responsible City department serving as the Permit Authority is the Public Works Project Controls Office. As a clarification, the Development Services Department of the City serves as the point of intake and permit processing center.

23.0.1.13 Permit Enforcement Authority

The Department authorized by the City to inspect and enforce CASDP Rules and Conditions for all construction Projects within the City's MS4 Boundary. The responsible City department serving as the Permit Enforcement Authority is the Wastewater Management Division of the Department of Public Works.

23.0.1.14 State Construction Stormwater Permit

Colorado Revised Statutes require that all construction sites/development Projects, which, by definition, disturb one or more acres in area, shall be covered by a State issued general permit for construction activities. Information on the application requirements for the State permit can be obtained by phone at 303-692-3500; or by visiting their offices located at 4300 Cherry Creek Drive South, Denver, CO 80246 – 1530 or on the Web at: www.cdphe.state.co.us

23.0.1.15 State Waters

Any and all surface waters which are contained in or flow in or through this State, not to include waters in sewage systems, waters in treatment works of disposal systems, waters in potable water distribution systems, and all water withdrawn for use until use and treatment have been completed. Examples of State Waters include, but are not limited to, perennial streams, intermittent or ephemeral gulches and arroyos, ponds, lakes, reservoirs, irrigation canals or ditches, wetlands, stormwater conveyances (when they discharge to a surface water), and groundwater.

23.0.1.16 Substantial Completion of Erosion Control

Point of construction when permanent BMPs have been installed, initial growth is in place, and the site is waiting for vegetative cover to reach 70% of pre-disturbance vegetative cover.

23.0.1.17 Stormwater Management Plan (SWMP)

A SWMP establishes a minimum standard to construct, install, maintain, and remove required BMPs during the life of the Contract to prevent or minimize pollution of stormwater due to erosion, sediment transport, and construction related pollutant generated during all phases of the Project.

23.0.2 General

This Work shall consist of constructing, installing, maintaining, and removing when required, BMPs during the life of the Contract until Final Stabilization to prevent or minimize erosion, sedimentation, and pollution of any waters including storm, drainageways, MS4, State Waters, and/ or wetlands. Work under this Section includes the Contractor obtaining required Permits, utilizing SWMP elements provided in the Contract, and/ or SWMP elements specifically prepared by the Contractor as defined herein. The work shall also consist of providing on-going maintenance and monitoring of the SWMP as may be necessary due to the specific and/ or dynamic needs of the Project as well as meet all requirements set forth within the CASM.

The Contractor shall coordinate the construction of temporary BMPs with the construction of permanent BMPs to assure economical, effective, and continuous erosion and sediment control and water pollution prevention throughout the construction period until Final Stabilization is achieved

When a provision of this Section or an order by the Permit Enforcement Authority requires that an action be immediate or taken immediately, it shall be understood that the Contractor will at once begin effecting completion of the action and pursue it to completion in a manner acceptable to the Permit Enforcement Authority, and in accordance with applicable Permitting requirements.

A SWMP consists of the following elements:

- (i) CASDP Narrative Worksheet with Narrative Report. The Narrative Report and supporting documents should fully address the methods to be used to prevent sediment, debris, and other pollutants from entering the MS4 and/ or State Waters in and around the Project area. Proposed structural and non-structural BMPs should be described with sufficient implementation detail to insure that the logical phases of the proposed construction Project meet the performance standards listed in the CASM.
- (ii) Proposed site drawings and Best Management Practice (BMP) installation details as they apply to the site conforming to the Urban Storm Drainage Criteria Manual, Vol. 3, "Best Management Practices", most current version as issued by the Urban Drainage and Flood Control District (UDFCD), or those established by the City's Department of Public Works. If erosion control drawings were included within the bid documents for the Project, they shall be used for bid purposes and initial planning/ deployment of BMPs on the Project. If provided drawings are signed/ sealed by a Professional Engineer, they have been pre-approved by the Permit Authority and may be used without revision for purposes of submitting for CASDP. If provided drawings do not have signature/ seal of Professional Engineer licensed by the State of Colorado, they will require revision by the Contractor with

Professional Engineer signature/ seal prior to submission to the City and County of Denver for CASDP.

- (iii) Supporting documentation related to proposed BMPs that are not currently identified in UDFCD Vol. 3 or as otherwise published by the City.

Any preparation of or adjustments to a SWMP must be performed either by or under the supervision of a Professional Engineer licensed in the State of Colorado. SWMP elements submitted to the City shall also meet currently established criteria of the CDPHE as the SWMP must meet all local, State and Federal requirements.

23.0.3 Materials

Materials to be used for BMPs shall conform to each specific detail as set forth within the approved project SWMP or as noted within the Contract Documents.

23.0.4 Erosion Control Permit

The applicable storm water management bid item included within the contract documents will indicate which of the following scenarios applies for the project.

23.0.4.1 Scenario 1: CASDP is not required.

A SWMP is currently not required for this project as the proposed disturbed area and/ or proximity to stream does not meet the minimum criteria for requiring a CASDP. All portions of this specification following this subsection are hereby deleted and shall not be made part of the Project. However, the responsibilities for minimizing sediment pollution from the Project have not been waived, and as such, the City hereby requires the Contractor to perform as specified within this subsection. All costs for performance of the following are included within the associated Storm Water Management bid item included within the contract and shall not be paid for separately.

- a) A CASDP Permit will not be required for this project, however, the Contractor and/or their authorized agents shall ensure that all potential pollutants generated during demolition, excavation, trenching, boring, grading, or other construction Work associated with this permit, be prevented from discharge to stormwater conveyance systems in the vicinity of the Project.
- b) The Contractor shall remove all sediment, mud, construction debris, or other potential pollutants that may have been discharged to or, accumulate in the flow lines of storm drainage appurtenances and public rights of ways of the City and County of Denver as a result of construction activities associated with this Project. All removals shall be conducted in a timely manner.
- c) The Contractor shall be held responsible for remediation of any adverse impacts to the MS4, State Waters, waterways, wetlands, and or other public or private properties, resulting from work done as part of this Project.

- d) The Contractor shall insure that all loads of cut and fill material imported to or exported from the Project shall be properly covered to prevent loss of the material during transport on public rights of way.” (Sec.49-552; Revised Municipal Code)
- e) Approved erosion and sediment control ‘Best Management Practices’ shall be maintained and kept in good repair for the duration of the Project. All necessary maintenance and repair shall be completed immediately upon discovery of any deficiency or defect.
- f) The Contractor shall implement the following Best Management Practices (BMPs) on site during construction:
- i. **VEHICLE TRACKING CONTROL:** This BMP is required at all access points to a construction site that are used by vehicular traffic or construction equipment.
 - ii. **INLET PROTECTION:** This BMP is required on all existing or proposed storm sewer inlets in the vicinity of the construction site that may receive site runoff. The BMP must be appropriate to the type of storm inlet and appropriate for the ground surface at the inlet.
 - iii. **INTERIM SITE STABILIZATION:** This BMP is required to provide a measure for preventing the discharge of sediment from construction sites where overlot grading or other site disturbance has occurred. This BMP is particularly necessary on sites where construction activities/disturbance will be limited to small areas of the project site. Acceptable BMPs include:
 - Preserving existing vegetation
 - Seeding and planting
 - Mulching
 - Mulching and seeding
 - Temporary/Permanent re-vegetation operations
 - Chemical soil stabilizer application (requires Permit Enforcement Authority approval)
 - iv. **WASTE MANAGEMENT/CONTAINMENT:** This BMP requires that all construction wastes, fuels, lubricants, chemical wastes, trash, sanitary wastes, contaminated soils or debris shall be contained on site, protected from contact with precipitation or surface runoff, periodically removed from the construction site, and properly disposed of.
 - v. **SPILL PREVENTION /CONTAINMENT:** This BMP defines the measures proposed for preventing, controlling, or containing spills of fuel, lubricants, or other pollutants; and protecting potential pollutants from contact with precipitation or runoff.
 - vi. **CHUTE WASHOUT CONTAINMENT:** Water used in the cleaning of ready mixed concrete truck delivery chutes shall be discharged into a predefined, bermed containment area on the job site. The required

- containment area is to be bermed so that wash water is totally contained. Wash water discharged into the containment area shall be allowed to infiltrate or evaporate. Dried concrete waste shall be removed from the containment area and properly disposed of.
- vii. Should a predefined bermed containment area not be available due to the project size, or lack of an area with a suitable ground surface for establishing a containment area, proper disposal of ready mix washout and rinse off water at the job site shall conform to the approved techniques and practices identified in the Colorado Department of Public Health & Environment's training video entitled "Building For a Cleaner Environment, Ready Mix Washout Training", and its accompanying manual entitled, "Ready Mix Washout Guidebook, Vehicle and Equipment Washout at Construction Sites."
 - viii. The direct or indirect discharge of water containing waste concrete to the storm sewer system is prohibited (Sec.56-102a, c; Revised Municipal Code, City and County of Denver).
 - ix. Information about, or copies of the video and training manual are available from the Water Quality Control Division, Colorado Department of Public Health & Environment, 4300 Cherry Creek Drive South, Denver, Colorado 80222-1530, (303) 692-3555.
 - x. **STREET SWEEPING:** This BMP requires that paved surfaces which are adjacent to construction sites be swept in a timely manner when sediment and other materials are tracked or discharged on to them. Either sweeping by hand or use of street sweepers is acceptable. Street sweepers using water while sweeping is preferred in order to minimize dust. Flushing off paved surfaces with water is prohibited.
 - xi. **PERIMETER CONTROL:** This BMP requires that a construction site install a perimeter control measure along the edge of the construction site, to prevent, or filter the discharge of surface runoff from the construction site. The type of perimeter control used shall be determined based on site conditions and location. Maintenance and repair of the control measure shall occur as needed, in a timely manner.
 - xii. **STOCK PILES:** Soils that will be stockpiled for more than thirty (30) days shall be protected from wind and water erosion within fourteen (14) days of stockpile construction. Stabilization of stockpiles located within 100 feet of an MS4 or State Waters, or with slopes 3 to 1 or greater shall be completed within seven (7) days following stockpile construction. Stabilization and protection of the stockpile may be accomplished by any of the following: Mulching, Temporary/Permanent Revegetation Operations, Chemical Soil Stabilizer Application (requires Permit Enforcement Authority approval), or erosion control matting/Geotextiles. If stockpiles are located within 100 feet of an MS4 or State Waters, a drainageway or the site perimeter, additional sediment controls shall be required.

- xiii. **SAW CUTTING OPERATIONS:** The Contractor shall protect all storm sewer facilities adjacent to any location where pavement cutting operations involving wheel cutting, saw cutting, or abrasive water jet cutting are to occur. The Contractor shall remove and properly dispose of all waste products generated by said cutting operations on a daily basis or as needed throughout the work day. The discharge of any water contaminated by waste products from cutting operations to the storm sewer system is prohibited. (Sec.56-102a, c; Revised Municipal Code, City and County of Denver).”

23.0.4.2 Scenario 2: CASDP and State Construction Storm Water Permit(s) are required. No SWMP element(s) are included. The City has not provided SWMP elements nor obtained required CASDP or State Construction Stormwater Permit(s) in advance of bid.

SWMP elements have not been included in the Contract Documents. The Contractor shall plan and coordinate with the Permit Authority to prepare all required SWMP elements and obtain required CASDP. Per CASDP requirements, the Contractor shall obtain the endorsement of a Professional Engineer licensed in the State of Colorado for preparation of the initial SWMP and/or any proposed Major or Minor SWMP Amendments. This will require the Contractor to provide or retain a Professional Engineer or subcontract with the original Professional Engineer that prepared the Bid Documents.

The Contractor is hereby made aware that the Permit Authority allots up to 3 weeks per review cycle for CASDP Permit applications (2 review cycles are not uncommon).

Per definition, a Major SWMP Modification requires the submission of revised SWMP elements to the Permit Authority for review and approval.

Prior to issuance of a Notice to Proceed, the Contractor shall obtain required State Construction Stormwater Permit(s) as applicable.

23.0.4.3 Scenario 3: CASDP and State Construction Storm Water Permit(s) are required and “For reference only” SWMP erosion control drawings have been provided. The City has not obtained required CASDP or State Construction Stormwater Permit(s) in advance of bid.

The Contractor shall submit a complete SWMP and application to the Permit Authority to obtain the required CASDP. The Contractor shall use the provided “For reference only” erosion control drawings provided in the Contract as a starting point for preparation of required SWMP elements (as required for CASDP) and for general information as to the origin of pay items included in the Bid Documents. The included erosion control drawings have been previously reviewed by the Permit Authority, and the BMPs shown therein have been found to be generally acceptable by the Permit Authority.

It shall be the responsibility of the Contractor to prepare and acquire approval of a complete SWMP and obtain a CASDP from the Permit Authority prior to beginning construction. The

Contractor is hereby made aware that the Permit Authority allots up to 3 weeks per review cycle for CASDP applications (2 review cycles are not uncommon).

Per CASDP requirements, the Contractor shall obtain the endorsement of a Professional Engineer licensed in the State of Colorado for preparation of the initial SWMP and/ or any proposed Major or Minor SWMP Amendments. This will require the Contractor to provide or retain a Professional Engineer or subcontract with the original Professional Engineer of the "For reference only" erosion control drawings.

Per definition, a Major SWMP Modification requires the submission of revised SWMP elements to the Permit Authority for review and approval.

Prior to construction, the Contractor shall obtain the required State Construction Stormwater Permit(s) as applicable.

23.0.4.4 Scenario 4: CASDP and State Construction Storm Water Permit(s) are required and completed SWMP has been included. The City has obtained CASDP in advance of bid. The City has not obtained State Construction Stormwater Permit prior to bid.

An approved SWMP has been prepared and CASDP obtained by the City prior to bidding of the Project and as such must be properly transferred to the Contractor prior to the start of construction. The SWMP has been provided within the Bid Documents and shall be made a part of the Contract. The Contractor shall coordinate with the Construction Project Manager and Permit Authority to perform the necessary transfer of CASDP from City to Contractor prior to the start of construction. The Permit transfer will be performed at no cost to the Contractor.

Prior to transfer of CASDP, additional elements shall be completed by the Contractor before the CASDP will be transferred from City to Contractor:

- a) Complete Sections B&E (Permittee & Site Supervisor) of the CASDP "Narrative Report Information Worksheet".
- b) Prepare a complete SWMP including any required adjustments for proposed construction phasing, staging areas, or additional items necessary to address applicable project specific Permit requirements. This will require the Contractor to provide or retain a Professional Engineer or subcontract with the original Professional Engineer that prepared the Bid Documents.
- c) Complete the "Construction Scheduling" section of the "Narrative Report Information Worksheet".
- d) Include specific methods and/or BMPs that the Contractor will implement to address hazardous spill prevention/ containment response.
- e) Provide any "Additional Documentation and Correspondence" applicable to the Contractor as stated in the CASM. This will require the Contractor to provide or retain a Professional Engineer or subcontract with the original Professional Engineer that prepared the Bid Documents.

If deemed necessary, the Contractor may propose modifications to the approved SWMP once the CASDP has been transferred to the Contractor. Per CASDP requirements, the Contractor shall obtain the endorsement of a Professional Engineer licensed in the State of Colorado for any proposed Major or Minor SWMP Amendments. This may require the Contractor to provide or retain a Professional Engineer or subcontract with the original Professional Engineer of the “For reference only” erosion control drawings.

Per definition, a Major SWMP Modification requires the submission of revised SWMP elements to the Permit Authority for review and approval.

Prior to construction, the Contractor shall obtain the required State Construction Stormwater Permit(s) as applicable.

23.0.5 Construction Requirements

23.0.5.1 Construction Implementation

The Contractor shall incorporate into the Project all BMPs as outlined in the accepted Critical Path Method Construction schedule.

23.0.5.2 Alterations to Project BMPs

The Contractor shall design and implement BMPs for correcting potential conditions unforeseen during design of the Project, or as possible for emergency situations, which arise during construction. The Project’s SWMP, UDFCD Vol 3 standards and details, and CDOTs “Erosion Control and Storm-Water Quality Guide,” and any approved modification to these documents as proposed by the Contractor, shall be used as reference documents for the purpose of designing appropriate BMPs. Measures and methods proposed by the Contractor to deal with unforeseen conditions shall be reviewed and approved in writing by the Permit Enforcement Authority and the Project Construction Engineer prior to implementation and construction.

In an emergency situation, the Contractor shall use best judgment for immediately responding to the emergency situation as it arises.

All costs associated with revising the BMPs utilized throughout the project, for its duration, shall be included within the applicable Storm Water Management bid item. No separate or additional payment shall be made.

23.0.5.3 Permits

The Contractor shall obtain all required permits for the Project including those required by federal, state, and local agencies. The Contractor shall obtain (or transfer from the City when specified) required erosion control and water quality permits and shall be responsible for compliance with all requirements under any such permits.

23.0.5.4 Erosion Control Supervisor

Contractor shall assign to the Project an employee or subcontractor to serve as Erosion Control Supervisor (ECS). The ECS shall be a person other than the Contractor's superintendent, foreman, or equivalent supervisory position. The ECS shall be experienced in aspects of BMP construction and have satisfactorily completed a Colorado DOT or equivalent ECS training program authorized by the City. Proof that this requirement has been met shall be submitted to the City's Construction Project Manager at least ten working days prior to the beginning of any soil disturbance work. A list of authorized ECS training programs is available from the City upon request. Additionally, per definition, the ECS shall be under the direction of a Professional Engineer licensed in the State of Colorado when performing any modifications to the Project Stormwater Management Plan (SWMP).

The ECS shall be responsible for oversight of the implementation, maintenance, and revision of the SWMP for the duration of the Project. The ECS's responsibilities shall be as follows:

- a) Ensure compliance with all water quality permits or certifications in effect during the construction work.
- b) Supervise the installation, construction, and maintenance of all BMPs specified in the Contract and coordinate the construction of BMPs with all other construction operations.
- c) Direct the implementation of suitable BMPs as necessary to correct unforeseen conditions or emergency situations. Direct the dismantling of those features when their purpose has been fulfilled due to completion of each Project phase unless the Permit Enforcement Authority agrees that the features be left in place.
- d) Inspect the construction site and document inspection activities at least every seven (7) days and immediately following any precipitation or snowmelt event with the potential to cause surface erosion. If no land disturbing construction activities are present during a storm event, post-storm event inspections shall be conducted prior to commencing any new land disturbing construction activities, but no later than seventy-two (72) hours following the storm event.
- e) Attend the preconstruction conference, erosion control preconstruction inspection, Project scheduling meetings, weekly construction/ field meetings, substantial completion and final stabilization inspections, and other meetings regarding construction that could impact water quality.
- f) Evaluate all non-stormwater coming onto the site, such as springs, seeps, and landscape irrigation return flow. If such flow is identified, the ECS shall propose appropriate SWMP modifications to the Contractor to protect off-site water from becoming contaminated with sediment or other pollutants.
- g) Coordinate with the Contractor to implement necessary actions to reduce anticipated or presently existing water quality or erosion problems resulting from construction activities.
- h) Coordinate with the Contractor to ensure all labor, material, and equipment deployed to meet SWMP requirements is judged appropriately.
- i) During construction, update and record the following items in the SWMP as changes occur:

- i. Construction boundaries (may require Major SWMP Modification)
 - ii. Areas of disturbance (may require Major SWMP Modification)
 - iii. Areas used for storage of construction materials, equipment, soils, or wastes.
 - iv. Location of any dedicated asphalt or concrete batch plants.
 - v. Location of construction offices and staging areas.
 - vi. Location of work access routes during construction.
 - vii. Location of borrow and waste.
 - viii. Location of temporary and permanent stabilization
 - ix. The ECS shall start a new site map before the current one becomes illegible. All site maps shall remain with the SWMP paperwork.
- j) Amend the SWMP whenever there are: additions, deletions, or changes in locations of BMPs. SWMP revisions shall be recorded immediately. Items shall be dated and signed at time of occurrence. Specifically, amendments shall include the following:
- i. A change in design, construction, operation, or maintenance of the site which would require the implementation of new or revised BMPs; or
 - ii. Changes when the SWMP proves to be ineffective in achieving the general objectives of controlling pollutants in stormwater discharges associated with construction activity.
 - iii. Changes when temporary BMPs are no longer necessary from changes in Project phase and are removed. All inspection and maintenance activities or other repairs shall be documented.
- k) All inspection and maintenance activities or other repairs shall be documented. The SWMP and documentation shall be kept on the Project site at all times.
- l) Modify the site map with arrows to indicate direction of surface and storm water flowing across the Project site.
- m) When adding or revising BMPs in the SWMP, amend the narrative to explain what, when, where, why, and how the BMP is being used, and add a detail to the SWMP.
- n) If using existing topography, vegetation, etc. as a BMP, label it as such in the SWMP site map; amend the Narrative to explain when, why, and how the BMP is being used to the SWMP.
- o) Record on the SWMP, and implement the approved plan for concrete and asphalt saw cutting, grinding, and milling containment and removal.
- p) Update the potential pollutants list in the SWMP throughout construction meeting CASDP requirements.
- q) Spills, leaks, or overflows that result in the discharge of pollutants shall be documented on the inspection form. The ECS shall record the time and date, weather conditions, reasons for spill, and how it was remediated. The ECS shall immediately report to the Contractor and Construction Project Manager the following instances of noncompliance:
- i. Noncompliance which may endanger health or environment.

- ii. Spills or discharge of hazardous substance or oil which may cause pollution of the City MS4 or State Waters.
 - iii. Discharge of stormwater which may cause an exceedance of a water quality standard.
- r) Perform a thorough inspection of the stormwater management system at least every seven (7) days and within 24 hours after any precipitation or snowmelt event with the potential to cause surface erosion. The inspection records shall be kept on-site in a written or previously approved format. Inspections shall be conducted during the progress of the work, during work suspensions, or until Final Stabilization of all disturbed areas is approved by Permit Enforcement Authority and shall include the following services at a minimum:
- i. The construction site perimeter, disturbed areas, and areas used for material storage that are exposed to precipitation shall be inspected for evidence of, or the potential for, pollutants entering the drainage system. BMPs identified in the SWMP shall be observed to ensure that they are operating correctly.
 - ii. The description of potential pollutant sources, and the BMPs identified in the SWMP, shall be revised and modified as appropriate based on the results of the inspection as soon as practicable after such inspection. Modification to the SWMP shall be implemented in a timely manner and in accordance with applicable Permit requirements.
 - iii. The operator shall keep a record of inspections. Uncontrolled releases of sediment or polluted storm water or measurable quantities of sediment found off the site shall be recorded with a brief explanation as to the measures taken to prevent future releases as well as any measures taken to clean up the sediment that has left the site. Inspection records shall be made available to the City upon request. Note: documentation of uncontrolled releases at site DOES NOT alleviate any State or Federal requirements for reporting of discharges or upset conditions. Care should be taken to ensure compliance with all regulatory requirements at site.
 - iv. Seven (7) day inspections are required during construction and at all times until Final Stabilization has been achieved. Seeding and mulching of disturbed areas does NOT count as final stabilization until such time as 70% pre disturbed vegetative cover has been achieved. Sites with growth in place sufficient to deter erosion that have not yet achieved final stabilization may petition the City to grant an alternative inspection schedule while awaiting additional growth for final stabilization. These inspections must be conducted in accordance with the above paragraphs.

23.0.5.5 Applying BMPs

The duration of the exposure of uncompleted construction to the effects of weather shall be as short as practicable. BMPs such as: seeding, surface roughening, mulching, applying

tackifier, use of geotextiles and matting, permanent landscaping, or other selected BMPs shall be applied within fourteen (14) calendar days of completion of grading/soil disturbance activities to stabilize the construction site unless disturbed area is within 100 feet of an MS4 or State Waters or has slopes of 3 to 1 or greater in which case BMPs shall be implemented within seven (7) calendar days of completion of grading activities. Disturbed areas where work is temporarily halted shall be temporarily stabilized within seven (7) days after the activity ceased unless work is to be resumed within thirty (30) calendar days after the activity ceased.

Clearing and grubbing operations shall be scheduled and performed to minimize both the area of the Project disturbed at a given time and the amount of time that disturbed areas remain open. BMPs such as temporary seeding are required between successive construction stages when disturbed areas will not be stable or active for thirty (30) calendar days or more. No payment will be made for additional work required because the Contractor has failed to properly coordinate the BMP schedule, thus causing previously stabilized areas to be disturbed by operations that could have been performed prior to the stabilization. Upon failure of the Contractor to coordinate the permanent BMPs with the grading operations in a manner to effectively control erosion and prevent water pollution, the Permit Enforcement Authority can suspend the Contractor's grading operations and the Construction Project Manager can withhold monies due to the Contractor on current estimates until such time that all aspects of the work are coordinated in an acceptable manner.

23.0.5.6 Work Outside Limits of Construction

Non-contiguous areas outside the limits of construction that are used by the Contractor that include, but are not limited to, borrow pits, haul routes, storage and disposal areas, field offices, maintenance, batching areas, etc., shall have appropriate BMPs implemented by the Contractor at the Contractor's expense. Should said areas meet applicable CASDP Permit criteria, the Contractor shall obtain a separate CASDP for each area as applicable at no additional expense to the City.

23.0.5.7 Maintenance

The Contractor shall continuously maintain erosion and sediment control BMPs on a daily basis or as directed by the ECS so that they function properly during and after construction (including work suspensions) until Final Stabilization has been approved by the Permit Enforcement Authority. Maintenance includes, but is not limited to, the following items:

- a) From the time seeding and mulching work begins until the date the Project has reached Substantial Completion of Erosion Control, the Contractor shall keep all seeded areas stabilized at all times. Any damage to seeded areas or to mulch materials shall be promptly repaired.
- b) All inspection sediment removal, and BMP maintenance activities to comply with all Federal, State & Local erosion control permit requirements until Final Stabilization is reached.

- c) All removal and replacement of existing BMPs due to damage to same suffered either by the contractor, outside agencies, the public, or acts of God.
- d) All required mechanical and/ or manual street sweeping.
- e) Discretionary changes required of any regulatory enforcement officer.

If the Contractor fails to maintain the BMPs in accordance with the Contract, or as directed, the City may at the expiration of a period of 48 hours, after having given the Contractor written notice, proceed to maintain BMPs as deemed necessary. The cost thereof will be deducted from any compensation due, or which may become due to the Contractor under this Contract.

23.0.5.8 Minor SWMP Modifications

These shall be made in the field by the Contractor and thoroughly documented in the Contractor's SWMP narrative and drawings. Should the Permit Enforcement Authority deem minor field modifications inadequate, the Contractor may be required to a) make specific modifications as requested by the Permit Enforcement Authority or b) return to the original approved design specifications. Minor SWMP Modifications are allowed, covered under the original CASDP, and required as part of standard maintenance and operation.

23.0.5.9 Major SWMP Modifications

The City reserves the right to require changes in the Work or Project Limits that may require a Major Modification to the SWMP and/ or CASDP due to unforeseen circumstances. Should this occur, the Contractor will be responsible for the following (as applicable):

- a) Make required revisions to comply with changing federal or state rulemaking if occurs within timeframe of Project
- b) Make required revisions due to unforeseen or unplanned conditions leading to deficient Drawings/ SWMP (hazardous materials encountered, landfills, expansion of work limits, etc.)
- c) Prepare revised SWMP elements endorsed by a Professional Engineer licensed in the State of Colorado.

23.0.5.10 Substantial Completion of Erosion Control

When a CASDP is required for the Project, Substantial Completion of the Project as defined by the City and County of Denver General Contract Conditions cannot be reached until Substantial Completion of Erosion Control has been granted. Granting of Substantial Completion of Erosion Control must be requested by the Contractor and be approved by the Permit Enforcement Authority in the form of a "Certificate of Substantial Completion of Erosion Control".

23.0.5.11 Final Stabilization

Granting of Final Stabilization must be requested by the Contractor and be approved by the Permit Enforcement Authority. Other permanent soil stabilization techniques may be proposed, in writing, by the Contractor and used upon approval, in writing, by the Construction Project Manager and Permit Enforcement Authority.

The Contractor may reach Final Stabilization via the following procedures:

- a) The Contractor shall file Inactivation Request for Construction Activities Stormwater Discharge Permit (available within CASDP guidance documents) with the Permit Enforcement Authority.
- b) The Contractor shall coordinate with the Permit Enforcement Authority to hold a Final Inactivation Inspection.
- c) If passing, the Permit Enforcement Authority transmits a letter of approval for Final Stabilization.
- d) If not passing, the Permit Enforcement Authority transmits a letter of denial for Final Stabilization with associated inspection report to Contractor.
- e) Stabilization, inspection and maintenance requirements shall continue until confirmation of having met final closure requirements have been granted in writing by the Permit Enforcement Authority. When Final Stabilization has been reached, the Permit Enforcement Authority shall issue a "Certificate of Final Stabilization".

23.0.5.12 Final Acceptance

CASDP obligations (including reaching Final Stabilization) may hinder the ability to reach Final Acceptance for the overall Project as defined in the City General Contract Conditions.

23.0.6 Construction of BMPs

BMPs shall be constructed so that they conform to all requirements as set forth within the Project SWMP. They shall meet all requirements set forth within each BMP detail and shall be installed and maintained so that they function in an effective and operable manner.

End of Specification



CITY AND COUNTY OF DENVER
ENGINEERING DIVISION

Wastewater Capital Projects Management Standard Construction Specification

25.0 Hot Mix Asphalt Pavement

25.1 Design Intent

These specifications include general requirements applicable to all types of plant mixed hot mix asphalt pavements (HMAP). This work consists of one or more courses of asphalt mixture constructed on a prepared foundation in accordance with specifications. The design intent is to provide pavement with adequate thickness and quality to provide a service life of 20 years. It is also the intent to provide construction in accordance with these specifications and with a high standard of practice. This item shall include all labor, equipment, and materials to manufacture, place and compact asphalt cement concrete for pavement purposes.

TEST PROCEDURE DEFINITIONS	
CP-##	Colorado Department of Transportation: Field Materials Manual (Colorado Testing Procedures)
ASTM	American Society for Testing & Materials
AASHTO	American Association of State Highway & Transportation Officials
CP-L #####	Colorado Department of Transportation: Laboratory Manual of Test Procedures (Lab Testing Procedures)

25.2 Materials

The hot mix asphalt shall be composed of a mixture of aggregate, filler, hydrated lime and asphalt cement. Some mixes may require polymer modified asphalt cement. Some mixes may allow up to 25% reclaimed asphalt pavement (RAP). All RAP shall meet the requirements of section 25.2.5

25.2.1 Aggregate

Aggregates for HMAP shall be of uniform quality, composed of clean, hard, durable particles of crushed stone, crushed gravel, or crushed slag. Excess of fine material shall be wasted before crushing. The material shall not contain clay balls, vegetable matter, or other deleterious substances and shall meet the requirements in Table 25.2.1.1.

**Table 25.2.1.1
Aggregate Requirements**

Aggregate Test Property	Coarse: Retained on #4	Fine: Passing the #4
Fine Aggregate Angularity, CP-L 5113 Method A or AASHTO T 304 Note: Fine aggregate angularity does not apply to RAP aggregates		45% Min
Two Fractured Faces, CP-45 or ASTM D 5821 SG Mixtures Top and Middle Lifts Bottom Lifts SMA Mixtures	90% Min. 80% Min. 70% Min. 100% required	
LA Abrasion, AASHTO T 96	45% Max.	
Flat and Elongated (Ratio 5:1) %, AASHTO M 283	10% Max.	
Adherent Coating (Dry Sieving) ASTM D 5711	0.5% Max.	
Sand Equivalent. AASHTO-T 176		45% Min.
Micro Deval CP-L 4211 or AASHTO T 327	18% Max	

Reclaimed Asphalt Pavement material (RAP) shall be used only where specifically allowed as shown on the plans and shall be of uniform quality and gradation with a maximum size no greater than the nominal aggregate size of the mix. Mixes shall not contain more than 25 percent RAP.

The HMAP gradation for the proposed design job mix gradation shall be wholly within the control point gradation range set forth in Table 25.2.1.2. The allowable job mix gradation for production shall be the design job mix gradation with the tolerances of Section 25.13.2 applied. The proposed design job mix and the final allowable job mix gradation for production shall report all sieve sizes listed in table 25.2.1.2

Table 25.2.1.2
Dense Graded HMA Gradation Range
(Percent by Weight Passing Square Mesh Sieves, CP-31, AASHTO 11 & T27)

Mixture Grading	SX (1/2" nominal)		S (3/4" nominal)		SG (1" nominal)	
	Control Points	Caution Zone*	Control Points	Caution Zone*	Control Points	Caution Zone*
1 1/2"					100	
1"			100		90-100	
3/4"	100		90-100		@	
1/2"	90-100		@		@	
3/8"	@		@		@	
#4	@		@		@	39.5
#8	28-58	39.1	23-49	34.6	19-45	26.8-30.8
#16	@	25.6-31.6	@	22.3-28.3	@	18.1-24.1
#30	@	19.1-23.1	@	16.7-20.7	@	13.6-17.6
#50	@	15.5	@	13.7	@	11.4
#200**	2.0-8.0		2.0-7.0		1.0-7.0	

* The caution zone is guideline only. It is recommended that mix design gradations go above the caution zone boundaries, on the "fine" side

** These limits shall include the weight of lime at 1.0%

@ These sieve sizes used only to determine the final Allowable Job Mix Formula (JMF) in accordance with 25.13.

25.2.2 Performance Graded Asphalt Binders

The Contractor shall provide to the Construction Project Manager acceptable 'Certifications of Compliance' of each applicable asphalt binder grade from the supplier. Upon non-conformance with specifications, the asphalt binder may be rejected as directed by the Construction Project Manager. When production begins the Contractor shall, upon request, provide to the Construction Project Manager a one quart can of each specified asphalt binder. Additionally, when requested, the Contractor shall provide the refinery test results that pertain to the asphalt binders used during production.

Asphalt binder shall meet the requirements of the Superpave Performance-Graded Binders (PG) as presented in table 25.2.2

TABLE 25.2.2. -PROPERTIES OF PERFORMANCE GRADED BINDERS

Usage for each Binder Grade	PG 58-28	PG 64-22	PG 76-28
Traffic Loading, Total 18 kip ESALs Over Design Life (Usually 20 Years)***	Low Volume (0-100,000)	100,000 to <10.0 Million	3.0 Million to <10 Million
Superpave Compactor Design gyrations Recommended (alternate) Usage	$N_{design} = 50$ (75)	$N_{design} = 75$ (100)	$N_{design} = 100$
Property of Binder Grade	PG 58-28	PG 64-22	PG 76-28
Flash Point Temperature, °C, AASHTO T 48	230 Min.	230 Min.	230 Min.
Viscosity at 135 °C, Pas, ASTM D 4402	3 Max.	3 Max.	3 Max.
Dynamic Shear, Temperature °C, where $C^*/\sin \delta @ 10 \text{ rad/sec.} \geq 1.00 \text{ Kpa}$, AASHTO TP 5	58 ° C	64 ° C	76 ° C
Rolling Thin Film Oven Residue Properties, AASHTO T 240			
Mass Loss, %, AASHTO T 240	1.00 Max.	1.00 Max.	1.00 Max.
Dynamic Shear, Temperature °C, where $G^*/\sin \delta @ 10 \text{ rad/sec.} \geq 2.20 \text{ Kpa}$, AASHTO TP 5	58 ° C	64 ° C	76 ° C
Elastic Recovery ¹ , 25°C, % Min.*	N/A	N/A	50 Min.
TABLE 25.2.2. -PROPERTIES OF PERFORMANCE GRADED BINDERS continued			
Pressure Aging Vessel Residue Properties, Aging Temperature 100 °C AASHTO PP1			
Dynamic Shear, Temperature °C, where $G^*/\sin \delta @ 10 \text{ rad/sec.} \leq 5,000 \text{ Kpa}$, AASHTO TP 5	19 ° C	25 ° C	28 ° C
Creep Stiffness, @ 60 sec. Test Temperature in °C,	-18 ° C	-12 ° C	-18 ° C

AASHTO TP 1			
S, Mpa, AASHTO TP 1	300 Max.	300 Max.	300 Max.
m-value, AASHTO TP 1	0.300 Min.	0.300 Min.	0.300 Min.
**Direct Tension Temperature in °C, @ 1.0 mm/min., Where Failure Strain >1.0%, AASHTO TP 3	-18 °C	-12 °C	-18 °C

* Elastic Recovery by Task Force 31, Appendix B Method

** Direct tension measurements are required when needed to show conformance to AASHTO MP.1

*** Project Design Engineer is to determine PG Binder

25.2.3 Additives – Hydrated Lime

Lime shall be added at the rate of 1% by dry weight of the aggregate and shall be included in the amount of material passing the No. 200 sieve. Hydrated lime for aggregate pretreatment shall conform to the requirements of ASTM C 207, Type N. In addition, the residue retained on a 200-mesh sieve shall not exceed 10% when determined in accordance with ASTM C 110. Drying of the residue in an atmosphere free from carbon dioxide will not be required.

25.2.4 Tack Coat

The emulsified asphalt, for Tack Coat shall be CSS-1h or SS-1h and conform to AASHTO M208 or M140, respectively.

25.2.5 Reclaimed Asphalt Pavement

Reclaimed Asphalt Pavement (RAP) may be allowed in the HMA mixture by the **Project Design Engineer**. It shall be of uniform quality and gradation with a maximum size particle no greater than the maximum size allowed in the HMA mixture. HMA mixtures containing RAP shall meet the same gradation requirements as a virgin HMA mix. The Project Design Engineer may allow mixtures with a maximum of 20% RAP may be allowed in the top lift of any asphalt pavement, and a maximum of 25% RAP may be allowed in layers below the top lift, RAP is not allowed in Stone Mastic Asphalt Mixtures, except by agreement by the **Project Design Engineer**.

The reclaimed asphalt pavement shall meet all the requirements for HMA pavement, as contained herein. The **General Contractor** shall have an approved mix design for the amount of RAP to be used prior to placement.

The **Construction Project Manager** may require the **General Contractor** to maintain separate stockpiles for each type of RAP material. All processed material shall be free of foreign materials and segregation shall be minimized. Any RAP material that cannot be readily broken down in the mixing process, and/or affects the paving operation, shall be processed prior to mixing with the virgin material.

Fine Aggregate Angularity requirements shall not apply to any RAP aggregate. The RAP will not contain clay balls, vegetable matter, or other deleterious substances.

Verification testing for asphalt content and gradation will be performed on RAP at the frequencies listed in section 25.5.2, below. The **Construction Project Manager** may request the mix supplier's testing results on RAP at any time. In addition, the mixture shall be tested for properties as listed in Table 25.15

When the use RAP is allowed, the following additional conditions shall apply:

25.2.5.1. The processed RAP must be 100 percent passing the 1¼" sieve. The aggregate obtained from the processed RAP shall be 100% passing the 1" sieve. The aggregate and binder obtained from the processed RAP shall be uniform in all the measured parameters in accordance with the following schedule:

Table 25.2.5.1 RAP AGGREGATE UNIFORMITY TOLERANCES

<u>Element</u>	<u>Uniformity*</u>
Binder Content	0.5
% Passing ¾"	4.0
% Passing ½"	4.0
% Passing 3/8"	4.0
% Passing #4	4.0
% Passing #8	4.0
% Passing #30	3.0
% Passing #200	1.5

* Uniformity is the Maximum allowable Standard Deviation of test results of processed RAP.

25.2.5.2. The **General Contractor** shall have an **approved RAP Quality Control (QC) Plan** that details how the RAP will be processed and controlled. The QC plan must address the following:

25.2.5.2. A. RAP Processing Techniques. This requires a schematic diagram and narrative that explains the processing (crushing, screening, and rejecting) and stockpile operation for normal plant operation or a specific project.

25.2.5.2. B. Control of RAP Asphalt Binder Content: - Minimum Testing Frequency: 1/1,000 tons of processed RAP material (minimum 3 tests) for recent production of the mix type.

25.2.5.2. C. Control of RAP Gradation (CP31 or AASHTO T-30): Minimum Testing Frequency: 1/1,000 tons of processed RAP material (minimum 3 tests) for recent production of the mix type.

25.2.5.2. D. Process Control Charts shall be maintained for binder content and each screen listed, during addition of any RAP material to the stockpile. The **General Contractor** shall maintain separate control charts for each RAP stockpile. The control charts shall be displayed and shall be made available to the **Construction Project Manager** upon request.

25.2.5.3 Example of **RAP QUALITY CONTROL PLAN**

25.2.5.3. A Initial quality control of the reclaimed asphalt pavement shall be performed prior to and during crushing. Material for reclamation shall be separated by quality and source before being accepted for processing. Reclaimed asphalt must be free of concrete, dirt and organic materials... These stockpiles shall be built from the ground up, completely mixing all loads as they come in.

25.2.5.3. B Crushing of the reclaimed asphalt pavement shall be accomplished by means of a cone crusher and a screen deck. Oversize material shall be to be rejected on a ¾" scalping material, which reprocesses the material through the cone additional times. The processed material shall be stockpiled at the crushing facility and kept in separate piles and separate from other products to prevent intermingling of products, as well as the feed bins to prevent intermingling of the aggregates.

25.2.5.3. C The reclaimed asphalt pavement material shall be sampled during the crushing operations according to AASHTO T 2 at frequencies greater than 1/1000 tons and tested for gradation and asphalt content in accordance with AASHTO T 27 AND T11, and AASHTO T 308. Testing shall be done randomly on a daily basis to ensure conformance to specifications.

25.2.5.3. D The reclaimed asphalt pavement material at the asphalt plant shall be again sampled and tested according to the appropriate procedures to ensure that the asphalt content and gradation meet specifications and represent

initial quality control data. Once data is collected, a statistical analysis shall be performed to determine the blend for the asphalt mixture design. This analysis shall be provided with the Asphalt Mixture Design submittal. The RAP will meet the Uniformity Specification of Table 25.2.5.1 above.

25.2.5.3. E The RAP system at the asphalt plant consists of a feed bin with a variable speed motor controlled by the plant computer, which ensures the proper quantity of RAP material called for by the mix design. Material is delivered to the asphalt-mixing chamber of the asphalt plant by means of conveyor belts. The RAP material falls from one conveyor to another through a shaker screen that serves to break up any RAP material that has recompacted. Any oversize material shall be rejected at the shaker screen. While in production, the front-end loader shall work the full face of the stockpile, to ensure a representative batch is being produced.

25.2.5.3. F Prior to starting a project and at any other time necessary, the RAP feed system shall be calibrated by placing an amount of RAP measured by certified external scales into the feed bin. That measured material is fed from the RAP bin across the belt scales. The weights are compared and, if outside of accepted tolerances for the blending system, adjustments are made by the plant-blending computer. This process is the same as for all other components of the mix design.

25.3 Mix Design and Plant Produced Mixture Requirements

The mix design materials shall be those listed in Section 25.2 and used for the project. No substitutions are allowed during production, unless approved by the **Construction Project Manager**.

The **Project Design Engineer** shall indicate on MGPEC Form #9 the project specific criteria concerning mix design method, traffic level, asphalt binder type, mixture grading, and maximum amount of RAP allowed. This information shall be provided on MGPEC Form #9, "Requirements for Hot Mix Asphalt (HMA)", or other Contract bidding documents. Grading SG (1-inch nominal aggregate) shall only be designed using the 150 mm Superpave molds. Hveem Stability and Lottman test are not required for Grading SG mixtures. Grading S and SX shall be designed using 100 mm Superpave molds.

25.3.1 Superpave Mixture Design Method

The **General Contractor** shall submit a Proposed Design Job Mix Formula (PDJMF) for each mixture required by the Contract. The mixture design shall be determined using AASHTO T-312 or Colorado Procedure CP-L 5115 for the Superpave Method of Mixture Design. Guidance is provided in "Superpave Level 1 Mix Design" SP-2 published by the Asphalt Institute. Mixture design and field control testing shall meet the following requirements of Table 25.3.1a (located on the following page) for Dense Graded HMA.

Mixture design and field control testing of SMA shall meet the following requirements of Table 25.3.1b.

This area is a blank space inserted for the purpose of keeping the table whole

TABLE 25.3.1a SUPERPAVE MIXTURE PROPERTIES FOR DENSE GRADED HMA

Property or Test	Traffic Levels (ESALs)		
Traffic Loading, Total 18 kip ESALs Over Design Life (Usually 20 Years)	Low (0-100,000)	Medium (100,000 to <3.0 Million)	High (3.0 Million to <30 Million)
Design gyrations, N_{design} (Air Void: 3.5% to 4.5%) (See Note 1,2)	50	75	100
Air Voids in Total Mix (VTM) CPL 5115 or AASHTO T 312	(See Note 1)	(See Note 1)	(See Note 1)
Hveem Stability CP-L 5106 or AASHTO T 246 (Grading S & SX only) (See Note 3)	N/A	28 Min.	30 Min.
Voids Filled with Asphalt (VFA), MS-2	70-80	65-78	65-75
Lottman, Tensile Strength Ratio, % Retained, CP-L 5109 or AASHTO T 283, Method B	80 Min.	80 Min.	80 Min.
Lottman, CP-L 5109 or AASHTO T 283 Dry Tensile Strength, psi	30 Min.	30 Min.	30 Min.
VMA %. CP-48 or AASHTO PP 19 (See notes 2,3,4)	Minimum VMA criteria applies to the mix design only (Table 25.2.1.2). The minimum VMA criteria shall be linearly interpolated based on actual air voids. See 25.13 for production tolerances		

Note 1: Select the target Job Mix Optimum Binder Content for HMA gradings as close to 4.0% air voids as possible (3.5% to 4.5% air voids).

VTM is also referred to as Pax in CPL 5115, and %Gmmx in T 312

Note 2: Maximum Theoretical Specific Gravity of mix by CP-51 or AASHTO T 209.

Note 3: Refer to Section 25.13 for production tolerances.

Note 4: VMA shall be based on tests of the Bulk Specific Gravity of the Compacted Mix (CP-L 5103 or AASHTO T 166) and Aggregate (AASHTO T 84 & T 85), and calculated according to CP-48 or AASHTO PP 19. All mixes shall meet the minimum VMA specified in Table 25.3.2, below.

Table 25.3.1b SUPERPAVE MIXTURE PROPERTIES FOR OPEN GRADED SMA

Property	Test Method	Value for SMA
Lab compaction (Revolutions) N_{Design}	CPL 5115 or AASHTO T 312	100
Air Voids, percent at: N_{Design} (See Note 1)	AASHTO T 312	3.0 – 4.0
Hveem Stability	CP-L 5106 or AASHTO T 246	30 Min.
Accelerated Moisture Susceptibility, tensile strength Ratio, (Lottman)	CPL 5109 or AASHTO T 283, Method B	80 Min.
Dry Split Tensile Strength, psi	CPL 5109 or AASHTO T 283, Method B	30 Min.
Grade of Asphalt Binder	n/a	PG 76-28
Voids in the Mineral Aggregate (VMA) %, minimum (see note 2)	CP 48 or AASHTO PP 19	17
Draindown at Production Temperature	AASHTO T 305	0.3 maximum
$\% VCA_{MIX}$ (See Note 3)	AASHTO PP 41-02	Less than VCA_{DRC} (See Note 4)

General Note: Copies of AASHTO PP 41-02 and MP 8-02 (for designing SMA mixes) can be obtained from the CDOT Region Materials or the Project Design Engineer

Note 1: Select the target Job Mix Optimum Binder Content for SMA grading at 3.0% to 4.0% air voids

Note 2: VMA shall be based on tests of the Bulk Specific Gravity of the Compacted Mix (CP-L 5103 or AASHTO T-166) and Aggregate (AASHTO T 84 & T 85), and calculated according to CP-48 or AASHTO PP 19. All mixes shall meet the minimum VMA specified in Table 25.3.2, below

Note 3: VCA = Voids in the Coarse Aggregate

Note 4: DRC = Dry-Rodded Condition

TABLE 25.3.2 MINIMUM VOIDS IN MINERAL AGGREGATE (VMA) for Dense Graded HMA & Open Graded SMA, %

Nominal Maximum* Particle Size	Air Voids ++		
	3.5%	4.0%	4.5%
1"	12.2	12.7	13.2
¾"	13.2	13.7	14.2
½"	14.2	14.7	15.2
SMA	17.0	17.0	17.0

* Nominal Maximum Particle Size is defined as one sieve size larger than the first sieve to retain more than 10%, but shall not exceed the 100% passing size. The Nominal Maximum Particle Size can vary during mix production even when the 100% passing size is constant.

++ Minimum VMA criteria apply to the mix design only. The minimum VMA criteria shall be linearly interpolated based on actual air voids. See Section 25.13 for tolerances.

25.4 Mixture Design Submittals

25.4.1 General Requirements

The General Contractor shall submit all mixture designs, certificates, refinery reports, and laboratory data to the Construction Project Manager for approval at least 7 days before construction is to begin. The job mix formula may be rejected as directed by the Construction Project Manager on the basis of incompleteness, timeliness or changes in materials. Submittals shall be in a timely fashion such that rejection will not delay completion of the project.

Proposed Design Job Mix testing shall be performed in a materials laboratory under the direct supervision of; and shall be stamped and signed by a Professional Engineer licensed in the State of Colorado practicing in this field. In addition, the General Contractor shall submit as part of the Proposed Design Job Mix, documents to verify the following:

1. Source of materials.
2. Gradation, specific gravity, source and description of individual aggregates and the final blend.
3. Aggregate physical properties.
4. Source and Grade of the Performance Graded Binder (PG Binder)

5. Proposed Design Job Mix – aggregate and additive blending, final gradation shown on 0.45 power graph, optimum asphalt content.
6. Mixing and compaction temperatures used.
7. Mixture properties determined at a minimum of four asphalt contents and interpolated at optimum and graphs showing mixture properties versus asphalt content.

The Construction Project Manager reserves the right to test the General Contractor’s mix for each hot asphalt pavement grading utilizing materials actually produced and stockpiled. General Contractor shall provide a sufficient quantity of each aggregate, mineral filler, RAP, and additive for the required laboratory tests, if required by the Construction Project Manager.

The Contractor shall not place any materials without acceptance and approval of the Construction Project Manager.

25.4.2 Change in source or grade

Should a change in the source of Asphalt Cement (AC) or Lime occur, a one point verification test (at optimum asphalt content) of the mix must be performed to verify that the applicable Table 25.3.1a(Dense Graded HMA) or 25.3.1b (SMA) or 25.3.2 (VMA), is still met. If this testing shows noncompliance, a new design job mix shall be established before the new AC or Lime source is used. Any change in aggregate type or source will require a new mix design.

25.4.3 Mix Production Verification

Production verification shall occur prior to the start of the project. The production verification shall be performed by LABCAT Level C certified technicians with current Certification to verify the volumetric properties of the mix. If the mix has been produced for another project within the last 90 days, data from that project can be submitted for this verification. Volumetric properties of the mix verification testing shall be within the following tolerances compared to the Proposed Design Job Mix. The mix verification test reports shall be submitted to the Construction Project Manager prior to mix placement.

TABLE 25.4.3.1 MIX DESIGN VERIFICATION TOLERANCES

Air Voids	+/- 1.2%
VMA	+/- 1.2%
Asphalt Binder Content	+/-0.3%
Stability	Applicable minimum

The tolerances in this table are for mix design verification only. See section 25.13 for production tolerances.

25.4.4 Pre-paving Meeting

The Construction Project Manager may require a pre-paving meeting of all parties involved in supply, haul, laydown inspection, quality control and quality acceptance of HMA. Areas of responsibility and contact names and numbers should be shared. A construction (joint) plan will be submitted at the pre-paving meeting, see section 25.9 for joint requirements. Form 25.1 provided at the end of this specification is an example of a pre-paving meeting agenda.

25.5 Equipment

25.5.1 Mixing Plant

The mixing plant shall be capable of producing a uniform material, have adequate capacity, and be maintained in good mechanical condition. Defective parts shall be replaced or repaired immediately if they adversely affect the proper functioning of the plant or plant units, or adversely affect the quality of the hot bituminous plant mix.

Dust, smoke, or other contaminants shall be controlled at the plant site to meet all air quality requirements in the "Colorado Air Quality Control Act," Title 25, Article 7, CRS and regulations promulgated there under.

Acceptable safety equipment, approved by the Construction Project Manager, shall be provided by the General Contractor to accommodate sampling and testing.

25.5.2 Hauling Equipment

Trucks used for hauling HMAP shall have tight, clean, smooth metal beds thinly coated with a minimum amount of paraffin oil, lime solution, or other approved release agent. Petroleum distillates such as kerosene or fuel oil will not be permitted. Each truck shall have and use a cover of canvas or other suitable material to protect the mixture from the weather and excessive temperature loss or cooled layers of mix in truck.

25.5.3 Bituminous Pavers

Self-propelled pavers shall be provided for full lane width paving capable of spreading and finishing the HMA, material in full lane widths applicable to the typical section and thicknesses shown in the Contract and shall be equipped with:

1. anti-segregation devices,
2. A vibratory screed assembly capable of being heated.

Pavers used for shoulders, patching and similar construction, not requiring fine grade control, shall be capable of spreading and finishing courses of HMA material in widths shown in the Contract without segregation.

The paver's receiving hopper shall have sufficient capacity for a uniform spreading operation and shall have an automatic distribution system that will place and spread the mixture uniformly in front of the screed.

The paver shall be capable of operating at forward speeds consistent with uniform and continuous laying of the mixture. Stop and go operations of the paver shall be avoided. The screed or strike-off assembly shall produce the specified finished surface without tearing, shoving, or gouging the mixture. Self-propelled pavers shall be equipped with automatic screed controls with sensors capable of sensing grade from an outside reference line, and maintaining the screed at the specified longitudinal grade and transverse slope. The sensors may be contact or non-contact type devices. The sensor shall be constructed to operate from either or both sides of the paver and shall be capable of working with the following devices when they are required for the situation:

1. Grade control device at least 30 feet in length.
2. Joint matching device
3. Adequate length of control line and stakes, if no other type of geometric control is present
4. A straight edge at least 10 feet in length will be available to verify the crown on the screed, at the request of the Construction Project Manager

The controls shall be capable of maintaining the screed at the specified transverse slope within plus or minus 0.1 percent. Automatic mode should be used where possible. If the automatic controls fail or malfunction, the equipment may be operated manually for the remainder of the normal working day, provided specified results are obtained.

If the Contractor fails to obtain and maintain the specified surface tolerances, the paving operations shall be suspended until satisfactory corrections, repairs, or equipment replacements are made.

Placement of HMA on a waterproofed bridge deck shall be accomplished with equipment that will not damage the membrane or protective covering.

25.6 Manufacture

25.6.1 Preparation of Aggregates

Heating and drying of the aggregates shall be accomplished without damaging the aggregate. Lime shall be added to achieve complete and uniform coating of the aggregate. When hydrated lime is used it shall be added to the aggregate in accordance with one of the following methods:

- a. Lime Slurry Added to Aggregate: The hydrated lime shall be added to the aggregate in the form of a slurry and then thoroughly mixed in an approved pugmill. The slurry shall contain a minimum of 70 percent water by weight.
- b. Dry Lime Added to Wet Aggregate: The dry hydrated lime shall be added to wet aggregate (a minimum of three percent above saturated surface dry) and then thoroughly mixed in an approved pugmill.

The lime-aggregate mixture may be fed directly into the hot plant after mixing or it may be stockpiled for not more than 90 days before introduction into the plant for mixing with the asphalt cement. The hydrated lime may be added to different sized aggregates and stockpiled, by adding 75 percent of the lime to the aggregate passing the No. 4 sieve and 25 percent to the aggregate retained on the No. 4 sieve.

25.6.2 Mixing

The dried aggregates and asphalt cement shall be combined in the mixer in the quantities required to meet the design job mix. The materials shall be mixed until the aggregate is completely and uniformly coated, and the asphalt cement is uniformly distributed throughout the aggregate. The output rate shall not exceed the manufacturer’s capacity rating.

Baghouse fines shall be fed to the mixing plant in a uniform and continuous manner so as to maintain uniformity in the mixture. The Baghouse, fines feeder, auger, and related equipment, shall be in good working condition and operated in accordance with manufacturer’s recommendation. If the Construction Project Manager determines that non-uniform operation of the equipment is detrimental to the mixture, he may halt all construction until the General Contractor takes appropriate action.

The minimum temperature of the mixture when discharged from the mixer shall be as shown in the following table:

**Table 25.6.2.1
Mixture Discharge Temperatures**

Asphalt Grade	Minimum Discharge Temperature	Maximum Discharge Temperature
PG 58-28	275° F	310° F
PG 64-22	290° F	325° F
PG 76-28*	318° F	326° F

* Contractor or Binder supplier must supply production temperature as require by their product

The General Contractor may provide refinery information that recommends revised

discharge temperatures depending on the base binder grade or source being used. HMA mix shall be produced at the lowest temperature within the specified temperature range that produces a workable mix and provides for uniform coating of aggregates (95 percent minimum in accordance with AASHTO T 195), and that allows the required compaction to be achieved.

HMA mix may be stored provided that any and all characteristics of the mixture are not altered by such storage. If storing or holding of the mixture causes segregation, excessive heat loss, or adversely affects the quality of the finished product, corrective action shall be taken. Unsuitable mixture shall be disposed of at the **General Contractor's** expense.

When placing hot mix asphalt over bridge decks covered by waterproofing membrane, the minimum temperature of the mixture, when rolling operations begin, shall be 250 ° F. The job mix temperature may be increased up to 30 ° F to obtain this temperature.

The mineral filler for SMA shall be stored in a separate silo and added automatically in the correct proportion. The mineral filler addition equipment shall be electronically or mechanically interlocked to the aggregate feed sensors so that the proper amount of mineral filler is added whenever SMA is produced.

The SMA mineral filler shall be added at the same point the asphalt binder is added to the aggregate.

25.6.3 Hauling

Each truck shall use covers (tarps) to protect the mix during transport. The Construction Project Manager can reject mix, which is hauled without a cover. Should the mixture show an excess or deficiency of asphalt cement, damage due to burning or overheating, an improper gradation, or thermal segregation with cold areas 10° F below the minimum discharge temperature, the truck shall be rejected.

25.7 Tack Coat

Prior to placement of HMA, a tack coat shall be applied. The material shall be in accordance with 25.2.4. The emulsified asphalt shall be diluted 1:1 with water and applied at 0.10 ± 0.01 gallons per square yard of diluted material. The Construction Project Manager may direct other application rates to match the age of condition of the surface.

All work shall be done at locations and with the grade and quantities of material designated on the plans. The surface to receive the tack coat shall be dry and cleaned by sweeping or other approved method until dust, debris, and foreign matter are removed. The tack coat shall then be applied uniformly by squeegee, brooms, or distributor. Prior to placement of SMA, tack coat between the existing pavement and Stone Matrix Asphalt pavement shall be placed at a rate between 0.03 and 0.05 gallons per square yard

25.8 Placement

Hot mix asphalt shall be placed only on approved, properly constructed surfaces that are

free from loose material, water, frost, snow or ice. The hot mix asphalt and tack coat shall be placed in accordance with the temperature limitations of Table 25.8 and only when weather conditions permit the pavement to be properly placed and finished as determined by the Construction Project Manager. Placement temperature as stated shall be increased by 5° F for each 10 miles per hour wind velocity to a maximum increased minimum placement temperature of 70° F.

**Table 25.8
Placement Air and Surface Temperature Limitations**

Compacted Layer Thickness	Top Layer of Pavement*		Lower Layers*	
	PG 58-28 PG 64-22	PG 76-28	PG 58-28 PG 64-22	PG 76-28
<2 inches not permitted	N/A	N/A	N/A	N/A
2 inches to <3 inches	50° F	65° F	40° F	50° F
3 inches or more	50° F	60° F	40° F	40° F
SG mix only	N/A	N/A	38° F	38° F

* Air temperature is taken in the shade. Surface temperature is taken on the subgrade or base. The Construction Project Manager may not waive the above temperature limitations for PG 76-28.

The mixture shall not be placed at a temperature lower than 245° F for mixes containing PG 58-28 or PG 64-22 asphalt, and 290° F for mixes containing polymer modified asphalt. Mix, which is too cold or damaged by weather, will be rejected.

The mixture shall be laid upon an approved surface, spread and struck off to obtain the required grade and elevation after compaction. The minimum lift thickness shall be **at least three times (preferably four times)** the normal particle size. The mixture shall be placed approximately 10-25 percent thicker than the existing surrounding mat thickness to account for compaction based on the materials being placed. Raking is not permitted and will not be allowed. Casting that causes any segregation will not be permitted.

On areas where the use of mechanical spreading and finishing equipment is impracticable, the mixture shall be carefully dumped, spread, raked, screeded, and luted by hand tools to the required compacted thickness plus 25 percent based on the materials being placed.. Carefully move or minimally work the HMA mix with the use of rakes, lutes, or shovels to avoid segregation. Mixtures made with modified asphalt cement require more rapid completion of handwork areas than for normal mixtures. Hauling and placement sequences shall be coordinated so that the paver is in constant motion. Starting and stopping shall not be allowed. A construction joint shall be placed at anytime the power stops, and the screed

drops enough to cause a surface dip in violation of Section 25.13.1, "Surface Tolerances"; or the mat temperature falls below that allowed in Section 25.12, "Compaction". Bituminous pavers shall be used to distribute the mixture either over the entire width or over such partial width as may be practicable. Echelon paving will be permitted.

If an unsatisfactory mix has been placed, it shall be removed, disposed of and replaced as directed. No compensation will be allowed for rejected material.

25.8.1 SMA PLACEMENT & Compaction

A Roller Pass Study (RPS) for Density and 1000 foot demonstration control strip are required for placement of lifts less than or equal to 1.5 inch thick, optional for thicker lifts.

25.8.1.A For Thin Lift SMA less than or equal to 1.5 inch thick.

In-place density shall be determined through the completion of a Roller Pass Study (RPS) to be conducted during placement of the required 1000-foot demonstration control strip. The RPS will determine the necessary roller compaction process needed to produce a minimum pavement density of 94 percent of theoretical maximum density (RICE). During the RPS, a minimum of three sets of three 4-inch diameter cores each shall be taken to measure SMA mat density for the various sections of the RPS. All coring shall be completed by the **General Contractor** and submitted to the **Construction Project Manager**. The densities of the three cores will be averaged to produce the density for each RPS section tested.

Full production of the thin SMA shall not begin until density test results are determined and the project compaction process is established by the **General Contractor** and approved by the **Construction Project Manager**. The approved compaction process established from the RPS shall be used for the duration of the thin SMA paving. Changes to the thin SMA mixture will be reviewed and a new RPS may be required.

Using the same method for determining density during the RPS, density will be determined daily for each day of full production and tested to confirm pavement density. If a daily density check shows density below 92 percent of RICE, the **General Contractor** shall stop production and the **General Contractor** will again complete a RPS to establish the necessary compaction process. The **General Contractor** will be allowed two daily density checks below 92 percent of RICE to be addressed in this manner during the project. All subsequent daily checks that identify locations having density below 92 percent of RICE shall be removed and replaced and a new RPS shall be completed and approved prior to again beginning production. Thin SMA density requirements will be enforced when the SMA mix design gradation and specified lift thickness are in accordance with or exceed the 3:1 requirements for the ratio of nominal maximum aggregate size to lift thickness.

The **General Contractor** shall submit a plan for a Roller Pass Study (RPS) to the **Construction Project Manager** for approval. Upon approval by the **Construction Project Manager**, the **General Contractor** shall perform a RPS. The plan for the RPS shall include, but is not limited to the following:

Number, size, and type of rollers.
Amplitude, frequency, size and speed of vibratory rollers.
Temperature of mixture being compacted.
Roller patterns.

The method of measuring density will be by roller passes. If a density element is based on a RPS, the Pay Factor shall be as shown in section 25.14.3.

25.8.1.B For SMA lifts greater than 1.5 inch thick.

If in the opinion of the **Construction Project Manager**, the roller pass study presented by the **General Contractor** is inadequate, then the **General Contractor** shall modify the compaction procedures as directed.

25.8.1.C Before Proceeding with SMA placement,

The General Contractor shall demonstrate the ability to produce and place a satisfactory mix.

The actual work may proceed when a full lane width demonstration control strip, having a minimum length of 1000 feet has been successfully placed. The **GENERAL CONTRACTOR** shall determine properties (Superpave Air voids, VMA, in-place density, and Hveem Stability) of the project produced mix that is used in the demonstration control strip and provide the results to the **Construction Project Manager**. No other SMA production or placement will be allowed until densities are determined. If the material in the demonstration control strip is not in close conformity with the specifications, the demonstration control strip will be removed and replaced at the **General Contractor's** expense. The **Construction Project Manager** will designate the location of the control strip.

SMA mixture shall be transported and placed on the roadway without drain-down or flushing. All flushed areas behind the paver shall be removed immediately upon discovery. If more than 50 square feet of flushed SMA pavement is ordered removed and replaced in any continuous 500 linear feet of paver width laydown, operations shall be discontinued until the source of the flushing has been found and corrected. The **Construction Project Manager** will designate the depth and area of all flushed areas requiring removal and replacement. All costs associated with the removal and replacement of the flushed areas shall be at the **General Contractor's** expense.

Stone Matrix Asphalt Pavement shall be placed and compacted in accordance with the temperatures listed in table 25.8 or as revised for the project.

The relative compaction for all SMA mixtures will be measured from roadway cores in accordance with CDOT-CP 44 or AASHTO T-166, Method B, unless the SMA mixture is being placed on a structure (bridge deck) in which case the **Construction Project Manager** may specify that nuclear gauge measurements be used.

When cores are used, the **General Contractor** shall provide all labor and equipment for the coring operation and filling the core holes. When nuclear density gauges are used, the tests will be performed in accordance with CDOT-CP 81 or ASTM D 2950 and CDOT-CP 82 or AASHTO T 230.

In-place density for SMA shall be 95 ± 2 percent of the SMA Mix maximum specific gravity as measured according to Maximum theoretical value (Rice) (CDOT-CP 51 or AASHTO T 209).

25.9 Longitudinal Joints

25.9.1 Joint Placement

The longitudinal joints in both a new pavement and an overlay pavement layer shall offset the joint in the layer immediately below by 6 inches. The joints in any pavement layer shall not fall in a wheel track. The joints in the top layer of new pavement not built on top of an existing pavement shall be located on lane lines or as shown on the plans. Longitudinal joints shall be minimized, where feasible, with wide paving pulls or echelon paving. Joints shall be parallel to the flow of traffic and shall not cross any centerline, lane line, or edge line unless approved by the **Construction Project Manager**. The **General Contractor** shall submit, prior to paving, a joint plan and pavement marking plan showing locations and the methods to establish a field control line. The **Construction Project Manager** must approve such plans prior to paving. The **General Contractor** shall use a continuous string line to delineate longitudinal joints during paving as shown on the joint plan. All string lines shall be removed at the end of each day's paving.

The free edge of the paved pass shall be laid as straight as possible, to the satisfaction of the **Construction Project Manager**. This joint, if cold, shall be tack coated prior to placement of adjacent paving.

The new compacted mat shall overlap the previously placed mat no more than 1.5 inches. Excess overlap or thickness shall not be raked or cast onto the new mat, but shall be wasted by pulling back and removing. The hot edge shall be blocked or bumped in a smooth line consistent with the previous longitudinal edge. Minor raking will only be allowed to correct major grade problems or provide mix around manholes and meter covers. The longitudinal joint shall be rolled from the hot side and overlap the joint by approximately 6 inches on the cold side.

25.10 Transverse Joints

The **General Contractor** shall submit, prior to paving, a joint plan showing locations and the methods to be used to construct transverse joints. The **Construction Project Manager** must approve such plans prior to paving. Placing of the HMA shall be continuous with a minimum of transverse joints, and rollers shall not pass over the unprotected end of a freshly laid mixture. Transverse joints shall be formed by cutting back on the previous run to expose the full depth of the course. Tack coat material shall be applied to contact surfaces of all joints just before additional mixture is placed against the previously compacted material.

The end of transverse joints shall be located so they will be constructed with a full head of mix in front of the screed. When butt joints are constructed, runoff boards shall be used to support the roller on the downstream side of the joint. All tapered sections, rounded edges and segregated areas shall be removed to achieve a vertical face at the butt joint before paving is restarted.

When a temporary tapered joint is required for temporary traffic access, the ramp shall be removed back to a full depth section before paving is restarted.

When restarting paving operations, the paver screed shall be placed on the starter block on the completed side of the transverse joint. The starter block should be approximately 25% greater than the thickness of the existing completed mat, so that adequate grade and compaction can be achieved on starting the paving operation. The screed should be nulled (angle removed) when on starting blocks and an up angle of attack set. Proper head of mix should be introduced into the paver prior to starting. The new compacted (downstream) side of the joint may be up to 3/16 inches higher than the old (upstream) side. Raking of this joint shall not be allowed except to correct major grade problems. The surface tolerance at the transverse joint must be verified by the **General Contractor** with a 10-foot straight edge before the paver is more than 100 feet from the joint. If the surface tolerance is not within the 3/16", the **General Contractor** shall make corrections before proceeding

25.11 Segregation

The asphalt mixture shall be transported and placed on the roadway without segregation. All segregated areas shall be removed immediately and replaced with specification material before the initial rolling. If more than 50 square feet of segregated pavement is removed and replaced in any continuous 500 linear feet of paver width laydown, operations shall be discontinued until the source of the segregation has been determined and corrected.

The Construction Project Manager will visually determine areas, which are segregated, and may also use density and gradation measures to help in this determination. The Construction Project Manager will visually determine the extent of the segregation. The General Contractor will not be allowed additional compensation for correction of segregated areas.

25.12 Compaction

The temperature of the mixture immediately behind the screed shall be sufficient to allow for proper compaction of the HMA layer and at least 245 °F for PG 58-28 or PG 64-22 binder and between 297°F and 305 °F for PG 76-28 binder. The breakdown compaction should be completed as quickly as possible after placement occurs.

The HMA shall be compacted by rolling. The number, weight, and type of rollers furnished shall be sufficient to obtain the required density and surface texture while the mixture is in a workable condition. Compaction shall begin immediately after the mixture is placed and be continued until the required density is obtained. Final compaction shall be obtained using steel wheel rollers.

Pavement operations shall be suspended when density requirements are not met and the surface temperature falls below 185 °F, or there is obvious surface distress or breakage, the problem shall be resolved prior to continuing paving operations. The criteria for mixtures containing PG 76-28

asphalt cements shall be 235 °F. The minimum compaction temperatures may be adjusted according to the asphalt binder supplier recommendations. Adjusted minimum compaction temperatures must be shown on the approved mix design or on other asphalt binder supplier documents, and be available on the job site. Pay Reduction criteria in Section 25.14 shall still apply in such cases.

All roller marks shall be removed with the finish rolling. Use of vibratory rollers with the vibrator on will not be permitted on bridge decks.

The **General Contractor** shall establish a rolling pattern or procedure during the beginning of paving operations, which will achieve the required compaction and surface tolerances. This procedure may be re-evaluated by the **General Contractor** and **Construction Project Manager** throughout the paving operations.

All HMA paving shall be compacted to 94.0 ± 2 percent of Maximum Theoretical (RICE) Density, (CP-51 or AASHTO T-209: Maximum Specific Gravity of Bituminous Paving Mixtures) as determined by ASTM D 2950. RICE values shall be used in calculating Relative Compaction according to CP-44 or AASHTO T 166. The **General Contractor** shall determine the proper RICE value to use for the initial day's placement. Subsequent day's RICE value(s) will be based on the current day's production. The **General Contractor** shall provide the producer's RICE value, which shall be used for production until the actual day's RICE value is determined by the testing firm of record for the project as approved by the **Construction Project Manager**.

All joints shall be compacted to 92.0 ± 2 percent of RICE, taken fully on each side of joint, every 200 Linear Feet. RICE values shall be used in calculating Relative Compaction according to AASHTO T 166, Cores if need will be used to verify compaction results.

The **General Contractor** shall core the pavement, as required by the **Construction Project Manager**, for field density tests in accordance with Colorado Procedure 44 or AASHTO T 230, Method B, or for field calibration of nuclear density equipment in accordance with the ASTM D 2950 or Appendix of Colorado Procedure 81. At a minimum, cores for nuclear density equipment calibration shall be taken at the beginning of placement of each pavement layer or change of mixture materials or gradation. Untested areas during placement will also require cores to be taken to verify compaction.

Along forms, curbs, headers, walls, and all other places not accessible to the rollers, the mixture shall be thoroughly compacted with mechanical tampers.

Any mixture that becomes loose and broken, mixed with dirt, or is in any way defective, shall be immediately removed and replaced with fresh hot mixture and compacted to conform to the surrounding area.

Compaction requirements for SMA are covered in section 25.8.1. Rollers shall not be used in a vibratory mode on SMA unless they are first used successfully in the demonstration control strip. Pneumatic wheel rollers shall not be used on SMA Mix.

25.13 Production Tolerances

25.13.1 Top Lift Surface Tolerances

The variation between any two contacts with the surface shall not exceed 3/16 inch in 10 feet. For patching surface tolerances, the variation shall not exceed 3/8 inch in 10 feet. Irregularities exceeding the specified tolerance shall be corrected at the General Contractor's expense. Transverse measurements for variations shall exclude breaks in the crown sections.

25.13.2 Job Mix Formula Tolerances

Production test results that deviate from the design job mix by more than shown in the following table are subject to Section 25.14:

**Table 25.13.2.
Gradation Tolerances**

Item	
Passing No. 3/8" and Larger (note 1)	± 6%
Passing No. 4 and No.8	± 5%
Passing No. 30 to No. 50	± 4%
Passing No. 200 (note 2)	± 2%
Air Voids	± 1.2%
VMA (note 4)	± 1.2%
Hveem Stability	(note 3)
Asphalt Content	± 0.3%

(Note 1) There is 1.0 percent tolerance for the maximum sieve size.

(Note 2) Mixes with passing No. 200 sieve material produced over 7.0 percent are allowed only when the above Air Voids and VMA tolerances are still met.

(Note 3) Hveem Stability must meet the minimum value specified in table 25.3.2.

(Note 4) When calculating VMA, use the most current aggregate specific gravity G_{sb} ,

When disagreements concerning determination of specification compliance occur, only valid tests from the Construction Project Manager will be considered. The Construction Project Manager shall determine validity. Generally, valid tests are those in which sampling and test have been performed according to referenced procedures and the results are within stated precision statements. When disagreements occur with Asphalt Content and gradation tests results, solvent extracted aggregate testing shall take precedence over burn off oven extracted aggregate, which shall take precedent over cold feed belt testing.

25.14 CONFORMITY WITH PLANS AND SPECIFICATION

25.14.1 General

All work performed and all materials furnished shall conform to the lines, grades, cross sections, dimensions, and material requirements, including tolerances, shown in the contract.

For those items of work where working tolerances are not specified, the **General Contractor** shall perform the work in a manner consistent with reasonable and customary manufacturing and construction practices.

When the **Construction Project Manager** determines that the material furnished, work performed, or the finished product is not in conformity with the contract and has resulted in inferior or unsatisfactory product, the finished product or materials shall be removed and replaced or otherwise corrected by, and at the expense of, the **General Contractor**.

Materials shall be sampled and tested by a qualified testing laboratory in accordance with the sampling, testing schedules, and procedures contained in the Section 25.15 Testing and Inspection. The approximate maximum quantity represented by each sample shall be as set forth in the testing schedule. An additional number of samples, in relation to the quantity of materials represented, may be selected and tested at the **Construction Project Manager's** discretion. The quantity represented by five consecutive random samples shall constitute a lot, whenever production schedules and material continuity permits. When it is necessary to represent short production runs, significant material changes, or other unusual characteristics of the work, the **Construction Project Manager** may establish a lot consisting of the quantity represented by any number of consecutive random samples from one to seven inclusive. Testing results that are determined to have sampling or testing errors, as determined by the **Construction Project Manager**, shall not be used.

25.15 Testing and Inspection

If any materials furnished or work performed by the **General Contractor** fails to fulfill the specification requirements, such deficiencies shall be reported to the **Construction Project Manager** and the **General Contractor** immediately. Preliminary written field reports of all tests taken and observation results shall be given to the **General Contractor** and **Construction Project Manager**, within 1 business day after samples were obtained or density testing performed. Field reports shall be forwarded to the Project Manager no later than 1 week following the testing.

Reports of all tests taken, including failing tests, shall be reported to the **Construction Project Manager** and to the **General Contractor** no later than 1 week following the sampling. Density test results will be given in writing at the time the testing occurs.

Testing of Hot Mix Asphalt Pavement shall be performed in accordance with Table 25.15. The tests shall be performed under the general supervision of and signed by a **Professional Engineer** registered in the State of Colorado. Laboratories shall be inspected by either AASHTO or accredited A2LA or equivalent in the elements listed below. Technicians taking samples and conducting compaction tests must have a LABCAT Level A certification or equivalent. Technicians conducting tests of asphalt content and gradation must have a LABCAT Level B certification or equivalent. Technicians performing volumetric testing must have a LABCAT Level C certification or equivalent.

Table 25.15.1
Schedule for Minimum Materials Sampling and Testing

Test	Standard*	Minimum Frequency
Sampling	AASHTO T 168, ASTM D 979 and ASTM D3665	One test for each day
Density	AASHTO T 166, T 238, T 230 Or CP-44, CP-81, CP-82	One test for each 250 lineal feet per Lane
Thickness (Core)	ASTM D 3549	One test for each 1000 lineal feet per Lane,
Air Voids & VMA	AASHTO T 166 & AASHTO PP 19 or CP-48	One test for each day (See note 4, Table 25.13.2)
Gradation	AASHTO T 27, T 11 or CP-31A, CP-31B	One test for each day
Asphalt (AC) Content	AASHTO T 164 or CP-L 5120 or other methods agreed upon between Construction Project Manager and General Contractor	One test for each day
Maximum Theoretical Specific Gravity (Rice)	AASHTO T 209 or CP-51	One test for each day
Lottman Stripping, TSR & Dry Density	AASHTO T 283 or CP-L 5109, Method B	As requested by the Construction Project Manager .
Micro Deval	AASHTO T 327 or CP-L 4211	One per 5000 tons or 1 per project minimum

Construction Project Manager or designee shall be responsible for checking temperatures of mix in truck and on pavement, segregation, rolling patterns and other construction means and method that affect the performance of the pavement system. The General Contractor shall provide assistance in sampling and testing at all facilities and at the job site.

End of Specification



CITY AND COUNTY OF DENVER
ENGINEERING DIVISION

Wastewater Capital Projects Management Standard Construction Specification

26.0 Excavation and Embankment

26.0.1 General

This work pertains to construction and consists of excavation, hauling, disposal, placement, and compaction of all material encountered on-site within the limits identified in the plans. All excavation and embankment for construction will be classified as “unclassified excavation” as hereafter described.

26.0.2 Referenced Standards

AASHTO M 145	Classification of soils and soil-aggregate mixtures
AASHTO T 99	Moisture-Density Relations of Soils using a 5.5-lb Rammer and a 12-inch Drop
AASHTO T 180	Moisture-Density Relations of Soils using a 10-lb Rammer and a 18-inch Drop

26.0.3 Excavation

Unclassified Excavation. Unclassified excavation shall consist of the excavation of all materials of whatever character required for the work, obtained within the construction project site, including surface boulders, masonry, organics, rocks, muck material, miscellaneous debris and slag that are not removed under some other item. The work also includes excavation for the ditches, channels, and placement, water and compaction of the material to construction embankments in accordance with the plans.

26.0.4 Embankment

Embankment: Embankment material shall consist of approved material acquired from excavations, hauled and placed in embankments. Approval of the embankment material will be contingent on the material having a maximum dry density of not less than 90 pounds per cubic foot. Soil embankment shall consist of materials obtained on-site and approved by the Engineer.

26.0.5 Construction Requirements

26.0.5.1 General

The excavations and embankments shall be finished to a smooth and uniform surface conforming to the line and grade specified. Variation from the subgrade plan elevations specified shall not be more than 1.0 inch. Excavation operations shall be conducted so material outside of the slope limits will not be disturbed. Prior to beginning grading operations, all necessary clearing and grubbing and site demolition in that area shall be performed.

The Contractor shall notify the Engineer not less than ten working days prior to beginning excavation so the necessary cross sections may be taken. Baseline survey for purposes of payment of the unclassified excavation work item will be obtained by the CCD Survey Group. The baseline survey will be taken once all building and site demolition, including removal of the buildings, parking lots, driveways is complete. The baseline survey is intended to set the topography of the existing native soil below the pavements and building elevations. Once the construction is complete a second survey will be completed to determine the final quantity of unclassified excavation. The Contractor shall not excavate beyond the dimensions and elevations established.

26.0.5.2 Unclassified Excavation

All material to be excavated shall be stockpiled as subgrade material or removed from the site. Materials excavated beneath the top twenty six (26) inches shall, at the discretion of the Engineer, either be placed in the subgrade stockpile or removed from the site and disposed of at Denver Arapahoe Disposal Site (DADS). It shall be the responsibility of the Contractor to determine the amount of subgrade material to be stockpiled and necessary for completion of the work. All stockpiled material not used shall be disposed of per Contract requirements.

26.0.5.3 Embankment

Embankment construction shall include preparation of the areas upon which embankments are to be constructed, placing, moisture conditioning and compacting of approved material to the limits shown on the plans or as directed. Only approved materials shall be used in the construction of embankments and fills. The type of relative compaction required shall be a minimum of 95% of Standard Proctor density AASHTO T-99 within 2% of optimum moisture content.

The soil upon which the embankments are to be constructed shall be scarified to a depth of eight (8) inches and compacted with moisture and density control. The moisture content of the soil at the time of compaction shall be as specified or directed.

Embankment shall be placed in horizontal layers not to exceed six (6) inches loose measurement and shall be compacted as specified before the next layer is placed. Spreading equipment shall be used to obtain uniform thickness prior to compaction. As the compaction progresses, continuous mixing, leveling and manipulating shall be done to assure uniform moisture and density.

Embankments shall be constructed with moisture and density control. The moisture content of the soil at the time of compaction shall be as specified or directed. Maximum dry density of all soil types encountered or used will be determined in accordance with AASHTO T-99. The amount of water to be used in compacting A-2-6, A-2-7, A-4 and A-6 through A-7 soils shall not deviate from optimum on the dry side by more than two percentage points as determined by AASHTO T-99. A-4 soils, which are unstable at the above moisture content, shall be compacted at lower moisture content to the specified density.

Additional work involved in drying embankment material to the required moisture content shall be included in the work.

26.0.6 Finished Grade

Finished grade as shown on the plans or as directed shall be achieved by placement of a minimum of twelve (12) inches of compacted subgrade followed by placement of six (6) inches of topsoil. Materials, compaction, moisture and density requirements for the subgrade are as specified above.

End of Specification



CITY AND COUNTY OF DENVER
ENGINEERING DIVISION

Wastewater Capital Projects Management Standard Construction Specification

31-3223.12 Soil Improvement by Compaction Grouting

Part 1 - General

1.01 Introduction

- A. Compaction grouting involves the injection under high pressure of a low-slump, mortar-like grout to compact and displace the adjacent soils. The grout does not penetrate soil pores but displaces the subsurface soils by forming a homogeneous grout bulb near the grout pipe tip.
- B. In situ soil types: Refer to the project specific geotechnical report for soil types.
- C. Applications: Loose fill stabilization; remediation of settling structures and utilities; sinkhole remediation; building/utility protection during tunneling; soil densification for site improvement; liquefaction mitigation. In certain cases, procedures can be designed to intentionally lift structures and/or utilities.

1.02 Intent

The intent of the compaction grouting specified herein is to provide soil improvement within the limits indicated on the Project Drawings to achieve the required degree of improvement detailed in these specifications.

1.03 Standards and References

- A. The most recent version of the following testing methods or standards shall be employed:
 1. ASTM D1586 Standard Penetration Testing (SPT) and Split-Barrel Sampling of Soils
 2. ASTM C1019 Sampling and Testing Grout
 3. ASTM C150/C150M Portland Cement
 4. ASTM C143/C143M Slump of Hydraulic-Cement Concrete

B. Reference documents as provided to the grouting contractor shall include:

1. This specification.
2. Construction Drawings.
3. Project specific geotechnical report.
4. Bid Documents.

1.04 Definitions

A. *Compaction Grout*: A material blend of fine aggregate, fines and water to achieve a pumpable, thixotropic, viscous grout of a low slump to enable pumping at high pressure and remain intact after injection.

B. *Field Quality Control Representative (FQCR)*: The Contractor's representative given specific inspection tasks identified in this specification.

C. *Treated Zone* – the area requiring subgrade stabilization (compaction grouting) as measured between bedrock (or depth of refusal) and the subgrade of the facility to be supported

D. *Overburden/untreated zone* – the area as measured between the existing ground surface and the subgrade of the facility to be supported.

E. *Refusal* – **This definition relies on information provided by the approved contractor and is required as a submittal. In general Refusal is the point at which pipe advancement has stopped.** We agree that Refusal is based upon the physical limitations of the machine being used to advance the pipe. There is a point, based upon different mechanical limits, at which advancement ceases and may not be within the anticipated limits of bedrock.

F. *Geotechnical Data Report (GDR)* - A document that presents an interpretation of the known subsurface data for the project. The purpose of the GDR is to compile all geological, geotechnical, groundwater, and other data obtained from the geotechnical investigations for use by the various participants in the project. If available, this information will be included within the contract documents as specifically applicable to the project.

G. *Geotechnical Baseline Report (GBR)*- The intent of a GBR is to clearly and contractually define the geotechnical conditions through which tunneling will occur in order to evaluate a differing site condition (if encountered) and it is used as a basis of bid for the contractor. By assessing the anticipated geotechnical conditions for a project and providing baselines in the contract, the contractor has a basis from which to prepare their bid and select their means and methods. The baseline conditions do not necessarily reflect the actual conditions; they are not geotechnical fact to be encountered. Rather, they represent the owner's assumption of existing geotechnical conditions for the project. If available, this information will be included

within the contract documents as specifically applicable to the project. Regardless of inclusion, this information shall be investigated, interpreted, verified and/or developed by the contractor prior to commencement of the work.

1.05 SCOPE OF WORK

A. The work shall consist of installation, monitoring and testing of compaction grouting within the limits indicated on the Drawings to meet the acceptance criteria presented in within these specifications.

B. In connection with the compaction grouting program, as shown on the drawings, the grouting contractor shall provide all labor, materials and equipment as detailed in the contract documents and within the Measurement and Payment to accomplish the work:

1.06 SUBMITTALS

A. The following shall be submitted to the Construction Project Manager by the General Contractor a minimum of two (2) weeks *prior to the start of the work*:

1. A ground movement monitoring plan, as detailed in this specification, if structures are located within a horizontal distance equal to the depth of treatment.

2. A mix design for the project indicating sources and types of grout materials, with volumetric proportions, and field test data from previous projects indicating compressive strength and slump of 1 inch or less achieved. If the grouting contractor intends to deviate from the gradation provided in this specification, the contractor shall submit evidence of satisfactory use of the proposed material from past projects with similar geotechnical conditions.

3. Work procedures and control criteria (including volumes and pressures for each stage).

4. A general Work Procedures Plan outlining the spacing as shown on the Drawings, location, depth and estimated quantity of grout to achieve the specified criteria detailed in this specification. Grout hole locations shall be dimensionally referenced to the facility foundation as shown on the Drawings.

B. The following shall be submitted to the Construction Project Manager by the General Contractor *during construction*:

1. Accurate daily records of all grout pipe installation, compaction grouting quantities, including stage data, volume, pressure and depth for each grout pipe location.
2. Any change in the predetermined grouting program necessitated by a change in the subsurface conditions.

Part 2 – Equipment and Materials

2.01 GROUTING EQUIPMENT

- A. The grouting contractor shall supply equipment capable of advancing the grout pipe through overburden, soils and other obstructions to the specified depth or as is required to meet the project objectives.
- B. The grouting contractor shall supply all equipment required to operate a compaction grouting system capable of supplying the specified grout at variable flow rates and pressures, measured at the pump, up to 250 psi and at rates of 0.5 to 12 cubic feet per minute, as required to suit the application.
- C. The mixer shall be a continuous auger type to ensure complete uniform mixing of the materials used and shall be of sufficient capacity to continuously provide the pumping unit with mixed grout at its normal pumping range. The mixer must be capable of volumetrically proportioning the grout materials.
- D. The grouting contractor shall provide gauges or other instrumentation (measuring devices) to measure:
 - 1. Continuous grout pressure close to the top of the injection casing
 - 2. Flow rate of grout.
 - 3. Volume of grout injected.
- E. The grouting contractor shall supply and install structural monitoring equipment in accordance with these specifications.
- F. A communication system shall be maintained between the pumping and batching plant and the injection location. As an alternate, the grouting contractor may furnish a remote control system to allow full control (start, stop, flow rate, reversing) of the pump directly by the contractor's personnel from the injection point).

2.02 GROUT PIPES

- A. Grout pipes and connections shall be steel casing of adequate strength to maintain the hole and to withstand the required jacking and pumping pressures. The pipes shall be at least 2.0 inches inside diameter in order to adequately handle the specified low slump material without plugging. All casing shall be flush joint threaded or a single piece tubing to provide a smooth inner wall and unobstructed inside diameter. It shall be the contractor's responsibility to install casing that does not detrimentally impact the grouting procedure.

- B. Pipes shall be installed such that grout material will not travel in the annular space between the pipe and adjacent ground and escape at the surface when pumped.

2.03 GROUT MATERIALS

- A. Portland Cement (ASTM C150)
- B. Fine aggregate shall be sand with fines content (percent passing No. 200 sieve) of not less than 10 percent and not more than 30 percent. Natural fines may be supplemented with Fly/ash, a minimal amount of bentonite, or aggregate washings.
- C. Proportions of the mixture shall be as required to achieve a pumpable mix with not more than 1 inch slump.
- D. Upon discharge into the pump hopper or holding tank, the grout must be continuously agitated. Mixed grout may not be held in the agitator for more than 1.5 hours unless a set retarder, approved by the Owner's representative, is used.

Part 3 – Execution

3.01 Site Examination

- A. If adjacent buildings are involved, a building survey shall be performed.

3.02 Compaction Grouting

- A. Compaction grouting shall be performed in accordance with the approved grout injection point layout scheme to achieve the following acceptance criteria in the in situ soil between the injection points:
 - 1. Post-grouting average, corrected Standard Penetration values exceeding 15 in typical site soils. Locations of the tests shall be agreed upon between the grouting contractor, Construction Project Manager and FQCR and will be spaced at no greater than 100 foot intervals. At each location, the Standard Penetration tests will begin at the approximate bottom of the facility to be supported and will be taken at 3 to 5-ft intervals in the treated zone.
- B. Compaction grouting shall extend from bedrock up to the subgrade of the facility to be supported.
- C. The grout shall be injected in stages until one of the following occurs:
 - 1. Grout flow ceases at a gauge pressure reading of 50 to 150 psi (250 psi maximum) or,
 - 2. Surface ground heave of 1 inch as measured via survey or,

3. An injected grout volume equal to approximately 2 to 6 cubic feet per 1 vertical linear foot of the material being treated.
- D. Compaction grouting shall be sequenced so that grouting does not take place within 4 feet of locations grouted within the previous 12 hours.
- E. As compaction grouting is completed at each location, the grouting contractor shall completely fill the grout hole to the ground surface with an approved granular material.
- F. Should the contractor reach refusal, at an elevation other than that which is expected, the FQCR shall notify the Construction Project Inspector immediately.

3.03 Field Quality Control

The General Contractor's FQCR will ensure that procedures and documentation conform to these specifications.

- A. All compaction grouting shall be performed under the inspection of the FQCR.
- B. Monitoring and logging of compaction grouting operations for both test areas and production work shall be done by the grouting contractor and the FQCR.
- C. The FQCR will perform slump tests of grout and take measurements of grout mix quantities to verify the grouting contractor's grout mix, as follows:
 1. Slump tests will be performed a minimum of twice during each grout shift.
 2. Grout mix proportions will be checked a minimum of once daily.
- D. The FQCR will cast minimum size 2 inch by 4 inch grout test cylinders or 2 inch by 2 inch cube molds for strength testing (per ASTM C1019). One set of four cylinders or molds will be cast during each slump test.
- E. Layout of grout injection points shall be by the grouting contractor and checked by the FQCR and Project Inspector with survey control provided by the General Contractor.
- F. As detailed in this specification, daily records shall be maintained by the grouting contractor and submitted to the General Contractor on a daily basis.
- G. The grouting contractor shall monitor nearby structures as follows:
 1. A level control system will be installed by the contractor for each structure within a horizontal distance equal to the depth of treatment of the grouting operations.
 2. Monitoring shall be carried out on a continuing basis whenever compaction grouting is occurring within a horizontal distance equal to the depth of treatment.
 3. After completion of the compaction grouting program, the monitoring system and grout pipes will be removed and all holes will be filled with an approved material and the surface shall be restored to match existing materials.

As compaction grouting is completed at each location, the grouting contractor shall completely fill the grout hole to the ground surface with an approved granular material.

3.04 Testing and Inspection

- A. The effectiveness of the proposed grouting layout scheme shall be verified as follows:
 - 1. The Contractor's FQCR shall perform the in situ Standard Penetration testing as directed by the Construction Project Manager. Two test sections will be performed before and during production work, as follows:
 - a. Test section locations will be agreed upon by the FQCR, Project Inspector and Grouting Contractor within the treatment area. A test section shall consist of a single module comprised of at least three grout injection points for isolated footings and sixteen grout injection points for area applications (such as along the alignment of the facility being supported). Tests will be performed at the center of the module prior to and after grouting. Standard Penetration tests will begin at the approximate bottom of the facility being supported and will be taken at 3 to 5-ft intervals in the treated zone below the facility being supported.
 - b. All testing to determine specification compliance will be provided by the FQCR. The same test method shall be utilized both before and after the soil improvement work in order to provide the most accurate assessment of the degree of improvement obtained.
 - c. The method of installation of the test section shall comply with this specification and shall be performed using the same grout line sizes, grout mix drilling and grouting equipment and procedures as that to be used for production work.
 - d. Prior to commencement of production grouting, two (2) test sections shall be performed. If the pre-production test sections indicate that the required ground improvement has not been achieved, the grouting contractor shall revise the Work Procedure Plan and re-test at two (2) test sections.
- B. Monitoring and logging of compaction grouting operations in the test areas and for production work shall be done by the grouting contractor and submitted to the FQCR on a daily basis.

END OF SECTION



CITY AND COUNTY OF DENVER
ENGINEERING DIVISION

Wastewater Capital Projects Management Standard Construction Specification

47.0 Construction Survey and Monumentation

47.0.1 Description

The Contractor shall be responsible for construction surveying, calculating, and staking necessary for the construction of all elements of the project. The Contractor shall also provide locating, preserving, referencing, installing and restoring of land monuments based upon the project's Land Survey Control drawing(s) as provided in the Contract Documents. Unless otherwise noted, payment for construction surveying and monumentation shall be via separate bid items.

The work shall be done under the supervision of a Professional Land Surveyor (PLS) who is experienced and competent in storm sewer construction, sanitary sewer construction and roadway construction surveying and licensed in the State of Colorado.

The PLS shall be available to review work, resolve problems, and make decisions in a timely manner.

47.0.2 Materials and Equipment

The Contractor shall furnish all personnel, survey equipment, safety equipment, materials, and traffic control necessary to perform the required construction surveying and staking. If any survey equipment is found to be functioning outside the manufacturer's specified tolerance, certification from an approved repair facility showing that the instruments have been repaired, properly adjusted, or both if necessary shall be included in the survey records and submitted to the City Surveyor's Office before being used.

47.0.3 Construction Requirements

A Construction Survey Conference shall be held with the City Surveyor's Office prior to performing any surveying work under this section. The Contractor's Surveyor (PLS) and Party Chief shall attend. A Construction Survey Checklist shall be completed and signed by the City Surveyor's Office and the contractor.

The Contractor shall check and verify all established Primary horizontal and vertical control points.

All survey records generated shall be the property of the City and shall be available to the City Surveyor's Office for inspection or reproduction at all times. All survey records shall be transmitted to the City Surveyor's Office for inclusion into the project records before final project acceptance.

Electronic formats may be acceptable, please coordinate with the City Surveyor's Office.

Copies of any new Monument Records filed by the PLS with the State Board of Registration shall be submitted to the City Surveyor prior to filing.

47.0.4 Construction Surveying

The Contractor's PLS shall perform all construction surveying and staking that is necessary for construction of the project. Additionally, the contractor shall establish and maintain control points and stationing during construction to allow the City's Project Manager or designee a reference to determine contract pay quantities.

47.0.5 Staking

It is the responsibility of the Contractor's PLS to adhere to industry standards and acceptable practices in regards to staking. Any re-staking will be the responsibility of the Contractor at no cost to the City.

47.0.6 Accuracy and Tolerances

It is the responsibility of the Contractor's PLS to adhere to industry standards and applicable standards with regard to horizontal and vertical accuracy tolerances.

47.0.7 Responsibility and Inspections

Supervision and coordination of construction surveying and staking is the Contractor's responsibility. The City Surveyor may inspect the Contractor's surveying; however such inspection will not relieve the Contractor of any responsibility for accuracy or completeness of work. The Contractor shall check the work to verify the accuracy and include documentation of this check in the Survey Records. All Contractor surveying inaccuracies, errors, or omissions shall be corrected at the Contractor's expense. The City Surveyor's inspection or the Contractor's corrections shall not entitle the Contractor to additional payment or contract time extension.

Survey control, benchmarks, and other significant stakes that are damaged, destroyed, or made inaccessible by the progress of construction shall be replaced, transferred or reestablished at the Contractor's expense.

47.0.8 Changes

All changes in lines and grades required by the field conditions and all discrepancies in grades, alignments, locations or dimensions detected by the Contractor shall be immediately submitted to the City Project Manager in writing. No changes in given data or

plans will be allowed unless approved by the City Project Manager in writing. All changes shall be documented in the survey records.

47.0.9 Traffic Control

Traffic control necessary for surveying and monumentation work shall not be measured and paid for separately. All traffic control costs incurred due to this work shall be included within the associated bid item(s).

47.0.10 Survey Records

Survey records shall be completed as the work is done. Field survey notes for construction surveying and checking by the Contractor shall be recorded in survey records in conformance with industry standards and acceptable practices.

All survey records generated shall be the property of the City and shall be available to the City Surveyor's Office or the City Construction Project Manager for inspection or reproduction at all times. All survey records shall be transmitted to the City Surveyor's Office for inclusion into the project records before final project acceptance. All survey records shall be stamped with the seal of, and signed by, the responsible PLS.

"As-built" and "Red-lined" drawings and prints necessary for the construction and preparation of record drawings for all elements of the project shall be the responsibility of the Contractor.

All "As-built" and "Red-lined" drawings generated shall be the property of the City and shall be submitted to the Construction Project Manager upon completion. In addition to red-lined prints, the Contractor shall supply the Construction Project Manager with electronic survey data information in the form ".asc", ".txt", and/or ".dwg" files upon request.

47.0.11 Survey Monumentation

This work consists of locating, preserving, referencing, installing and restoring land monuments as indicated in the Land Survey Control drawing(s) for the specific contract. Survey Monumentation includes but is not limited to: City of Denver Range Points and accessories, Primary Control monuments from which the Right of Way or any land boundary will be calculated, described or monumented, Public Land Survey System (PLSS) monuments, Right of Way (ROW) monuments, General Land Office (GLO) monuments, Bureau of Land Management (BLM) monuments, Mineral Survey (MS) monuments, property boundary monuments and offsets, benchmarks, easement monuments, and other monuments that are required by law or regulation to be established and recorded by a Professional Land Surveyor (PLS).

At the close out of the project the following Survey documents shall be submitted to the City Surveyor for review and acceptance:

1. City and County of Denver Monument Tie Out Sheets for all range points within the project influence.
2. A survey of all project monumentation per State Statute.

The production of additional documentation may be required by the City Surveyors' Office. All such work included in this section shall be under the supervision of a PLS who is licensed in the State of Colorado.

47.0.12 Reset Monuments

Survey monuments, benchmarks, and other significant monuments that are damaged, destroyed, or made inaccessible by the progress of construction shall be replaced, transferred or reestablished at the Contractor's expense.

Locating, preserving, referencing, installing and restoring land monuments as described in this specification shall be done under the supervision of a PLS who is experienced and competent in Right of Way and boundary surveying and licensed in the State of Colorado

47.0.13 Locating Monuments

This work consists of field locating all survey monumentation as discussed in 47.0.11 which is in place within the project limits. A diligent search of construction zones and project limits shall be performed by the PLS.

47.0.14 Preserving and Referencing Monuments

All monuments as described in this specification shall be preserved, referenced and reset by the Contractor's PLS within the project limits.

47.0.15 Installing Monuments

All monuments as described in the contract documents shall be preserved through construction. If any monuments are to be disturbed/removed during construction, it will be the contractor's responsibility to have all monuments reset to current City of Denver standards. Appropriate documentation will be required for all reset monuments.

47.0.16 Monument Box

This survey work shall consist of installing or adjusting monument boxes to current City or State requirements.

47.0.17 Method of Measurement

All survey work will be paid for via the associated bid item(s) and in accordance with the respective Measurement and Payment portions of the Contract Documents.

End of Specification



CITY AND COUNTY OF DENVER
ENGINEERING DIVISION

**Wastewater Capital Projects Management
Standard Construction Specifications**

Measurement and Payment

March 15, 2016

Measurement and Payment

01-5213 Temporary Office Facilities

No quantity measurement will be made for any of the work and materials required to accomplish this aspect of the project and payment will be based upon the percentage of this work item completed in accordance with the plans and specifications and as approved by the City Construction Project Manager.

This item includes: furnishing, installing, maintaining, cleaning, periodic inspections, adjustments and modifications, and removal of all temporary office facilities; providing utilities and services including but not limited to the following: water, electric, telephone, DSL hard line, acceptable scanner, copy machine, printer, internet, sanitary facilities, security measures, storage areas, etc. and payment of associated monthly bills during project duration; development and maintenance of access and haul routes, furnishing and installation of temporary construction fencing; securing temporary facility location, securing of required permits, payment of all associated fees, restoring the site to a better or equal condition than prior to use, and all other equipment and labor required for the implementation, maintenance and removal of all temporary office facilities.

At the option of the Construction Project Manager, one quarter of the lump sum price for temporary office facilities may be paid to the Contractor at the time of the first monthly progress payment, the second quarter may be paid at the time of the second monthly progress payment, and the third quarter may be paid to the Contractor at the time of the third monthly progress payment, or at the discretion of the Construction Project Manager. The total payment for this bid item shall not exceed seventy-five percent (75%) of the lump sum price during construction. The remaining twenty-five percent (25%) shall be paid after all facilities have been completely removed and the location of said facilities has been returned to an equal or better condition than prior to use by the Contractor.

02-2213 Vibration Assessment

No quantity measurement will be made for any of the work and materials required to accomplish this aspect of the project and payment will be based upon the completion of the work in accordance with the Contract Documents.

The lump sum price for Vibration Assessment shall include all of the Contractor's costs of whatsoever nature. The price bid shall include: all labor, equipment, materials, subcontractors, and transportation to and from project site required to complete vibration monitoring and assessment during the entire project duration regardless of extensions; furnishing submittals, baseline and monthly reports; theft and vandalism protection; web based data access and site training; incidentals; meetings and coordination with business owners and residents as necessary during construction; and all other related and necessary materials work and equipment required to accomplish this item in accordance with the Contract Documents.

At the option of the Construction Project Manager, one third of the lump sum price for this item may be paid to the Contractor upon satisfactory completion of and/or incorporation of proper measures. The second third may be paid upon fifty percent completion of the work as determined by the percent of work completed on the day of progress payment. The last third may be paid to the Contractor at the time of final progress payment or at the discretion of the Construction Project Manager.

Measurement and Payment

02_8216.10 Certified Asbestos Inspector (CABI)/Air Monitor

No quantity measurement will be made for any of the work and materials required to accomplish this aspect of the construction and payment will be based upon completion of the work in accordance with the Contract Documents. The lump sum price bid shall include the coordination and performance of an onsite CABI and air monitoring.

The lump sum price for the CABI/air monitor shall include all of the Contractor's costs of whatsoever nature, including licensing and certification of the CABI. The price bid shall include: all labor, materials and equipment required for the inspector to monitor the construction site, evaluate potential asbestos containing material, and collect air fiber samples; lab testing as required; and all other related and necessary materials, work, and equipment required for completion of this work in accordance with the Contract Documents. Duties of the CABI/Air monitor shall be to monitor and cause to enforce that all project activities, excavations, and site controls are in compliance with Denver Environmental Health – Asbestos-Contaminated Soil Management Standard Operating Procedure (current version); all state and federal laws and regulations and guidelines; provide asbestos awareness training for all personnel associated with the project; and any other duties as defined within a site specific Material Management Plan.

At the option of the Construction Project Manager, monthly percentage payments, based upon Period of Performance, may be paid to the contractor upon satisfactory completion of and/or proper controls submitted in monthly payment application, or at the discretion of the Construction Project Manager. Up to the last progress payment or at the discretion of the Construction Project Manager.

31-3223.12 Soil Improvement by Compaction Grouting

The measurement for payment of this item will be the total number of vertical lineal feet of soil improvement by compaction grouting as measured between bedrock (or depth of refusal) and the subgrade of the proposed facility to be supported (treated area).

Measurement will be based on the total vertical linear feet that the grout injection rod advances from the existing ground surface to bedrock or refusal less the plan depth at the grout port location (as shown on the plans) for rod advancement measured from ground surface to subgrade of the facility to be supported (untreated area). Drilling logs showing actual vertical lineal footages of rod advancement depth through the untreated area and into the treated area shall be provided by the contractor as basis for payment of this item.

Payment will be made based upon documented drilling logs showing the vertical linear feet of complete, in place, in a manner satisfactory to the Construction Project Manager, provided, however no payment will be made for compaction grouting due to negligence or unauthorized operations by the Contractor.

The unit price bid per vertical linear foot of compaction grouting within the treated zone shall include all of the Contractor's costs of whatsoever nature. The price bid shall include: all labor, equipment, materials, grout, testing ground/structure monitoring system, installation and removal of grout pipes, furnish and injection of compaction grout, monitoring of ground/structure movements; survey, following the grouting sequence of operations as set forth in the contract documents, monitoring of all vertical measurements, all revisions of work

Measurement and Payment

plans and retesting to establish if grouting meets the contract requirements; hauling and disposal of construction debris, unsuitable material and contaminated materials at the Denver Arapahoe Disposal Site (DADS); in accordance with all specifications included within the contract documents. The Contractor shall be responsible for obtaining all permits, field verification of all utilities

31-3223.12a Overburden Penetration for Compaction Grouting

The measurement for payment of this item will be the total number of vertical linear feet of overburden penetration during soil improvement by compaction grouting as measured between the existing ground surface to the subgrade of the proposed facility to be supported (untreated area). Measurement will be based on vertical linear feet (plan depth) at the grout port location (as shown on the plans) for rod advancement measured from ground surface to subgrade of the facility to be supported (untreated area). Drilling logs showing actual vertical lineal footages of rod advancement depth through the untreated area and into the treated area shall be provided by the contractor as basis for payment of this item.

Payment will only be made based upon the plan depth of overburden penetration measured in vertical linear feet and as documented in drilling logs showing the vertical linear feet of overburden penetration, where successful grout placement has occurred, and as in a manner satisfactory to the Construction Project Manager, provided, however no payment will be made for overburden penetration due to negligence or unauthorized operations by the Contractor.

The unit price bid per linear foot of overburden penetration for compaction grouting shall include all of the Contractor's costs of whatsoever nature. The price bid shall include: steel casing pipe and all labor, equipment, materials and all other related and necessary items, complete in accordance with the Contract Documents.

- 2-1.1a Remove Combination Concrete Curb, Gutter and Sidewalk (2'8")**
- 2-1.1b Remove Combination Concrete Curb, Gutter and Sidewalk (3'11")**
- 2-1.2a Remove 6" Concrete Curb and/or Gutter**
- 2-1.2b Remove 9" Concrete Curb and/or Gutter**
- 2-1.3 Remove Concrete Curb Head**
- 2-1.4 Remove Handicap Concrete Curb Ramp**
- 2-1.5 Remove Concrete Median Strip**
- 2-2.1 Remove Concrete Sidewalk**
- 2-2.1a Remove Concrete Sidewalk/Bike Path**
- 2-2.2 Remove Concrete Driveway Paving**
- 2-2.4 Remove Concrete Channel Paving**
- 2-2.5 Remove Miscellaneous Concrete Flatwork**

The measurement for payment of this item will be the total number of linear feet or square feet of existing concrete curb and gutter, combination concrete curb and gutter, concrete curb head, concrete handicap curb ramp, concrete median strip, concrete sidewalk, concrete bike path, concrete driveway pavement, concrete slab, concrete alley return, concrete alley paving, concrete channel paving or any other type of miscellaneous concrete flatwork as specified in the Contract Documents or designated by the Construction Project Manager to be removed for construction of the proposed sewer and/or appurtenances; provided, however, no

Measurement and Payment

measurement for payment will be made for concrete flatwork removed or damaged due to negligence or unauthorized operations by the Contractor.

The unit price bid per linear foot or square foot removal of this item shall include all of the Contractor's costs of whatsoever nature. The price bid shall include: excavation, concrete sawing or otherwise effectively cutting the concrete item smoothly and squarely in a manner satisfactory to the Construction Project Manager; excavation and overexcavation; removal and disposal of unsuitable material, existing flatwork and/or any reinforcing materials per the requirements set forth in the Contract Documents; and all other related and necessary materials, work, and equipment required to remove this item in accordance with the Contract Documents.

2-2.6 Remove and Replace Flagstone Curb Head

2-2.7 Remove and Replace Flagstone Walk

The measurement for payment of this item will be the total number of linear feet of Flagstone Curb Head or the total square feet of flagstone walk required to be removed or placed for construction of the proposed sewer and/or appurtenances; provided, however, no measurement for payment will be made for flagstone removed and replaced due to negligent or unauthorized operations by the Contractor.

The unit price bid per linear foot or square foot removal and replacement of this item shall include all of the Contractor's costs of whatsoever nature. The price bid shall include: excavation, sawing or otherwise effectively cutting the flagstone item smoothly and squarely in a manner satisfactory to the Construction Project Manager; excavation and over excavation; removal and disposal of unsuitable material; storing on site for reuse; placement and/or replacement of flagstone; furnishing of new flagstone or equivalent stone as necessary; cutting, shaping, leveling, grouting, spacing; bedding, supply and placement of select subgrade material or select fill as necessary, compaction, and all other related and necessary materials, work, and equipment required to remove and replace this item in accordance with the Contract Documents.

2-2.8 Remove Asphalt Walk

The measurement and payment of this item will be the total number of linear feet of asphalt walk required to be removed, and/or removed and replaced for the proposed sewer and/or appurtenances; provided, however, no measurement for payment will be made for asphalt walk removal or replacement required due to negligent or unauthorized operations by the Contractor.

The unit price bid per linear foot removal, removal and replacement, or placement of this item shall include all of the Contractor's costs of whatsoever nature. The price bid shall include: excavation, grading and shaping; placement of bedding; excavation and overexcavation; removal and disposal of unsuitable material; placement and/or replacement; furnishing of asphalt; leveling and compaction, and all other related and necessary materials, work, and equipment required to remove this item in accordance with the Contract Documents.

2-3 Remove Concrete Wheel Stops

The measurement for payment of this item will be the total number existing wheel stops required to be removed or placed for construction of the proposed sewer and/or appurtenances; provided, however, no measurement for payment will be made for wheel stops removed and replaced due to negligent or unauthorized operations by the Contractor.

Measurement and Payment

The unit price bid per wheel stop removal shall include all of the Contractor's costs of whatsoever nature. The price bid shall include: excavation, sawing or otherwise effectively removing the wheel stop in a manner satisfactory to the Construction Project Manager; excavation and overexcavation; removal and disposal of unsuitable material; storing on site for reuse; placement of replacement; furnishing of new wheel stops; cutting, leveling, grouting, spacing; bedding, compaction, and all other related and necessary materials, work, and equipment required to remove this item in accordance with the Contract Documents.

2-3.1 Remove Concrete Alley Gutter

2-3.2 Remove Concrete Alley Returns

2-3.3 Remove Concrete Alley Paving

2-3.4 Remove Concrete Street Intersection Gutter (Crosspan) and/Or Valley Gutter

2-3.5 Remove Concrete Street Paving

The measurement for payment of this item will be the total number of square feet of concrete required to be removed for construction of the proposed sewer; provided, however, no payment will be made for damaged material required to be removed due to negligence or unauthorized operations by the Contractor or any Subcontractors.

The unit price bid per square foot for removing this item shall include all of the Contractor's costs of whatsoever nature. The price bid shall include: concrete sawing and otherwise effectively cutting the existing concrete smoothly and squarely in a manner satisfactory to the Construction Project Manager; removal and disposal of concrete, asphalt, and/or any reinforcing materials, including removal of the square radius beyond the lip of the standard two-foot gutter; furnishing additional base material; subgrade preparation and compaction; rotomilling within the effective removal limits; and all other related and necessary materials, work, and equipment required to accomplish the removal of this item in accordance with the Contract Documents.

In addition to the above listed items, the unit price bid per square foot removal of concrete street intersection gutter and/or valley gutter shall include repaving of the street within the effective removal limits to a point not less than 2-inches below the new finished street grade (matching cross street crowns to within 2-inches of finished street grade to the satisfaction of the Construction Project Manager), including surrounding areas damaged during removal. The effective removal limits encompass the surface area shown on the Project Paving Schematic included within the Contract Documents. This area varies based on location within the project. The additional 2-inches of paving within the effective removal limits, as well as all required rotomilling and asphalt placement outside the limits will be paid for using bid items

provided for elsewhere in the Contract Documents. No separate measurement or payment will be made for additional paving materials or rotomilling necessary for adherence to this item, all such costs will be included in the square foot price for removal.

2-4 Remove Concrete Steps

The measurement for payment of this item will be the total number of square feet of concrete steps required to be removed for construction of the proposed sewer and/or appurtenances; provided, however, no measurement for payment will be made for concrete steps removed and replaced due to negligent or unauthorized operations by the Contractor.

The unit price bid per square foot of concrete steps, which shall be quantified by the width of the stairs multiplied by the summation of each stair hypotenuse (the hypotenuse of the rise and run of each stair). The unit price shall include all of the Contractor's costs of whatsoever nature.

Measurement and Payment

The price bid shall include: excavation, sawing or otherwise effectively removing the steps in a manner satisfactory to the Construction Project Manager; excavation and overexcavation; removal of any foundation concrete; removal and disposal of unsuitable material; backfilling of foundation with suitable bedding, compaction, and all other related and necessary materials, work, and equipment required to remove this item in accordance with the Contract Documents.

2-5 Remove Concrete Retaining Wall

The measurement for payment of this item will be the total number of linear feet of retaining wall, including attached railing and/or fence required to be removed for construction of the proposed sewer and/or appurtenances; provided, however, no measurement for payment will be made for retaining wall removal required due to negligent or unauthorized operations by the Contractor.

The unit price bid per linear foot of retaining wall removal shall include all of the Contractor's costs of whatsoever nature. The price bid shall include: excavation, sawing or otherwise effectively removing the wall in a manner satisfactory to the Construction Project Manager; excavation and overexcavation; removal of any foundation concrete; removal of tie backs, drainage pipe; removal and disposal of fence and/or railings; removal and disposal of unsuitable material; removal of brick, wood, cinder block, steel sheeting, or rock walls; backfilling of foundation with suitable bedding, compaction, and all other related and necessary materials, work, and equipment required to remove this item in accordance with the Contract Documents.

2-6 Remove Concrete Headwall

No partial measurement for payment will be made for this item, removal and payment will be based upon complete removal of the concrete headwall and/or attached railing and/or fence to the satisfaction of the Construction Project Manager or to the requirements of the Contract Documents; provided, however, no measurement for payment will be made for retaining wall removal required due to negligent or unauthorized operations by the Contractor.

The unit price bid per lump sum concrete headwall removal shall include all of the Contractor's costs of whatsoever nature. The price bid shall include: effectively removing the wall in a manner satisfactory to the Construction Project Manager; excavation and overexcavation; removal of any foundation concrete; removal of tie backs, drainage pipe; removal and disposal of unsuitable material; removal of brick, wood, cinder block, steel sheeting, or rock headwalls; removal and disposal of fence and/or railings; backfilling of foundation with suitable bedding, compaction, and all other related and necessary materials, work, and equipment required to remove this item in accordance with the Contract Documents.

2-11 Remove or Abandon Existing Pipe and Box Culverts

8-4 Remove Existing Waterline

The measurement and payment for this item will be the total number of linear feet of existing pipe, flared end sections, box culvert, and/or waterline of the dimensions specified, required to be removed or abandoned for construction of the proposed sewer and/or appurtenances; however, no payment will be made for pipe removed or abandoned due to negligence or unauthorized operations by the Contractor.

The unit price bid per linear foot of removal or abandonment shall include all of the Contractor's costs of whatsoever nature. The price bid shall include: excavation; care and diversion of drainage courses; removal of pipe, cone sections and sewer appurtenances as necessary to

Measurement and Payment

complete the removal or abandonment as specified in the Contract Documents including removal and disposal of the existing conduit and appurtenances (per State and Local requirements where applicable for lines containing asbestos); hauling and disposal of construction debris, unsuitable material and contaminated materials at the Denver Arapahoe Disposal Site (DADS); removal of pavement, sod and other surfacing materials; excavation, including exploratory excavation; diversion, cutting and plugging of pipe, as necessary, per the Contract Documents, any additional labor, equipment and materials required to disconnect the existing facility as required by the owner, salvaging of pipe when directed by the Construction Project Manager or when specified in the Contract Documents, placing of the salvaged pipe on the job site in a location designated by the Construction Project Manager; reforming and reshaping of manhole inverts as required; backfilling to final grade with approved backfill material; filling of abandoned pipe with an approved CLSM or alternately approved product, per the requirements set forth in the Standard Construction Specifications; compaction of materials as necessary; paving, curb, gutter, sidewalk, landscaping and any other surface restoration required due to removal of associated items; coordination with utility owner as required and all other related and necessary materials, work, and equipment required to complete removal or abandonment in accordance with the Contract Documents.

2-11.8 Remove Abandoned Steam Pipe With Asbestos Lining (<24" Diameter)

The measurement for payment of this item will be the total number of linear feet of pipe required to be removed and transported to an approved disposal site for construction of the proposed sewer; provided, however, no payment will be made for removal due to negligence or unauthorized operations by the Contractor or any Subcontractors.

The removal of abandoned steam pipe with asbestos lining shall comply with Colorado State Regulation No. 8, Part B, which incorporates the Environmental Protection Agency (EPA) National Emissions Standards for Hazardous Air Pollutants (NESHAP) Regulations for Asbestos (40 CFR Part 61). More specifically, the removal activity must comply with § III.S.4. (Other Non-friable Asbestos-Containing Materials) and if at a quantity above trigger levels (§I.B.104) are also subject to § III.E. (State Notifications) of the stated regulation. If during abatement, the asbestos cement product becomes friable, the project activity shall meet and conform with all the requirements in sections I (Definitions), II (Certification Requirements), and III (Abatement, Renovation and Demolition Projects) of the stated regulation. All abatement projects involving asbestos products are subject to Occupation Safety and Health Administration (OSHA) Standards for Asbestos (29 CFR Parts 1910.1001 and 1926.1101). Transportation of asbestos-containing waste materials is regulated by the Colorado Department of Transportation (CDOT). All expenses incurred to comply with the above noted items shall be borne by the Contractor.

The unit price bid per linear foot for removal shall include all of the Contractor's costs of whatsoever nature. The price bid shall include: excavation; care and diversion of drainage courses; removal of pipe, insulating materials and appurtenances; removal of pavement, sod, and other surfacing materials; excavation, including exploratory excavation; coordination and interaction with abandoned facility owner to ensure that a chain of custody is maintained; hauling and disposal of construction debris, excess excavated material, damaged materials and asbestos contaminated materials at the Denver Arapahoe Disposal Site (DADS) unless otherwise specified or required by State regulations; backfilling and compaction to final grade with an approved backfill material; and all other related and necessary materials, work and equipment required to remove the existing abandoned steam pipe with asbestos lining in accordance with the Contract Documents.

Measurement and Payment

- 2-12.1 Remove Existing Sanitary Manhole**
- 2-12.2 Remove Existing Storm Manhole**
- 2-12.3 Abandon Existing Sanitary Manhole**
- 2-12.4 Abandon Existing Storm Manhole**
- 2-12.7 Remove Existing Structure**
- 2-13.1 Remove Existing Storm Inlet**
- 2-13.2 Remove Existing Special Storm Inlet**

The measurement for payment of this item will be the total number of manholes, inlets or structures required to be removed or abandoned for construction of the proposed sewer and/or appurtenances; however, no payment will be made for structures removed due to negligence or unauthorized operations by the Contractor.

The unit price bid per manhole, inlet or structure removal and/or abandonment shall include all of the Contractor's costs of whatsoever nature. The price bid shall include: excavation, overexcavation, exploratory excavation; care and diversion of drainage courses; removal of brick, grate, ring and cover, manhole barrel sections, concrete and any related reinforcing materials, unsuitable material, reducers, etc. to a minimum of 2 foot below finish grade; removal of pavement and sod; cutting and plugging of associated pipe per the Contract Documents, or as required by the Construction Project Manager; salvaging of ring and cover or grates when so designated by the Construction Project Manager; storing of all salvaged materials on the job site at a location designated by the Construction Project Manager; disposal of unsuitable material; placement of approved backfill material and/or Controlled Low Strength Material to final grade elevation, compaction; removal and replacement of paving, curb, gutter, sidewalk, landscaping and any other surface restoration required due to removal of associated item, unless specifically provided for elsewhere in the Contract Documents; and all other related and necessary materials, work, and equipment required to remove, abandon and/or salvage the existing structure in accordance with the Contract Documents.

-
- 2-14 Remove Riprap**
 - 2-15 Remove Gabions**

The measurement for payment of this item will be the total number of cubic yards of riprap, gabions or other rock materials required to be removed for construction of the proposed sewer and/or appurtenances; provide, however no measurement for payment will be made for rock required to be removed due to negligence or unauthorized operations by the Contractor.

The unit price bid shall include all of the Contractor's costs of whatsoever nature. The price bid for removal shall include; excavation, backfilling, removal and disposal of unsuitable material, compaction and all other related and necessary materials, work, and equipment required to remove the riprap or gabions in accordance with the Contract Documents.

-
- 2-16.1 Remove Chain Link Fence**
 - 2-16.2 Remove Wood Fence**
 - 2-16.3a Remove Single Swing Gate**
 - 2-16.3b Remove Double Swing Gate**
 - 2-16.4 Remove Security Fence**
 - 2-18 Remove Permanent Barricades**
 - 2-21.1 Remove Guard Rail**

Measurement and Payment

2-21.2 Remove Hand Rail

The measurement for payment of this item will be the total number of linear feet of wood fence, chain link fence, security fencing, gate work, guard rail, hand rail, or the number of barricades required to be removed for construction of the proposed sewer and/or appurtenances; provided, however, no measurement for payment will be made for items required to be removed due to negligence or unauthorized operations by the Contractor.

The unit price bid per linear foot of removal shall include all of the Contractor's costs of whatsoever nature. The price bid shall include: removal and disposal of materials to include: concrete bases, rails, posts, pickets, wire, fabric, slats, w-beams, nails, nuts, bolts, fencing, etc.; removal and salvage of materials if determined to be reusable by the Construction Project Manager; filling postholes, backfilling and regrading as necessary to promote drainage and eliminate safety hazards; and all other related and necessary materials, work and equipment required to complete the removal in accordance with the Contract Documents.

2-17.1 Remove and Replace/Relocate Utility Poles

2-17.2 Temporary Utility Pole

2-17.3 Remove and Replace/Relocate Sign

2-17.5 Remove and Replace Parking Meter Pole

The measurement and payment of this item will be the total number of utility poles, parking meter poles and/or signs required to be removed and/or removed and relocated or replaced, and the total number of temporary poles placed and removed, for construction of the proposed sewer and/or appurtenances; provided, however, no measurement for payment will be made for poles removed due to unauthorized operations of the Contractor.

The unit price bid shall include all of the Contractor's costs of whatsoever nature. The price bid shall include: coordination with the utility owner; adherence to rules and procedures set forth by utility owners; scheduling relocates as required to insure that no time is lost for the project; excavation; removal and storage of poles and/or signs; replacement with new pole and/or signs if necessary; bedding, select fills, backfilling and compaction; removal and replacement of guy wires; drilling, casings; installation of new foundations to utility owner or Construction Project Manager's requirements as necessary; disposal of all trash and construction unsuitable material associated with this bid item; and all other related and necessary materials, labor and equipment required to complete the construction in accordance with the Contract Documents.

2-17.7 Relocate Existing Utility

No quantity measurement will be made for any of the work and materials required to accomplish this aspect of the construction project and payment will be based upon the completion of the work in accordance with the Contract Documents.

The lump sum cost for coordination and relocation of the specified existing utility line shall include all of the Contractor's costs of whatsoever nature. The price bid shall include: coordination with the utility owner as necessary to complete the relocation; adherence to rules, regulations, specifications and procedures set forth by utility owner; obtaining all required permits and paying associated fees; railroad flagging/inspection and fees as necessary; shoring and trench support; hand digging as necessary; removal and disposal of concrete encasement material; removal and disposal of abandoned appurtenances; scheduling, rescheduling and facilitating all relocations as required to ensure the project stays on time, all associated delay costs; excavation as necessary for relocation of existing utility; removal, disposal and hauling of

Measurement and Payment

all construction debris, excess excavated material, unsuitable materials and manifested contaminated materials at the Denver Arapahoe Disposal Site (DADS), recycle and salvage of materials as required by contract; temporary utility supports; relocation of the utility; providing temporary service and rerouting as necessary; preserving service and continuity as required by utility owner; cutting of existing utility conduit and line as necessary; providing all materials, equipment and specialty labor necessary for reconnection of specific utility; brushing, cleaning and pigging of utility conduit as required by owner; providing and installing marking/tracing wire; concrete encasement of relocated utility as required and per utility company standards; traffic control supporting a standalone configuration; air testing; material testing; relocation engineering and plan development; directional boring if needed; removal and replacement of concrete flatwork at directional bore pits; specialized welding at points of connection and pipe junctions; backfilling and compaction after completion of relocate; and all other related and necessary materials, work and equipment required to relocate the existing utility as required in the Contract Documents or as directed by the Construction Project Manager.

2-19 Remove Existing Culvert

The measurement for payment of this item will be the total number of linear feet of concrete culvert or concrete channel required to be removed for construction of the proposed sewer and/or appurtenances; provided, however, no measurement for payment will be made for removal of culvert due to negligence or unauthorized operations by the Contractor.

The linear foot price bid for culvert removal shall include all of the Contractor's costs of whatsoever nature. The price bid shall include: excavation, including overexcavation to remove unsuitable foundation material; removal and disposal of all culvert materials including pipe, wood, concrete, reinforcing; backfilling and compaction; and all other related and necessary materials, work and equipment required to remove the culvert in accordance with the Contract Documents.

2-20a Remove Trolley Tracks

2-20b Remove Railroad Tracks

The measurement for payment of this item will be the actual number of linear feet per pair of trolley, street car, or railroad tracks required to be removed for construction; provided, however, no payment will be made for track removed due to negligence or unauthorized operations by the Contractor.

The unit price bid per linear foot removal of this item shall include all of the Contractor's costs of whatsoever nature. The linear foot price bid (per pair of rails) shall include: removal of paving within the entire track facility footprint and adjacent paving requiring removal to properly complete this item; cutting and disposal; stockpiling, storage and protection; or recycling of rails; removal and disposal of ties, fasteners, spikes, special joints; removal and disposal of special bedding and/or ballast under the tracks, removal and disposal of concrete panels and/or rubber matting; hauling and disposal of all excess excavated at the Denver Arapahoe Disposal Site; backfilling and compaction of subgrade with suitable material; temporary driving surfaces required prior to final pavement or new track installation, maintenance of temporary driving surfaces to includes removal and installation of new temporary surfaces as necessary prior to final treatment; and all other related and necessary materials, work and equipment required for removal of this item in accordance with the Contract Documents.

Measurement and Payment

2-22 Remove Parking Lot Trench Drain

The measurement for payment of this item removal will be the actual number of linear feet of trench drain required to be removed for construction of the proposed sewer and/or appurtenances; provided, however, no payment will be made for trench drain removed due to negligence or unauthorized operations by the Contractor.

The unit price bid per linear foot removal of this item shall include all of the Contractor's costs of whatsoever nature. The price bid shall include: excavation, removal of concrete, unsuitable material, grates, backfilling and compaction; and all other related and necessary materials, work and equipment required for removal of this item in accordance with the Contract Documents.

2-23 Remove Decorative Landscaping

No quantity measurement will be made for any of the work and materials required to remove and replace this item. Payment will be based upon completion of the work in accordance with the Contract Documents; provided, however, no payment will be made for removing and replacing decorative landscaping required to be replaced due to negligent or unauthorized operations by the Contractor.

The lump sum bid price shall include all of the Contractor's costs of whatsoever nature. The price bid shall include: excavation; removal and replacement of concrete, rock; removal and replacement of plants; disposal of excess excavated materials; topsoil, fertilizer, water, storage and all other related and necessary materials, work and equipment, required to replace the decorative landscaping in accordance with the Contract Documents.

2-24 Remove and Replace Bus Stop

The measurement and payment of this item will be the total number of bus stops to be removed and replaced for construction of the proposed sewer and/or appurtenances; provided, however, no measurement for payment will be made for bus stops removed and/or replaced due to unauthorized operations by the Contractor.

The unit price bid shall include all of the Contractor's costs of whatsoever nature. The price bid shall include: coordination with the Regional Transportation District (RTD); adherence to the rules and procedures set forth by RTD; scheduling all necessary relocations and utility disconnections/reconnections, as required, to insure that no time is lost on the project; excavation, removal and disposal of materials as necessary; removal, storage, and replacement of poles, signs, benches, shelters, trash cans, guy wires and all other appurtenances associated with the bus stop; installation and removal of temporary bus stops, as required by RTD; removal and replacement of concrete bus pads, pavement, subgrade material, curb, gutter and sidewalk, landscaping materials and all other items required to complete construction of the proposed sewer and/or appurtenance and replace the bus stop in the same or better condition upon completion; and all other related and necessary materials, labor and equipment required to complete the construction in accordance with the Contract Documents.

Measurement and Payment

3-2 Hauling of Contaminated Materials to Denver/Arapahoe Disposal Site (DADS)

The measurement for payment of this item will be the number of tons of contaminated material required to be hauled off to the Denver/Arapahoe Disposal Site for construction of the proposed sewer and/or appurtenances; provided, however, no measurement for payment will be made for hauling of non-contaminated materials and contaminated materials not authorized by the Construction Project Manager. Payment shall be based upon weights obtained from a certified mobile scale, or at a location agreed to with the Construction Project Manager prior to commencement of activities. Certified weight tickets from the agreed to scale shall be used for payment purposes. Payment shall not be made for muck excavation necessary to poor shoring methods or unauthorized operations by the contractor.

The unit price bid per ton of contaminated material disposal shall include all of the Contractor's costs of whatsoever nature. The price bid shall include: excavation; identification, storage, loading; hauling, wrapping and obtaining weights on a certified scale prior to disposal; providing a mobile scale, disposal of debris at the Denver Arapahoe Disposal Site; acquisition of all required permits; all special personnel and equipment required to haul the construction debris to DADS; laboratory testing as required; equipment decontamination; fugitive dust control, containment and monitoring; compliance with Denver Environmental Health – Asbestos-Contaminated Soil Management Standard Operating Procedure (current version); management of on-site treatment; stockpiling, profiling, storage and disposal of contaminated materials; implementation and coordination of Federal, State and Municipal Rules and Regulations as required by the respective agencies and governmental entities; all fees and fines associated and all other related and necessary materials, work, and equipment required for removal of this item in accordance with the Contract Documents.

3-3 Hazardous Waste Disposal

The measurement for payment of this item will be the total number of tons of hazardous waste required to be removed and hauled off, for construction of the proposed sewer and/or appurtenances; provided, however, no measurement for payment will be made for removal and disposals not authorized by the Construction Project Manager. Payment shall be based upon weights obtained from a certified scale agreed to with the Construction Project Manager prior to commencement of activities. Certified weight tickets from the agreed to scale shall be used for payment purposes. Payment shall not be made for muck excavation necessary to poor shoring methods or unauthorized operations by the contractor.

The unit price bid per ton of Hazardous Waste disposal shall include all of the Contractor's costs of whatsoever nature. The price bid shall include: all required permits and fees; excavation, loading, hauling and obtaining weights at a certified scale prior to disposal; and backfilling; disposal of hazardous waste at the Denver Arapahoe Disposal Site; and as required by State and Federal regulations; and all other related and necessary materials, work, and equipment required for hazardous waste disposal in accordance with the Contract Documents.

3-4 Rock Excavation

The measurement for payment of this item will be the total number of cubic yards of rock required to be removed for construction of the proposed sewer and/or appurtenances; provided, however, no measurement for payment will be made for rock excavation beyond the

Measurement and Payment

maximum prescribed trench width or for depths exceeding 12 inches below the pipe nor for excavation due to negligence or unauthorized operations by the Contractor.

The unit price bid per cubic yard of rock excavation shall include all of the Contractor's costs of whatsoever nature required to perform the excavation and to replace the void area with granular bedding and/or any other material specifically approved by the Construction Project Manager. The price bid shall include: excavation, blasting, removal and disposal of rock unsuitable material; furnishing, placing and compacting the approved backfill material required to fill the void area; and all other related and necessary materials, work, and equipment required to excavate the rock in accordance with the Contract Documents.

3-5 Muck Excavation

The measurement and payment for this item will be the total number of tons of muck required to be excavated and disposed of; provided, however, no measurement for payment will be made for any excavation of material that does not meet the definition of muck as described in the technical specifications or as determined by the Construction Project Manager. Measurement for muck excavation will be made only to the limits specifically determined by the Construction Project Manager. Payment shall be based upon weights obtained from a certified scale agreed to with the Construction Project Manager prior to commencement of activities. Certified weight tickets from the agreed to scale shall be used for payment purposes. Payment shall not be made for muck excavation necessary to poor shoring methods or unauthorized operations by the contractor.

The unit price bid per ton of muck removal shall include all of the Contractor's costs of whatsoever nature: The price bid shall include: excavation; loading, hauling and obtaining weights at a certified scale prior to disposal; removal and disposal of muck at the Denver Arapahoe Disposal Site; dewatering; placing and compacting approved select materials in void areas left by the excavation in a timely fashion; and all other related and necessary materials, labor, and equipment required to remove the muck in accordance with the Contract Documents or as directed by the Construction Project Manager.

3-6 Construct, Repair, or Stabilize Embankments

The measurement and payment for this item will be the total number of cubic yards of embankment materials required for construction of the proposed sewer and/or appurtenances; provided, however, no payment will be made for embankment materials not authorized by the Construction Project Manager.

The unit price bid per cubic yard of embankment construction shall include all of the Contractor's costs of whatsoever nature. The price bid shall include: excavation, haul, furnishing and placement of embankment materials, geotextiles, soils, compaction, placement of riprap, concrete, grouting, grading; and all other related and necessary materials, work, and equipment required to construct the embankment in accordance with the Contract Documents.

3-7a Health & Safety Plan

No quantity measurement will be made for any of the work and materials required to accomplish this aspect of the construction project and payment will be based upon the completion of the work in accordance with the Contract Documents.

Measurement and Payment

The lump sum payment for health and safety plans shall include all of the Contractor's costs of whatsoever nature. The lump sum price bid shall include: creation and modification of a Health & Safety Plan, facilities coordination for health and safety; training of all personnel as necessary to perform work; coordination of Federal and Municipal Rules and Regulations as required by the respective agencies and municipalities; all fees, and fines due to non-compliance with regulations, monitoring of the health and safety plan; contaminant testing as required; and all other related and necessary materials, work and equipment required to complete this item in accordance with the Contract Documents.

At the option of the Construction Project Manager, monthly percentage payments, based upon Period of Performance, may be paid to the contractor upon satisfactory completion of and/or proper controls submitted in monthly payment applications. At the discretion of the Construction Project Manager, payment may be withheld for any Non-conformance reports issued for failure to comply with the accepted Health & Safety Plan.

3-7b Material Management Plan

No quantity measurement will be made for any of the work and materials required to accomplish this aspect of the construction project and payment will be based upon the completion of the work in accordance with the Contract Documents.

The lump sum payment for materials management plan shall include all of the Contractor's costs of whatsoever nature. The lump sum price bid shall include: creation of and modification of a Material Management Plan; facilities coordination for health and safety; training of all personnel as necessary to perform work; coordination for testing and disposal of materials; waste classification, profiling and manifesting, protecting workers and the public from exposure to contaminants; decontamination procedures for personnel and equipment; fugitive dust control, containment and monitoring; compliance with Denver Environmental Health – Asbestos-Contaminated Soil Management Standard Operating Procedure (current version); management of on-site treatment, storage and disposal; procurement and stockpiling of lined containers; waste classification, profiling and manifesting; protecting workers and the public from exposure to contaminants; Decontamination of anything exposed to contaminated substances; fugitive dust control and containment including monitoring implementation and coordination of Federal, State and Municipal Rules and Regulations as required by the respective agencies and governmental entities; all fees and fines associated with the Material Management Plan; contaminant testing as required; and all other related and necessary materials, work and equipment required to complete this item in accordance with the Contract Documents.

At the option of the Construction Project Manager, monthly percentage payments, based upon Period of Performance, may be paid to the contractor upon satisfactory completion of and/or proper controls submitted in monthly payment applications. At the discretion of the Construction Project Manager, payment may be withheld for any non-conformance reports issued for failure to comply with the accepted Materials Management Plan.

3-8 Unclassified Excavation

5-3b Overexcavation

The accepted quantities will be paid for at the contract unit price for unclassified excavation or overexcavation. The measurement for payment of this item will be the number of cubic yards

Measurement and Payment

of material required to be removed for construction, excluding demolition and removal items specified elsewhere. The measurement and payment for overexcavation or unclassified excavation shall be defined based on field conditions (insitu) prior to commencing operations (excavated volumes shall not be allowed) and agreed to by the Construction Project Manager. If feasible, a before and after field survey may be conducted to define this volume. In either method, this area shall be defined as the unclassified or over excavation zone. The quantity paid shall not include any material excavated above the proposed facility subgrade, as shown within the contract documents.

The unit price bid per cubic yard of excavation shall include all of the Contractor's costs of whatsoever nature. The unit price bid shall include: all labor, equipment, materials and incidentals required to excavate the materials, loading, hauling and disposal on-site and off-site to the Denver Arapahoe Disposal Site, and stockpiling of materials; placement as subgrade and/or topsoil elsewhere on site as specified within the contract documents; placement for embankments, water conditioning and compaction to specified limits. Embankment construction will not be measured separately but will be included as a separate unclassified excavation bid item with additional notes.

5-1 Structural Fill

5-2a Subgrade Material (Select Backfill)

5-2b Topsoil

5-4 Crusher Fines

5-5 Recycled Concrete

5-8 Crushed Gravel Base Course (CDOT Class 6 Road Base)

The measurement for payment of this item will be the number of tons of structural fill, subgrade material, topsoil, crusher fines, and/or recycled concrete placed and accepted for construction of the proposed facilities and/or appurtenances. No measurement for payment will be made for materials that are placed without specific written approval of the Construction Project Manager. In addition, no payment will be made for: placement due to poor subgrade preparation, cave-ins, and/or negligent or unauthorized activities by the Contractor. This item shall follow the requirements set forth in Section 5.0 of the Standard Construction Specifications.

All delivery trucks shall be plainly numbered and all records of gross, tare and net weights (determined by use of a certified scale) shall be kept in detail and furnished to the Construction Project Manager upon request. These records will be used for payment purposes, and may be reviewed by the Construction Project Manager at any time.

The unit price bid per ton of classified material shall include all of the Contractor's costs of whatsoever nature. The price bid shall include; excavation and preparation of subgrade; removal and disposal of all unsuitable materials; furnishing of approved materials, transporting, weighing at a certified scale as required for payment placing, addition of water as necessary and compacting the classified material; finish grading; and all other related and necessary materials, work, labor and equipment required to complete the site preparation and placement of the classified material in accordance with the Contract Documents.

5-3a Overexcavation and Replacement With Select Backfill Material

The measurement and payment for this item will be the total number of cubic yards of overexcavation and replacement with select backfill material (and/or stabilization materials

Measurement and Payment

consisting of 1-1/2 inch angular aggregate as approved by the Construction Project Manager) required to construct the proposed facilities and/or appurtenances; provided, however, no measurement for payment will be made for overexcavation and replacement required due to negligence or unauthorized activities by the Contractor. The measurement for overexcavation and replacement shall start at the proposed pipe or facility subgrade, extend downward as required to produce a stable sub-base for the proposed infrastructure and extend a maximum trench width as defined in the most recent addition of the Standard Detail drawings or a maximum width agreed to by the Construction Project Manager prior to commencing overexcavation. This area shall be defined as the stabilization zone.

Payment will be solely based on the cubic yards of approved select material imported and installed within the stabilization zone defined above. Separate payment will not be made for the overexcavation under this bid item. Select material must conform to the requirements set forth in Section 5.0 of the Standard Construction Specifications. The Contractor must obtain approved submittals for all select materials used under this item from the Construction Project Manager, to ensure that the material proposed for use meets the field conditions and intended use. All delivery trucks shall be plainly numbered and all records of gross, tare and net weights (determined by use of a certified scale) as well as load volumes and weights shall be kept in detail and furnished to the Construction Project Manager upon request. These records will be used for verification purposes during payment and may be reviewed by the Construction Project Manager at any time. All hauling and disposal of construction or contaminated materials generated due to construction activities must be managed in strict conformance with the Standard Construction Specifications.

The unit price bid per cubic yard of overexcavation and replacement shall include all of the Contractor's costs of whatsoever nature. The unit price bid shall include: trench protection, overexcavation, removal and disposal of material within the stabilization zone, removal and disposal of unsuitable material, hauling and disposal to the Denver Arapahoe Disposal Site (DADS); furnishing and installation of approved select materials, transporting, weighing at a certified scale as required for verification of payment; compaction and installation of approved select materials; dewatering as necessary to allow installation and stabilization of select materials; furnishing and installation of geotextiles or filter fabrics as required in the Contract Documents, and all other related and necessary materials, work, labor and equipment required to complete the removal in accordance with the Contract Documents.

5-7 **Controlled Low Strength Material (CLSM)**

The measurement and payment for this item will be the total number of cubic yards of Controlled Low Strength Material, controlled density fill, etc. approved for construction of the proposed facilities and/or appurtenances; provided, however, no measurement for payment will be made for materials required due to careless or unauthorized activities by the Contractor.

The unit price bid per cubic yard shall include all of the Contractor's costs of whatsoever nature. The price bid shall include: furnishing and hauling; placement, as directed by the Construction Project Manager; maintaining the mixture to the requirements provided for within the Contract Documents; protection of existing facilities; and all other related and necessary materials, work, and equipment required to furnish the material in accordance with the Contract Documents.

Measurement and Payment

5-9 Permeation Grouting

The measurement and payment for this item will be per linear foot of tunnel center line that requires permeation grouting, as shown in the plans and/or as approved for construction of the proposed facilities and/or appurtenances. This is a one time, linear foot payment per tunnel, from face of structure to face of structure, no further payment will be made for additional permeation grouting needed or for careless or unauthorized activities by the Contractor.

The unit price bid per linear foot shall include all of the Contractor's costs of whatsoever nature. The price bid shall include and is not limited to: mobilization, demobilization and remobilization of all equipment and materials as necessary to complete the work and/or accommodate access restrictions to property and special requests by property owners; permits, rental fees for offsite storage of equipment and materials; site clearing and construction access necessary for site preparation; dewatering, water control; utility locates and potholing of existing utilities prior to drilling; support of steel casing; removal, transport and disposal of muck; surface monitoring, deep settlement monitoring, surveying, surface pressure tests, monitoring of surface for leakage; design of grout program; development and submittal of a grouting layout plan; installation and removal of sleeve port pipes for grouting operations; supply, mixing, field and lab testing, and installation of chemical grout; monitoring and reporting of grouting operations; clean up and restoration of all surface features effected by grouting operations; abandonment of bore holes; furnishing and hauling; placement, as directed by the Construction Project Manager; maintaining the mixture to the requirements provided for within the Contract Documents; protection of existing facilities; demonstrating the effectiveness of grouting program; additional permeation grouting outside the estimated limits shown in the drawings as necessary for construction and all other related and necessary materials, work, and equipment required to furnish the material in accordance with the Contract Documents.

8-1.1 Dip AWWA C151, Class 50 Water Line

8-1.3 PVC AWWA C900, Class 200 and Class 150 Water Line

8-1.6 PVC AWWA C905 DR18 Water Line

The measurement and payment of each specific size of waterline pipe, except segments as may be otherwise provided for in the Contract Documents, will be the actual number of linear feet of pipe required to be removed and relocated or installed, complete, in place, as measured along the centerline of the waterline pipe from given station to given station, from center of valve to center of valve or from center of manhole to center of manhole with deductions made for the internal diameter or dimensions of manholes, structures and/or valves; provided, however, no measurement for payment will be made for pipe removed or damaged due to negligence or unauthorized operations by the Contractor.

The unit price bid per linear foot for the construction of each section of waterline shall include all of the Contractor's costs of whatsoever nature for the complete construction of the pipeline in accordance with the requirements of the Board of Water Commissioners of Denver. The price bid shall include: furnishing of temporary sanitary facilities, bottled water and coordinating shut off to correspond with non-work hours, including night and weekends if necessary, payment of all associated inspection fees, trench sloping, benching, bracing, shoring and/or sheeting for pipe and associated appurtenances to assure safe working conditions; removal and disposal of the existing conduit and appurtenances (per State and Local requirements where applicable for lines containing asbestos), including valves, water meter's, stop boxes, fire hydrants, pressure regulating devices, restraints, and fittings; furnishing and installing required waterline pipe,

Measurement and Payment

fittings, appurtenances, temporary facilities and blow offs; tapping and/or connecting to mainlines, installing required copper service line pipe or structures; cutting and/or plugging of all abandoned facilities crossed during construction; furnishing and installing special fittings and restraints, including: transitional pipe sections required to properly connect different types of pipe and/or any other special fittings not specifically provided for elsewhere in the Contract Documents; joints and jointing materials, including: grout, mortar, gaskets, seals, bolts, connecting bands, and other miscellaneous items as required to construct the specific pipe section; removal and disposal of pavement, roadway surface materials, concrete flatwork, sod, landscaping, stumps, brush and any other materials encountered prior to excavation; excavation, including exploratory excavation, as required by the Construction Project Manager; over-excavation to remove unsuitable foundation material and replacement with granular or other approved select materials; constructing the specified bedding including the furnishing, placing, and compaction of sand, gravel, rock and controlled low strength materials, as required by the Denver Water Board; supply and installation of protective coatings or wrappings, locate wires and boxes; backfilling to include furnishing, transporting, and placement of any additional suitable backfill material required (except for those classified backfill materials provided for elsewhere in the Contract Documents); compaction and backfilling as specified (no additional or separate payment will be made for excess excavated material used as backfill or select material elsewhere on the project); restoration of ground surface to its original condition; grading and leveling; care and diversion of drainage courses; pumping and provision of facilities for diversion of flows; trench dewatering; protection, adjustment and/or reconnection of aboveground and underground utilities and service connections, replacement of hydrant laterals and assemblies damaged during crossing, reconnection of water services; coordination of gas service and electric relocates; crossing of existing and abandoned utilities; hauling and disposal of construction debris, excess excavated material, damaged materials and contaminated materials at the Denver Arapahoe Disposal Site (DADS), recycle and salvage of materials as necessary; saw cutting and/or rotomilling within mainline (B_f extents) and lateral trench extents prior to excavation; removal and replacement and/or relocation of signs, and pipe bollards; providing for additional traffic control, to include barricades, detours and flagmen unless provided for elsewhere in the Contract Documents; removal and replacement of all traffic signal and/or activated loops; valve operation tests, pipe chlorination, clear water tests, pressure tests, locate wire testing; and all other related and necessary materials, labor and equipment required to construct a complete operable pipeline in accordance with the Contract Documents and in accordance with the Denver Water Board Standards.

In addition to the above, the unit price bid per linear foot for slip lining, bursting, jacking, tunneling, boring and/or micro tunneling shall include the following: installation of jacking, tunneling and/or boring pits and related equipment; launching and access pits; automated spoil transportation systems; hoists; signal systems, safety equipment; sealing materials, grout, sand, casings, skids and end seals as approved by the Construction Project Manager and as required by the Denver Water Board, filling of all annular spaces and any other necessary labor; purchase, delivery and installation of all equipment and materials required to install the pipe segment and/or associated casing per the Contract Documents; heating and butt fusion jointing; removal and replacement of existing waterlines, valves, hydrants, vaults, restraints, sod, seeding, sprinkler systems, trees, bushes, shrubs, bike path, curb, gutter, sidewalk, pavement, asphalt base course, asphalt wearing surface, and any other surface restoration and/or removal/replacement required within the areas impacted due to these operations.

Measurement and Payment

8-1.2 Install Water Valve, Water Meter and Stop Box

The measurement and payment for this item will be the total number of water valves, water meters and stop boxes required to be installed for construction of the proposed sewer and/or appurtenances; provided, however, no measurement for payment will be made for items required to be installed due to negligent or unauthorized operations by the Contractor.

The unit price bid for installation of this item shall include all of the Contractor's costs of whatsoever nature. The price bid shall include: excavation, backfilling and compaction; removal and disposal of the existing water valve, water meter and/or stop box; installing required copper service line or other pipe, installation of the item in accordance with the requirements of the Denver Water Board; supply and installation of all components required to complete the work, including stop(curb) boxes; removal and disposal of pavement and unsuitable material; and all other related and necessary materials, labor, and equipment required for removal and replacement of each item in accordance with the Contract Documents, and in accordance with Denver Water Board Standards.

8-1.4 Temporary Water Main Bypass

The measurement for payment of this item will be the actual number of linear feet from the center of intersection to the center of intersection for the block being bypassed. Every block requiring temporary water main bypass will only be paid once and all work necessary within the block measured shall be included within this item. Only those sections specifically authorized by the Construction Project Manager will be bypassed and measured for payment.

The unit price bid per linear foot for this item shall include all of the Contractor's costs of whatsoever nature. The price bid shall include: furnishing and setting up of all equipment, labor, and materials required to temporarily bypass the existing water main around the facilities being repaired, reconstructed, or constructed to all properties being served within the effected construction areas and as approved by the Construction Project Manager; installation and maintenance of entire temporary water bypass system during the work to ensure uninterrupted service, safe operation and multimodal access by owners; vacuum breakers and inclement weather devices or procedures to protect system; supply of temporary service connections and fire services in accordance with Denver Water requirements; valve operation tests, pipe chlorination, clear water tests, pressure tests and locate wire testing; permits and fees from applicable entities; compaction and backfilling as specified (no additional or separate payment will be made for excess excavated material used as backfill or select material elsewhere on the project); materials testing and quality control; supplying of energy required to operate all bypass equipment; temporary installation of bypass piping under the pavement of cross streets, or raised transitional crossings as may be required per the approved traffic control plan; temporary surfacing; restoration of ground surface to its original condition including removal and replacement of sod, seeding, sprinkler systems, trees, bushes, shrubs, bike path, curb, gutter, sidewalk, pavement (concrete, asphalt base course, asphalt wearing surface, sub grade materials, etc.) and any other surface restoration and/or removal/replacement within the areas impacted due to these operations; removal and replacement of water fixtures, fire hydrants, valves, or any other appurtenances as necessary

Measurement and Payment

to permit bypassing; hauling and disposal of construction debris, excess excavated material, damaged materials, unsuitable material and contaminated materials at the Denver Arapahoe Disposal Site (DADS); and all other related and necessary equipment, work, and materials required to complete the water bypassing as required in the Contract Documents or as directed by the Construction Project Manager.

8-1.5a Lead Service Line Replacement, <2”ID

8-1.5b Lead Service Line Replacement, >2”ID

The measurement for payment of this item will be the actual number of lineal feet of lead water service line removed and replaced as measured from the corporation stop or tee on the water main to the centerline of the external water meter. Lead services shall be replaced with a minimum size copper service line of $\frac{3}{4}$ ” or to a size adequate to supply all the requirements of the property being served in accordance with Denver Water specifications and details. No measurement for payment will be made for lead service line replacement required due to negligence or unauthorized operations by the Contractor.

The unit price bid per lead service line replacement shall include all of the Contractor’s costs of whatsoever nature for the complete removal and replacement of the lead service line in accordance with the requirements of Denver Water, exclusive of appurtenances or items otherwise provided for in the Contract Documents. The price bid shall include: trench sloping, benching, bracing, shoring and/or sheeting for service lines and associated appurtenances to assure safe working conditions; barricades, fencing and signage as necessary to ensure the safety of the public; removal and disposal of the existing lead service line and appurtenances (per State and Local requirements where applicable), including valves, and fittings; furnishing, transporting, and installing required copper service line pipe, fittings, valves, and appurtenances; providing temporary service and facilities as necessary during construction; tapping and/or connecting to mainlines and/or meters; furnishing and installing special fittings for connection to the water meter, not specifically provided for elsewhere in the Contract Documents; gaskets, seals, bolts, connecting bands, and other miscellaneous items as required to construct the service line; saw cutting and/or rotomilling within trench section prior to excavation; removal and disposal of asphalt, millings, roadway surfacing materials, sod, surfacing materials, stumps, brush and unsuitable material prior to excavation; excavation, including exploratory excavation, as required by the Construction Project Manager; over-excavation to remove unsuitable foundation material and replacement with granular or other approved select materials at the specific written approval of the Construction Project Manager; constructing the specified bedding including the furnishing, placing, and compaction of sand, gravel, rock or controlled low strength materials, as required by Denver Water; supply and installation of protective coatings or wrappings, locate wires and boxes; backfilling to include furnishing, transporting, and placement of any additional suitable backfill material required (except for those classified backfill materials provided for elsewhere in the Contract Documents); compaction and backfilling as specified (no additional or separate payment will be made for excess excavated material used as backfill or select material elsewhere on the project); grading and leveling; restoration of ground surface to its original condition including the removal and replacement of sod, seeding, sprinkler systems, trees, bushes, shrubs, bike path, curb, gutter, sidewalk, pavement, asphalt base course, asphalt wearing surface and any other surface restoration and/or removal/replacement required within areas impacted due to these operations; care and diversion of drainage courses; trench dewatering; protection, adjustment and/or reconnection of aboveground and underground utilities; coordination of gas service and electric relocates; crossing of existing and abandoned

Measurement and Payment

utilities; hauling and disposal of construction debris, excess excavated material, damaged materials and contaminated materials at the Denver Arapahoe Disposal Site (DADS); removal and replacement and/or relocation of signs, and pipe bollards; providing for additional traffic control, to include barricades, detours and flagmen as specified per the approved MHT/Street Occupancy permit; removal and replacement of all traffic signal and/or activated loops; valve operation tests, pipe chlorination, clear water tests, pressure tests, locate wire testing; permits and fees from applicable entities; and all other related and necessary materials, labor and equipment required to construct a complete operable water service line in accordance with the Contract Documents and in accordance with Denver Water specifications and standards.

8-2 Remove Fire Hydrant Assembly

The measurement and payment for this item will be the total number of fire hydrants required to be removed for construction of the proposed sewer and/or appurtenances; provided, however, no payment will be made for hydrants replaced due to negligent or unauthorized operations by the Contractor.

The unit price bid for removal of this item shall include all of the Contractor's costs of whatsoever nature. The price bid shall include: excavation; removal and disposal(or recycling as applicable) of hydrant, fittings, restraints, valves and appurtenances; plugging and capping of hydrant service line as required; backfilling and compaction; removal and disposal of pavement and unsuitable material; and all other related materials, work, and equipment required for removal of this item in accordance to the Contract Documents, and in accordance to the Denver Water standards.

8-3 Reset or Install Fire Hydrant Assembly

The measurement and payment for this item will be the total number of fire hydrants required to be reset and/or placed for construction of the proposed sewer and/or appurtenances; provided, however, no payment will be made for hydrants reset and/or installed without authorization by the Construction Project Manager or due to negligent operations of the Contractor.

The unit price bid for this item shall include all of the Contractor's costs of whatsoever nature. The price bid shall include: excavation; furnishing, installation and assembly of all materials including but not limited to: hydrant, risers, fittings, restraints, valves and appurtenances; resetting existing hydrants as permitted; backfilling and compaction; removal and disposal of pavement and unsuitable material; operation tests, chlorination tests, clear water tests, pressure tests, and all other related and necessary materials, work, and equipment required for installation of the fire hydrant assembly in accordance with Denver Water standards.

- 12-1.1 6" Curb and Gutter – 2' Pan (CDOT T2, IIB)**
 - 12-1.2 6" Curb and Gutter – 1' Spill Pan (CDOT T2 IB)**
 - 12-1.4 9" Curb and Gutter**
 - 12-1.5 Combination Curb, Gutter and Sidewalk (2'-8")**
 - 12-1.6 Combination Curb, Gutter and Sidewalk (3'-11")**
 - 12-1.6a Combination Curb, Gutter and Sidewalk (4'-11")**
 - 12-1.7 6" Concrete Curb Head**
-

Measurement and Payment

- 12-1.8 Handicap Concrete Curb Ramp
- 12-1.9 Gutter Overlay
- 12-2.1 Concrete Sidewalk
- 12-2.2 Reinforced Concrete Sidewalk
- 12-2.3 Concrete Bike Path
- 12-2.4 Miscellaneous Concrete Flatwork
- 12-3 Concrete Valley Gutter (all sizes)
- 12-4.1 Concrete Street Intersection Gutter (Crossspan)
- 12-4.2 Concrete Street Intersection Gutter with Slot
- 12-4.3 Special Precast Concrete Intersection Gutter
- 12-5.1 Concrete Driveway Paving
- 12-5.2 Concrete Apron
- 12-5.3 Concrete Bus Pad
- 12-5.4 Concrete Alley Gutters
- 12-5.5 Concrete Alley Paving
- 12-5.6 Concrete Alley Returns
- 12-5.7 Concrete Street Paving
- 12-6 Concrete Median Strip
- 12-8 Concrete Steps

The measurement and payment for installation of this item will be the total number of linear feet for: gutter overlay, curb and gutter, curb head, combination curb gutter and sidewalk, or the total number of square feet for: median strips, sidewalk, bike path, driveway pavement, street paving, crossspans, handicap curb ramps, alley paving, alley gutters, alley returns, single or double flare aprons, bus pads, valley gutter, concrete steps or any other type of miscellaneous concrete flatwork placed and accepted; provided, however, no measurement and payment will be made for flatwork placed due to careless or unauthorized operations by the Contractor.

All concrete ingredients and additives must be combined and mixed at the batch plant prior to transport. Onsite additions to the concrete mix, of any type, will not be allowed without prior authorization of the Construction Project Manager.

The unit price bid per square foot of concrete steps shall be quantified by the width of the stairs multiplied by the summation of each stair hypotenuse (the hypotenuse of the rise and run of each stair). The unit price bid per linear foot or square foot placement of these items shall include all of the Contractor's costs of whatsoever nature. The price bid shall include: sawcutting and/or rotomilling surrounding surface to allow placement, removal of pavement or roadway surfacing; concrete sawing, furnishing and placing the concrete; forming, finishing and curing compounds; contraction and expansion joints where required by Construction Project Manager, including partial depth sawcuts; joint sealing compounds; reinforcing as required and specified; providing high early concrete as necessary to meet specific project needs; concrete additives including, but not limited to: set retarders, accelerators and polypropylene fibrillated fibers as directed and approved by Construction Project Manager; edging the concrete surface; furnishing, transporting, installing and compaction of materials required for a stable sub-base; removal and disposal of unsuitable subgrade materials (including frost), replacement with suitable backfill as necessary; backfilling and pavement around new flatwork; protection from freezing and vandalism; and all other related and necessary materials, work and equipment required to construct this item in accordance with the Contract Documents.

Measurement and Payment

- 12-7 Non-reinforced Concrete Median Barrier**
- 12-9 Concrete Headwall**
- 12-10 Concrete Lined Ditches**
- 12-11 Concrete Planters**
- 12-12 Concrete Cradle for Class "A" Bedding**
- 12-13 Concrete Encasement around Pipe**
- 12-14 Concrete Cut-Off Wall**
- 12-16a Concrete Retaining Wall**
- 12-16b Block Retaining Wall**

The measurement for payment of bulk concrete items such as median barriers, cradles, encasements, cut off walls, lined ditches and planters will be the total number of cubic yards of concrete required for construction. The measurement and payment for retaining walls will be a lump sum payment for each wall and type as indicated in the contract documents. The measurement and payment for headwalls will be based upon the actual number required as indicated within the contract documents for construction of the proposed sewer and/or appurtenance. No payment will be made for any of these items replaced due to negligent or unauthorized operations by the Contractor.

The unit price bid per cubic yard, lump sum or each for these items shall include all of the Contractor's costs of whatsoever nature. The price bid shall include: furnishing, transporting, and installing concrete materials, steel reinforcement, add mixtures and fiber reinforcement as required, and block materials; excavation and overexcavation; furnishing, transporting and installing necessary subgrade, bedding and drainage materials, forming and curing compounds; finishing and edging of concrete; winter protection; backfilling and compaction; grinding, patching and finishing of concrete wall surfaces, application of wall finishes as indicated in the contract documents, installation and furnishing of all fence and/or railing noted for individual wall segments; hauling and disposal of construction debris, excess excavated material, damaged materials and contaminated materials to the Denver Arapahoe Disposal Site (DADS); and all other related and necessary materials, work and equipment required to construct this item in accordance with the Contract Documents.

-
- 16-1 Security Fence**
 - 16-2a Single Swing Gate**
 - 16-2b Double Swing Gate**
 - 16-3 Chain Link Fence**
 - 16-4 Wood Fence**
 - 16-5 Single Steel Post Guardrail**
 - 16-6 Single Wood Post Guardrail**
 - 16-7 Permanent Barricades**
 - 16-8 Hand Rail**

The measurement and payment for this item will be the total number of linear feet of security fence with view obscuring material (privacy screen), chain link fence, wood fence, guardrail, hand rail, and permanent barricades or the total number of swing gates required to be placed for construction, as agreed upon by the Construction Project Manager; provided, however, no measurement for payment will be made for fence work required to be placed due to negligence or unauthorized operations by the Contractor.

Measurement and Payment

The unit price bid per lineal foot or per item placement shall include all of the Contractor's costs of whatsoever nature. The price bid shall include: furnishing and placement of new fencing materials to the height specified in the Contract Documents, including rails, posts, pickets, hardware, locks, paints, special treatments, concrete for posts, single swing gates, double swing gates, steel posts for guard rail, guard rail, wood posts; maintenance, relocation and removal of security fencing, hand rails; replacement of electric outlets, security wire (barbed, razor, etc.) and all other related and necessary materials, work and equipment required to construct the fence work in accordance with the Contract Documents.

20-1 Asphalt Temporary Patching

The measurement for payment of this item will be the actual number of square yards per inch of asphalt temporary patching mix placed, complete and in place, after the area has been properly backfilled and compacted, as required for the proposed sewer and/or appurtenances; provided, however, no measurement for payment will be made for asphalt temporary mix placed in areas not specifically approved by the Construction Project Manager, or required due to careless or unauthorized operation by the Contractor.

The asphalt temporary mix may consist of either hot or cold asphaltic surface material. Unless otherwise specified in the Contract Documents, the minimum thickness of asphalt temporary patching mix required is two inches (2").

The unit price bid per square yard per inch of asphalt temporary patching mix shall include all of the Contractor's costs of whatsoever nature for the complete construction of the sewer, appurtenances, street or items otherwise indicated within the Contract Documents. The price bid shall include: all preparatory work for placement to grade; disposal of construction debris and unsuitable materials at the Denver/Arapahoe Disposal Site (DADS); street sweeping; removal and disposal of backfill or subgrade materials to the required elevation and preparation for temporary asphalt placement; temporary asphalt material, hauling, rolling, and compaction; maintenance of the temporary patch to include regrading, recompacting, and renewing the material at sufficient intervals of time to ensure a smooth, dust/mud free driving and/or walking surface; temporary striping as required; removal and disposal of temporary asphalt mix prior to permanent asphalt paving operations; and all other related and necessary materials, work and equipment required to furnish and place the asphalt temporary patch in a manner satisfactory to the Construction Project Manager and in accordance with the Contract Documents.

20-2 Asphalt Surface Course

The measurement for payment of this item will be the actual number of square yards per inch of hot mix asphalt surface course, in place, complete, and accepted by the Construction Project Manager, as required for construction of the proposed improvements in accordance with the Contract Documents; provided, however, no measurement for payment will be made for hot mix asphalt surface course placed in areas not specifically approved by the Construction Project Manager, nor required due to careless or unauthorized operation by the Contractor.

Unless otherwise directed by the Construction Project Manager, the hot mix asphalt surface course shall be placed at a minimum of two-inch (2") thickness and only in the areas indicated within the Contract Documents. This item may be used for work within the trench limits and/or outside the trench limits as indicated within the Contract Documents and as directed by the Construction Project Manager.

Measurement and Payment

The unit price bid per square yard per inch for hot mix asphalt surface course shall include all of the Contractor's costs of whatsoever nature for the complete construction of the proposed sewer, appurtenances, street or items otherwise indicated within the Contract Documents. The price bid shall include: obtaining all necessary permits and paying any associated fees; additional milling and/or sawcutting of the existing pavement to ensure a smooth and square joint between existing and new pavement; loading, hauling, and disposal of existing asphalt, all related construction debris and unsuitable materials at the Denver/Arapahoe Disposal Site (DADS); recycling of appropriate materials generated during the work; asphalt tack coat; hot mix asphalt, hauling, placing, rolling, and compaction; raising of manhole rings; street sweeping and clean up; traffic control not provided for elsewhere in this Contract Documents; temporary striping as required; QC testing; and all other necessary materials, work, and equipment required for placement of the hot mix asphalt surface course in a manner satisfactory to the Construction Project Manager and in accordance with the Contract Documents.

20-3 Asphalt Base Course

The measurement for payment of this item will be the actual number of square yards per inch of hot mix asphalt base course, in place, complete, and accepted by the Construction Project Manager, as required for construction of the proposed improvements in accordance with the Contract Documents; provided, however, no measurement for payment will be made for hot mix asphalt base course placed in areas not specifically approved by the Construction Project Manager, nor required due to careless or unauthorized operation by the Contractor.

Unless otherwise directed by the Construction Project Manager, the hot mix asphalt base course paving shall be placed to the depth and only in the areas specified in the Contract Documents. This item may be used for work within the trench limits and/or outside the trench limits as indicated within the Contract Documents and as directed by the Construction Project Manager.

The unit price bid per square yard per inch of hot mix asphalt base course shall include all of the Contractor's costs of whatsoever nature for the complete construction of the proposed sewer, appurtenances, street or items otherwise indicated within the Contract Documents. The price bid shall include: obtaining all necessary permits and paying any associated fees; saw cutting and/or milling the existing pavement smoothly and squarely in a manner satisfactory to the Construction Project Manager to assure a smooth joint (ripping and wheel-cutting is not permitted); loading, hauling, removal and disposal of existing asphalt pavement, unsuitable material and excess excavated material at the Denver/Arapahoe Disposal Site (DADS); subgrade preparation, backfilling and compaction to include furnishing, transporting and placement of any additional suitable backfill material required; recycling of appropriate materials generated during the work; asphalt tack coat; hot mix asphalt, hauling, placing, rolling, and compaction; street sweeping and clean up; traffic control not provided for elsewhere in the Contract Documents; temporary striping as required; QC testing; and all other necessary materials, work, and equipment required for placement of the hot mix asphalt base course in a manner satisfactory to the Construction Project Manager and in accordance with the Contract Documents.

20-4 Asphalt Rotomilling

The measurement for payment of this item will be the actual number of square yards per inch of asphalt or concrete material rotomilled to the depth specified within the Contract Documents or as directed by the Construction Project Manager to complete the proposed street paving. No measurement for payment will be made for asphalt or concrete rotomilled in areas which

Measurement and Payment

are not specifically approved by the Construction Project Manager, indicated within the Contract Documents or required due to careless or unauthorized operations by the Contractor.

No measurement for payment will be made under this bid item for rotomilling within the designated pipe trench limits or other miscellaneous areas where sewer, appurtenances or associated flatwork are to be constructed. These costs shall be included in the unit price bid for the related pipe, structures, or appurtenances and are provided for elsewhere in the Contract Documents. This pay item will be used to pay for rotomilling required after installation of the proposed sewer and/or appurtenances for milling on either side of the trench limits prior to placement of the asphalt base and/or surface course, and as specified within the Contract Documents or as directed by the Construction Project Manager.

The unit price bid per square yard per inch of rotomill shall include all of the Contractor's work of whatsoever nature for the complete construction as indicated within the Contract Documents. The price bid shall include: obtaining all necessary permits and paying any associated fees; loading; hauling, removal and disposal of unsuitable materials, millings and excess excavated material at the Denver/Arapahoe Disposal Site (DADS) or recycling as appropriate; traffic control not provided for elsewhere in the Contract Documents; street sweeping; surface preparation; and all other necessary materials, work, and equipment required for rotomilling in a manner satisfactory to the Construction Project Manager and in accordance with the Contract Documents.

20-5 Asphalt Patch

The measurement for payment of this item will be the actual number of square yards per inch thickness of hot mix asphalt used for asphalt patching purposes, complete, in place and accepted by the Construction Project Manager; provided, however, no measurement for payment will be made for asphalt patching placed in areas not specifically approved by the Construction Project Manager, or required due to careless or unauthorized operations by the Contractor.

This pay item will be used to pay for asphalt material used outside the limits established in Pay Items 20-2 and 20-3. This pay item will be used to pay for replacement of street paving outside the normal specified limits in areas deemed necessary by the Construction Project Manager.

The unit price bid per square yard per inch of thickness of hot mix asphalt patching shall include all of the Contractor's costs of whatsoever nature. The price bid shall include: obtaining all necessary permits; paying any associated fees; saw cutting and/or milling the existing pavement smoothly and squarely in a manner satisfactory to the Construction Project Manager to assure a smooth joint (ripping and wheel-cutting is not permitted); loading, hauling, removal and disposal of existing asphalt pavement, rotomillings, unsuitable material and/or excess excavated material; subgrade preparation, backfilling and compaction of subgrade to include furnishing, transporting and placement of any additional suitable backfill material required; asphaltic tack coat; fresh asphalt hauling, placing, rolling, and compaction; street sweeping and clean up; traffic control not provided for elsewhere in the Contract Documents; temporary striping as required; QC testing; and all other necessary materials, work, and equipment required for placement of the hot mix asphalt trench pavement in a manner satisfactory to the Construction Project Manager and in accordance with the Contract Documents.

Measurement and Payment

20-6 Placement (Only) For Recycled Asphalt

The measurement for payment of this item will be the actual number of square yards per inch thickness of recycled asphalt pavement placed, complete, in place, and accepted by the Construction Project Manager, as required for construction of the proposed sewer and/or appurtenances; provided, however, no measurement for payment will be made for recycled asphalt pavement placed in areas not specifically approved by the Construction Project Manager, or required due to careless or unauthorized operations by the Contractor, or pavement damage caused by the Contractor's equipment or method of operation.

The unit price bid per square yard per inch of recycled asphalt shall include all of the Contractor's costs of whatsoever nature for the complete construction of the proposed sewer, appurtenances, or items otherwise provided for elsewhere in the Contract Documents. The price bid shall include: obtaining all necessary permits and paying all associated fees; saw cutting to achieve a smooth joint; asphalt tack coat; asphalt hauling, placement, rolling, and compaction; disposal of unsuitable material; street sweeping and cleanup; and all necessary materials, work, and equipment required to furnish and place the recycled asphalt pavement smoothly and squarely in a manner satisfactory to the Construction Project Manager in accordance with the Contract Documents.

20-7 Install Asphalt Path

The measurement and payment for this item will be the actual number of square yards per inch thickness of hot mix asphalt placed to the dimensions shown in the Contract Documents or as directed by the Construction Project Manager, complete, in place, accepted, and as required for construction of the proposed sewer and/or appurtenances; provided, however no measurement for payment will be made for asphalt path placed in areas not specifically approved by the Construction Project Manager or required due to careless or unauthorized operations by the Contractor.

The unit price bid per square yard per inch of hot mix asphalt shall include all of the Contractor's costs of whatsoever nature for the complete construction of the proposed sewer, appurtenances, or items otherwise provided for elsewhere in the Contract Documents. The price bid shall include: obtaining all necessary permits and paying all associated fees; saw cutting to achieve a straight joint; weed removal, grubbing, subgrade preparation, removal and disposal of unsuitable material and excess excavated material, placement of select subgrade material as necessary, compaction, installation of weed block fabric; asphalt tack coat; asphalt hauling, placement, rolling, and compaction; permanent stripping as required; disposal of unsuitable material; street sweeping and cleanup; and all necessary materials, work, and equipment required to furnish and place the hot mix asphalt path smoothly and squarely in a manner satisfactory to the Construction Project Manager in accordance with the Contract Documents.

20-8 Asphalt Curb Head

The measurement for payment of this item will be the total number of linear feet of asphalt curb head required to be placed for construction of the proposed sewer and/or appurtenances; provided, however, no measurement for payment for asphalt curb will be made for curb head required to be placed due to negligence or unauthorized operations by the Contractor.

Measurement and Payment

The unit price bid for placement of this item shall include all of the Contractor's costs of whatsoever nature. The price bid shall include: asphalt hauling, placement, rolling, compaction, shaping; excavation, backfilling and compaction; stabilizing the sub base; establishing grade; providing all labor, equipment and materials required to place asphalt curb as required and specified in the Contract Documents; disposal of excess or unsuitable materials including asphalt, concrete, landscaping materials etc; saw cutting, milling; street sweeping and clean up; traffic control not provided for elsewhere in the Contract Documents; asphalt tack coat; replacement and reestablishment of landscaping, sod, seed, irrigation systems and/or any other items impacted during placement of this item; and all other related and necessary materials work and equipment required to place this item in accordance with the Contract Documents or at the direction of the Construction Project Manager.

20-9a Saw Cut Asphalt/Concrete (0-150 LF)

The measurement and payment for saw cutting from 0-150 linear feet will be the actual number of linear feet up to 10-inches of depth of asphalt or concrete that is saw cut and accepted; however, no measurement for payment will be made due to negligent or unauthorized operations by the Contractor.

The unit price bid will be the actual number of linear feet of asphalt or concrete that is saw cut to the full depth and shall include all of the Contractor's costs of whatsoever nature. The unit price bid shall include but not be limited to: mobilization, traffic control, surface preparation, clean up and disposal of debris, fugitive dust control, slurry removal and protection of storm water inlets; protection of utilities, street cut and occupancy permits, and all other related and necessary materials, work and equipment required to complete the saw cut as directed by the Construction Project Manager and in accordance with the Contract Documents.

20-9b Saw Cut Asphalt/Concrete (>150 LF)

The measurement and payment for saw cutting distances greater than 150 lineal feet will be the actual number of linear feet up to 10-inches of depth of asphalt or concrete that is saw cut and accepted; however, no measurement for payment will be made due to negligent or unauthorized operations by the Contractor.

The unit price bid will be the actual number of linear feet of asphalt or concrete that is saw cut to the full depth and shall include all of the Contractor's costs of whatsoever nature. The unit price bid shall include but not be limited to: mobilization, traffic control, surface preparation, clean up and disposal of debris, fugitive dust control, slurry removal and protection of storm water inlets; protection of utilities, street cut and occupancy permits, and all other related and necessary materials, work and equipment required to complete the saw cut as directed by the Construction Project Manager and in accordance with the Contract Documents.

21-1 Concrete Pavement

The measurement and payment for this item will be the actual number of square feet of concrete placed and accepted; provided, however, no measurement for payment will be made for concrete pavement outside of the prescribed trench width or other dimensions as shown in the Contract Documents. Pavement required to be replaced due to careless or unauthorized operations by the Contractor will not be included in the amount computed for payment.

Measurement and Payment

All concrete ingredients and additives must be combined and mixed at the batch plant prior to transport. Onsite additions, to the concrete mix, of any type will not be allowed without prior authorization of the Construction Project Manager.

The unit price bid per square foot of pavement shall include all of the Contractor's costs of whatsoever nature. The price bid shall include: forming, reinforcing chairs or supports as required by the Construction Project Manager, concrete, reinforcement, doweling; excavation; disposal of unsuitable material; curing compounds; contraction and expansion joints where required by Construction Project Manager, including partial depth sawcuts; joint sealing compounds; reinforcing as required and specified; providing high early concrete as necessary to meet specific project needs; concrete additives including, but not limited to; set retarders, accelerators and polypropylene fibrillated fibers as directed and approved by Construction Project Manager; finishing and edging; furnishing, transporting, installing, and compaction of all materials required for a stable subbase; removal and disposal of excess subgrade materials; QC testing; and all other related and necessary materials, work and equipment required to construct the pavement in accordance with the Contract Documents.

22-1 Earthwork

The measurement and payment for this item will be the total number of square yards of material to be removed and/or filled for construction as shown in the plans. The measurement for payment of this item will be based on the actual surface area within the footprint of the proposed embankment prior to construction activities.

The unit bid price per square yard of earthwork shall include: all labor, equipment, material, subcontractors and incidentals required to perform earthwork as identified within the contract documents; clearing and grubbing; excavation; loading, hauling and disposal of excess excavated material and debris, stockpiling as necessary; hauling, procurement, placement and compaction of embankment materials as required; grading; diversion of water courses and/or dewatering operations as necessary; compaction to specified limits; excavation below the grades shown on plans to remove unsuitable foundation material, replacement of unsuitable foundation materials with suitable select materials; QC testing; and all other materials, work and equipment required to complete the construction in accordance with the contract documents.

27-1 Steel Sheet Piling

The measurement and payment for this item will be the actual number of horizontal lineal feet of steel sheet piling installed, regardless of depth needed, accepted, and left in place (or removed after completion of construction activities) up to one foot above the top of the new sewer pipe and/or appurtenance or the utility being protected. Provided, however, no measurement for payment will be made for steel sheet piling placed due to careless or unauthorized operations by the Contractor.

The unit bid price per linear foot of steel sheet piling shall include all of the Contractor's costs of whatsoever nature. The price bid shall include: placement, excavation, materials, diversion of water courses, welding where required, removal where applicable, backfilling and compaction; cutting of the steel sheeting smoothly and squarely in a manner satisfactory to the Construction Project Manager.

Measurement and Payment

- 30-1 Riprap**
- 30-2 Grouted Rip Rap**
- 30-2a Grouted Boulders (2-Foot Diameter)**
- 30-2b Grouted Boulders (3-Foot Diameter)**
- 30-2c Grouted Boulders (5-Foot Diameter)**
- 30-2k Boulder (4-Foot Diameter)**
- 30-2l Boulder (5-Foot Diameter)**
- 30-3 Rock Filled Gabions**
- 30-4 Derrick Stone/Riprap Outfall**

The measurement for payment of this item will be the total number of square yards of riprap, soil riprap, grouted riprap, grouted boulders and/or derrick stone, or the total number of boulders, or the total number of tons used for rock filled gabions required to be furnished and placed on site for construction of the proposed sewer and/or appurtenances; provided, no measurement for payment will be made for items installed due to careless or unauthorized operations by the Contractor.

The unit price bid per square yard of riprap, soil riprap, grouted riprap, grouted boulders and derrick stone, shall be quantified based on the area of the installed surface directly parallel with the ground. The unit price bid per square yard, per ton, or per boulder shall include: clearing and grubbing; excavation; preparation of bedding/subgrade areas to include over excavation, furnishing, transporting, installing and compaction of all materials required for a stable sub-base and as shown in the details; removal and disposal of excess excavated materials; diversion of water courses and/or dewatering operations as necessary; supply and installation of filter and/or stabilization materials; filter and riprap drains; drain materials; concrete and/or grout; grouting of riprap or boulders; placing of riprap or boulders to the elevations shown on the Contract Documents or as directed by the Construction Project Manager; mattress units and materials for rock filled gabions; overexcavation and replacement with suitable materials; hauling and placing of all materials; and all other materials, work and equipment required to complete construction in accordance with the Contract Documents.

-
- 30-2e 36" Grouted Boulder Edge**
 - 30-2f 48" Grouted Boulder Edge**

The measurement and payment of this item will be the total linear feet of boulder edge required to be furnished and placed on site for construction of the proposed channel; provided, no measurement for payment will be made for items installed due to careless or unauthorized operations by the Contractor.

The unit price bid per linear foot of boulder edge shall be quantified based on the length of installed boulder along the proposed channel edge. The unit price bid per linear foot of boulder shall include: excavation; preparation of bedding/subgrade areas to include over-excavation as necessary; clearing and grubbing; furnishing, transporting, installing and compaction of all materials (bedding, rip rap, rock, or select fill) required for a stable sub-base and as shown in details; removal and disposal of excess excavated materials; diversion of water courses and/or dewatering operations as necessary placing of boulders to the elevations shown on the Contract Documents or as directed by the Construction Project Manager; grouting of boulders as shown in the details; installation of weep holes

Measurement and Payment

as required; hauling and placing of all materials; and all other materials, work and equipment required to complete construction in accordance with the Contract Documents.

-
- 34-2 C-76 RCP**
 - 34-3 C-361 RCP**
 - 34-4 C-506 ARCH Pipe**
 - 34-5 C-507 RCP**
 - 34-6.1 Box Culvert - Cast-In-Place**
 - 34-6.2 Box Culvert - Precast**
 - 34-7.1 PVC Pipe**
 - 34-7.2 PVC Slipliner Pipe**
 - 34-7.3 PVC Pipe with Steel Casing**
 - 34-8.1 HDPE SDR 17 Pipe By Bursting (PE 345434E)**
 - 34-9.1 ASTM A746 D.I. Pipe**
 - 34-10.4 Steel Casing Pipe BY JACKING/BORING with Centrifugally Cast Concrete Liner**
 - 34-10.5 Steel Pipe by JACKING/BORING**
 - 34-11.1 PVC Pipe By Jacking/Boring With Steel Casing**
 - 34-11.2 C-76 RCP, Class V By Jacking/Boring, Joint Type R-2**
 - 34-11.3 C-361 RCP By Jacking/Boring (see notes for class & cover depth)**
 - 34-11.4 HDPE SDR 17 Pipe By Jacking/Boring With Steel Casing (PE 345434E)**
 - 34-11.5 C-76 RCP, Class III By Jacking/Boring With Steel Casing**
 - 34-11.6 RPMP By Jacking/Boring**
 - 34-11.7 C-76 RCP, Class III By Jacking/Boring, Steel Bell Band**
 - 34-11.8 C-76 RCP, Class V By Jacking/Boring, Steel Bell Band**
 - 34-11.9 RPMP by Open Cut**
 - 34-11.10 RCBC By Jacking/Boring**

The measurement and payment of each specific size or type of pipe, except segments as may be otherwise provided for in the Contract Documents, will be the actual number of linear feet of sewer pipe installed, complete, in place, as measured along the centerline of the pipe from inside face of manhole to inside face of manhole, from inside face of manhole to given station, from given station to given station, or from center of manhole to center of manhole with deductions made for the internal diameter or dimensions of manholes and/or structures. Where special fittings have been specified and provided for elsewhere in the Contract Documents, deductions will be made for their lengths.

Open Cut

The unit price bid per linear foot for the construction of each section of pipeline shall include all of the Contractor's costs of whatsoever nature for the complete construction of the pipeline, exclusive of manholes, appurtenances, or items otherwise provided for in the Contract Documents. The bid item shall include: trench sloping, benching, bracing, shoring and/or sheeting for pipe and associated appurtenances to assure safe working conditions; design of shoring, stamping and approval by an Engineer licensed in the State of Colorado, submittal as required; furnishing, transporting and installing all pipe and materials; tapping and/or connecting to mainline pipes, structures, stub outs or block outs; concrete coring; plugging of all abandoned lines crossed during construction; furnishing and installing special fittings, including: trash racks, concrete pipe plugs as required, transitional pipe sections required to properly

Measurement and Payment

connect different classes of pipe without a manhole or structure and any other special fittings not provided for elsewhere in the Contract Documents; joints and jointing materials, including: grout ,mortar, fiberglass resin, gaskets, seals, bolts, concrete collars, connecting bands, and other miscellaneous items as required to construct the specific pipe joint per manufacturer and City standards; saw cutting and/or rotomilling within mainline (B_f extents) and lateral trench extents prior to excavation; removal and disposal of pavement, roadway surface materials, concrete flatwork, sod, landscaping, stumps, brush, unsuitable material within the trench width and any other materials encountered prior to excavation; excavation, including exploratory excavation, as required by the Construction Project Manager; over-excavation to remove unsuitable foundation material and replacement with granular or other approved select materials; constructing the specified bedding including the furnishing, placing, and compaction of sand, gravel and rock as required for class B bedding or approved substitution; supply and installation of protective coatings or wrappings; backfilling to include furnishing, transporting, and placement of any additional suitable backfill material required (except for those classified backfill materials provided for elsewhere in the Contract Documents); compaction and backfilling as specified, no additional or separate payment will be made for excess excavated material used as backfill or select material elsewhere on the project; restoration of ground surface to its original condition; grading and leveling; care and diversion of drainage courses; pumping and provision of facilities for diversion of flows; trench dewatering; protection and adjustment of aboveground and underground utilities and service connections or laterals, including water service reconnections and adjustments; sanitary sewer encasement; adjustment and reconnection of sanitary sewer services from mainline sewer to a point where proper connection and drainage can be achieved, unless provided for elsewhere in the Contract Documents; removal and replacement of hydrant laterals and assemblies damaged or relocated during crossing; coordination of gas service and electric relocates; crossing of existing and abandoned utilities; cutting and/or plugging of abandoned or crossed lines where indicated in the Contract Documents, or as directed by the Construction Project Manager; hauling and disposal of construction debris, excess excavated material, damaged materials, unsuitable materials and manifested contaminated materials at the Denver Arapahoe Disposal Site (DADS), recycle and salvage of materials as necessary; removal and replacement and/or relocation of signs, and pipe bollards; providing for additional traffic control, to include barricades, detours and flagmen unless provided for elsewhere in the Contract Documents; removal and replacement of all traffic signal and/or activated loops; QC testing for all associated work components; and all other related and necessary materials, labor and equipment required to construct a complete operable pipeline in accordance with the Contract Documents.

Tunneling

In addition to the above, the unit price bid per linear foot for slip lining, bursting, jacking, tunneling, boring and/or micro tunneling shall include the following: installation of jacking, tunneling and/or boring pits, intermediate jacking stations, rescue pits and related equipment; launching and access pits; design of bracing/shoring for all pits by an Engineer licensed in the State of Colorado; dewatering and water control; installation and maintenance of pit safety equipment; removal of shaft support systems; utility coordination, locating and potholing within pit and tunnel locations prior to starting construction operations; compensation grouting, all equipment and materials necessary to complete this work, developing and submitting detailed grout programs; installation of grout pipes; monitoring, recording and reporting of grouting operations; associated QC testing; removal of grout pipes after completion of tunneling, subsurface investigation and testing prior to installation; installation, monitoring/recording, maintenance and removal upon completion of surface monitoring points/arrays, deep settlement monitoring points, inclinometers and all related equipment

Measurement and Payment

and/or software; steel joint rings on reinforced concrete pipe; automated spoil transportation systems; hoists; fluids and slurries; signal systems, safety equipment; protective joint seals/wraps; sealing materials, joint cushions, reaction thrust blocks, grout, sand, casings, skids and end seals as approved by the Construction Project Manager; filling of all annular spaces after completion of tunnel installation via contact grouting; steel casing pipe and welding to create water tight joints and any other necessary labor, equipment and materials; purchase, delivery and installation of all equipment and materials required to install the pipe segment and/or associated casing per the Contract Documents; heating and butt fusion jointing; within pit locations: removal and replacement of existing waterlines, valves, hydrants, vaults, restraints, sod, seeding, sprinkler systems, trees, bushes, shrubs, bike path, curb, gutter, sidewalk, pavement, asphalt base course, asphalt wearing surface, and any other surface restoration and/or removal/replacement required within the areas impacted due to these operations.

34-12.1 4' Diameter Precast Manhole

34-12.2 5' Diameter Precast Manhole

34-12.3 6' Diameter Precast Manhole

The measurement and payment for manholes shall be the total number of individual manholes, complete, in place required for construction of the proposed sewer and /or appurtenances.

The unit price bid per manhole structure shall include all of the Contractor's costs of whatsoever nature. The price bid shall include: furnishing, transporting and installation of all materials, excavation including overexcavation to remove unsuitable foundation material and replacement with suitable material; sheeting and/or bracing; forming; cast-in-place or precast bases; concrete; steel reinforcement; precast barrel sections, flat tops and cones; brick, mortar, plastic joint sealant and grout; manhole steps, rings, cover, cast iron riser rings as specified by the Construction Project Manager; construction and shaping of the manhole base invert as shown in the standard details, and to incorporate lateral connections and flows into the main channel; water stop gaskets, all boots and bands; cutting and plugging of existing sewer lines as required; reconnection of existing lateral sewer lines to new structure as required, including pipe, couplings and all other materials, equipment and labor required to complete proper reconnection; core drilling into structure as necessary; construction of stub-outs or block-outs; elimination of infiltration; removal and replacement of pavement, base course, sub-base material, sod and other surfacing materials; backfill and compaction; and all other related and necessary materials, work and equipment required to construct the manholes, complete in accordance with the Contract Documents.

34-12.4 Type B Manhole

34-12.5 Type P Manhole

34-12.6 Outfall Structure

34-12.7 Special Structure

The measurement and payment for cast in place manholes and/or structures shall be the total number of manholes or structures, complete, in place, required for construction of the proposed sewer and/or appurtenances.

The unit price bid per manhole and/or structure shall include all of the Contractor's costs of whatsoever nature. The price bid shall include: furnishing, transporting and installation of all materials, excavation (including overexcavation to remove unsuitable foundation material and replacement with suitable material); sheeting and/or bracing; forming; concrete; providing high

Measurement and Payment

early concrete as necessary to meet specific project needs; concrete additives including, but not limited to; set retarders, accelerators and polypropylene fibrillated fibers as directed and approved by Construction Project Manager; steel reinforcement; precast barrel sections, flat tops and cones; brick, mortar, plastic joint sealant and grout; manhole rings, covers and cast iron riser rings as specified by the Construction Project Manager; construction and shaping of the manhole base invert as shown in the Standard Construction Specifications, and to incorporate lateral connections and flows into the main channel; beveling and shaping of entrance/exit as required; cutting and plugging of existing sewer lines as required; reconnection of existing lateral sewer lines to new structure as required, including pipe, couplings and all other materials, equipment and labor required to complete proper reconnection; core drilling into structure as necessary; construction of stub-outs or block-outs; construction of waterproof joints; installation of water stop gaskets, boots and bands; elimination of infiltration; removal and replacement of pavement, base course, sub-base material, sod, decorative landscaping and other surfacing materials; backfill and compaction; and all other related and necessary materials, work and equipment required to construct the manholes and/or structures, complete, in accordance with the Contract Documents.

34-12.8 Uncover and Raise (Adjust) Manhole

The measurement and payment for this item will be the number of vertical linear feet of manhole height required to be located, uncovered, and raised for construction of the proposed sewer and/or appurtenances as required in the Contract Documents, by the Construction Project Manager or as determined via video inspection. Payment will be based upon completion of the work to a manner satisfactory to the Construction Project Manager and in accordance with the Contract Documents. No measurement for payment will be made for manhole adjustments required due to negligence or unauthorized operations by the Contractor.

The unit bid for completion of this item shall include all of the Contractor's costs of whatsoever nature. The price bid shall include: locating, including electronic sensing if needed; excavation and overexcavation; removal and disposal of unsuitable material and excess excavated materials; backfill with approved materials; compaction; furnishing and transporting of all materials and equipment; cutting or adjusting of the manhole in a manner satisfactory to the Construction Project Manager; furnishing and placement of concrete, brick, mortar, concrete risers, concrete barrels, flat tops, cones, rings, covers, cast iron risers, plastic joint sealant, grout, manhole steps and all other related and necessary materials, work and equipment required to adjust manholes in accordance with the Contract Documents.

34-12.9 Adjust Utility Lids

The measurement and payment for this item will be the number of utility lids including but not limited to fiber optic, telecommunications, pull boxes, valve boxes, electrical vaults, water vaults, utility manhole lids, etc. required to be uncovered, raised and adjusted to final grade for construction of the proposed sewer and/or appurtenances as required in the Contract Documents, or as required by the Construction Project Manager. Payment will be based upon completion of the work to a manner satisfactory to the Construction Project Manager and in accordance with the Contract Documents. No measurement for payment will be made for utility lid adjustments required due to negligence or unauthorized operations by the Contractor.

The unit bid for completion of this item shall include all of the Contractor's costs of whatsoever nature. The price bid shall include: locating, including electronic sensing if needed; excavation

Measurement and Payment

and overexcavation; removal and disposal of unsuitable material and excess excavated materials; backfill with approved materials; compaction; furnishing and transporting of all materials and equipment; cutting or adjusting of the utility lid in a manner satisfactory to the Construction Project Manager; furnishing and placement of concrete, brick, mortar, concrete and/or cast iron risers, concrete barrels, flat tops, cones, rings, covers, grout, joint sealants, and all other related and necessary materials, work and equipment required to adjust utility lids in accordance with the Contract Documents.

34-13.1 Pipe Outside Drop

The measurement for payment of this item will be the total number of outside sanitary drops of the specified diameter required for construction of the proposed sewer facilities; provided, however, no measurement for payment will be made for outside drops not approved by the Construction Project Manager.

The unit price bid per outside drop shall include all of the Contractor's costs of whatsoever nature. The price bid shall include: pipe and fittings, including additional pipe and/or materials necessary to connect the existing sewer to drop; concrete encasement and reinforcement; excavation and backfill; trench supporting; reshaping of inverts and benches to the top of the highest incoming pipe; reconnection of sidelines; forming and steel reinforcement; and all other related and necessary materials, work and equipment required to construct the outside drop in accordance with the Contract Documents.

34-14.1 RCP Precast Bend

34-14.3 RCP Flared End Section with Trash Rack

34-14.4 Concrete Collars

34-14.5 Flap Gate/Storm Control

The measurement for payment of each specific size or type of special fitting shall be the total number of fittings required for construction of the proposed sewer and/or appurtenances.

The price bid per special fitting shall include all of the contractor's costs of whatsoever nature. The price bid shall include: furnishing, transporting and installing all pipe specials and materials; joints and jointing materials; fasteners and tie downs; pipe collars and closures; bolts, grout, mortar, O-rings, connecting bands; excavation and compaction; shoring and backfilling; removal and disposal of unsuitable material and construction debris; adaptable trash racks for flared end sections; flap gates, assembly and installation; and all other related and necessary materials, work and equipment required to furnish and install these items in accordance with the Contract Documents.

34-15.1 Sewer Tap Location and Verification

The measurement for payment of this item will be the actual number of sewer service connections (sewer taps) required to be located and determined to be active; provided, however, no payment will be made due to negligence or unauthorized operations by the Contractor and only those sections specifically authorized by the Construction Project Manager shall be measured for payment.

Measurement and Payment

The unit price bid for locating all sewer service connections and verification of active sewer taps shall include all of the Contractor's costs of whatsoever nature for the complete verification and location of each active sewer tap. The price bid shall include: providing 48 hours public notification in advance of the work, furnishing and setting up all equipment required for location and/or verification and digital video and written log documentation of active sewer taps; labor; energy supply required for all equipment; permits and fees; coordination with locators (IUG and/or related utility companies); advance coordination and planning with facility owner to ensure access to mainline sewer; location (vertically and horizontally) and verification of active and capped sewer taps by digging, vacuuming, sensing, electronic locators, televising, dye testing, smoke tracing, and/or any other means necessary to ensure tap location, verification and adequate elevation for connection to sewer main per the Contract Documents; excavation, backfill, compaction; temporary and/or permanent paving; removal and replacement of curb, gutter, sidewalk, sod, sprinkler lines, etc. damaged during location and verification; removal and disposal of unsuitable material and construction debris; and all other related and necessary materials, work, and equipment required to complete this item in accordance with the Contract Documents.

34-15.2 Reconnect Sanitary Sewer Services (Open Cut)

The measurement and payment for each service connection, reconnection and/or adjustment shall be the total number of connections, reconnections and/or adjustments required for construction of the proposed sewer and/or appurtenance.

The price bid for this item of work shall include all of the Contractor's costs of whatsoever nature. The price bid shall include; locating and verifying of service connections unless provided for elsewhere in the Contract Documents; furnishing and installing all pipe, fittings and materials; disconnecting/reconnecting and plugging existing services; plugging all necessary lines; construction of new services from mainline sewer to a point where proper connection and drainage can be achieved; chasing sewer taps from point of crossing or conflict with mainline to a point where proper relocation/reconnection can be attained; removal and replacement of sod, curb, gutter, and pavement outside mainline trench extents and all other surface items within affected areas; crossing of existing and abandoned facilities; excavation and backfill; bedding and compaction; temporary bypass pumping; extension of building sewers where required; loading, hauling and disposal of construction debris, excess excavated material, and contaminated materials at the Denver Arapahoe Disposal Site (DADS); and all other related and necessary materials, work, and equipment required to construct the service connection or reconnection in accordance with the Contract Documents.

34-15.3 Utility Exploratory Investigation

The measurement for payment of this item will be the actual number of field locations or verifications required for construction of the proposed sewer and/or appurtenances as required in the Contract Documents, or as directed by the Construction Project Manager.

The unit price bid per location or verification shall include all of the Contractor's costs of whatsoever nature. The price bid shall include: mobilization and furnishing of all equipment required for location or verification of storm, sanitary or any other utility; acquisition of all permits; coordinating and scheduling the work with appropriate locating entities; coordination of this component of the work in a manner that ensures completion of the overall project per the critical path schedule and in accordance with the contract documents, excavation and backfill, including Controlled Low Strength Materials as required; paving, patching and

Measurement and Payment

compaction; location of the utility by digging, vacuuming, sensing, or employment of other methods in utility location and/or verification; and all other related and necessary materials, work, and equipment required for location or verification of the sewer or utility as required in the Contract Documents or as directed by the Construction Project Manager.

34-16.1 #14 Inlet

34-16.2 Single #16 Inlet

34-16.3 Double #16 Inlet

34-16.4 Triple #16 Inlet

34-16.5 Parking Lot Trench Drain

The measurement for payment of each specific size and/or type of inlet will be the individual structure, complete, in place in accordance with the Contract Documents.

The unit price bid per inlet structure shall include all of the Contractor's costs of whatsoever nature. The price bid shall include: furnishing, transporting, and installing all materials; excavation, including overexcavation to remove unsuitable foundation materials; concrete, pipe collars, reinforcement steel, mortar and grout; manhole lids, rings, covers, grates, frames and curb boxes; open throat construction; galvanized steel rods; manhole steps; concrete ribbed deflectors; backfilling and compaction; removal and replacement of pavement, base course, sub-base materials, sod, decorative landscaping and any other surfacing materials; constructing and shaping of the base and invert; replacement of curb, gutter and sidewalk between the transitions as stipulated on the Details; and all other related and necessary materials, work, and equipment required to construct the storm inlet in accordance with the Contract Documents.

34-16.8 Adjust Existing Inlet Structure

The measurement and payment for this bid item will be the actual number of existing inlet structures (excluding flagstone curb head) adjusted. Payment will be based upon completion of the work to a manner satisfactory to the Construction Project Manager and in accordance with the Contract Documents. No measurement for payment will be made for existing inlet structure adjustments due to negligence or unauthorized operations by the Contractor.

The unit price bid will be the actual number of existing inlet structures (Inlet Grates, Frames, Beams, Curb Boxes, etc.), excluding flagstone curb head, adjusted. The unit price bid will include but shall not be limited to: mobilization; raising, lowering, moving, adding and/or removing of concrete, masonry, brick, mortar, concrete risers, inlet grates, plastic joint sealant, grout and all other related and necessary materials, work and equipment required to adjust inlet structures in accordance with the Contract Document; resetting of grates; replacement of curb, gutter and sidewalk between the inlet transitions as stipulated in the Details; traffic control; surface preparation and compaction as necessary; obtaining of a street occupancy permits and street cut permits; locating, including electronic sensing if needed; removal and disposal of construction debris; furnishing and transporting of all materials and equipment; and all other related and necessary materials, work and equipment required for the adjustment of the existing inlet structure.

Measurement and Payment

34-17.1 Pre-Video Inspection of Sewer Pipe

34-17.2 Cleaning of Sanitary Sewer Pipe

34-18.2 Cleaning of Storm Sewer Pipe

The measurement for payment of this item will be the actual number of linear feet of sewer line cleaned and/or pre-video inspected and documented on the log sheet as measured along the centerline of the pipe from center of manhole to center of manhole with deductions made for the diameter of structures and appurtenances. Only those sections specifically authorized by the Construction Project Manager or noted in the Contract Documents will be measured for payment.

The unit price bid per linear foot of sewer line cleaning and/or pre-video inspection shall include all of the Contractor's costs of whatsoever nature. The price bid shall include: providing 48 hours public notification in advance of the work furnishing and setting up of all equipment, labor, and materials necessary to clean and perform pre-video inspection of the sewer, including an intrinsically safe camera, as necessary; recording all information on USB Plug and Play device (flash drive or hard drive) for review by City; submittal of video in MP4 format and logs in .pdf format, both of which must be submitted in accordance to the naming convention required within the applicable Standard Construction specification section; Identification and locating of all active and inactive (capped) sewer taps, to include linear footage from center upstream manhole, by dye testing, electronic sensing, smoke tracing or use of any other means necessary to verify the active taps; determination of taps requiring trimming; locating, identifying and reporting structurally deficient pipe sections for replacement or point repair; completion of additional pre-installation inspections and sewer cleaning as necessary prior to CIPP installation; supply energy for all equipment; obtain permits for the inspection and covering any related fees; furnishing and setting up all equipment and labor necessary to clean the sewer; furnishing of water for jetting; removal of all foreign material from the sewer line that will prevent installation of cured in place products; all inspection and cleaning of manholes; by-pass pumping and/or diversion of sewer flows around the section of pipe to be cleaned and to another sewer line accepted by the Construction Project Manager to receive such bypass; temporary installation of bypass piping under the pavement of cross streets, or raised transitional crossings as may be required per the approved traffic control plan; repaving of street cuts after completion of bypassing; removal and replacement of manhole rings, covers, steps and cone sections as necessary to permit bypassing; storage of cleaning sediment on the job site in containers or other approved methods; maintaining storage during the waiting time for laboratory test results on the sediment; disposal of sediment according to Local, Federal, and State environmental requirements; removal and disposal of unsuitable material and construction debris; and all other related and necessary equipment, work, and materials required to accomplish this item in accordance with the Contract Documents.

34-17.3 Sanitary Sewer By-Pass

34-18.3 Storm Sewer By-Pass

The measurement for payment of this item will be the number of linear feet of sewer line as measured along the centerline of the pipe run, where the work (ie: lining, repairing or replacing) is occurring from center of upstream manhole to center of downstream manhole and shall only be paid for once during the time necessary to complete each section of work. Bypass plans shall be submitted by the Contractor to the Construction Project Manager for review and shall include written by-pass pumping plans on the approved MHT map for the proposed bypass pumping segment, including plans for contingency activities in the event of weather changes,

Measurement and Payment

equipment malfunction, or other disruptions. Bypass plans shall include providing a 48 hour public notification in advance of the work. Only those sections specifically identified within the contract documents or authorized by the Construction Project Manager will be bypassed and measured for payment. All by-pass activities will be performed using materials and methods that result in a complete system that provides zero leakage during all components of by-pass operations.

The unit price bid per linear foot for this item shall include all of the Contractor's costs of whatsoever nature. The price bid shall include: furnishing and setting up of all equipment, labor, measurement and determination of sewer flow, all materials required to pump or divert sewer flows around the section of pipe or manhole being lined, repaired, reconstructed, or constructed to another sewer line accepted by the Construction Project Manager to receive such bypass; supplying of energy required to operate all bypass equipment; temporary installation of bypass piping under the pavement of cross streets, or raised transitional crossings as may be required per the approved traffic control plan; repaving of streets after completion of bypassing; removal and replacement of manhole rings, covers, steps and cone sections as necessary to permit bypassing; cleanup and removal of unsuitable material; and all other related and necessary equipment, work, and materials required to complete the bypassing as required in the Contract Documents or as directed by the Construction Project Manager.

34-17.4 Cured-in-Place-Pipe

The measurement for payment of this item will be the actual number of linear feet of cured-in-place pipe installed, measured along the centerline of the pipe from center of manhole to center of manhole. Only those sections specifically authorized by the Project Manager or noted in the Contract Documents will be measured for payment.

The unit price bid per linear foot of the Cured-In-Place-Pipe shall include all of the Contractor's costs of whatsoever nature. The price bid shall include, but is not limited to: providing 48 hours public notification in advance of the work, furnishing all equipment, materials, and labor necessary to complete CIPP installation; furnishing and setting up of all equipment, labor, and materials required to pump or divert sewer flows around the section of pipe being lined to another sewer line accepted by the Construction Project Manager to receive such bypass; supplying of energy required to operate all bypass equipment; temporary installation of bypass piping under the pavement of cross streets, or raised transitional crossings as may be required per the approved traffic control plan; repaving of streets after completion of bypassing; removal and replacement of manhole rings, covers, steps and cone sections as necessary to permit bypassing; cleanup and removal of unsuitable material; all other related and necessary materials, work, and equipment required to complete by pass; post-installation inspection video and engineering inspections of the sewer being rehabilitated; use of intrinsically safe equipment as necessary; recording all information on USB Plug and Play device (flash drive or hard drive) for review by City; submittal of video in MP4 format and logs in .pdf format, both of which must be submitted in accordance to the naming convention required within the applicable Standard Construction specification section; Identification and locating of all active and inactive (capped) sewer taps, to include linear footage from center upstream manhole, by dye testing, electronic sensing, smoke tracing or use of any other means necessary to verify the active taps; completion and submittal of written logs and digital as-constructed drawings; determination of taps requiring trimming; locating, identifying and reporting structurally deficient pipe sections for replacement or point repair, completion of additional pre-installation inspections and sewer cleaning as necessary prior to CIPP installation; supply energy for all equipment; obtain all

Measurement and Payment

required permits for CIPP installation, materials used, the inspection and covering any related fees; furnishing and setting up all equipment and labor necessary to: clean the sewer; furnish water for jetting, perform bypass pumping required to install product; providing power for de-rooting equipment and other types of machinery; removal and disposal of all foreign material from the sewer line that will prevent installation of cured in place linings; storage of cleaning sediment on the job site in containers or other approved methods; maintaining storage during the waiting time for laboratory test results on the sediment; disposal of sediment according to Local, Federal, and State environmental requirements; all public information and notifications; attending the weekly construction meeting and any other meeting required by the Project Manager; all inspection and cleaning of manholes; removal and disposal of unsuitable material and construction debris; furnishing and setting up all equipment, materials, and labor necessary for the construction process; furnishing water, steam and energy required for the rehabilitation process; furnishing, installing and applying the Cured-In-Place-Pipe Material; curing the CIPP liner, cutting, trimming and brushing active sewer service connection; hydrophilic water swelling material as needed to prevent infiltration between the CIPP liner and host pipe at each manhole; providing access to the City and County of Denver, or their designee, for the purpose of obtaining samples of installed material for onsite and laboratory testing; incidentals referenced in other sections of the Specifications; and all other related and necessary materials, work, and equipment required to complete this item in accordance with the Contract Documents.

34-17.5 Grinding

The measurement for payment of this item will be the actual number of linear feet of grinding within the sewer line submitted and approved by the Project Manager.

It shall be the Contractor's responsibility to notify the Project Manager of pipe segments that require grinding to facilitate CIPP installation. Only those sections specifically designated by the Construction Project Manager will be ground and measured for payment. Measurement shall commence at the point at which the obstruction is encountered and terminate the point at which the obstruction is removed. Payment for grinding will not be made due to negligence or unauthorized operations by the Contractor.

The unit price bid per linear feet of sewer line grinding shall include all of the Contractor's costs of whatsoever nature. The price bid shall include: providing 48 hours public notification in advance of the work, providing pre and post digital verification video of the specific pipe segments proposed for grinding, removal of roots, protruding objects, chemical deposits, unsuitable material or any other materials as directed by the Construction Project Manager prior to placement of any liner; grinding via mechanical, chemical or other approved methods; furnishing and setting up of all equipment and labor necessary to inspect the line to be rehabilitated; video inspection of the line to locate and identify live sewer taps and to locate taps that require trimming; recording of the video inspection; removal of all materials from the pipe walls that will prevent the proper installation of cured-in-place or formed-in-place plastic liners; furnishing of water and power for de-rooting equipment; storing of cleaning sediments on the job site in containers or other Federal or locally approved storage methods; maintaining of stored materials during the time required to obtain laboratory tests; transporting of the sediment for disposal to a landfill upon receipt of laboratory tests results showing that all tests meet Federal and local standards for normal disposal, payment of disposal and landfill fees, if the material is being hauled to any site other than Denver/Arapahoe Disposal Site (DADS); cleaning and inspection of manholes; and all other related and necessary materials, work and equipment required to complete this item in accordance with the Contract Documents.

Measurement and Payment

34-17.6a Sanitary Sewer Service Reactivation for CIPP

34-17.6b Storm Sewer Service Reactivation for CIPP

The measurement for payment of this item will be the actual number of sewer service taps required to be reactivated as determined to be active during the pre-video inspection study. No measurement for payment will be made for taps which are opened/reactivated and have not been determined to be active. The Contractor shall accept all responsibility to provide residents, businesses, etc. with an established and reconnected sewer service. No measurement will be made for sewer service reactivations due to negligent or unauthorized operations by the Contractor.

The unit price bid shall include all of the Contractor's costs of whatsoever nature. The price bid shall include: furnishing and setting up of all equipment and labor necessary to locate and reactivate active services; cutting and brushing of CIPP material and linings, coatings and/or coverings required to open active sewer services; removal and disposal of all unsuitable material; providing 48 hours public notification in advance of the work and notifying residents and business upon reactivation; and all other related and necessary materials, work and equipment required to complete this item in accordance with the Contract Documents or at the direction of the Construction Project Manager.

34-17.7 Extended Tap Cutting

The measurement and payment for this item will be the actual number of submitted and approved extended taps or services that would have to be cut or otherwise repaired for construction of the proposed sewer and or appurtenances. No measurement will be made for extended tap cutting required due to negligent or unauthorized operations by the Contractor.

The unit price bid shall include all of the Contractor's costs of whatsoever nature. The price bid shall include: furnishing of all equipment and labor required to cut the extended tap; cutting of the tap to a smooth and hydraulically functional opening; furnishing of power for all equipment; video-inspection and locating of the extended tap; removal and disposal of materials; and all other related and necessary materials, work and equipment required to complete this item in accordance with the Contract Documents or at the direction of the Construction Project Manager.

34-17.8 Intrinsically Safe Electrical Equipment

No measurement for payment will be made for any of the work and materials required to accomplish this aspect of the construction project and payment will be based upon the completion of the work in accordance with the Contract Documents.

The areas/extents within the Contract Documents requiring the use of explosion proof equipment shall be determined by the Contractor. Damage and repair to the sanitary system and surrounding areas due to misuse of equipment, faulty equipment or negligence are the responsibility of the Contractor.

The lump sum price bid for Intrinsically Safe Electrical Equipment shall include all of the Contractor's costs of whatsoever nature. The lump sum price bid shall include: furnishing, installing, and activating the camera; all labor of whatsoever nature to the various areas of construction, and all other related and necessary materials, work, and equipment required to accomplish this item in a manner satisfactory to the Construction Project Manager and in accordance with the Contract Documents.

Measurement and Payment

36-1 Install Railroad Tracks

The measurement for payment of this item will be the actual number of linear feet of railroad tracks constructed, including appurtenances, as shown within the contract documents; provided, however, no payment will be made for track installation outside the project limits or for track installation due to negligence or unauthorized operations by the Contractor. Payment will be based upon each pair of tracks constructed, as measured along the centerline of the newly installed tracks.

The unit price bid per pair of railroad tracks shall include all of the Contractor's costs of whatsoever nature. The linear foot price bid per pair of railroad tracks shall include: all work and materials required to install the tracks per the Governing Railroad Company, contract documents and design criteria; procurement, including protection and stockpiling of materials removed and approved for re-use, hauling, delivery and installation of ballast; track hardening; railroad ties; pre-stressed concrete panels; full depth asphalt or concrete paving up to the concrete panels as delineated by the area perpendicular to the length of tracks being replaced and within 25 feet of the centerline of the tracks on each side; joining of rails; fasteners, spikes, special joints; grading the subgrade and special bedding under the tracks; hauling and disposal of all excavated material which is not recyclable to the Denver Arapahoe Disposal site; backfilling and compaction; and all other related and necessary materials, work and equipment required for the installation of this item in accordance with the Contract Documents.

40-1 Seeding and Mulching

The measurement and payment for this item will be the total number of square feet of seed, mulch and required soil amendment placed for construction of the proposed sewer and or appurtenances; however, no measurement will be made for seed and mulch placed due to negligent or unauthorized operations by the Contractor.

The unit price bid per square foot of seed and mulch placed shall include all of the Contractor's costs of whatsoever nature. The price bid shall include: furnishing, transporting and placing of seed, mulch, erosion control fabric, blankets or protective coverings; protection and care of stockpiled seed and mulch; preparation, fertilization and soil amendment; furnishing of new seed and mulch of like quality to replace any improperly maintained seed and mulch; watering, raking and rolling the ground surface after placement of seed and mulch; placement of erosion blanket on all slopes greater than 3:1; and all other related and necessary materials, work and equipment required to furnish and place the seed and mulch, complete, in accordance with the Contract Documents.

40-2 Seeding

The measurement and payment for this item will be the total number of square feet of seed to be placed for construction of the proposed sewer and/or appurtenances; however, no measurement for payment will be made for seeding required due to negligent or unauthorized operations by the Contractor.

The unit per square foot of seed placed shall include all of the Contractor's costs of whatsoever nature. The price bid shall include: preparation of soils, ripping and tilling, cleaning, fertilization, leveling to the elevations specified in the Contract Documents; furnishing of seed as specified in the Contract Documents; placing of the seed, wetting, and compaction; erosion control fabric,

Measurement and Payment

blankets, or protective coverings as required; watering; reseeding and/or replacement of any improperly maintained seed; and all other related and necessary materials, work, and equipment required to place the seed in accordance with the Contract Documents.

40-3 Sodding

The measurement and payment for this item will be the total number of square feet of sod required to be placed for construction of the proposed sewer and/or appurtenances; provided, however no measurement will be made for sod placed due to negligent or unauthorized operations by the Contractor.

The unit price bid per square foot shall include all of the Contractor's costs of whatsoever nature. The price bid shall include: preparation and cleaning of the ground surface; furnishing of sod as specified in the Contract Documents or to the same quality as the existing sod; replacement of any improperly maintained sod; proper placement of the sod; watering, rolling and compaction; clean up and disposal of unsuitable material; and all other related and necessary materials, work and equipment required to place the sod in accordance with the Contract Documents.

40-4a Install Sprinkler Line

40-4b Relocate Existing Sprinkler Line

The measurement and payment for this item will be the total number of linear feet of sprinkler line required to be installed or relocated for construction of the proposed sewer and/or appurtenances; provided, however no measurement will be made for sprinkler placed due to negligent or unauthorized operations by the Contractor.

The unit price bid shall include all of the Contractor's costs of whatsoever nature. The price bid shall include: excavation, furnishing of materials, protection and installing pipework and heads; adjusting heads; fittings and connections; backfilling, grading, installing and adjusting valves; and all other related and necessary materials, work, and equipment required to install the sprinkler system in accordance with the Contract Documents or as directed by the Construction Project Manager.

40-5 Install or Relocate Sprinkler System

No quantity measurement will be made for any of the work and materials required to install and/or relocate sprinkler systems. Payment will be based upon completion of the work in accordance with the Contract Documents; provided, however, no payment will be made for installing and/or relocating sprinkler systems due to negligent or unauthorized operations by the Contractor.

The lump sum bid price shall include all of the Contractor's costs of whatsoever nature. The price bid shall include: excavation, furnishing and installation of all sprinkler system materials and materials necessary for relocation of an existing system; protection and installing pipework and heads; adjusting heads; fittings and connections; backfilling, grading, installing and adjusting valves; trace wires; electrical hookups, valve boxes and controls; pressure testing of system; winterization and recharging of system as necessary during project period of performance; and all other related and necessary materials, work, and equipment required to install and/or relocate the sprinkler system in accordance with the Contract Documents or as directed by the Construction Project Manager.

Measurement and Payment

40-6 Decorative Landscaping

No quantity measurement will be made for any of the work and materials required to remove and replace this item. Payment will be based upon completion of the work in accordance with the Contract Documents; provided, however, no payment will be made for removing and replacing decorative landscaping required to be replaced due to negligent or unauthorized operations by the Contractor.

The lump sum bid price shall include all of the Contractor's costs of whatsoever nature. The price bid shall include: excavation; removal and replacement of concrete, rock; removal and replacement of plants, mulch, support systems and retaining structures; disposal of excess excavated materials; topsoil, fertilizer, water, storage and all other related and necessary materials, work and equipment, required to replace the decorative landscaping in accordance with the Contract Documents.

40-7 Remove Trees (>6" Diameter)

40-8 Remove Bushes

The measurement for payment of this item will be the total number of trees, bushes, shrubs or landscaping units, required to be removed for construction of the proposed sewer as specified in the Contract Documents and directed by the Construction Project Manager; provided, however, no measurement for payment will be made for items removed which are less than six (6) inches in diameter at a height of one (1) foot above the existing ground.

The unit price bid per tree, bush, shrub or specified landscaping item removal shall include all of the Contractor's costs of whatsoever nature. The price bid shall include: removal of a sufficient length of the root system to insure that the tree, bush, shrub or landscaping unit will not continue to grow; disposal of all materials removed; acquisition of all permits required for removal; backfilling with soil material approved by the Construction Project Manager; and all other related and necessary materials, work and equipment required to remove trees in accordance with the Contract Documents.

40-9 Remove and Transplant Trees (>6" Diameter)

40-10 Replace Bushes and/or Shrubs

The measurement for payment of this item will be the total number of trees required to be removed and transplanted and/or the total number of shrubs and/or bushes required to be replaced for construction of the proposed sewer; provided, however, no measurement for payment will be made for trees required to be removed and transplanted, or shrubs and/or bushes required to be replaced due to negligent or unauthorized operations by the Contractor.

The unit price bid per tree removal and transplant or shrub and/or bush replacement shall include all of the Contractor's costs of whatsoever nature. The price bid shall include: removal, storing, planting, replanting or replacing, puddling, backfilling, and all other related and necessary materials, work and equipment required to remove and transplant the tree or replace the shrub and/or bush in accordance with the Contract Documents.

40-11 Replace Green Ash Tree (2" Caliper)

40-12 Replace Tree (>6" Diameter)

Measurement and Payment

The measurement for payment for tree planting or replanting will be the total number of trees required to be placed per plans and due to construction of the proposed sewer; provided, however, no measurement for payment will be made for trees planted due to negligent or unauthorized operations by the Contractor.

The unit price bid per tree placement or replacement shall include all of the Contractor's costs of whatsoever nature. The price bid shall include: removal, storing, replanting or replacing, backfilling, staking and supporting devices; formed wells and/or cages; insulating wrap; protection from animals; watering and care throughout the warranty period; and all other related and necessary materials, work and equipment required to plant and replant the tree in accordance with the Contract Documents.

40-13 Shade Trees (> 2" Caliper)

40-14 Ornamental Trees (> 2" Caliper)

The measurement for payment for tree planting will be the total number of trees required to be placed per plans and due to construction of the work; provided, however, no measurement for payment will be made for trees planted due to negligent or unauthorized operations by the Contractor.

The unit price bid per tree placement shall include all of the Contractor's costs of whatsoever nature. The price bid shall include: delivery, temporary protection, storage, planting, backfilling, staking and temporary support devices; formed wells and/or cages; insulating wrap; protection from animals; watering and care throughout the warranty period; and all other related and necessary materials, work and equipment required to plant the tree in accordance with the Contract Documents.

40-15 Landscape Improvements

No quantity measurement will be made for any of the work and materials required for this item in construction of the proposed landscape and irrigation improvements. Payment will be based upon completion of the work in accordance with the Contract Documents; provided, however, no payment will be made for any work performed due to negligent or unauthorized operations by the Contractor.

The lump sum bid price shall include all of the Contractor's costs of whatsoever nature. The price bid shall include all of the work and equipment, and all other related and necessary materials, required to construct all of the proposed landscape and irrigation improvements shown on the landscape/irrigation plans, in accordance with the Contract Documents.

41-1 Traffic Control

No quantity measurement will be made for any of the work and materials required to accomplish this aspect of the construction project and payment will be based upon the completion of the work in accordance with the Contract Documents.

The lump sum price for Traffic Control shall include all of the Contractor's costs of whatsoever nature. The lump sum bid price shall include: All coordination with relevant agencies and utility companies; including by-pass pumping plans on the MHT plans submitted to City and County of Denver- Public Works Right of Way Services; furnishing, installing, moving, maintaining and removing all temporary traffic signs, barricades, channeling devices, warning lights, delineators, and any other equipment or personnel as required by the latest revision of the "Manual on

Measurement and Payment

Uniform Traffic Control Devices for Streets and Highways”, and the requirements set forth by the City and County of Denver, Transportation Engineering Division; all signs, emergency replacements, warning lights, variable message boards, traffic cones, and barricades; approved traffic maintenance plans as required; concrete median barriers as required; lane markings and temporary striping; flagging and notification of property owners; traffic control management; furnishing, installing, adjusting, maintaining and removing all special signs required to direct pedestrians and/or vehicles to businesses or parking facilities disrupted due to construction activities; additional traffic control and safety devices as required by the Construction Project Manager; and all other related and necessary materials, work, and equipment required to accomplish this item in accordance with the Contract Documents.

At the option of the Construction Project Manager payment will be made in percentage installments based upon type, location and scope of work in relation to the period of performance.

41-2 Rerouting and Construction of Bike Path

No quantity measurement will be made for any of the work and materials required to accomplish this aspect of the construction project and payment will be based upon the completion of the work in accordance with the Contract Documents.

The lump sum price bid for rerouting and construction of bike paths shall include all of the Contractor’s costs of whatsoever nature. The price bid shall include: furnishing, installing, moving, maintaining and removing all temporary traffic signs, barricades, channelization devices, warning lights, delineators, bike path signage and any other equipment or personnel required for safe conductance and detouring of bike path personnel off and around the designated construction zone in a safe and professional manner; construction of safety fence, including placement of concrete barriers; coordination with Parks and/or Traffic personnel; obtaining of necessary permits and paying associated fees; water control; placement of rock or pavement for temporary bike path; and all other related and necessary materials, work, and equipment required to accomplish this item in accordance with the Contract Documents or the direction of the Construction Project Manager.

At the option of the Construction Project Manager, one third of the lump sum price for this item may be paid to the Contractor upon satisfactory completion of and/or incorporation of proper controls, the second third may be paid upon fifty percent completion of the work as determined by the percent of work completed on the day of progress payment, and the last third may be paid to the Contractor at the last progress payment or at the discretion of the Construction Project Manager.

42-1 Railroad Control

No measurement will be made for any of the work and materials required to accomplish this aspect of the construction project and payment will be based upon the percent completion of the work in accordance with the Contract Documents.

The City and County of Denver (railroad Licensee) will obtain all necessary license agreements. The contractor(agent of Licensee including subcontractors, officers, agents and employees; and others acting under the licensee or agent of licensee’s authority) will be responsible for the acquisition and maintenance of all railroad protective liability insurance as required by the railroad crossing agreements included within the bid document package, and which is deemed

Measurement and Payment

necessary by the railroad to complete construction. In no way should the railroad pipeline crossing agreement be used to dictate railroad flagger/inspector participation in a project. Railroad Flagger/inspector participation shall be determined by local railroad officials.

The lump sum price for Railroad Control shall include all of the Contractor's costs of whatsoever nature. The price bid shall include: acquisition of additional insurance required by the railroad company to work within railroad right-of-ways, or as otherwise noted within the license agreement; acquisition of all permits, payment of all railroad flagging, inspection and associated permit fees; detouring, railroad traffic control, as required; furnishing of approved base materials, as required to bring the subgrade up to ballast elevation; supplying materials required to protect railroad tracks for equipment crossing; adhering to the conditions of permits, easements, and railroad agreements; preparation of submittals required by the railroad and receipt of approvals prior to work, design and stamping by an Engineer licensed in the State of Colorado as necessary; notification of the railroad and the public of proposed work; arrangements with the railroad for use of railroad property not covered under permits, easements, or railroad agreements; coordination with the railroad and its sub tiers for removal and replacement of the track and its related facilities; railroad safety training for all personnel working within the railroad right-of-way; and all other related and necessary materials, work and equipment required to accomplish this item in accordance with Right of Entry Permits, Pipeline Crossing Agreements and adherence to the latest edition of the American Railway Engineering and Maintenance-of-Way Association (AREMA) Standards, the Contract Documents or as directed by the Construction Project Manager.

At the option of the Construction Project Manager, monthly percentage payments, based upon Period of Performance, may be paid to the contractor upon satisfactory completion of and/or proper controls submitted in monthly payment application, or at the discretion of the Construction Project Manager. Up to the last progress payment or at the discretion of the Construction Project Manager.

43-1 Storm Water Management

No quantity measurement will be made for any of the work and materials required to accomplish this aspect of the construction project and payment will be based upon the completion of the work in accordance with the Contract Documents.

The lump sum price for Storm Water Management shall include all of the Contractor's costs of whatsoever nature. The price bid shall include: implementing measures per Best Management Practices (BMPs); obtaining all permits and paying any associated fees (i.e. NPDES, etc.); coordination with State and Local agencies as required to setup all required plans for the project; furnishing, installing and removing erosion control materials required by the Contractor's plans; protection of existing flow lines, inlets and manholes; care and diversion of drainage courses; pumping and bypass pumping; construction and design of special erosion control plans for emergency situations that develop during construction or unexpected weather conditions; providing filter fabric, bales, stakes, rock, filter material, silt fence, gabions, wire mesh, temporary berms, temporary diversions, temporary slope drains, check dams, geotextile protection, sediment traps and basins; clearing and grubbing for placement of planned control features, etc.; flushing, jetting and/or removal of construction debris from existing systems as required by the Construction Project Manager; stabilization of the work area by seeding and/or mulching during and after construction; disposal of work materials; maintenance of all erosion control features and seeded areas, so they function properly during construction; testing of

Measurement and Payment

sediment and disposal as required; and all other related and necessary materials, work and equipment required to accomplish this item in accordance with the Contract Documents.

At the option of the Construction Project Manager, one third of the lump sum price for this item may be paid to the Contractor upon satisfactory completion of and/or incorporation of proper controls, the second third may be paid upon fifty percent completion of the work as determined by the percent of work completed on the day of progress payment and the last third may be paid to the Contractor at the time of final progress payment or at the discretion of the Construction Project Manager.

44-1 Dewatering

No quantity measurement will be made for any of the work and materials required to accomplish this aspect of the construction project and payment will be based upon the completion of the work in accordance with the Contract Documents. This bid item is for dewatering to accomplish the work, however no payment will be made for dewatering due to failure to protect the excavation from storm events, failure to protect existing utilities or dewatering included elsewhere in these contract documents. No payment will be made for this lump sum item without specific written approval of the Construction Project Manager.

The lump sum price for dewatering shall include all of the Contractor's costs of whatsoever nature. The price bid shall include: pumping and bypass pumping; furnishing of all equipment and manpower; furnishing and installing erosion control materials; obtaining all required discharge permits and paying associated fees; excavation, haul, backfill; installation of caissons, pump pits, piping and drainage courses; disposal of excess and contaminated water; water testing; and all other related and necessary materials, work and equipment required to accomplish this item in accordance with the Contract Documents.

44-2 Water Treatment

No quantity measurement will be made for any of the work and materials required to accomplish this aspect of the construction project and payment will be based upon the completion of the work in accordance with the Contract Documents

The lump sum price for treatment of contaminated water shall include all of the Contractor's costs of whatsoever nature. The price bid shall include: pumping and bypass pumping; sampling and/or water testing; furnishing of all labor, equipment and materials for treatment of contaminated water on site; furnishing and installing of erosion control materials; obtaining all required discharge permits and paying of associated fees; installation of caissons, pumps, pump pits and drainage courses; disposal of excess and contaminated water; excavation, haul , backfill; and all other related and necessary materials and equipment required to accomplish this item in accordance with the Contract Documents. All work must proceed in a manner that does not delay the project

45-1 CIPP Laboratory Testing

The measurement for payment of this item will be the actual number of laboratory tests required for completion of this project and/or installation of related appurtenances.

Measurement and Payment

The unit price bid shall include all of the Contractor's costs of whatsoever nature. The price bid shall include: coordination with a third party tester, creating the sample, for third party transport to the testing lab; receipt of written results by the Construction Project Manager; testing of: final CIPP product, sediment removed from sewer line during cleaning, water quality, soils or other types of laboratory tests as required by the Construction Project Manager; tests shall determine materials composition, concentrations of chemicals, or contaminants present, Atterberg soils limits, soil stress, permeability, volatile organic compounds; testing of CIPP pipe as outlined in the Technical Specifications; and all other related and necessary materials, work and equipment required to complete this item in accordance with the Contract Documents and as directed by the Construction Project Manager.

45-2 Quality Control Testing

No quantity measurement will be made for any of the work and materials required to accomplish this aspect of the construction and payment will be based upon completion of the work in accordance with the Contract Documents. The lump sum price bid shall include the coordination and performance of quality control testing for all facets of the Work in accordance with the City's Frequency of Testing standards.

The lump sum price for Quality Control Testing shall include all of the Contractor's costs of whatsoever nature. The price bid shall include: procurement and payment of professional services; testing of: soils, asphalt, concrete and any materials incorporated into the work (bedding, controlled low strength materials, select or imported fill, etc.) in accordance with the Contract Documents; all testing associated with any form of grouting, as specified in these contract documents; coordination and scheduling of testing; travel to and from work site; additional testing by the Contractor for its own use; re-testing of work components (backfill, concrete used in structures, etc.) as necessary to ensure conformance with Contract Documents, re-testing of work components due to failing QA test results by owner; delivery and transport to testing lab; furnishing of written results to the Construction Project Manager; and all other related and necessary materials, work and equipment required to complete this item in accordance with the Contract Documents and as directed by the Construction Project Manager.

At the option of the Construction Project Manager, one quarter of the lump sum price for quality control testing may be paid to the Contractor at the time of the first monthly progress payment, the second quarter may be paid at the time of the second monthly progress payment, and the third quarter may be paid to the Contractor at the time of the third monthly progress payment, or at the discretion of the Construction Project Manager. The total payment for this bid item shall not exceed seventy-five percent (75%) of the lump sum price during construction. The remaining twenty-five percent (25%) shall be paid after substantial completion of the work and only after all project testing and/or results have been completed and/or provided for project recordation. Any costs paid by the City which are the result of retesting previously failing QA events may be deducted from the Contractor's payment, as applicable and as determined by the Construction Project Manager.

-
- 46-1 Pavement Marking (Paint)**
 - 46-2 Epoxy Pavement Marking**
 - 46-3 Thermoplastic Pavement Marking**
 - 46-4 Preformed Plastic Pavement Marking**
 - 46-5 Pavement Marking Tape**

Measurement and Payment

The measurement for payment of this item will be the actual square feet of pavement marking material or paint installed, as required to accomplish this aspect of the construction. Payment will be based upon completion of the work in accordance with the Contract Documents.

The unit price square foot shall include all of the Contractor's costs of whatsoever nature. The price bid shall include: pavement marking plans when required; furnishing and installation of paint, marking tape, thermoplastic and methyl methacrylate materials; furnishing of all equipment required for application of all pavement marking materials; sandblasting and high pressure cleaning to remove all dirt, laitance, and curing compound residues; and all other related and necessary materials, work and equipment for pavement marking as required in the Contract Documents or as directed by the Construction Project Manager.

47-1 Construction Surveying

No quantity measurement will be made for any of the work or materials required to accomplish this aspect of the construction project and payment will be based upon the completion of the work in accordance with the Contract Documents.

The lump sum cost shall include all of the Contractor's cost of whatsoever nature. The price bid shall include: construction surveying and staking; boundary staking; re-staking as necessary during construction; maintenance and submittal of as-built records, red-lined drawings, final survey and recordation, and prints necessary for the creation of as-built documents for all elements of the project to the Construction Project Manager ; elevation/survey checks as requested by the City during construction; verification of all survey control points, City of Denver range points, section corners and benchmarks prior to starting work; submittal of required items to the City Survey per the specifications; traffic control required to perform work under this bid item; and all other related and necessary materials, work and equipment required to accomplish this item in accordance with the Contract Documents.

All work performed within this bid item shall be done under the supervision of a Professional Land Surveyor (PLS) or Professional Engineer (PE) who is experienced and competent in storm sewer construction, sanitary sewer construction and roadway construction surveying and is licensed in the State of Colorado.

At the option of the Construction Project Manager, one quarter of the lump sum price for Construction Surveying may be paid to the Contractor at the time of the first monthly progress payment, the second quarter may be paid to the Contractor at the time of the second monthly progress payment, and the third quarter may be paid to the Contractor at the time of the third monthly progress payment, or at the discretion of the Construction Project Manager. The total payment for this bid item shall not exceed seventy-five percent (75%) of the lump sum price during construction. The remaining twenty-five percent (25%) shall be paid after submittal of final survey and recordation documents to the Construction Project Manager for creation of as-built drawings.

47-2 Survey Monumentation

The measurement and payment of this item will be the total number of survey monuments removed and replaced for construction of the proposed sewer and/or appurtenances as indicated within the contract documents; provided, however, no measurement for payment will be made for survey monumentation required due to careless or unauthorized operations

Measurement and Payment

by the Contractor. No measurement will be made for locating survey monuments, preserving and referencing monuments within the project limits.

The unit price bid shall include all of the Contractor's costs of whatsoever nature. The price bid shall include: record searches and research; locating, preserving, referencing, adjusting, installing and/or restoring survey monumentation as described within the contract documents; the preparation and depositing of monument tie-out sheets and final monumentation diagram; traffic control required to perform work under this bid item; construction survey checklists, equipment calibrations; monumentation related survey records; and all other related and necessary materials, work and equipment required to accomplish this item in accordance with the Contract Documents.

All work performed within this bid item shall be done under the supervision of a Professional Land Surveyor (PLS) who is experienced and competent in storm sewer construction, sanitary sewer construction, roadway construction surveying, boundary surveying and is licensed in the State of Colorado.

50-1 Mobilization

No quantity measurement will be made for any of the work and materials required to accomplish this aspect of the construction project and payment will be based upon the completion of the work in accordance with the Contract Documents

The lump sum cost shall include all of the Contractor's costs of whatsoever nature. The price bid shall include: mobilization and demobilization to the site or sites defined within the contract documents, multiple mobilizations and demobilizations to accommodate construction moratoriums, events, schools, and/or special circumstances outlined in the Contract Documents; transporting all equipment and materials; temporary sanitary facilities; complete setup, removal, repair, coordination and payment of fees associated with temporary staging facilities; project signs; obtaining groundwater discharge permits and all additional permits required by state and local agencies to complete any facet of the work; fugitive dust control in accordance with D.R.M.C. Title II Chapter 4 Sec. 4-25 throughout entire project duration, development of fugitive particulate control plans as required and street sweeping and site cleanup as necessary; loading, hauling and disposal of all construction related debris and excess excavated material not provided for elsewhere in the Contract Documents; advance coordination, notification and scheduling with City and County of Denver agencies, all affected utility companies, railroads, businesses, and homeowners; scheduling of work to accommodate residents, business owners and special circumstances encountered during construction and/or as indicated in the Contract Documents; all aspects of public information services as required with the Standard Construction Specifications for the project; night and weekend work as necessary; any labor of whatsoever nature required in various areas of construction site as necessary to complete the work in accordance with the Contract Documents. The contractor shall be responsible for all maintenance of parks facilities affected by construction activities. This includes, but is not limited to, the maintenance and irrigation of landscaping items outside of the work area which are disconnected from service due to construction operations. All cost for this work shall be included within this bid item and no additional payment will be made. At the option of the Construction Project Manager, payment may be made in percentage installments based upon type, location and scope of work in relation to the period of performance. . The total payment for this bid item shall not exceed seventy-five percent (75%) of the lump sum price during construction. The remaining twenty-five percent (25%) shall be paid after final site cleanup, completion of all punch list items and demobilization from site.

Measurement and Payment

50-1a Emergency Mobilization

No quantity measurement will be made for any of the work and materials required to accomplish this aspect of the construction and payment will be based upon the completion of the work in accordance with the Contract Documents. The required time for mobilization to site shall be five (5) hours from official written notification.

The measurement for payment of this item will be the actual number of emergency mobilizations required to complete the work in accordance with the Contract Documents and shall include all of the Contractor's costs of whatsoever nature. Each individual site response officially requested by the Construction Project Manager shall be considered one emergency mobilization. The price bid shall include: emergency mobilization; demobilization; transporting all equipment and materials; temporary sanitary facilities; complete setup, removal, repair, coordination and payment of fees associated with temporary staging facilities; obtaining groundwater discharge permits and all additional permits required by state and local agencies to complete any facet of the work; fugitive dust control in accordance with D.R.M.C. Title II Chapter 4 Sec. 4-25 throughout entire project duration, development of fugitive particulate control plans as required and street sweeping and site cleanup as necessary; loading, hauling and disposal of all construction related debris and excess excavated material not provided for elsewhere in the Contract Documents; advance coordination, notification and scheduling with City and County of Denver agencies, all affected utility companies, railroads, businesses, and homeowners; scheduling of work to accommodate residents, business owners and special circumstances encountered during construction and/or as indicated in the Contract Documents; all aspects of public information services as required with the Standard Construction Specifications for the project; night and weekend work as necessary; any labor of whatsoever nature required in various areas of construction site as necessary to complete the work in accordance with the Contract Documents.

END OF MEASUREMENT AND PAYMENT



DENVER

PUBLIC WORKS

Wastewater Capital Projects Management

Supplemental Measurement & Payment

For Asbury and Tejon Park

October 2018



CITY AND COUNTY OF DENVER
ENGINEERING DIVISION

Wastewater Capital Projects Management Project Specific Construction Specification

Bid Item 01-21.26.03: PRODUCT ALLOWANCE FOR PROCUREMENT OF CARLSONATOR WATER QUALITY SYSTEM

Asbury & Tejon Park

ALLOWANCE ACCOUNT ITEMS

DESCRIPTION

This Special Provision contains the City and County of Denver's estimate for Allowance Account Items for **all allowances** necessary for the **PROCUREMENT and DESIGN of a Carlsonator Water Quality System** to be installed in accordance with manufacturer instructions and/or per City and County of Denver Engineering, Wastewater Capital Projects Management Standard Construction Specifications.

Carlsonator Water Quality System shall be defined as those items detailed on an example plan set, which are included in the items **A-B** within the basis of payment for this bid item. The location and placement of the **Carlsonator Water Quality System** shall be as detailed on the plan set, unless a change is proposed by the contractor and accepted by Denver Parks and Recreation in writing and approved by the City and County of Denver Construction Project Manager. The contractor shall confirm and transmit warranty paperwork to Denver Parks and Recreation for the **Carlsonator Water Quality System**. The Contractor shall warranty the installation of the **Carlsonator Water Quality System** for one (1) year after the City and County of Denver issues a letter of acceptance for the project.

Unless otherwise specifically called out in these contract documents, through other pay items; when other pay items are included, no payment shall be made for the procurement of these items **A-B** under the Cast-In-Place Special Structures 34-12.7 *Installation of Carlsonator Vault System and any other appurtenances associated with the Carlsonator system. This bid item also includes repairs to the existing irrigation system that are impacted during the installation of the Carlsonator system*) bid item, for installation of the system.

The estimated amount for this bid item will be added to the total bid to determine the amount of the performance and payment bonds. The **Carlsonator Water Quality System** shall be **procured** from Aqua dE Vita, Contact Chris Carlson at phone: (970) 744-0241. The contractor shall be reimbursed to the contractor as approved by the City Construction Project Manager. In no event shall reimbursement to the contractor exceed that maximum total indicated in the basis of payment.



CITY AND COUNTY OF DENVER
ENGINEERING DIVISION

Wastewater Capital Projects Management Project Specific Construction Specification

BASIS OF PAYMENT

Payment will be made at unit prices for a schedule of values that are associated with each allowance account item category indicated below **(A-B)**.

The unit prices for allowance account item category indicated below **(A-B)** and the schedule of values shall be submitted by the contractor and accepted by the City Construction Project Manager within 60 days of Notice to Apparent Low Bidder. The unit prices will only be paid at true and verifiable cost plus a 3% mark up in accordance with the City and County of Denver General Contract Conditions. Mark up shall not be applied to sales tax or reclamation fees/charges. Payment will constitute full compensation for all true and verifiable costs associated with this bid item 01-21.26.03 and allowances necessary to complete the scope of the project. The contractor will be required to submit itemized invoices for all costs along with a spreadsheet tabulation indicating the 3% mark up on the **Carlsonator Water Quality System** provided for inclusion in the Field Measurement Report (FMR). The City Construction Project Manager will approve payments in the appropriate dollar amount on the monthly payment applications.

No payment will be made under this bid item for any items not included in the list of items below.

*Approval will be in the form of an accepted submittal, made through the submittal process.

Item No.	Allowance Account Item	Quantity	Estimated Amount
<u>01-21.26.03A</u>	Design of Carlsonator System	A/A	\$7,000.00
<u>01-21.26.03B</u>	Vault (All Internal pipes, gaskets, connections, and fittings)	A/A	\$43,000.00
Maximum Total:			\$50,000.00



CITY AND COUNTY OF DENVER
ENGINEERING DIVISION

Wastewater Capital Projects Management Project Specific Construction Specification

Allowance Account Item Definitions:

- 01-21.26.03A Design of Carlsonator System – all costs associated with the design of the Carlsonator System which will include the design of the 2 - 8' diameter manholes, 48" RCP, 24" PVC lateral connection pipes and any other site work associated with the system.
- 01-21.26.03B Vault – all costs associated for procurement of the vault (which includes all internal pipes, gaskets, connections and fittings)

*Approval will be in the form of an accepted submittal, made through the submittal process.

**Note: 2 - 8' diameter manholes, 48" RCP, 24" PVC lateral connection pipes, removal of existing 48" RCP, and other site work associated with the Carlsonator system are accounted for with bid items and will be procured and installed per the associated measurement payment for those bid items. However, the design associated with those bid items will be paid for using 01-21.26.03A allowance account.

Supplemental Measurement and Payment

PAYMENT PROCEDURES

- A. The following requirements apply to all subsequent measurement and payment items in this section.
- B. For each bid item, the Work will be measured and paid for on either a unit price basis or on a lump sum basis. The quantities provided on the bid form and statement of quantities are estimates of the actual quantities of Work only and are included solely for determining the probable cost of Work. The actual quantities of Work may differ from the bid quantities. The basis of measurement and payment for each unit price bid item will be the actual amount of Work authorized, completed, and accepted. All labor, equipment, materials, and any incidentals required to complete the Work will be considered subsidiary to that bid item and will not be measured or paid for separately.
- C. Payment will be made only for each item included in the bid. No Work will be paid for that is not completed in accordance with the Contract Documents and accepted by the Construction Project Manager. Except as may be otherwise stipulated, no labor, equipment, materials, or any incidentals required to complete the Work will be furnished by the City and County of Denver.
- D. The basis of measurement and payment for each supplemental bid item is described herein. A general listing of bid items, accompanied by a summary of the Work, is provided below. It is not intended to completely describe all Work. Refer to the Contract Documents for detailed information on each bid item.

Bid Item Supplemental

3-2a: Hauling of contaminated materials to Denver/Arapahoe Disposal Site

The measurement for payment for this item will be the actual number of cubic yards hauled from the site and delivered to DADS, measured and computed by the average end area method or grid method (difference between existing and finished grade) in accordance with the Drawings and Plans or as otherwise directed by the Construction Project Manager. The quantity is based on the neat lines shown on the Drawings and does not account for shrinkage or swell. The unit price will include all of the Contractor's costs. This bid item includes all soil excavation but excludes bedrock excavation.

Payment will be based on units completed and accepted.

<u>Bid Item</u>	<u>Pay Unit</u>
Hauling of Contaminated Materials to Denver/Arapahoe Disposal	CY

Bid Item Supplemental
3-4a: Earthwork, Rock Excavation

- a. **Measurement:** The measurement for payment for this item will be the actual number of cubic yards excavated, measured and computed by the average end area method or grid method (difference between existing and finished grade) in accordance with the Drawings and Plans or as otherwise directed by the Construction Project Manager. The quantity is based on the neat lines shown on the Drawings and does not account for shrinkage or swell. The unit price will include all of the Contractor's costs. This bid item includes, but is not limited to:
- 1) Hauling of materials to DADS in accordance with the Contract Documents
 - 2) Excavating, transporting, grading, hauling excavated material to areas within project, and temporary stockpiling with BMPs
 - 3) Ripping, chipping, chiseling as required for excavation
 - 4) Placing, reworking, and compacting fill material
 - 5) Cross hauling material as required
 - 6) Providing all other related and necessary labor, equipment, and materials to complete the Work
- b. **Payment:** Payment will be based on units completed and accepted.

Bid Item	Pay Unit
Earthwork, Rock Excavation	CY

Bid Item Supplemental
3-5a: Clearing and Grubbing

- a. **Measurement:** No separate measurement for payment will be made for any labor, equipment, and materials required for this item. The lump sum price will include all the Contractor's costs. This bid item includes, but is not limited to:
- 1) Hauling of materials to DADS in accordance with the Contract Documents
 - 2) Completing the clearing and grubbing
 - 3) Removal and disposal of trash, debris and all other deleterious material
 - 4) Management of invasive species as required by all Federal, State and local regulations
 - 5) Providing all other related and necessary labor, equipment, and materials to complete the work
- b. **Payment:** Payment will be based on the percentage of completed and accepted work.

Bid Item	Pay Unit
Clearing and Grubbing	LS

Bid Item Supplemental

3-5b: Excavation, Muck, Replace with Approved Material

Measurement: The measurement for payment for this item will be the actual number of cubic yards of material removed beyond what is required for the construction of the improvements in accordance with the Drawings and Plans or as otherwise directed by the Construction Project Manager. Measurement will be based upon actual field measurements and calculated volumes (no allowance for shrinkage or swell). The unit price will include all of the Contractor's costs. This bid item will be only used at the direction of the Construction Project Manager. This bid item includes, but is not limited to:

- 1) Excavating, hauling of materials to DADS in accordance with the Contract Documents
- 2) Replacing with approved material
- 3) Placing approved geotextile as required
- 4) Quality Control testing as required
- 5) Providing all other related and necessary labor, equipment, and materials to complete the Work

- b. **Payment:** Payment will be based on units completed and accepted. No payment will be made for placement due to poor subgrade preparation, lack of dewatering, cave-ins, and/or negligent or unauthorized activities by the Contractor.

Bid Item	Pay Unit
Excavation, Muck, Replace with Approved Material	CY

Bid Item Supplemental

5-1a: Earthwork, Imported Fill

Measurement: The measurement for payment for this item will be the actual number of cubic yards of fill to be imported from an offsite source to be properly stockpiled and placed along the finished lines and grades in accordance to the Drawings and Plans or as otherwise directed by the Construction Project Manager. Measurement of this item will be completed by the Construction Project Manager measured and computed by the average end area method or grid method (difference between existing and finished grade) in accordance with the Drawings and Plans or as otherwise directed by the Construction Project Manager. The quantity is based on the neat lines shown on the Drawings and does not account for shrinkage or swell. The unit price will include all of the Contractor's costs. This bid item includes, but is not limited to:

- 1) Locating, supplying, and transporting of approved material
- 2) Providing material test data and soil properties
- 3) Stockpiling with BMP's
- 4) Moistening, drying, and reconditioning material, as necessary, to meet moisture-density requirements
- 5) Hauling, placing, and compacting fill material
- 6) Surface roughening and terracing BMPs as shown in the Contract Documents.
- 7) Quality Control testing as required
- 8) Providing all other related and necessary labor, equipment, and materials to complete the Work

b. **Payment:** Payment will be based on units completed and accepted.

<u>Bid Item</u>	<u>Pay Unit</u>
Earthwork, Imported Fill	CY



DENVER

PUBLIC WORKS

Wastewater Capital Projects Management Project Special Provisions

Project Special Provisions

For Asbury and Tejon Park

October 2018

Project Special Provisions

1. Excavation and Earthwork

Existing on-site material includes miscellaneous debris, asbestos and other potential contaminants. All excavated material including soil, topsoil, aggregate, riprap and muck shall be hauled off site to the Denver Arapahoe Disposal Site (DADS) for disposal. A Certified Asbestos Inspector (CABI) shall monitor excavation, loading and haul off procedures. Imported soil/fill and imported topsoil will be required for project backfill, earthwork and final grading. All Work shall be completed in accordance with an approved Materials Management Plan (MMP). Contractor shall finalize and implement the MMP and prepare a Regulated Asbestos Contaminated Soil (RACS) Management Plan. The RACS Management Plan shall be reviewed and approved by the City and County of Denver. **Contacto**r shall anticipate RACS affecting all aspects of work on this project and account for the proper handling of the material per the approved MMP. Contractor's bid item unit prices which require excavation or could possibly be affected by the presence of RACS shall include all costs associated with the proper handling of the materials.

2. Bedrock

Shallow bedrock has been encountered and is documented in the project geotechnical report. Approximate bedrock depths are also included on the Drawings. It is anticipated that bedrock ripping, chiseling and excavation will be required for channel construction. Bedrock locations, depths and conditions may affect shoring methods and subgrade stabilization approaches. Vibration assessment during work at bedrock will be necessary to ensure protection of nearby structures.

3. Boulders and Grouted Boulders

The Contractor shall anticipate field fitting of this material, as it is a natural product with non-standard dimensions. Additionally, the Contractor shall plan for a large boulder stockpile with a variety of boulder sizes. The Construction Project Manager, landscape architect and/or design engineer will be on-site during placement of boulders to provide guidance and feedback.

The Contractor shall prepare a written Grouted Boulder Installation Plan to submit for review and approval. The plan shall outline processes for subgrade preparation, stabilization, boulder selection/placement and grout installation. A test section of stacked boulder walls shall be required for on-site observation and approval by the Construction Project Manager prior to continuation of boulder wall construction. The test section can be included as part of the final boulder wall structure

4. Water Control and Dewatering

Water Control and Dewatering shall adhere to the supplemental technical specification 31 23 19 and CDPS General Permit COG070000 *Construction Dewatering Discharges*, Certification Number: COG076281.

5. Permits

CDPS General Permit COG070000 *Construction Dewatering Discharges*, Certification Number: COG076281 has been obtained. The contractor shall adhere to all requirements of this permit. A copy of the authorization is included in the Project Specifications. The Permit shall be transferred to the Contractor prior to construction.



DENVER

PUBLIC WORKS

Wastewater Capital Projects Management

Supplemental Technical Specifications

For Asbury and Tejon Park

October 2018

**WASTEWATER CAPITAL PROJECTS MANAGEMENT SUPPLEMENTAL TECHNICAL SPECIFICATION
FOR ASBURY AND TEJON PARK**

FOR USE WITH SUPPLEMENTAL BID ITEMS: 3-4a Rock Excavation; 3-5a Clearing and grubbing;
3-5b Muck, Replace with approved material; 5-1a Imported Fill

31 23 00 EARTHWORK

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. This work shall consist of excavation, embankment fill, disposal of excess material, shaping, and compaction of all material encountered within the limits of work site, not associated with utility trenching, structural excavation or where excavation or earthwork is specifically included in other specifications or areas of work. The earthwork shall include, but is not limited to, the native soils that shall be excavated for the construction of the project. All work shall be completed in accordance with the Wastewater Capital Project Management Standard Construction Specifications, the lines and grades, and typical cross-sections shown on the Drawings and Plans.

1.02 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
 - 1. ASTM International (ASTM):
 - a. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft³ (600 kN-m/m³)).
 - b. D1557, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN-m/m³)).
 - c. D4253, Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.

1.03 DEFINITIONS

- A. "Embankment Material" shall consist of approved material acquired from outside sources, hauled and placed in embankments.
- B. "Muck Excavation" shall consist of the removal of mixtures of soils and organic matter not suitable for foundation material and replacement with approved material.
- C. "Rock Excavation" shall consist of igneous, metamorphic and sedimentary rock which cannot be excavated without the use of rippers, and all boulders or other detached stones each having a volume of one-half (1/2) cubic yard or more, as determined by physical or visual measurement. It shall also include replacement with approved material as required.

- D. "Unclassified Excavation" shall consist of the excavation of all materials of whatever character required of the work, obtained within the project limits, including surface boulders, masonry, organics, rocks, muck material, miscellaneous debris and slag that are not removed under some other bid item.

1.04 QUALITY ASSURANCE

- A. Final topography and/or cross-sections shall be surveyed by the Contractor of areas that are to finished grade and compared to the design section for accuracy.
- B. Final grade shall match design grades within the tolerances discussed in PART 3 EXECUTION.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Embankment Material may consist of approved material acquired from on-site excavations (see DDPHE Soil Reuse Guidelines) or material hauled from outside the project limits.
 - d. Suitable material identified on-site (tested by the Contractor for re-use according to Denver Department of Public Health and Environment guidelines) may be used first for embankments and backfill.
- B. Excess excavated native soils which are not used as embankment or backfill shall be disposed of in accordance with Executive Order 115 or shall be tested by the end user for re-use according to Denver Department of Public Health and Environment guidelines.
- C. Muck Excavation shall also include the replacement of excavated muck with uniformly graded rock, riprap, on-site or imported soils, or other material, whichever is most suitable for the specific situation encountered.
- D. The Construction Project Manager will determine which type of aggregate or other material that shall be used to replace muck after observing the specific site conditions.
- E. Impervious structural backfill, where shown or specified, shall consist of material having one hundred percent (100%) finer than two (2) inches in diameter and a minimum of thirty-five percent (35%) passing a No. 200 U.S. Standard Sieve.

PART 3 EXECUTION

3.02 GENERAL EXCAVATION/EMBANKMENT

- A. General:
 - 1. The excavation and embankment shall be finished to reasonably smooth and uniform surfaces conforming to the line and grade specified.
 - 2. Variation from the subgrade plane shall not be more than eight-hundredths (0.08) foot in soil or more than eight-hundredths (0.08) foot above or one-half (0.50) foot below in rock.

3. Where bituminous or concrete surfacing materials are to be placed directly on the subgrade, the subgrade plane shall not vary more than four-hundredths (0.04) foot.
4. Materials shall not be wasted without the permission of the Construction Project Manager.
5. Excavation operations shall be conducted so that material outside of the limits of slopes will not be disturbed.
6. The Contractor shall notify the Construction Project Manager 10 days prior to beginning excavation or embankment such that the necessary topography and/or cross-sections may be taken, if required. The Contractor shall not excavate beyond the dimensions and elevations established, and material shall not be removed prior to surveying the site.
7. When the Contractor's excavating operations encounter remains of prehistoric people's dwelling sites or artifacts of historical or archaeological significance, the operations shall be temporarily discontinued.
 - a. The Construction Project Manager will contact the appropriate authorities to determine the disposition thereof.
 - b. When directed, the Contractor shall excavate the site in such a manner as to preserve the artifacts encountered and shall remove them for delivery to the custody of the proper state authorities.

B. Excavation:

1. Unclassified:

- a. All excess suitable material excavated from the job site and not used for embankment shall be removed from the job site and be disposed of in accordance with Executive Order 115 or shall be tested by the end user for re-use according to Denver Department of Public Health and Environment guidelines.
- b. Where material encountered within the limits of the work is considered unsuitable for embankment (fills) on any portion of this work, such material shall be excavated as directed by The Construction Project Manager and replaced with suitable fill material.
- c. All unsuitable excavated material from excavation consisting of any type of debris (surface or buried), excavated rock, bedrock or rocks larger than four (4) inches in diameter, and boulders shall be hauled from the job site and disposed of in accordance with Executive Order 115 or shall be tested by the end user for re-use according to Denver Department of Public Health and Environment guidelines. Debris is defined as "anything that is not earth which exists at the job site."

2. Muck:

- a. Where excavation to the finished grade section results in a subgrade or slopes of unsuitable soil, the Construction Project Manager may require the Contractor to remove the unsuitable materials and backfill to the finished graded section with approved material.
- b. Disposal of the unsuitable material shall be in accordance with Executive Order 115 or shall be tested by the end user for re-use according to Denver Department of Public Health and Environment guidelines. Excavated muck shall be replaced with aggregate or other suitable material as designated by the Construction Project Manager.

3. Rock:

- a. Unless otherwise specified, rock shall be excavated to a maximum depth of 0.5 foot below subgrade within the limits of the designated area, and the excavation shall be backfilled with material shown on the Drawings and Plans or as designated by the Construction Project Manager.
- b. Disposal of material shall in accordance with Executive Order 115 or shall be tested by the end user for re-use according to Denver Department of Public Health and Environment guidelines. Excavated rock shall be replaced with suitable material approved by the Construction Project Manager.
- c. Good surface drainage shall be provided around all permanent cuts to direct surface runoff away from the cut face.

C. Embankment Construction:

- 1. Embankment construction shall consist of constructing all fill areas, including preparation of the areas upon which they are to be placed, the placing and compacting of approved material within areas where unsuitable materials have been removed, and the placing and compacting of embankment material in holes, pits and other depressions within the project limits.
- 2. Only approved materials shall be used in the construction of embankments and backfills.
- 3. Approved materials shall consist of clean on-site cohesive soils or approved imported soils.
- 4. On-site cohesive soils or imported soils shall be placed and compacted in horizontal lifts, using equipment and procedures that produce recommended moisture contents and densities throughout the lift and embankment height. Onsite or imported cohesive soils shall be compacted within a moisture content range of two percent (2%) below, to two percent (2%) above optimum moisture content and compacted to ninety-five percent (95%) of the Maximum Standard Proctor Density (ASTM D698) or as specified by a geotechnical engineer or report prepared for the project.
- 5. When embankment is to be placed and compacted on hillsides, or when new embankment is to be compacted against existing embankments, or when embankment is built one-half (1/2) width at a time, the slopes that are steeper than four-to-one (4:1) when measured longitudinally or at

right angles to the adjacent ground shall be continuously benched over those areas where it is required as the work is brought up in layers.

- a. Benching shall be well “keyed” and where practical a minimum of eight (8) feet. Each horizontal cut shall begin at the intersection of the original ground and the vertical sides of the previous cuts.
 - b. Material thus cut out shall be recompacted along with the new embankment material.
6. The ground surface underlying all fills shall be carefully prepared by removing all organic matter, scarification to a depth of eight (8) inches and recompacting to ninety-five percent (95%) of the Maximum Standard Proctor Density (ASTM D698) within a moisture content range of two percent (2%) below, to two percent (2%) above optimum moisture content prior to fill placement or as specified by a geotechnical engineer or report prepared for the project.
7. Embankment Material shall be placed in horizontal layers not exceeding 6 inches (loose measurement) and shall be compacted to ninety five percent (95%) of the Maximum Standard Proctor Density (ASTM D698) within a moisture content range of two percent (2%) below, to two percent (2%) above optimum moisture content prior to fill placement or as specified by a geotechnical engineer or report prepared for the project.
 - a. Effective spreading equipment shall be used on each lift to obtain uniform thickness prior to compacting.
 - b. As the compaction of each layer progresses, continuous mixing, leveling and manipulating are required to ensure uniform density.
8. For embankments which serve as berms, the downstream portion shall be keyed into the subsurface soils a minimum of three (3) feet to enhance the stability of the slope.
9. Materials which are removed from excavations that are over the optimum moisture content shall be required to be dried out prior to reusing them and included in the work for embankment construction.
10. Cross hauling or other action as appropriate will be ordered when necessary to ensure that the best available material is placed in critical areas of embankments, including the top two (2) feet of all embankments. No additional payment will be made for cross hauling ordered by the Construction Project Manager.
11. Frozen materials shall not be used in construction of embankments.
12. During the construction of channels, the channel bottom shall be maintained in such condition that it will be well drained at all times.
13. Excavation or embankment (fill), and structural backfill work either completed or in a stage of completion that is either eroded or washed away or becomes unstable as a result of either rains,

snow, snow melt, channel flows, or lack of proper water control shall be removed and replaced, recompacted, or reshaped as directed by the Construction Project Manager and in accordance with the Drawings and Plans and these Specifications, at no additional cost to the City and County of Denver.

14. Impervious structural backfill when designated shall be placed in six-inch (6") loose lifts within a range of two percent (2%) above to two percent (2%) below the optimum moisture content and compacted to ninety-five percent (95%) of Maximum Standard Proctor Density for cohesive soils as determined by ASTM D698 or as specified by a geotechnical engineer or report prepared for the project.

D. Finished Grade:

1. Finished grade as shown on the Drawings and Plans or as directed by the Construction Project Manager shall be achieved after placement of materials, compaction, moisture and density requirements as specified.

E. Proof Rolling:

1. Proof rolling with a heavy rubber-tired roller shall be required, if designated on the Drawings and Plans or when requested by the Construction Project Manager.
2. Proof rolling shall be done after specified compaction has been obtained. Areas found to be weak and those areas which failed shall be ripped, scarified, wetted if necessary, and recompacted to the requirements for density and moisture at the Contractor's expense.
3. Proof rolling shall be completed with equipment and in a manner acceptable to Construction Project Manager. Proof rolling as shown on the Drawings and Plans or as requested by the Construction Project Manager shall not be measured and paid for separately but shall be included in the unit prices bid for the work.

END OF SECTION 31 23 00

**WASTEWATER CAPITAL PROJECTS MANAGEMENT SUPPLEMENTAL TECHNICAL SPECIFICATION
FOR ASBURY AND TEJON PARK**

SUPPLEMENT TO BID ITEM 44-1 DEWATERING

31.23.19.01 WATER CONTROL AND DEWATERING

Until final written acceptance of the project by the City and County of Denver, the Contractor shall have the charge and care thereof and shall take every precaution against injury or damage to any part thereof from any cause, including all surface and subsurface water, whether arising from the execution or from the nonexecution of the work. The Contractor shall rebuild, repair, restore, and make good all injuries or damages to any portion of the work due to causes beyond the control of and without the fault of negligence of the Contractor, including but not restricted to, acts of God, of the public enemy, or of governmental authorities.

The Contractor shall be responsible for the project site and shall take such precautions as may be necessary to construct the project in a dry condition and provide for drainage, dewatering, and control of all surface and subsurface water and shall erect any necessary temporary structures or other facilities at the contractor's expense. The Contractor is advised that this project site is within in a natural drainage path and existing detention pond subject to intermittent and extensive runoff and surcharge conditions, such that unless the construction area is properly protected, localized flooding and/or extensive soil erosion may occur.

At the Preconstruction Conference, and prior to beginning any work, the Contractor shall submit a plan for water control to the City and County of Denver Construction Project Manager for review. The City and County of Denver may require the Contractor to update the Water Control Plan.

The Contractor, at the contractor's expense, shall furnish all necessary equipment and materials required to control the surface and subsurface water in all the areas from start of work through the completion of the total project work.

As part of water control, the Contractor is responsible for furnishing, transporting, and installing all materials and equipment, well points, pumping, channelization, diversion, damming, or other means of controlling surface water, ground waters, and runoff from other drainage tributaries flowing into Asbury & Tejon Park as necessary to complete all the work in accordance with the Contract Documents.

31.23.19.02 Scope Of Work

The work of this section consists of controlling and dewatering all surface and subsurface water from the Asbury and Tejon Project site.

31.23.19.03 Materials

Suitable on-site materials approved by the Construction Project Manager, or designee, may be used within the limits of construction to construct temporary dams and berms. Other approved materials may also be used if desired by the Contractor, at the contractor's expense.

31.23.19.04 Construction

- A. General: For all work, the Contractor shall provide suitable prevention materials; equipment and labor to prevent water from entering the construction site or to remove water. The contractor shall keep all excavations dewatered so that construction can be carried on under dewatered conditions where required by the Drawings and Specifications. Water control shall be accomplished in such a manner as to not damage adjacent properties. The Contractor is responsible for investigating and performing due diligence in regard to all site conditions that may affect the work including surface water, surface water courses, level of groundwater and the time of year the work is to be done. All excavations made as part of dewatering operations shall be backfilled with approved fill material similar to what was removed and compacted to 95 percent of maximum density (ASTM D698) or to 75 percent relative density (ASTM D2049), except where replacement by other materials and/or methods are required.
- B. Surface Water Control: Surface water control generally falls in to the following categories:
1. Normal low flows through Asbury & Tejon Park;
 2. Storm/flood flows through Asbury & Tejon Park;
 3. Flows from existing storm drain pipelines; and
 4. Local surface inflows not conveyed by pipelines.

The Contractor shall coordinate, evaluate, design, construct, and maintain temporary water control conveyance systems. These systems shall not worsen flooding, alter major flow paths, or worsen flow characteristics during construction. The Contractor is responsible to ensure that any such worsening of flooding does not occur.

The following is approximate storm flow data for Asbury & Tejon Park and is provided as information only. This information was documented in the Asbury & Tejon Park Retrofit Drainage Design Report dated June 21, 2017.

100-year Flood

659 cfs

The 100-year flood flow of 659 cfs has a one percent probability of being equaled or exceeded in any given year.

The Contractor shall be responsible for conveying surface flow around the construction area(s) so that the excavation for any boulders and/or riprap remain free of surface water for the time it takes to install these materials, and includes any time required for the curing of concrete that may be required.

At all times the Contractor shall maintain drainage conveyance through the Park and account for the Park's existing stormwater detention storage. Temporary structures such as berms, sandbags, pipeline diversions, etc., shall be allowed for water control, as long as such measures are not a major obstruction to flood flows, do not reduce stormwater detention volumes, do not worsen flooding or alter historic flow routes, and do not negatively impact any adjacent or downstream properties. Existing trees and vegetation should be preserved as indicated on the construction documents.

- C. Groundwater Control: The Contractor shall install adequate measures to maintain the level of groundwater below the foundation subgrade elevation and maintain sufficient bearing capacity for structures, pipelines, earthwork, and rock work. Such measures may include, but are not limited to, installation of perimeter subdrains, pumping from drilled holes or by pumping from sumps excavated below the subgrade elevation. The foundation bearing surfaces are to be kept dewatered and stable until the structures or other types of work are complete and backfilled. Disturbance of foundation subgrade by Contractor operations shall not be considered as originally unsuitable foundation subgrade and shall be repaired at Contractor's expense.

**WASTEWATER CAPITAL PROJECTS MANAGEMENT SUPPLEMENTAL TECHNICAL SPECIFICATION
FOR ASBURY AND TEJON PARK**

SUPPLEMENT TO WASTEWATER CAPITAL PROJECTS MANAGEMENT STANDARD CONSTRUCTION SPECIFICATION 12.0
RIPRAP BOULDERS AND SLOPE/CHANNEL PROTECTION
FOR USE WITH BID ITEMS IN THE 30-1 Riprap 30-2 Grouted Riprap pay items

31 37 00 RIPRAP, BOULDERS, SOIL RIPRAP, VOID-FILLED RIPRAP AND BEDDING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. The work includes excavation, backfill, grading, sub-grade preparation and installation of riprap, boulders, soil riprap, void-filled riprap, and bedding placed at the locations shown on the Drawings and Plans. The materials to be used and the construction of such structures shall be as specified herein.
- B. Final acceptance of work is contingent upon approval from all project stakeholders.

1.02 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
 - 1. American Association of State Highway and Transportation Officials (AASHTO):
 - a. T85, Standard Method of Test for Specific Gravity and Absorption of Coarse Aggregate.
 - b. T96, Standard Method of Test for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
 - c. T103, Standard Method of Test for Soundness of Aggregates by Freezing and Thawing.
 - d. T104, Standard Method of Test for Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate.
 - e. T248, Reducing Field Samples of Aggregate Test Size.
 - 2. ASTM International (ASTM):
 - a. D1557, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN-m/m³)).

1.03 SUBMITTALS

- A. The Contractor shall provide samples of all specified materials to the Construction Project Manager prior to beginning construction
- B. The Contractor shall submit certified laboratory test certificates for all items required in this section

PART 2 PRODUCTS

2.05 MATERIALS

A. RIPRAP

1. Riprap used shall be the type designated on the Drawings and Plans and shall conform to Table 1.

Table 1: Riprap Gradation

Riprap Designation	% Smaller Than Given Size By Weight	Intermediate Rock Dimension (inches)	d ₅₀ * (inches)
Type VL	70 - 100	12	6**
	50 - 70	9	
	35 - 50	6	
	2 - 10	2	
Type L	70 - 100	15	9**
	50 - 70	12	
	35 - 50	9	
	2 - 10	3	
Type M	70 - 100	21	12**
	50 - 70	18	
	35 - 50	12	
	2 - 10	4	
Type H	70 - 100	30	18
	50 - 70	24	
	35 - 50	18	
	2 - 10	6	

Riprap Designation	% Smaller Than Given Size By Weight	Intermediate Rock Dimension (inches)	d ₅₀ * (inches)
Type VH	70 - 100 50 - 70 35 - 50 2 - 10	41 33 24 9	24
*d ₅₀ = Mean Particle Size			
**Mix VL, L and M riprap with 35% topsoil (by volume) and bury it with 4 to 6 inches of topsoil, all vibration compacted, and revegetate.			

2. The riprap designation and total thickness of riprap shall be as shown on the Drawings and Plans.
3. The maximum stone size shall not be larger than the thickness of the riprap. Neither width nor thickness of a single stone of riprap shall be less than one-third (1/3) of its length.
4. The specific gravity of the riprap shall be two and one-half (2.5) or greater.
5. Riprap specific gravity shall be according to the bulk-saturated, surface-dry basis, in accordance with AASHTO T85.
6. The riprap shall have a percentage loss of not more than forty percent (40%) after five hundred (500) revolutions when tested in accordance with AASHTO T96.
7. The riprap shall have a percentage loss of not more than ten percent (10%) after five (5) cycles when tested in accordance with AASHTO T104 for ledge rock using sodium sulfate.
8. The riprap shall have a percentage loss of not more than ten percent (10%) after twelve (12) cycles of freezing and thawing when tested in accordance with AASHTO T103 for ledge rock, procedure A.
9. Rock shall be free of calcite intrusions.
10. Gradation:
 - a. Each load of riprap shall be reasonably well graded from the smallest to the largest size specified.

- b. Stones smaller than the two to ten percent (2 to 10%) size will not be permitted in an amount exceeding ten percent (10%) by weight of each load.
- c. Control of gradation shall be by visual inspection. However, in the event the Construction Project Manager determines the riprap to be unacceptable, the Construction Project Manager shall pick two (2) random truckloads to be dumped and checked for gradation.
 - 1) Mechanical equipment and labor needed to assist in checking gradation shall be provided by CONTRACTOR at no additional cost.

11. Color:

- a. The color of the riprap shall be gray with gray/blue hues, unless otherwise specified in the Drawings and Plans or approved by the Construction Project Manager prior to delivery to the job site.
- b. Color shall be consistent throughout the entire project site and shall match the color of rock to be used for all other portions of the work.

12. Broken concrete or asphalt pavement is not acceptable for use in the work.

13. Rounded riprap (river rock) is not acceptable, unless specifically designated on the Drawings and Plans.

B. BOULDERS

- 1. Boulders shall be the type and size designated on the Drawings.
- 2. The specific gravity of the boulders shall be two and one-half (2.4) or greater.
- 3. The density of the boulders shall be 140 lb/cf or greater.
- 4. The boulders shall have a percentage loss of not more than 0.1% when tested per ASTM C67.
- 5. The boulders shall have an absorption of not more than 4% when tested in accordance with ASTM C97.
- 6. The boulders shall have a minimum compressive strength of 20,000 psi.
- 7. Boulder specific gravity shall be according to the bulk-saturated, surface-dry basis, in accordance with AASHTO T85.
- 8. The bulk density for the boulder shall be 1.3 ton/cy or greater.

9. Rock shall be free of calcite intrusions.

10. Color:

- a. The color of the boulders shall be sienna buff, brown or other acceptable colors approved by the Construction Project Manager prior to delivery to the job site.
- b. Color shall be consistent on the entire project site and shall match the color of rock to be used for all other portions of the work.

C. SOIL RIPRAP

1. Rock requirements are to comply with riprap as specified in "Materials".
2. The soil material shall be native or topsoil and mixed with sixty-five percent (65%) riprap and thirty five percent (35%) soil by volume.
3. Soil riprap shall consist of a uniform mixture of soil and riprap without voids.

D. VOID-FILLED RIPRAP

1. Rock requirements are to comply with riprap material specifications in Paragraph A.
2. Samples of riprap and void-fill materials shall be submitted for the review and approval of the Construction Project Manager prior to construction.
3. Where "Void-Filled Riprap" is designated on the Drawings and Plans, riprap shall be mixed with the materials and associated proportions listed in Table 3 and Table 4 to fill the voids of the riprap.
4. If specified, an alternate void-filled riprap mix that includes river cobble shall be used; this mix appears in Table 5 and Table 6.
5. Mix proportions and material gradations in Tables 3 through 6 are approximate and are subject to adjustment by the Construction Project Manager. No adjustment in unit price for void-filled riprap will be allowed based on modifications to the mix proportions.

Table 3: Mix Requirements for Type VL and L Void-Filled Riprap without River Cobble

Approximate Proportions (loader buckets)	Material Type	Material Description
6	Riprap	Type VL or L
1	Void-fill material	VTC (Vehicle Tracking Control) rock (crushed rock with 100% passing 4-inch sieve, 50-70% passing 3-inch sieve, 0-10% passing 2-inch sieve)
1	Void-fill material	4-inch minus pit run surge (round river rock and sand, well graded, 90-100% passing 4-inch sieve, 70-80% passing 1.5-inch sieve, 40-60% passing 3/8-inch sieve, 10-30% passing #16 sieve).
1	Void-fill material	Type II bedding
½ to 1	Void-fill material	Native topsoil

Note: Mix proportions and material gradations are approximate and are subject to adjustment by the Construction Project Manager.

Table 4: Mix Requirements for Type M and H Void-Filled Riprap without River Cobble

<u>Approximate Proportions (loader buckets)</u>	<u>Material Type</u>	<u>Material Description</u>
6	Riprap	Type M or H
2	Void-fill material	7-inch minus crushed rock surge (100% passing 7-inch sieve, 80-100% passing 6-inch sieve, 35-50% passing 3-inch sieve, 10-20% passing 1.5-inch sieve)
1	Void-fill material	VTC (Vehicle Tracking Control) rock (crushed rock with 100% passing 4-inch sieve, 50-70% passing 3-inch sieve, 0-10% passing 2-inch sieve)
1	Void-fill material	4-inch minus pit run surge (round river rock and sand, well graded, 90-100% passing 4-inch sieve, 70-80% passing 1.5-inch sieve, 40-60% passing 3/8-inch sieve, 10-30% passing #16 sieve).
1	Void-fill material	Type II bedding
½ to 1	Void-fill material	Native topsoil

Note: Mix proportions and material gradations are approximate and are subject to adjustment by the Construction Project Manager.

Table 5: Mix Requirements for Type VL and L Void-Filled Riprap with River Cobble

Approximate Proportions (loader buckets)	Material Type	Material Description
6	Riprap	Type VL or L
1	Void-fill material	2 to 4-inch cobble (round washed river rock that is well-graded, 100% passing 6-inch sieve, 35-50% passing 3-inch sieve, 5-20% passing 2-inch sieve)
1	Void-fill material	4-inch minus pit run surge (round river rock and sand, well graded, 90-100% passing 4-inch sieve, 70-80% passing 1.5-inch sieve, 40-60% passing 3/8-inch sieve, 10-30% passing #16 sieve).
1	Void-fill material	Type II bedding
½ to 1	Void-fill material	Native topsoil
Top layer	Top dressing	Additional 4 to 12-inch cobbles (round washed river rock that is well graded, 80-100% passing 12-inch sieve, 35-50% passing 6-inch sieve, 5-20% passing 4-inch sieve) shall be mixed in on the surface of exposed sections of void-filled riprap (covering approximately 15% of the surface) prior to compaction of the void-filled riprap. Cobbles shall be fully embedded into the mass of the void-filled riprap.

Note: Mix proportions and material gradations are approximate and are subject to adjustment by the Construction Project Manager.

Table 6: Mix Requirements for Type M and H Void-Filled Riprap with River Cobble

Approximate Proportions (loader buckets)	Material Type	Material Description
6	Riprap	Type M or H
2	Void-fill material	7-inch minus crushed rock surge (100% passing 7-inch sieve, 80-100% passing 6-inch sieve, 35-50% passing 3-inch sieve, 10-20% passing 1.5-inch sieve)
1	Void-fill material	2 to 4-inch cobble (round washed river rock that is well-graded, 100% passing 6-inch sieve, 35-50% passing 3-inch sieve, 5-20% passing 2-inch sieve)
1	Void-fill material	4-inch minus pit run surge (round river rock and sand, well graded, 90-100% passing 4-inch sieve, 70-80% passing 1.5-inch sieve, 40-60% passing 3/8-inch sieve, 10-30% passing #16 sieve).
1	Void-fill material	Type II bedding
½ to 1	Void-fill material	Native topsoil
Top layer	Top dressing	Additional 4 to 12-inch cobbles (round washed river rock that is well graded, 80-100% passing 12-inch sieve, 35-50% passing 6-inch sieve, 5-20% passing 4-inch sieve) shall be mixed in on the surface of exposed sections of void-filled riprap (covering approximately 15% of the surface) prior to compaction of the void-filled riprap. Cobbles shall be fully embedded into the mass of the void-filled riprap.

Note: Mix proportions and material gradations are approximate and are subject to adjustment by the Construction Project Manager.

E. BEDDING:

1. Gradation for granular bedding shall conform to Table 7.
2. Granular bedding designation and total thickness of bedding shall be as shown on the Drawings and Plans.
3. Granular bedding shall meet the same requirements for specific gravity, absorption, abrasion, sodium sulfate soundness, calcite intrusion, and freeze-thaw durability as required for riprap.
 - a. Broken concrete asphalt pavement or sledge, is not acceptable for use in the work. Rounded river rock is not acceptable unless specifically designated on the Drawings and Plans.
 - b. The requirements for the wear test in AASHTO T96 shall not apply.

Table 7: Granular Bedding Gradation

U.S. Standard Sieve Size	Percent by Weight Passing Square-Mesh Sieves	
	Type I (CDOT Sect. 703.01)	Type II (CDOT Sect. 703.09 Class A)
3 inches	-	90 - 100
1½ inches	-	-
¾ inch	-	20 - 90
⅝ inch	100	-
No. 4	95 - 100	0 - 20
No. 16	45 - 80	-
No. 50	10 - 30	-
No. 100	2 - 10	-

	Percent by Weight Passing Square-Mesh Sieves	
U.S. Standard Sieve Size	Type I (CDOT Sect. 703.01)	Type II (CDOT Sect. 703.09 Class A)
No. 200	0 - 2	0 - 3

F. GROUTED RIPRAP:

1. When designated, grouted riprap shall consist of rock with all parts of the interstices filled with cement mortar.
2. Finished product shall be aesthetically pleasing and meet the intention of the design of the project.
3. Colored concrete grout may be specified as defined elsewhere within the Contract Documents.

G. FEATURE BOULDERS:

1. Feature Boulders shall consist of the same material as boulders, differing only by size.
2. Feature Boulders shall meet the same requirements for specific gravity, absorption, abrasion, sodium sulfate soundness, calcite intrusion, and freeze-thaw durability as required for boulders
3. Feature Boulders shall have a minimum dimension of four (4) feet, or as shown on the DRAWINGS.

PART 3 EXECUTION

3.01 PREPARATION

- A. Channel slope, bottom, or other areas that are to be protected with riprap, boulders, soil riprap, or void-filled riprap shall be free of brush, trees, stumps, and other objectionable material and be graded to a smooth compacted surface as shown on the Drawings and Plans.
- B. The Contractor shall excavate areas to receive riprap to the subgrade as shown on the Drawings and Plans accounting for granular bedding.

- C. The Contractor shall excavate areas to receive boulders, soil riprap, or void-filled riprap to the specified depth (bedding material is not required for boulders, soil riprap, or void-filled riprap).
- D. Subgrade Materials:
 - 1. The subgrade materials shall be stable.
 - 2. If unsuitable materials are encountered, they shall be removed and replaced as designated by the Construction Project Manager according to the Contract Documents.
- E. Additional Compaction:
 - 1. Additional compaction shall not be required unless specified by the Construction Project Manager.
 - 2. When subgrade is built up with embankment material it shall be compacted to ninety percent (90%) of the Maximum Modified Proctor Density (ASTM D1557).
- F. Bedding:
 - 1. After an acceptable subgrade is established, bedding shall be immediately placed and leveled to the specified elevation on the Drawings and Plans.
 - 2. Immediately following the placement of the bedding material, the riprap shall be placed.
 - 3. If bedding material is disturbed for any reason, it shall be replaced and graded at the Contractor's expense.
 - 4. Contamination:
 - a. In-place bedding materials shall not be contaminated with soils, debris or vegetation before the riprap is placed.
 - b. If contaminated, the bedding material shall be removed and replaced as designated by the Construction Project Manager.

3.02 PLACEMENT

A. RIPRAP

- 1. Following acceptable placement of granular bedding, riprap placement shall commence as follows:

- a. Machine Placed Riprap:
 - 1) Riprap shall be placed on the prepared slope or channel bottom areas in a manner which will produce a reasonably well graded mass of stone with the minimum practicable percentage of voids.
 - 2) Riprap shall be machine placed, unless otherwise stipulated in the Drawings and Plans or specifications.
 - 3) It is the intent of these specifications to produce a fairly compact riprap protection in which all sizes of material are placed in their proper proportions. Unless otherwise authorized by the Construction Project Manager, the riprap protection shall be placed in conjunction with the construction of embankment or channel bottom with only sufficient delay in construction of the riprap protection, as may be necessary, to allow for proper construction of the portion of the embankment and channel bottom which is to be protected.
- b. Slope Placement:
 - 1) When riprap is placed on slope, placement shall commence at the bottom of the slope working up the slope.
- c. The entire mass of riprap shall be placed on either channel slope or bottom so as to be in conformance with the required gradation mixture and to line, grade, and thickness shown on the Drawings and Plans.
- d. Riprap shall be placed to full course thickness at one operation and in such a manner as to avoid displacing the underlying bedding material. Placing of riprap in layers, or by dumping into chutes, or by similar methods shall not be permitted.
- e. All material used for riprap protection for channel slope or bottom shall be placed and distributed such that there shall be no large accumulations of either the larger or smaller sizes of stone. Some hand placement may be required to achieve this distribution.
- f. The basic procedure shall result in larger materials flush to the top surface with faces and shapes arranged to minimize voids, and smaller material below and between larger materials.
- g. Surface grade shall be a plane or as indicated, but projections above or depressions under the finished design grade by more than ten percent (10%) of the rock layer thickness shall not be allowed.

- h. Smaller rock shall be securely locked between the larger stone. It is essential that the material between the larger stones not be loose or easily displaced by flow or by vandalism.
- i. The stone shall be consolidated by the bucket of the backhoe or other means that will cause interlocking of the material.
- j. All rock is to be placed in a dewatered condition beginning at the toe of the slope or other lowest point.
- k. The Contractor shall maintain the riprap protection until accepted. Any material displaced for any reason shall be replaced to the lines and grades shown on the Drawings and Plans at no additional cost. If the bedding materials are removed or disturbed, such material shall be replaced prior to replacing the displaced riprap.

2. Hand Placed Riprap:

- a. Hand placed riprap shall be performed during machine placement of riprap and shall conform to all the requirements of PART 2, above.
- b. Hand placed riprap shall also be required when the depth of riprap is less than two (2) times the nominal stone size, or when required by the Drawings and Plans or specifications.
- c. After the riprap has been placed, hand placing or rearranging of individual stones by mechanical equipment shall be required to the extent necessary to secure a flat uniform surface and the specified depth of riprap, to the lines and grades as shown on the Drawings and Plans.

3. Soil Replacement Over Riprap:

- a. Where riprap is designated to be buried, place onsite excavated material that is free from trash and organic matter in riprap voids by washing and rodding.
- b. Prevent excessive washing of material into stream.
- c. When voids are filled and the surface accepted by the Construction Project Manager, place a nominal six (6) inches of topsoil over the area, or as designated on the Drawings and Plans.
- d. Fine grade, seed, and mulch per the specifications.

B. BOULDERS

1. Following excavation and acceptance of subgrade by Construction Project Manager, boulder placement shall commence as follows:
 - a. Boulders shall be placed on the prepared subgrade in a manner which will minimize voids.
 - b. Voids between boulders exceeding 4" shall be chinked.
 - c. Boulders shall be installed in a "stair-step" overlapping arrangement and as shown on Drawings.
2. If Boulders are to be grouted, boulders shall be installed according to Section 31 37 19, Grouted Boulders, Stacked Grouted Boulders and grouted Boulder Retaining Walls.

C. SOIL RIPRAP

1. Mix thirty-five percent (35%) soil by volume with stockpiled riprap, using additional moisture and control procedures that ensure a homogenous mixture; where the soil fills the inherent voids in the riprap without displacing riprap.
2. With prior approval of the Construction Project Manager, layering the riprap and soil instead of premixing may be allowed if the native soil is granular.
3. Place a first layer of smaller soil riprap of approximate d50 thickness. Then place the top layer with surface rocks that are largely d50 or greater, filling voids as necessary with smaller planted riprap. Create a smooth plane as described in Paragraph A.
4. The mixture shall be consolidated by large vibratory equipment or backhoe bucket to create a tight, dense interlocking mass.
5. The soil shall be further wetted to encourage void filling with soil.
6. Any large voids shall be filled with rock and small voids filled with soil.
7. Excessively thick zones of soil prone to washing away shall not be created (for example, no thicknesses greater than six (6) inches).
8. For buried soil riprap, the top surface shall be covered with four (4) inches of topsoil such that no rock points are protruding.
9. The final surface shall be thoroughly wetted for good compaction, smoothed and compacted by vibrating equipment; the surface shall then be hand raked to receive planting or seeding.

D. VOID-FILLED RIPRAP

1. The Construction Project Manager and/or Project Inspector shall observe mixing and placing of the material.
2. Approved individual component materials of void-filled riprap mix shall be delivered to site in separate marked stockpiles. Mixing shall be accomplished using a front end loader or other approved means to add the specified number of “loader buckets” of each material to a mixing stockpile. Ensure that each loader bucket comprises an approximately equal volume. If the loader operator is only able to fill the bucket partially full with large riprap (due to the force required to push the bucket into the pile), but uses full buckets of finer material, the mix proportions will not be correct. Avoid picking up excessive amounts of native soil from the subgrade under the stockpiled materials during the loader bucket mixing operations. The Construction Project Manager may reduce or eliminate the volume of topsoil added to the mixture based on the amount of native soil that was incorporated during the bucket mixing operation.
3. Once all the materials have been added to the mixing stockpile in the specified proportions, thoroughly mix the pile using a loader, large track-hoe excavator, or other approved means to fill the voids of the riprap without displacing the riprap or creating pockets of finer material absent of riprap.
4. Segregation of materials shall be minimized when hauling from the stockpile to the installation location. Remixing shall occur as necessary to correct for any segregation as the material is placed.
5. The loose material shall be placed in a single lift of sufficient height such that final grade will be achieved upon compaction. Additional mixing with a track excavator shall be required after initial placement to ensure that the void-filled riprap is thoroughly mixed and no segregation or excessive amount of smaller void-fill material is present on the surface. The mixing and placement process shall result in larger riprap (D_{50} size or larger) flush to the top surface with faces and shapes arranged to minimize voids, and smaller material between and below larger materials.
6. If the top of the compacted material is below final grade, placement of only the smaller void-fill materials to achieve final grade will not be permitted. Additional void-filled riprap shall be added and the entire section mixed with a track excavator to eliminate the presence of smaller void-fill material on the surface.
7. Avoid segregation of materials and remix any section where the combined material consists primarily of the void-fill materials. The density and interlocking nature of riprap in the mixed material shall essentially be the same as if the riprap was placed without filling the voids. This requires care and persistence on the part of the

Contractor to install the work and on the part of the Construction Project Manager to assure that the work is installed correctly.

8. At the direction of the Construction Project Manager, a 50:50 mixture of pit run and Type II bedding shall be sprinkled on the surface of the void-filled riprap and washed-in with water using a high pressure hose to fill-in small voids. This shall be done just prior to compaction of the void-filled riprap.
 9. If specified as part of the cobble mix, the top dressing of cobbles shall also be mixed in on the surface of exposed sections of void-filled riprap material prior to compaction of the riprap material.
 10. Compaction of the void-filled riprap shall be performed by running over the void-filled riprap with a large, heavy duty track excavator or dozer. The moisture content of the mixture shall be at optimum conditions prior to compaction and water shall be added, as necessary, at the direction of the Construction Project Manager. Compaction of void-filled riprap shall be reviewed and approved by the Construction Project Manager.
 11. Where indicated on the Drawings and Plans, a surface layer of 4 to 6 inches of moist topsoil shall be placed over the void-filled riprap. The topsoil surface layer shall be compacted to approximately 85% of maximum density and within two percentage points of optimum moisture in accordance with ASTM D698. Topsoil shall be added to any areas that settle.
 12. The Contractor shall install a test section of at least 100 square feet of void-filled riprap for the review and approval of the Construction Project Manager prior to installation of the remaining void filled-riprap.
 13. Elevation tolerance for the void-filled riprap shall be 0.10 feet. Thickness of void-filled riprap shall be no less than thickness shown and no more than 2-inches greater than the thickness shown.
- E. FEATURE BOULDERS
1. Feature Boulders serve an aesthetic function and as such shall be placed and rotated into final position as directed by ENGINEER in order to achieve the desired result.
- F. FACED RIPRAP
1. When riprap is placed on slope, placement shall commence at the bottom of the slope working up the slope

2. Riprap shall be placed in such a manner as to avoid displacing the underlying granular bedding material. Dumping, or similar methods shall not be permitted.
3. Riprap shall be placed and distributed as shown on the Drawings.
4. Materials shall be flush to the plane of the finished grade with faces and shapes arranged to minimize voids. The flattest surface of each stone shall be oriented toward finished grade.
5. Surface grade shall be a plane or as indicated, but projections above or depressions under the finished design grade by more than ten percent (10%) of the stone layer thickness shall not be allowed.
6. Smaller stones shall be securely locked between the larger stones. It is essential that no material is loose or easily displaced by vandalism.
7. The top of all stones shall be as indicated on the drawings.
8. The stones shall be carefully picked and arranged so that adjacent rock surfaces match within one (1) inch of finished grade.
9. Riprap shall be placed such that adjacent stones “touch” each other and voids do not exceed three (3) inches. It is the intent of construction to minimize voids between blocks. A maximum of 20% of the blocks to include 3” voids; up to 50% to include maximum 2” voids.
10. Contractor shall, if deemed necessary, support the blocks from falling over before and during the placement of backfill and completing compaction work on either side of the block.
11. Grouting
 - a. Prior to placing the grout, any type of debris, fines, smaller rock or silt shall be removed from around or under and on the blocks.
 - b. Grout shall be placed to fill all voids between, under and behind the boulders and stones, and shall be recessed approximately three (3) inches from the face in order to give a “dry stacked” appearance.
 - c. A “pencil” vibrator shall be used to make sure all voids are filled between the stones from the subgrade and around the stones. The “pencil” vibrator may be used to smooth the appearance of the surface, but Contractor shall use a wood float to smooth and grade the grout around the blocks.

- d. Any “loose” rocks shall be regouted by machine or hand methods.
- e. Clean and wash any spillage before the grout sets on the outside face and top of stones such that the visual surfaces of the rocks are free of grout to provide a clean natural appearance. If washing does not clean off grout residue, then Contractor shall wash off any grout residue with muriatic acid and water, using a brush to scrub off the residue.
- f. Grout shall receive cold or hot weather protection.

3.03 REJECTION OF WORK AND MATERIALS:

- A. The Construction Project Manager will reject placed riprap, boulders, soil riprap and bedding that do not conform to this section. The Contractor shall immediately remove and re-lay the riprap, boulders, soil riprap, void-filled riprap, and bedding to conform to specifications.
- B. Riprap, boulders, soil riprap, void-filled riprap and bedding that do not conform to this section shall be rejected, whether delivered to the job site or placed.
- C. Rejected riprap, boulders, soil riprap and bedding shall be removed from the job site by the Contractor and at the Contractor’s expense.

END OF SECTION 31 37 00

**WASTEWATER CAPITAL PROJECTS MANAGEMENT SUPPLEMENTAL TECHNICAL SPECIFICATION
FOR ASBURY AND TEJON PARK**

SUPPLEMENT TO WASTEWATER CAPITAL PROJECTS MANAGEMENT STANDARD CONSTRUCTION
SPECIFICATION 12.0 RIPRAP BOULDERS AND SLOPE/CHANNEL PROTECTION
FOR USE WITH BID ITEMS IN THE 30-2 Grouted Boulders Series pay items

31 37 19 GROUTED BOULDERS AND STACKED GROUTED BOULDERS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. This work shall consist of installing grouted boulders, and stacked grouted boulders constructed at the location (s) shown on the Drawings and Plans.
- B. Final acceptance of work is contingent upon approval from City and County of Denver Construction Project Manager.

1.02 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
 - 1. American Association of State Highway and Transportation Officials (AASHTO):
 - 2. T85, Standard Method of Test for Specific Gravity and Absorption of Coarse Aggregate.
 - 3. T103, Standard Method of Test for Soundness of Aggregates by Freezing and Thawing.
 - 4. T104, Standard Method of Test for Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate.
 - 5. ASTM International (ASTM):
 - 6. C39, Standard Test Method for Compressive Cylindrical Concrete Specimens.
 - 7. C150, Standard Specification for Portland Cement.
 - 8. D1557, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN-m/m³)).

1.03 DEFINITIONS

- A. Terms “boulders,” and “rock,” may be used interchangeably in this section.

1.04 SUBMITTALS

- A. The Contractor shall submit a grout mix design in writing to the Construction Project Manager for approval prior to placement of any grout.
- B. The Contractor shall cooperate with the Construction Project Manager in obtaining and providing samples of all specified materials.
- C. The Contractor shall submit certified laboratory test certificates for all items required in this section.

1.05 QUALITY ASSURANCE

- D. Quarry / Sample Work:
 - 1. The Contractor, the Construction Project Manager, City and County of Denver and other interested project partners shall visit the selected quarry to review and approve boulder samples or select the individual boulders that will be used for the project. At the cost of the Contractor, the quarry shall provide equipment and manpower as required to sort boulders for visual inspection or selection. Approval of the boulders at the quarry does not constitute final acceptance of the boulders for the project.
 - 2. Final review and acceptance of the boulders will be made based on the actual boulders delivered and placed in the designated stockpile area at the project site, ready to be used for installation. Individual boulders not meeting the project specifications or requirements shall be rejected by the Construction Project Manager and removed from the site by the Contractor at the Contractor’s expense. If agreed by the Construction Project Manager rejected boulders may be used for other portions of the project.
 - 3. Prior to the construction of any stacked grouted boulders the Contractor, or subcontractor who is constructing the stacked grouted boulders for the Contractor, shall provide the Construction Project Manager with samples of similar stacked grouted boulders that they have previously constructed.

4. After review and acceptance of this submittal, the Contractor or subcontractor may start construction of a sample section of the grouted boulders. The sample section shall be part of the required work with the size and location agreed upon by the Contractor and the Construction Project Manager. Prior to completing any grouting for the sample section, the Construction Project Manager shall perform a pre-grout inspection to assure the rock work is in conformance with the drawings, plans and specifications. Once approved, the Contractor may proceed with grouting as designated on the Drawings and Plans and specifications.
5. If the construction of the sample section is approved, the Contractor or subcontractor shall construct the rest of the grouted boulders. If the construction is not approved, the Contractor shall make any changes required by the Construction Project Manager to obtain approval and construct the remainder of the grouted boulders as approved.

PART 2 PRODUCTS

2.01 MATERIALS

A. Boulders

1. Boulders shall meet the requirements of Section 31 37 00 Riprap, Boulders, Soil Riprap, Void-Filled Riprap and Bedding.
2. Rhyolite rock shall not be used for any grouted boulders.
3. Gradation:
 - a. Each load of boulders shall conform to the dimensions specified on the Drawings and Plans and in Section 31 37 00 Riprap, Boulders, Soil Riprap, Void Filled Riprap and Bedding.
 - b. Boulders for a boulder edge shall have a maximum ratio of largest to smallest rock dimension shall be 1.5 or as shown on the Drawings and Plans.
 - c. Control of gradation will be by visual inspection.
 - 1) The Construction Project Manager will review the boulders for gradation and material requirements once delivered to the project site, ready for installation.

- 2) Mechanical equipment and labor needed to assist in checking gradation shall be provided by the Contractor at no additional cost to the project.
- 3) Any boulders that do not meet the specifications shall be rejected and removed from the site by the Contractor at the contractor's expense. If agreed by the Construction Project Manager rejected boulders may be used for other portions of the project
- 4) Color:
 - a. The color of boulders shall be gray with gray/blue hues, unless otherwise specified in the Drawings and Plans or approved by the Construction Project Manager prior to delivery to the job site.
 - b. Color shall be consistent throughout the entire project site and shall match the color of rock to be used for all other portions of the work.

B Grout:

1. Concrete for the grout shall be an approved batch meeting the following requirements:
 - a. All grout shall have a minimum 28-day compressive strength equal to 3,200 psi.
 - b. One cubic yard of grout shall contain a minimum of six (6) sacks of Type II Portland cement.
 - c. A maximum of 25% Type F Fly Ash may be substituted for the Portland cement.
 - d. Aggregate for the grout shall consist of 70% natural sand (fines) and 30% 3/8-inch rock (coarse).
 - e. Slump shall be four (4) inches to six (6) inches.
 - f. Air entrainment shall be 5.5% - 7.5%.
 - g. Grout shall contain one and one-half (1-1/2) pounds of Fibermesh, or approved equivalent, per cubic yard of grout.

- h. Color Additive in required amounts shall be used when so specified by contract or on the Drawings and Plans.

B. PART 3 EXECUTION

3.01 GROUTED BOULDERS AND STACKED GROUTED BOULDERS

- A. Grouted boulders shall be placed at the locations as shown on the Drawings and Plans and installed with the following requirements:

- 1. Subgrade:

- a. The subgrade to receive each boulder shall be excavated and any unstable material shall be removed.
- b. Grouted boulders shall be placed on subgrade without granular bedding unless shown otherwise on the Drawings and Plans or as approved by the Construction Project Manager.
- c. Material approved by the Construction Project Manager shall be placed and compacted in a maximum of four-inch (4") lifts to ninety percent (90%) of the Maximum Modified Proctor Density (ASTM D1557) to re-establish the subgrade of each boulder.
- d. Unstable material shall be removed from the project site and disposed of properly. Removal and replacement of unstable material shall only be completed at the direction of the Construction Project Manager.
- e. When sound subgrade exists, the subgrade shall be excavated a minimum of 6" to a maximum of 12" behind boulders.
- f. Backfill behind boulders shall be compacted to ninety percent (90%) of the Maximum Modified Proctor Density (ASTM D1557). Care shall be taken during compaction to avoid disturbing and/or damaging the integrity of the boulder edge.
- g. Finished grades and subgrade for boulders shall be determined from the height of each boulder used.

- 2. Boulders

- a. The top of all boulders shall be as indicated on the Drawings and Plans.

- b. The boulders shall be carefully picked and arranged so that adjacent rock surfaces match within two (2) inches in top elevation and two (2) inches along the vertical exposed face or channel side of rock.
- c. Boulders shall be placed such that adjacent boulders “touch” each other and voids do not exceed four (4) inches. It is the intent of construction to minimize voids and grout placed between boulders.
- d. The Contractor shall, if deemed necessary, support the boulders from falling over before and during the placement of grout, backfill, and completing compaction work on either side of the boulder.
- e. Smaller rocks shall be “chinked in” to fill all voids behind the boulders. Smaller rocks shall also be used to "chink in gaps larger than four (4) inches. Placement shall be approved by the Construction Project Manager prior to grouting.

3. Grouting

- a. Prior to placing the grout, any type of debris, fines, smaller rock, or silt shall be removed from around or under and on the boulders.
- b. Dewatering shall be implemented to guarantee that the grout will not be placed in water and for a period of twenty-four (24) hours after the grout has been placed.
- c. Keep boulders receiving grout wet at all times prior to receiving grout.
- d. The concrete grout shall be placed by injection methods by pumping under low pressure, to ensure complete penetration of the grout into the void area as detailed on the Drawings and Plans. The grout mix shall be stiffened, and other measures taken to retain the grout between the boulders.
- e. Grout placement shall begin at the bottom of the lowest boulder and proceed upward to ensure no air voids exist between the grout, subbase, and boulders.
- f. Grout shall be placed up to a height of one-half (1/2) of the diameter of the top row of boulders or as shown on the Drawings and Plans as directed by the Construction Project Manager. Grout shall be placed in the voids and behind the boulders and not on the surface of the rocks.

- g. A “pencil” vibrator or other vibration means shall be used to make sure all voids are filled between the boulders from the subgrade and around the boulders to a depth as shown on the Drawings and Plans. The “pencil” vibrator may be used to smooth the appearance of the surface, but the Contractor shall use a wood float or other means to smooth and grade the grout around the boulders.
- h. Grout between boulders shall be recessed one third (1/3) the diameter of the boulders on the side facing the channel or as shown on the Drawings and Plans as directed by the Construction Project Manager.
- i. Grout should be troweled out and finished to minimize visibility.
- j. Clean and wash any spillage before the grout sets so the visual surfaces of boulders will be free of grout to provide a clean, natural appearance, or if washing does not clean off grout residue, the Contractor shall wash off any grout residue with muriatic acid and water, using a brush to scrub off the residue.
- k. Care shall be taken when cleaning and washing grout spillage to assure that residue does not enter adjacent waterways, drainage areas and storm sewers. All grouting work shall be completed in accordance with CDPHE and Water Quality Guidelines.
- l. Grout shall receive cold or hot weather protection in accordance with the WASTEWATER CAPITAL PROJECT MANAGEMENT STANDARD CONSTRUCTION SPECIFICATIONS for concrete.

END OF SECTION 31 37 19



DENVER

PUBLIC WORKS

Wastewater Capital Projects Management

Denver Parks and Recreation

Technical Specifications and Measurement and Payment

For Asbury and Tejon Park

October 2018



CITY AND COUNTY OF DENVER
ENGINEERING DIVISION

Wastewater Capital Projects Management Project Specific Construction Specification

Bid Item 01-21.26.001: PARKS PRODUCT ALLOWANCE FOR PROCUREMENT OF PLAYGROUND PLAY STRUCTURES

WG REG ASBURY AND TEJON

ALLOWANCE ACCOUNT ITEMS

DESCRIPTION

This Special Provision contains the City and County of Denver's estimate for Allowance Account Items for **all allowances** necessary for the **PROCUREMENT of Playground Play Structures** to be installed in accordance with manufacturer instructions and per City and County of Denver Parks and Recreation installation requirements, in conjunction with the bid item **32-33.50.01 Playground Equipment Installation per manufacturer's specifications**.

Playground Play Structures shall be defined as those items detailed on the plan set, which are included in the basis of payment for this bid item. The location and placement of the **Playground Play Structures** shall be as detailed on the plan set, unless a change is proposed by the contractor or landscape architect and accepted by Denver Parks and Recreation in writing **and** approved by the City and County of Denver Infrastructure Project Management Construction Project Manager. The contractor shall confirm and transmit all warranty paperwork to Denver Parks and Recreation for the **Playground Play Structures**. The Contractor shall warranty the installation of the **Playground Play Structures** for one (1) year after the City and County of Denver issues a letter of acceptance for the project.

Unless otherwise specifically called out in these contract documents, through other pay items; when other pay items are included, no payment shall be made for the procurement of these items (A-K) under this bid item **32-33.50.01 Playground Equipment Installation per manufacturer's specifications**.

The estimated amount for this bid item will be added to the total bid to determine the amount of the performance and payment bonds. The **Playground Play Structures** shall be **procured** from vendors accepted in writing by Denver Parks and Recreation and approved* by City and County of Denver Infrastructure Project Management Construction Project Manager*. The contractor shall be reimbursed as approved by the Infrastructure Project Management Construction Project Manager. In no event shall reimbursement to the contractor exceed that maximum total indicated in the basis of payment.



CITY AND COUNTY OF DENVER
ENGINEERING DIVISION

Wastewater Capital Projects Management Project Specific Construction Specification

BASIS OF PAYMENT

Payment will be made at unit prices for a schedule of values that are associated with each allowance account item category indicated below (A-K).

The unit prices for allowance account item category indicated below (**A-K**) and the schedule of values shall be submitted by the contractor and accepted by the City Construction Project Manager within 60 days of Notice to Apparent Low Bidder. The unit prices will only be paid at true and verifiable cost plus a 3% mark up in accordance with the City and County of Denver General Contract Conditions. Mark up shall not be applied to sales tax or reclamation fees/charges. Payment will constitute full compensation for all true and verifiable costs associated with this bid item 01-21.26.001 and allowances necessary to complete the scope of the project. The contractor will be required to submit itemized invoices for all costs along with a spreadsheet tabulation indicating the 3% mark up on the **Playground Play Structures** provided for inclusion in the Field Measurement Report (FMR). The City Construction Project Manager will approve payments in the appropriate dollar amount on the monthly payment applications.

Prior to Procurement the Contractor Shall

- A. Submit documentation that the manufacturer of the playground equipment accepts the Contractor's playground equipment installer
- B. Submit As Built "record" drawings of the playground area
- C. Create a layout plan for the playground equipment in the playground area
- D. Provide a grading plan for the playground area to accommodate the sub drainage system
- E. Submit color palette for all playground pieces for approval prior to ordering the equipment.
- F. Submit Technical data for all playground pieces for approval prior to ordering the equipment
- G. Submit installation methods for all playground pieces for approval prior to ordering the equipment

Items A-K shall meet the following criteria:



CITY AND COUNTY OF DENVER
ENGINEERING DIVISION

Wastewater Capital Projects Management Project Specific Construction Specification

Manufacturer Qualifications: A firm whose playground equipment components have been certified by IPEMA's "3rd Party Certification" service.

The Contractor Shall:

1. Provide only playground equipment and play structure components bearing the IPEMA Certification Seal.
2. Provide the following playground equipment and play structure components bearing the IPEMA Certification Seal.
3. Provide playground equipment complying with or exceeding requirements in the following:
 - A. ASTM F 1487;
 - B. CPSC No. 325, "Handbook for Public Playground Safety"
 - C. Label play structures with warning label and manufacturer's identification per ASTM F 1487.
4. Protect materials from damage during delivery and while stored at site. The Project Manager reserves the right to inspect containers before or after installation to verify compliance with this requirement.

No payment will be made under this bid item for any items not included in the list of items below.

Allowance Account items must be **procured** from vendors accepted in writing by Denver Parks and Recreation and approved* by City and County of Denver Infrastructure Project Management Construction Project Manager*.

*Approval will be in the form of an accepted submittal, made through the submittal process.

<u>Item No.</u>	<u>Allowance Account Item</u>	<u>Quantity</u>	<u>Estimated Amount</u>
<u>01-21.26.001A</u>	Bear Cub (TC001)	A/A	\$12,000.00
<u>01-21.26.001B</u>	Embankment Slide Chute (1650-61-EMB)	A/A	\$10,000.00
<u>01-21.26.001C</u>	Custom PT Structure 5-12 (RDU)	A/A	\$90,000.00
<u>01-21.26.001D</u>	Kidnetix Twirl (90777)	A/A	\$5,000.00
<u>01-21.26.001E</u>	Deco Spring Rider Double (6248)	A/A	\$3,000.00
<u>01-21.26.001F</u>	Custom PT Structure 2-5 (RDU)	A/A	\$60,000.00
<u>01-21.26.001G</u>	Enclosed seat 3 ½" x 2 ea (8696)	A/A	\$1,000.00
<u>01-21.26.001H</u>	Belt Seat 3 ½" OD x 2 ea (8910)	A/A	\$1,000.00



CITY AND COUNTY OF DENVER
ENGINEERING DIVISION

Wastewater Capital Projects Management Project Specific Construction Specification

<u>01-21.26.001I</u>	Primetime swing 3 ½" x 8' (18826)	A/A	\$2,000.00
<u>01-21.26.001J</u>	Primetime swing Add-a-bay 3 ½" x 8' (18827)	A/A	\$1,000.00
<u>01-21.26.001K</u>	36" x 36" stabilizing mats	A/A	\$2,000.00

Maximum Total: \$187,000.00

Allowance Account Item Inclusions:

01-21.26.001A-K Playground Equipment – all costs associated for procurement, storage, protection from damage or theft.

*Approval will be in the form of an accepted submittal, made through the submittal process.

Date Issued October 4, 2018

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Contract Drawings and general provisions of the Contract, including General and Supplementary Conditions and the City and County of Denver Standard Specifications for Construction General Contract Conditions (2011)
- B. City and County of Denver Engineering Division, Wastewater Capital Project Management Standard Construction Specifications, dated March 15, 2016.
- C. Wastewater Capital Projects Management Special Project Provisions for Asbury & Tejon
- D. Wastewater Capital Projects Management Supplemental Technical Specifications.
- E. Denver Parks and Recreation Asbury and Tejon Specifications, OCT 2018.

1.2 SUMMARY

- A. This Section includes submittal requirements for the approval of a different material, equipment, or process than is described in the Contract Documents.
 - 1. If the substitution changes the scope of work, contract cost or contract time, General Contract Conditions Title 11 shall apply.
 - 2. Contract Record Drawings and specifications must include all approved substitutions even if a Change Order is not issued.
- B. Reference General Contract Conditions Title 4, section 406 "Substitution of Materials and Equipment".

1.3 QUALITY CONTROL

- A. The substitution must provide the same quality as what it is replacing. The level of quality is defined by:
 - 1. Maintenance and operating cost.
 - 2. Reliability.
 - 3. Durability.
 - 4. Life expectancy.
 - 5. Ease of cleaning.
 - 6. Ability to be upgraded as needed.
 - 7. Ease of interacting with other systems or components.
 - 8. Ability to be repaired.
 - 9. Availability of replacement parts.
 - 10. Established history of use in similar environments.

11. Performance equal or superior to that which it is replacing.

1.4 SUBMITTAL

- A. See General Contract Conditions Title 3, section 309 "Contractor Submittals and other Written Communications to the City" and Title 4, section 405 "Shop Drawings, Product Data, and Samples"
- B. Prior to construction, the contractor shall create a submittal log for review by the Construction Project Manager. The Construction Project Manager shall review and make recommendations for additional submittal items.
- C. The contractor shall allow a minimum cycle of ten (10) working days for review of each submittal by the City.
- D. All submittals shall be delivered to the Construction Project Manager.
- E. A complete Request for Substitution at least sixty (60) days prior to when an order needs to be placed or a method needs to be changed.
- F. The submittal shall contain, as appropriate, detailed product data sheets for the specified items and the substitution. Samples and shop Contract Drawings shall also be submitted of the substitution as applicable. The submittal shall contain all the data required to be submitted for acceptance of the originally specified item or process.

1.5 INFORMATION

- A. Provide the following information as applicable with the Request for Substitution on the item or process that is being requested to be substituted:
 - 1. A complete description of the item or process.
 - 2. Utility connections including electrical, plumbing, HVAC, fire protection and controls.
 - 3. The physical dimensions and clearances.
 - 4. A parts list with prices.
 - 5. Samples of color and texture.
 - 6. Detailed cost comparisons of the substitution and the contract specified item or process.
 - 7. Manufacturer warranties.
 - 8. Energy consumption over a one-year period.
 - 9. What local organization is certified to maintain the item.
 - 10. Performance characteristics and production rates.
 - 11. A list of any license fees or royalties that must be paid.
 - 12. A list of all variations for the item or method specified.

13. A list of at least three other projects of similar nature to this contract where the products or methods have been in use for at least one year including telephone number and name of the person to contact at these other projects.
14. An analysis of the effect of the substitution on the schedule and contract cost and on the overall project as it relates to adjoining work.

1.6 SUBSTITUTION REQUEST

- A. The formal Request for Substitution will be evaluated by the Project Manager and the Designer of Record based on the following criteria:
 1. Compatibility with the rest of the project.
 2. Reliability, ease of use and maintenance.
 3. Both initial and long-term cost.
 4. Schedule impact.
 5. The willingness of the Contractor to share equally in any cost savings.
 6. The ability of the item or process to meet all applicable governing regulations, rules and laws along with funding agency requirements.
 7. The cost of evaluating the substitution.
- B. Based upon the above evaluation the Project Manager will make a final determination of what is in the best interest of the City and either approve, disapprove or approve as noted the requested substitution.

1.7 CONDITIONS

- A. As a condition for submitting a Request for Substitution the Contractor waives all rights to claim for extra cost or change in contract time other than those outlined in the request and approved by the Project Manager. The Contractor, by submitting a Request for Substitution, also accepts all liability for cost and scheduling impact on other contractors or the City due to the substitution.
- B. Included with the Request for Substitution shall be the following statement:
 1. "The substitution being submitted is equal to or superior in all respects to the contract-required item or process. All differences between the substitution and the contract-required item or process are described in this request along with all cost and scheduling data."
- C. The statement shall be signed and dated by the Contractor's Superintendent.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

- A. No separate measurement shall be made for work under this Section.

4.2 PAYMENT

- A. No separate payment will be made for work under this Section. The cost of the work described in this Section shall be included in the Contract price.

END OF SECTION 01 25 00

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Contract Drawings and general provisions of the Contract, including General and Supplementary Conditions and the City and County of Denver Standard Specifications for Construction General Contract Conditions (2011).
- B. City and County of Denver Engineering Division, Wastewater Capital Project Management Standard Construction Specifications, dated March 15, 2016.
- C. Wastewater Capital Projects Management Special Project Provisions for Asbury & Tejon.
- D. Wastewater Capital Projects Management Supplemental Technical Specifications for Asbury & Tejon
- E. Denver Parks and Recreation Asbury and Tejon Specifications, OCT 2018.

1.2 SUMMARY

- A. This Section identifies the Quality Control activities to be performed during all phases of the contract by the Contractor. Quality Control is defined as the process by which the Contractor ensures the project is constructed per the construction documents.
- B. The Contractor shall have a Quality Control Program in place to ensure that all materials and work are completed in compliance with contract documents. The Contractor is solely responsible for Quality Control. The City reserves the right to conduct additional tests or audits to verify compliance.
- C. Test schedules and/or testing requirements for materials used on this project are included in the technical specifications. Laboratory and field testing identified in the technical specifications shall be conducted by an Independent Testing Agency (ITA) retained by the Contractor.

1.3 LEVEL OF CONTROL

- A. The intent of this section is to enable the Contractor to establish a necessary level of control that will:
 - 1. Adequately provide for the production of acceptable quality materials.
 - 2. Provide sufficient information to ensure both the Contractor and the Project Manager that the specification requirements are being met.
 - 3. Allow the Contractor as much latitude as possible to develop his or her own standards of control.

1.4 SUBMITTALS

- A. See General Contract Conditions Title 3, section 309 "Contractor Submittals and other Written Communications to the City" and Title 4, section 405 "Shop Drawings, Product Data, and Samples"
- B. Quality Control Plan: Within ten (10) days after Notice to Proceed, the Contractor shall submit a Quality Control Plan for review and acceptance. Acceptance by the Project Manager does not relieve the Contractor of compliance with the contract requirements. The Contractor Quality Control Plan shall address the following as a minimum:
 - 1. Provide a general description of Quality Control monitoring to be performed until final acceptance by the City. Include monitoring activities of Work and the worksite during times no construction activity is scheduled to take place.
 - 2. The Contractor shall designate an employee as the Quality Control Representative, qualified to perform quality control monitoring of the Work. The designated individual shall have the authority to direct work changes required to bring the Work into conformance with contract requirements including stopping non-conforming work in progress.
 - 3. The Quality Control Plan shall address each technical specification division's requirements for quality control. The Contractor shall identify each item requiring submittal and approval/acceptance prior to installation of work. Also, the Contractor shall identify each item of work requiring testing by the independent testing agency.
 - 4. The Quality Control Plan shall address and establish controls and documentation format to ensure that items or materials that have been accepted through receiving inspection are used or installed. Identification and traceability shall be provided throughout all inspections, test activities, and records. For stored items, provisions shall be made for the control of item/material identification, consistent with the expected duration and type of storage.
 - 5. Provide a methodology of monitoring, testing, and exercising of all equipment, valves and/or assemblies to ensure the Work installed is in proper working order.
- C. List of Suppliers and Subcontractors: Submit a list of suppliers and subcontractors, including items to be supplied by each supplier and/or subcontractor. Identify work to be performed by each subcontractor. The list shall be updated and resubmitted as required.
- D. Emergency Contact List: Submit a list of emergency contact information including name, company, title, work phone number, mobile phone number, and other means of contact for at least four individuals.

1. Review the Emergency Contact list on a weekly basis. In the event there is any change in any of the information, the Contractor shall forward the updated list to the Project Manager.
2. The Emergency Contact list shall include the project number, project title, and date of issue.

E. Quality Control Report:

1. The Quality Control Report shall be submitted weekly or per the discretion of the Project Manager in the format detailed in Division 01 Section "Standard Forms". The report shall address as a minimum the following: identify notifications and discussions with/by other agency inspectors, identify work placed that day and any deviations and/or corrections required to bring the Work into conformance with the contract. Reporting must be digital format and signed by the Contractors Quality Control Representative. Legible, hand written reports on the approved form shall be accepted. Scanned copies of daily reports are acceptable.
2. Submit one electronic copy of the Quality Control Report to the Project Manager the week following the work or per the discretion of the Project Manager. The report shall be signed by the Contractor's Quality Control Representative and the Contractor's Superintendent.

F. Non-Conformance Report (NCR): Conditions adverse to quality will be reviewed by the Contractor and the City Representative to determine the cause and to recommend a corrective action that will preclude recurrence.

1. The condition, its cause, and the corrective action planned shall be reported to the Project Manager prior to implementation.
2. Follow-up action shall be taken to verify implementation of the corrective action.
3. The Contractor will document the corrective action and a copy of the Non-Conformance Report (NCR) will be transmitted to the Project Manager.

1.5 DOCUMENTATION

- A. The Contractor shall not change or alter approved submittals, procedures, specifications, drawings, or other pertinent documentation without the Project Manager's written authorization.
- B. All records and documents that are quality related shall be prepared, identified, and maintained by the Contractor and shall be made available to the City upon request. Records shall be protected from damage, deterioration or loss. A copy of the records and documents shall be maintained at the Work site at all times unless the Project Manager has approved other locations in writing.
- C. The Contractor shall maintain records at the actual worksite and at Contractor's office to show the inspection status of materials and items installed in order to ensure that

the required inspections and tests have been performed in a timely and correct manner.

1.6 INSPECTIONS AND TESTS

- A. Inspections, tests, and system shut down requests, conducted by persons or agencies other than the Contractor, shall not in any way relieve the Contractor of his responsibility and obligation to meet all specifications and the referenced standards. The Contractor's designated Quality Control Representative shall inspect the work and shall ensure the work complies with the contract requirements prior to any requests for inspection or testing.
- B. When the specifications, laws, ordinances, rules, regulations or orders of any public agency having jurisdiction require the Project Manager's surveillance of inspections or tests, the Contractor shall notify the Project Manager of the place, date and time forty-eight (48)-hours prior to the inspection and/or test. The Contractor shall be responsible for notifying and requesting inspection by other agencies including but not limited to the Denver Building Inspection Division, Denver Fire Department, Denver Wastewater Management Division and Denver Water. Prior to request for other agency inspections, the Contractor shall meet and plan inspection times with the Project Manager and or his designated representative.
- C. Special inspections or tests may be required by the technical specifications, City, State and/or Federal Agencies in addition to those tests already performed. The Contractor shall notify the Project Manager at least forty-eight (48) hours in advance of the additional inspections or tests.

1.7 INSPECTION PLAN

- A. The Contractor shall utilize the following six-point inspection plan to ensure the conformance of the Work performed by the Contractor meets the requirements of the contract drawings and specifications, the referenced codes and standards and the approved submittals:
 - 1. Pre-work Coordination: Prior to the start of construction work, work under each separate specification section, where a change in a construction operation is contemplated by the Contractor, and a new subcontractor starting work, a coordination meeting will be held with the Contractor's superintendent, Quality Control, and Safety representative(s), and the ITA representative. Supervisory, Safety, and Quality Control representatives of all applicable subcontractors shall also attend. The Contractor's Quality Control Representative shall chair the meeting, and prepare and distribute minutes of Quality Control meetings. Meeting minutes shall be electronically distributed within twenty-four (24) hours of the meeting.
 - 2. The purpose of the meeting is to ensure that the Contractor's personnel have no misunderstandings regarding their safety and quality procedures as well as the

CONTRACTOR QUALITY CONTROL

01 45 16 - 4

Asbury and Tejon OCT 2018

technical requirements of the contract. The following items shall be presented and reviewed by the Contractor:

- a. Contract requirements and specifications.
 - b. Shop drawings, certifications, submittals and Record Drawings.
 - c. Testing and inspection program and procedures.
 - d. Contractor's Quality Control program.
 - e. Familiarity and proficiency of the Contractor's and subcontractor's workforce to perform the operation to required workmanship standards including certifications of installers.
 - f. Safety, security, and environmental precautions to be observed.
 - g. Any other preparatory steps dependent upon the particular operation.
 - h. The Contractor's means and methods for performing the Work.
3. Initial Inspection: Upon completion of a representative sample of a given feature of the Work and no later than two (2) weeks after the start of a new or changed operation, the Project Manager and/or his designated representative will meet with the Contractor's Quality Control representative and applicable subcontractor's supervisor and their Quality Control representatives to check the following items, as a minimum:
- a. Workmanship to established quality standards.
 - b. Conformance to Contract Drawings, Specifications and the accepted shop drawings.
 - c. Adequacy of materials and articles utilized.
 - d. Results of inspection and testing methods.
 - e. Adequacy of Record Drawings maintained daily.
4. Once accepted, the representative sample will become the physical baseline by which ongoing work is compared for quality and acceptability. To the maximum practical extent, approved representative samples of work elements shall remain visible until all work in the appropriate category is complete. Acceptance of a sample does not waive or alter any contract requirements or show acceptance of any deviation from the contract not approved in writing by the Project Manager.
5. Follow-up Inspection: The Contractor's Quality Control representative will monitor the work to review the continuing conformance of the work to the workmanship standards established during the preparatory and initial inspections.
6. Completion Inspection: This is not a Substantial Completion Inspection. Forty-eight (48) hours prior to the completion of an item or segment of work and prior to covering up any work, the Contractor will notify the Project Manager who will verify that the results of the segment of work are acceptable, and all inspections and tests have been completed.
- a. The purpose of this inspection is to allow further corrective work upon, or integral to, the completed segment of work.
 - b. If any items are determined to be deficient, need correction or are non-conforming, a Deficiency List will be prepared and issued to the respective

Contractor for correction, repair or replacement of any deficient or non-conforming items.

- c. The Project Manager and Contractor's Quality Control representative will verify the correction of the deficient and/or non-conforming items prior to the start of the next operation.
7. Prior to requesting a Substantial Completion Inspection by the City, all work and operational systems to be inspected shall be satisfactorily completed and tested by the Contractor.
8. Substantial Completion Inspection will occur when the Contractor notifies the Project Manager the work is completed to the required stage and is ready for inspection. The work shall have progressed to the point that the City can beneficially occupy or utilize the work. Refer to the Contract General Conditions, Title 19 – Substantial Completion of the Work.
9. After the Contractor receives Letter of Final Acceptance from the Project Manager, the Warranty period begins. Refer to the Contract General Conditions, Title 18 – Warranties, Guarantees, and Corrective Work.
10. Final Acceptance will occur when the punch list items have been completed and all site clean-up has been done. Refer to the Contract General Conditions, Title 20 – Final Completion and Acceptance of the Work.

1.8 SAMPLES

- A. The Contractor shall maintain at the worksite a copy of all samples submitted and accepted by the City. Samples shall be made available to the designer or the Project Manager's designated representatives for review and comparison in the field. The Project Manager prior to use on the project must accept all items and materials.
- B. The installed work will be compared to the samples and if any of the work is not of the same quality, material, finish, color, texture or appearance as the sample, that portion that is not the same will be considered defective and in nonconformance.
- C. Contractor selection of samples will only be considered if taken at random. The Contractor shall permit City Representatives to witness the selection of samples. Inspection or tests of items or materials that fail shall be sufficient cause to terminate further inspections/tests of the same brand, make or source of that product.
- D. The Contractor is obligated to correct any item deemed deficient.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 REQUIREMENTS

- A. The Contractor is responsible for Quality Control of the Construction. All acquisition of materials, sequence of construction (except as otherwise indicated), and means and methods of construction shall be the responsibility of the Contractor. Establish system to perform sufficient inspection and tests of all items of work, including that of subcontractors, to ensure conformance to Contract Documents for materials, workmanship, construction, finish, functional performance and identification.
1. Control System: Establish for all construction except where Contract Documents provide for specific compliance tests by testing laboratories and engineers employed by the City.
 2. Control System: Specifically include all testing required by various sections of Specifications.
 3. Quality Control System: Means by which Contractor assures himself that construction complies with requirements of Contract Documents.
 - a. Controls: Adequate to cover all construction operations and keyed to proposed construction schedule.
- B. All materials required for the contract shall be new except where specified otherwise. The Project Manager may elect to perform additional inspections and/or tests at the place of the manufacture, the shipping point or at the destination to verify conformance to applicable specifications. Inspections and tests performed by the City shall not relieve the Contractor from the responsibility to meet the specifications, nor shall such inspections/tests be considered a guarantee for acceptance of materials that will be delivered at a later time.
- C. The Contractor is obligated to correct or remove non-conforming materials, whether in place or not. If necessary, the Project Manager will send written notification to the Contractor to correct or remove the defective materials from the project. If the Contractor fails to respond, the Project Manager may order correction, removal and/or replacement of defective materials by others, in which case the Contractor shall bear all costs incurred by such actions.
- D. Materials accepted on the basis of a Certificate of Compliance may be sampled and inspected and/or tested by the Project Manager or his/her Designer at any time. The fact that the materials were accepted on the basis of such certification shall not relieve the Contractor of his responsibility to use materials that conform to the specifications.
- E. The Contractor shall impose upon his suppliers the same quality control requirements, including inspection and test procedures, as imposed upon him by the specifications

and referenced standards. The Contractor shall apply appropriate controls, designed to ensure that all materials supplied meet the requirements and specifications.

3.2 CONTRACTOR'S QUALITY CONTROL SYSTEM

- A. The Contractor is responsible for Quality Control of the Construction. All acquisition of materials, sequence of construction (except as otherwise indicated), and means and methods of construction shall be the responsibility of the Contractor. Establish system to perform sufficient inspection and tests of all items of work, including that of subcontractors, to ensure conformance to Contract Documents for materials, workmanship, construction, finish, functional performance and identification.
 - 1. Control System: Establish for all construction except where Contract Documents provide for specific compliance tests by testing laboratories and engineers employed by the City.
 - 2. Control System: Specifically include all testing required by various sections of Specifications.
 - 3. Quality Control System: Means by which Contractor assures himself that construction complies with requirements of Contract Documents.
 - a. Controls: Adequate to cover all construction operations and keyed to proposed construction schedule.

- B. The Contractor shall be responsible for assuring compliance with the quality standards as indicated in the Contract Documents. In addition, the Contractor shall be responsible for:
 - 1. Review of submittals prior to their being forwarded to the Project Manager for review. The Contractor shall mark submittals with comments and shall indicate the date and party conducting the Contractor's review of each submittal.
 - 2. Final inspection of the project prior to calling for the Project Manager to conduct a final inspection. The Contractor shall provide his inspection comments to the Project Manager prior to the scheduled final inspection.
 - 3. Verification of completion of punch-list items prior to calling for verification inspection by the Project Manager.

- C. Records: Maintain correct records on appropriate forms for all inspections and tests performed, instructions received from the Project Manager and actions taken as result of those instructions.
 - 1. Records: Include evidence that required inspections or tests have been performed (including type and number of inspections or tests, nature of defects, causes for rejection, etc.) proposed or directed remedial action, and corrective action taken.
 - 2. Document inspections and tests as required by each section of the Specifications.

3.3 MATERIAL AND WORKMANSHIP

- A. Unless otherwise specified, or indicated on the Drawings, material shall be new, of best quality, and without flaws, and delivered upon completion in an undamaged condition.
- B. Workmanship shall be the best of its respective kind. Labor shall be performed in a thorough workmanlike manner by qualified, efficient, and skilled mechanics, acceptable to the Project Manager, and other trades involved on the job requiring acceptable substrate for the performance of their work.

3.4 TESTING – GENERAL

- A. Testing Laboratory and/or Engineering services are required for quality control in portions of the work identified in other sections of these specifications.
- B. Tests required by these Specifications shall be performed in strict accordance with referenced testing methods, procedures, and conditions. Pertinent data shall be included in clear, comprehensive written forms according to the requirements of these Contract Documents.
- C. Contractor: Provide equipment and facilities as required for testing at no additional cost, subject to Project Manager's review, for conducting field tests and for collecting and forwarding samples.
 - 1. Do not use materials or equipment represented by samples until tests, if required, have been made and materials or equipment found to be acceptable.
 - 2. Do not incorporate any product into work which becomes unfit for use after acceptance thereof.
- D. Testing: Materials or equipment proposed to be used may be tested at any time during their preparation or use. Furnish required samples without charge and give sufficient notice of placing of orders to permit testing. Products may be sampled either prior to shipment or after being received at site of work.
- E. Tests: Made by testing laboratory approved by the Project Manager. Except as otherwise provided, sampling and testing of materials and laboratory methods and testing equipment shall be in accordance with latest standards and tentative methods of ASTM.
 - 1. Specific information concerning testing methods, sample sizes, etc., is included under applicable sections of Specifications.
 - 2. Any modification of, or elaboration on, these test procedures included for specific materials under their respective sections in Specifications shall take precedence over these procedures.

3.5 OTHER TESTING

- A. Following Testing: Performed at expense of Contractor:
 - 1. Any additional tests required because of any tests that fail subject to following conditions:
 - a. Quantity and Nature of Tests: Determined by the Project Manager.
 - b. Tests: Taken in presence of the City and/or the Project Manager.
 - c. Proof of Noncompliance: Contractor liable for corrective action which the Project Manager feels is required including complete removal and replacement of defective material.
 - 2. Material Substitution: Any tests of material or equipment offered as substitute for specified item on which test may be required in order to prove its compliance with the Contract Documents.
- B. Contractor: May have tests performed on material and equipment for his own information and job control so long as the City does not assume responsibility for costs or for giving them consideration when appraising quality of materials.

3.6 EQUIPMENT TESTING

- A. Equipment testing shall be as determined appropriate by the Project Manager to assure proper performance according to the manufacturer's specifications for each equipment item.
- B. After all utility connections to equipment have been completed, the Contractor shall conduct final tests of equipment in presence of the City and Project Manager.
- C. Unless waived in writing by the Project Manager, the requirements of this section shall apply to all installed equipment items having utility connections.

3.7 NOTIFICATION

- A. The Contractor shall be responsible for notifying the Project Manager at least 3 working days prior to commencing work which is identified as requiring testing.
- B. The Contractor shall be responsible for scheduling and coordinating all required testing with the Project Manager and, when required by the City's Agents, the City's Independent Testing Agency.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

- A. No separate measurement shall be made for work under this Section.

4.2 PAYMENT

- A. No separate payment will be made for work under this Section. The cost of the work described in this Section shall be included in the Contract price.

END OF SECTION 01 45 16

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Contract Drawings and general provisions of the Contract, including General and Supplementary Conditions and the City and County of Denver Standard Specifications for Construction General Contract Conditions (2011)
- B. City and County of Denver Engineering Division, Wastewater Capital Project Management Standard Construction Specifications, dated March 15, 2016.
- C. Wastewater Capital Projects Management Special Project Provisions for Asbury & Tejon
- D. Wastewater Capital Projects Management Supplemental Technical Specifications.
- E. Denver Parks and Recreation Asbury and Tejon Specifications, OCT 2018.

1.2 SUMMARY

- A. This section consists of retention and protection of trees during the construction of the project.

1.3 DEFINITIONS AND REFERENCE STANDARDS

- A. Drip Line: The outermost edge of the tree's canopy or branch spread. The area within a tree's drip line is all the ground under the total branch spread.
- B. High Value Shrub: Any specimen shrub with an appraised value of one-hundred dollars (\$100.00) or more.
- C. City Forester / Office of the City Forester: The City agency responsible for trees and shrubs in public parks, parkways, and other public property. Denver's street trees are under regulation of the City Forester.
- D. Project Consulting Arborist: An independent consultant working on behalf of the City and County of Denver; with a degree in forestry, horticulture, or arboriculture, an American Society of Consulting Arborists (ASCA) registered consulting arborist, an International Society of Arboriculture (ISA) Certified Arborist, and / or a consultant with at least five years (5) field experience in tree preservation or on-site monitoring of public works or construction projects involving tree retention and protection.
- E. Contractor's Consulting Arborist: An independent consultant working on behalf of the Contractor; with a degree in forestry, horticulture, or arboriculture, an American

Society of Consulting Arborists (ASCA) registered consulting arborist, an International Society of Arboriculture (ISA) Certified Arborist, and / or a consultant with at least five years (5) field experience in tree preservation or on-site monitoring of public works or construction projects involving tree retention and protection.

- F. Tree Protection Zone: The Tree Protection Zone shall be the area below ground and the space above ground, equal to one and one-half foot (1.5') radius from the base of the tree's trunk for each one (1") inch of the tree's diameter at four and one-half feet (4.5') above grade (referred to as diameter at breast height)
 - 1. With groups of trees, there may be discontinuous (non-overlapping) perimeters of Tree Protection Zones which result in difficult to maintain or ineffective tree protection fencing. In these cases, if the distance between the perimeters of such areas is less than thirty feet (30), they should be treated as one contiguous Tree Protection Zone. In effect, this will enlarge the area of tree protection but will result in a more clearly defined and manageable area.
- G. Contractor shall comply with applicable requirements and recommendations of the most current versions of the following standards and guidelines. Where these conflict with other specified requirements, the more restrictive requirements shall govern.
 - 1. ANSI Z133.1-2006: American National Standard for Tree Care Operations.
 - 2. ANSI A300: Tree, Shrub, and Other Woody Plant Management – Standard Practices.
 - 3. Guide for Plant Appraisal – Current Edition: Authored by the Council of Tree and Landscape Appraisers; published by the International Society of Arboriculture.

1.4 QUALITY CONTROL

- A. As established by Chapter 57 of the Denver Revised Municipal Code, the City Forester, or an approved designee from the Office of the City Forester, shall be responsible for ensuring that all construction activities are in compliance with established standards for removal, maintenance, and planting of trees with the goal of promoting the health, safety, welfare, and quality of life of the residents of the city through the development of a sustainable community forest and, specifically, the preservation of trees.
- B. At its discretion, the City may hire a Project Consulting Arborist to conduct daily observation of the Contractor's field crews during the critical phases of the project, such as: demolition of existing concrete, root pruning, construction of retaining walls, and construction of new curb or sidewalk in Tree Protection Zones.
- C. Motorized equipment and trailers, including tractors, bobcats, bulldozers, rubber-tired excavators, tracked excavators, trucks, cars, and carts shall not be allowed access within Tree Protection Zones. Should access be necessary within designated Tree Protection Zones the City Forester or Project Consulting Arborist shall be notified and shall approve of the access and driving surface prior to its use.

- D. Materials and supplies shall not be stockpiled or stored within the Tree Protection Zone unless otherwise approved by the City Forester. Should temporary storage be necessary within designated Tree Protection Zones, the existing grade shall be covered with twelve inches (12") of wood mulch with overlapping three quarter inch (3/4") thick plywood on top to help distribute the weight of equipment and to minimize soil compaction and rutting. Plywood and/or mulch are not acceptable bridging materials for driving over exposed tree roots.
- E. Under no circumstances shall any objects or materials be leaned against or supported by a tree's trunk, branches, or exposed roots. The attachment or installation of any sign, cable, wire, nail, swing, or any other material to trees that is not needed to help support the natural structure of the tree is prohibited. Standard arboricultural techniques such as bracing or cabling that are performed by the Contractor's Consulting Arborist are acceptable upon approval by the City Forester or Project Consulting Arborist.

1.5 SUBMITTALS

- A. Tree Protection Plan: Submit a tree protection plan based on the contract drawings for approval by the City Forester or Project Consulting Arborist.
- B. Proposed methods and schedule for implementing tree and other plant protection shall be submitted for approval.
- C. Proposed methods, materials, and schedule for root pruning, branch pruning, and other tree maintenance shall be submitted for approval.
- D. Construction Schedule: Contractor shall submit construction schedule which includes a time frame for work near existing plants. Approval of such shall be obtained from the City Forester or Project Consulting Arborist prior to commencement of construction near Tree Protection Zones.
- E. Maintenance Schedule: Submit maintenance schedule to the Project Manager for approval by City Forester or Project Consulting Arborist.

PART 2 - PRODUCTS

2.1 TREE PROTECTION FENCE

- A. Orange plastic safety fencing – minimum of forty-eight inches (48") in height, heavy duty T-posts.
- B. Galvanized Chain-link – Six feet (6') in height.

2.2 ROOT BARRIER

- A. Eight (8) mesh (0.028-inch or greater) copper wire screen.
- B. "Typar BioBarrier" as manufactured by Fiberweb, Inc. www.biobarrier.com or approved equal.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. If it appears any work may cause damage to the branches of a tree, the Contractor shall contact the Project Manager and the City Forester. The Project Manager and City Forester will make the determination as to whether such damage is likely and pruning is necessary.
- B. To prevent or minimize soil compaction, designated routes for equipment and foot traffic by work crews shall be determined prior to commencing construction activities, and shall be indicated in the tree protection plan to be submitted by the Contractor to the Project Manager for review and approval by the Office of the City Forester.
- C. Where work is proposed within a tree protection zone, the Contractor shall use a compressed air excavation tool or hand dig a trench at the limit of proposed work to reveal existing tree roots. Upon inspection and approval by the City Forester, if no tree roots larger than 2" are discovered, the location of the tree protection fence may be relocated to the limit of proposed work.

3.2 TREE PROTECTION FENCING

- A. Tree protection fence shall be installed prior to any site activity and shall remain in place and maintained in condition in which they were installed until its removal is authorized by the City Forester or the Project Manager.
- B. Tree protection fencing should be installed 1-foot behind the existing curb in areas where the street surface will be removed and replaced.
- C. Tree protection fences shall be constructed as follows:
 - 1. Plastic fencing shall have the top secured to metal T-posts with twelve-gauge (12) wire woven through the top of fencing along the entire length. Heavy duty T-posts shall be placed so that wire and fence are taut.
 - 2. Chain link fence shall have posts installed no less than ten feet (10') on center, at a depth of thirty-six inches (36") minimum. Installation of post shall not result in injury to tree surface roots; root flares or branches.

3. Chain link fence may be required by the Office of the City Forester where heavy construction activity is adjacent to existing trees. Fencing shall be installed to surround the trees within the limits of work.

3.3 TREE PROTECTION SIGNS

- A. A standard Forestry tree protection sign shall be mounted on tree protection fencing at fifty-foot (50') intervals, unless otherwise approved by the Project Manager or City Forester.
 1. Signs may be picked up at the Office of the City Forester in the Webb Municipal Building at 201 West Colfax Avenue.

3.4 DEMOLITION

- A. Caution should be used during removal of existing street, curb, gutter, sidewalk, drain inlets, and other concrete and asphalt demolition, to minimize injury to tree root systems. The following procedures should be used when removing existing concrete.
 1. Breaking of the existing concrete and asphalt for removal shall be done in a manner that will minimize ground disturbance and vibration.
 2. Curbs and sidewalks within designated Tree Protection Zones shall be removed in a manner approved by the City Forester. When removing existing sidewalks and curbs, care shall be taken to avoid injury to roots located under, over, or adjacent to paved surfaces.
 3. Roots and root-trunk flares growing over curbs shall not be injured during breaking of curbs and removal of debris. Wood and bark tissues shall not be injured by equipment.
 4. During the removal of concrete, all exposed root systems and soil areas shall not be disturbed.
 5. Motorized equipment and trailers, including but not limited to tractors, skid steers, bulldozers, rubber-tired excavators, tracked excavators, trucks, cars, and carts are to be limited to access on the existing paved areas only. Access is not allowed behind the curb within Tree Protection Zones.
 6. If access within designated Tree Protection Zones is approved by the City forester or Project Consulting Arborist the existing grade shall be covered with twelve inches (12") of wood mulch and overlapping sheets of three-quarter inch (3/4") thick plywood placed on top of the wood mulch to help distribute the weight of equipment and to minimize soil compaction and rutting.
 - a. Exposed tree roots shall not be driven over. Plywood and/or mulch are not acceptable bridging materials for driving over exposed tree roots.

3.5 CONSTRUCTION IN TREE PROTECTION ZONES

- A. The following procedures shall be used when constructing sidewalks, curbs, concrete, asphalt paving, and drainage inlets.
 1. Keep all materials and equipment within the street bounded by existing curbs.

2. Construct new sidewalks on, or above, the existing grade instead of excavating into root zones. The new grade shall not interfere with sheet-flow drainage.
 3. Protect exposed roots from contamination by stabilization materials and concrete.
 4. Locate concrete washouts away from Tree Protection Zones. Washout runoff shall be strictly contained within the washout area and shall not flow into Tree Protection Zones or proposed new planting areas.
 5. When excavating for the construction of inlets, excavated soil shall be deposited in trucks and hauled off or deposited temporarily on three quarter inch (3/4") thick plywood outside the Tree Protection Zones. Excavated and fill soil shall not be deposited, even temporarily, on unprotected natural grade.
 6. After proper root-pruning, as needed, cover exposed roots within thirty (30) minutes to minimize desiccation. Roots may be covered with soil, mulch, or moistened burlap (7 ounce or equivalent), and shall be kept moist until the final grade is established.
- B. Where possible, construction should be relocated to prevent damage to existing roots. Where relocation of walks is not possible, walks should be constructed in a manner with the least amount of impact/damage to roots including but not limited to raised, narrowed, curbed, ramped, bridged, cantilevered, use of pylons, root break out zones, root channeling, structural cells to prevent cutting and removing major roots (e.g. roots greater than two inches in diameter).
- C. Grading within the Tree Protection Zone shall be performed by hand or a method approved by the City Forester. Any fill material that needs to be placed in the Tree Protection Zone shall be limited to a maximum of one inch (1") of fill material over the area unless otherwise approved by the City Forester prior to grading. Fill should consist of sandy loam topsoil. Clay soils shall not be used as fill. When using fill soil, the existing surface to receive fill should be scarified by hand to a maximum depth of one inch (1") from the finished grade prior to placing fill material, to ensure proper incorporation of fill material. Any filling operation should not occur during water saturated soil conditions.
- D. Existing soil may be used as a form for back of curb and gutter, with or without the use of a thin masonite-type form, although a Masonite form is preferred. This will minimize excavation in the critical root zone and prevent undue injury to the roots. This method is unnecessary in areas outside the critical root zone. Place a layer of "Tyvar BioBarrier" between the curb and tree roots to help inhibit root growth that may exploit small cracks in the curb. Where appropriate, use curbs with discontinuous footings to maintain natural grade near the base of trees adjacent to the curbing, and to minimize injury to roots and root flares.
- E. Provide for easy concrete removal and replacement where an obvious raised root may cause sidewalk cracking in the future. This can be accomplished by installing an

expansion joint on either side of the root or by scoring (as shown on the Contract Documents) the concrete on either side of the root to allow that particular section to be broken out and replaced. Compaction rating for the replacement walkway should not exceed eighty percent (80%) Proctor density. Tree roots will continue to slowly add girth every year; therefore, the base material needs to be malleable (e.g. suitable subgrade aggregates, crushed granite, or compacted sand) to prevent a fulcrum or pressure point which can crack or heave the walkway.

1. Where appropriate, and under the direction of the City Forester or Project Consulting Arborist, root restricting barriers can be installed with a minimal amount of disturbance away from sidewalks, curbs, and streets.
2. In areas where roots need to be removed for construction of drain inlets, roots shall be pruned prior to excavation to eliminate unnecessary tearing of roots by equipment.
 - a. Excavate soil by hand at the construction cut limit to a depth of thirty (30) inches or to the depth of the required root cut, whichever is less.
 - b. Prune roots as specified.
 - c. Protect exposed roots as specified.
3. Concrete or chemicals spilled within Tree Protection Zones should be completely removed. Contaminated soil shall be completely removed at the time of the spill and removed by hand and/or air spade tool without disturbance to root systems. Appropriate soil should be added as necessary to restore the grade. Contact the Project Manager and City Forester immediately in the event of a spill within a Tree Protection Zone.

3.6 IRRIGATION OR UTILITY INSTALLATION

- A. Contractor shall protect all trees and high-value shrubs from injury due to irrigation related work. All injuries to trees and high-value shrubs shall be mitigated to the satisfaction of the City Forester or Project Consulting Arborist, and, if appropriate in accordance with guidelines established in the "Guide for Plant Appraisal". All costs of such mitigating shall be charged to and paid by the Contractor. See Article 3.9 – Injuries to Existing Plants – Damage Penalties of this section for definition of high value trees and shrubs.
- B. All irrigation lines in Tree Protection Zones indicated on construction plans shall be approved by the City Forester or Project Manager prior to installation. No irrigation lines shall be located within ten feet (10') of any existing tree trunk without prior approval of City Forester or Project Manager.
- C. Wherever trenching exposes roots extending through the trench wall, those roots shall be hand pruned immediately, refer to Root Pruning. All trenches shall be closed within twelve hours (12); if this is not possible, the trench walls shall be covered with burlap and kept moistened. Prior to backfilling, the Contractor shall contact the City Forester,

Project Consulting Arborist, or Project Manager to inspect the condition and treatment of roots injured by trenching.

3.7 ROOT PRUNING

- A. Tree roots shall not be pruned or cut unless their removal is unavoidable. The City Forester or Project Manager shall be notified prior to any operation known or suspected to involve cutting of more than:
- B. All roots needing to be pruned or removed shall be cut cleanly with sharp hand tools, with oversight by the City Forester or Project Consulting Arborist. No wound dressings shall be used.
- C. Recommended root pruning tools:
 - 1. Scissor-type lopper.
 - 2. Scissor-type pruner.
 - 3. Large and small hand saws.
 - 4. Wound scriber.

3.8 PROJECT SITE MONITORING

- A. The Tree Protection Zones should be monitored a minimum of two (2) times weekly (more frequently at the start of the project) until all procedures and specifications are understood and properly executed by the Contractor.
- B. Specific monitoring schedules shall be reviewed at the construction meetings and modified as deemed necessary by the appropriate parties.

3.9 INJURIES TO EXISTING PLANTS - DAMAGE PENALTIES

- A. Any plants designated as requiring retention or protection that are partially injured or lost due to Contractor neglect or improper construction activities will result in a penalty assessed to the Contractor as determined by the City Forester, as described in Chapter 57 of the Denver Revised Municipal Code.
- B. Tree and High-Value Shrub Appraisal: All protected trees and high-value shrubs that are damaged during construction will be evaluated and appraised by the City Forester.
 - 1. The threshold level for plants to be appraised shall be one-hundred dollars (\$100.00); only those trees and shrubs estimated to have a monetary value greater than one-hundred dollars (\$100.00) shall be appraised.
 - 2. A fine of one-thousand dollars (\$1,000.00) will be levied against the Contractor for each incident of construction damage, including construction traffic within designated Tree Protection Zones. This fine shall be independent of any applicable damage penalty for the appraised value of the tree.
 - 3. Documentation for appraisals will consist of:

- a. Measurement of plant size.
- b. Identification by common and botanical names.
- c. Current condition (overall health, injuries, overt hazard status, etc.).
- d. Location factors as described in the most current addition of "Guide for Plant Appraisal". Photographs may be taken of certain trees and shrubs to document debilitating condition factors.

3.10 TREE MAINTENANCE DURING CONSTRUCTION

- A. Tree Maintenance: Proper maintenance shall include, but not be limited to, structural and remedial pruning, watering, mulching, remediating soil compaction, fertilization, insect and disease control, soil and tissue analysis, aeration, and wound treatment.
 - 1. Minimum watering requirements shall be twenty-five (25) gallons per diameter inch every two (2) weeks March – October; thirty-five (35) gallons per diameter inch every month November – February; depending on weather conditions the City Forester or Project Consulting Arborist may approve less frequent watering.
- B. The timing duration and frequency of necessary maintenance practices should be determined and approved by the City Forester or Project Consulting Arborist, based on factors associated with the site and affected plants.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

- A. Measurement will be based on the percentage complete for the lump sum contract amount for Tree Retention and Protection.
- B. Measurement will be at the contract unit price specified, when included in the bid document package. Items with a contract unit price will be measured at the contract unit specified and shall include the actual number of units of specified material(s), installed, relocated, removed or demolished for disposal at the locations shown on the Contract Drawings, or as directed by the Project Manager, and in accordance with the Specifications.

4.2 PAYMENT

- A. Payment will be made at the lump sum contract price, and shall include required materials, transportation, equipment, and labor required to install, maintain and establish tree retention and protection per the specification; and includes the removal of all tree protection at the end of the project as required and in accordance with the Contract Drawings and Specifications. The City and County of Denver shall not make payment, nor consider compensation to the Contractor, for penalties assessed for damages pursuant to Chapter 57 of the Denver Revised Municipal Code.

Payment will also include the maintenance of the tree protection throughout the duration of the project as well as earthwork, loading, transporting, stockpiling, disposing, hauling off, watering, dust control, erosion and sediment control, fine grading, maintenance of temporary protection by fencing or other means, watering and all maintenance labor, materials and equipment required to restore the site to its original condition at the completion of the project required until Final Acceptance of the work as required in accordance with the Contract Drawings and Specifications. All cost for this work shall be included within this bid item and no additional payment will be made. At the option of the Construction Project Manager, payment may be made in percentage installments based upon type, location and scope of work in relation to the period of performance. The total payment for this bid item shall not exceed seventy-five percent (75%) of the lump sum price during construction. The remaining twenty-five percent (25%) shall be paid after final site cleanup, completion of all punch list items and demobilization from site.

- B. Payment will be made at the contract unit price, and shall include installation of required materials, transportation, equipment, labor, loading, until Final Acceptance of the work as required in accordance with the Contract Drawings and Specifications.

END OF SECTION 01 56 39

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Contract Drawings and general provisions of the Contract, including General and Supplementary Conditions and the City and County of Denver Standard Specifications for Construction General Contract Conditions (2011)
- B. City and County of Denver Engineering Division, Wastewater Capital Project Management Standard Construction Specifications, dated March 15, 2016.
- C. Wastewater Capital Projects Management Special Project Provisions for Asbury & Tejon
- D. Wastewater Capital Projects Management Supplemental Technical Specifications for Asbury & Tejon.
- E. Denver Parks and Recreation Asbury and Tejon Specifications, OCT 2018.

1.2 SUMMARY

- A. This Section includes the requirements for demolition and removal of:
 - 1. Asphalt walks, concrete slabs and curbs.
 - 2. Signs.
 - 3. Miscellaneous site furnishings.
- B. Related Sections:
 - 1. WCPM Standard Construction Specification 2.0 Section "Site Preparation".
 - 2. WCPM Standard Construction Specification 23.0 "Storm Water Management"
 - 3. WCPM Supplemental Technical Specification 31 23 00 "Earthwork".
 - 4. Division 01 56 39 Section "Tree Retention and Protection".

1.3 DEFINITIONS

- A. Remove: Detach items from existing construction and dispose in accordance with Executive Order 115 unless indicated to be removed and salvaged or removed and reinstalled.
- B. Remove and Salvage: Carefully detach from existing construction, in a manner to prevent damage, and deliver to the City in a condition ready for re-use.
- C. Remove and Reinstall: Detach items from existing construction, prepare for reuse, and reinstall where indicated.

- D. Existing to Remain: Existing items of construction that are not to be permanently removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.
- E. Recyclable Material: Material generated during demolition operations that can be reconditioned and reclaimed for the same or different use. Such materials include asphalt, concrete, metals (steel, iron, aluminum, copper, etc.), rubber, glass and paper.

1.4 PROJECT CONDITIONS

- A. Keep dust to a minimum at removal areas. Use water trucks as necessary.
- B. Ensure safety of persons in demolition area. Provide temporary barricades as required.

1.5 PRE-CONSTRUCTION MEETINGS

- A. Preconstruction: Inspect and discuss condition of construction to be selectively demolished.
- B. Review structural load limitations of existing structure.
- C. Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.
- D. Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.
- E. Review areas where existing construction is to remain and requires protection.
- F. Agenda Items

1.6 INFORMATIONAL SUBMITTALS

- A. Proposed Protection Measures: Submit report, including drawings, that indicates the measures proposed for protecting individuals and property, for environmental protection, for dust control and for noise control. Indicate proposed locations and construction of barriers.
- B. Schedule of Demolition Activities: Indicate the following:
 - 1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity. Ensure the City's on-site operations are uninterrupted.
 - 2. Interruption of utility services. Indicate how long utility services will be interrupted.

3. Coordination for shutoff, capping, and continuation of utility services.
- C. Inventory: Submit a list of items to be removed and salvaged and deliver to the Project Manager prior to start of demolition.
- D. Preconstruction Photographs or Video: Submit digital photographs or videos prior to Work commencing.

1.7 CLOSEOUT SUBMITTALS

- A. Inventory:
 1. Submit a list of items that have been removed and salvaged.
 2. Include documentation of the type and volume/weight of materials hauled to the nearest recycling center.
- B. Landfill Records: Provide records of receipt and acceptance of contaminated or hazardous wastes by a landfill facility licensed to accept contaminated or hazardous wastes.

PART 2 - PRODUCTS

2.1 FILL MATERIALS

- A. Soils as indicated on documents, free of debris, frozen materials, roots, and other organic matter.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect structures, pavement, trails, utilities, and vegetation to remain.
- B. Set up all barriers, including those for tree protection, in accordance with the Contract Documents and Plans and Division 01 56 39 Section "Tree Protection and Retention", prior to proceeding with any demolition.
- C. Protection and Repair of Underground lines:
 1. Existing Public Utilities: Locate existing underground utilities within the limits of work per General Contract Conditions, Article 804 Protection of Municipal, Public Service or Public Utility Systems. Request utility locates seventy-two (72) hours in advance of any excavations by calling the Utility Notification Center of Colorado at 811. The Contractor is responsible for providing written and graphical documentation from the utility owner. Take whatever precautions are necessary including potholing to verify location and depth to protect these

underground lines from damage. Should unmarked or incorrectly marked utilities or other piping be encountered during excavation, notify the Project Manager immediately for direction. If damage does occur, all damage shall be repaired by the utility owner and all costs of such repair shall be paid by the Contractor. Only written all clears will be acceptable from utility providers or utility locate services, verbal all clears will not be accepted.

2. Existing Private Utilities: Locate existing underground utilities within the limits of work per General Contract Conditions, Article 804 Protection of Municipal, Public Service or Public Utility Systems. The Contractor is required to contact all private utility companies including The City and County of Denver departments to locate all private utilities. The Contractor is responsible for providing written and graphical documentation from the private utility owner. The request for locates shall be a minimum of seventy-two (72) hours prior to proceeding with any excavation. If, after such requests, private utilities are encountered and damaged by the Contractor these shall be repaired at no cost to the City. If the Contractor damages staked or located private utilities, they shall be repaired by the utility owner and all costs of such repair shall be paid by the Contractor. Only written "all clears" will be acceptable from utility providers or utility locate services, verbal "all clears" will not be accepted.

3.2 DEMOLITION

A. Pavement, Slabs, and Miscellaneous Concrete Items:

1. Remove concrete slabs-on-grade, curbs, and miscellaneous concrete items as directed. Where concrete to be removed abuts concrete to remain, pavement shall be uniformly saw-cut along an existing joint. Jagged or crooked edges will not be acceptable. Concrete shall be broken up, hauled and disposed off site. All recyclable materials shall be hauled to nearest recycling center and any non-recyclable materials shall be hauled to Denver Arapahoe Disposal Site (DADS). DADS Disposal tickets shall be provided to the Contractor by the Project Manager.
2. Remove asphalt paved roads, parking lots, walks, curbs and miscellaneous asphalt as indicated on Contract Drawings. Cuts between pavement to be removed and pavement to remain shall be saw-cut to full depth, straight, smooth and clean with no jagged edges. Asphalt shall be broken up, hauled and disposed off site. All recyclable materials shall be hauled to nearest recycling center and any non-recyclable materials shall be hauled to DADS. DADS Disposal tickets shall be provided to the Contractor by Project Manager.
3. Remove concrete pipe sections and miscellaneous concrete items as directed.
 - a. Where concrete pipe is to be removed it shall be uniformly saw-cut along an existing joint or disassembled at the joints. Jagged or crooked edges will not be acceptable. Concrete shall be broken up, hauled and disposed off site. All recyclable materials shall be hauled to nearest recycling center

and any non-recyclable materials shall be hauled to DADS. DADS Disposal tickets shall be provided to the Contractor by Project Manager.

- b. When Asbestos Concrete Pipe (ACP) is determined or suspected to be present the Contractor will need to hand dig the pipe sections to be removed. Any ACP sections will need to remain intact. The use of mechanical trenching equipment within eighteen inches (18") of any known or suspected ACP will not be permitted. Once the section that is to be removed has been excavated, an abatement Contractor will remove the sections of the pipe that are to be replaced or removed and the pipe shall be flush cut. The Contractor is responsible for notifying the Project Manager of any ACP that needs to be removed forty-eight (48)-hours prior to excavation of the area. If ACP is excavated that has not be previously identified the Contractor is responsible to contact the Project Manager either verbally or by email immediately upon discovery. Any ACP that is discovered to be damaged must be immediately reported to the Project Manager. The Project Manager will then notify the Abatement Contractor of the work that needs to be performed. The Abatement Contractor has twenty-four (24)-hours to respond and remove the ACP section(s).

4. Remove road base material that is exposed after removing the pavement. This material shall be hauled and disposed off site unless otherwise directed by the Project Manager. All recyclable materials shall be hauled to nearest recycling center and any non-recyclable materials shall be hauled to DADS. DADS Disposal tickets shall be provided to the Contractor by the Project Manager.

- B. Abandoned Utilities: Remove aboveground utilities and terminate as approved by the utility company and the Project Manager. Remove necessary portions of underground utilities to a minimum of twenty-four inches (24") below the elevation of excavation or final grade. Cap off conduits with minimum twenty-four inch (24") long concrete plugs.

3.3 RESTORATION

1. Backfilling: Ensure that areas to be filled are free of standing water, frost, frozen material, vegetation, including roots and debris. Place fill materials in accordance WCPM Supplemental Technical Specification 31 23 00 "Earthwork".

- B. Grading:

1. Restored Areas: Grade surface to blend with original contours and provide free drainage flow. All ruts and depressions where any amount of standing water collects shall be re-graded to a smooth natural appearance to ensure positive drainage.
2. New Construction Areas: Grade as indicated in WCPM Supplemental Technical Specification 31 23 00 "Earthwork".

3.4 DISPOSAL

- A. Remove trash, debris and waste materials, haul and dispose in accordance with Executive Order 115. All recyclable materials shall be hauled to nearest recycling center and any non-recyclable materials shall be hauled to DADS. DADS Disposal tickets shall be provided to the Contractor by the Project Manager.
- B. Salvaged Material: All salvaged material remains the property of the City. Store or deliver as directed by the Project Manager.

3.5 FIELD QUALITY CONTROL

- A. Comply with safety requirements for demolition, ANSI A10.6-83.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

- A. Measurement will be made by the contract unit specified for items to be removed (Concrete Pad, Concrete Walkway, Site Furnishings, etc.). Measurement shall include the actual number of units of specified material(s) removed or demolished for disposal at the locations shown on the Contract Drawings, or as directed by the Project Manager, and in accordance with the Specifications.

4.2 PAYMENT

- A. Payment will be made at the contract unit price, and shall include required materials, transportation, equipment, labor, earthwork, loading, transporting, stockpiling, disposing, hauling off, watering, dust control, erosion and sediment control, fine grading, maintenance of temporary protection by fencing or other means, watering and all maintenance required until Final Acceptance of the work as required in accordance with the Contract Drawings and Specifications.
- B. At the option of the Construction Project Manager, when the unit price is lump sum, payment may be made in percentage installments based upon type, location and scope of work in relation to the period of performance. The total payment for this bid item shall not exceed seventy-five percent (75%) of the lump sum price during construction. The remaining twenty-five percent (25%) shall be paid after final site cleanup, completion of all punch list items and demobilization from site.
- C. The price shall include the removal and offsite disposal of all materials including any base course deemed unsuitable by the Project Manager. No payment will be made for the removal and/or replacement of any items damaged by the Contractor beyond the authorized limits of removal.

END OF SECTION 02 41 00

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Contract Drawings and general provisions of the Contract, including General and Supplementary Conditions and the City and County of Denver Standard Specifications for Construction General Contract Conditions (2011).
- B. City and County of Denver Engineering Division, Wastewater Capital Project Management Standard Construction Specifications, dated March 15, 2016.
- C. Wastewater Capital Projects Management Special Project Provisions for Asbury & Tejon.
- D. Wastewater Capital Projects Management Supplemental Technical Specifications for Asbury & Tejon
- E. Denver Parks and Recreation Asbury and Tejon Specifications, OCT 2018.

1.2 SUMMARY

- A. This Section of the Work includes furnishing, placing, shoring, bracing, and anchorage of formwork, concrete reinforcement, accessories, and placing concrete in connection with cast-in-place concrete installation including installation of control and expansion joints, concrete curing and concrete finishing
- B. Related Sections:
 - 1. General Contract Conditions Title 3, section 309 "Contractor Submittals and other Written Communications to the City"
 - 2. General Contract Conditions Title 4, section 405 "Shop Drawings, Product Data, and Samples"
 - 3. WCPM Standard Construction Specification 2.0 Section "Site Preparation".
 - 4. WCPM Standard Construction Specification 23.0 "Storm Water Management"
 - 5. WCPM Standard Construction Specification 47.0 "Construction Survey and Monumentation"
 - 6. WCPM Supplemental Technical Specification 31 23 00 "Earthwork".
 - 7. WCPM Supplemental Technical Specification 31 23 19 "Water Control and Dewatering".
 - 8. Division 01 45 16 Section "Contractor Quality Control".
 - 9. Division 32 11 16 Section "Aggregate Base Course"
 - 10. Division 32 13 13 Section "Concrete Walks, Curbs and Miscellaneous Flatwork"

1.3 REFERENCES

- A. Project Geotechnical Report (Kumar 2017).
- B. Note: All references below shall be from the most current edition.
- C. American Concrete Institute (ACI):
 - 1. ACI 117 - Standard Tolerances for Concrete Construction and Materials.
 - 2. ACI 301 - Specifications of Structural Concrete for Buildings.
 - 3. ACI 304 - Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete.
 - 4. ACI 305 and 306 - Hot and Cold Weather Protection for Concrete.
 - 5. ACI 315 - Details and Detailing of Concrete Reinforcement.
 - 6. ACI 318 - Building Code Requirements for Reinforced Concrete.
 - 7. ACI 347 - Recommended Practice for Concrete Formwork.
- D. American Society for Testing and Materials (ASTM):
 - 1. ASTM A615 - Deformed and Plain Billet-Steel for Concrete Reinforcement.
 - 2. ASTM A1064 / A1064M-17 - Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
 - 3. ASTM C33 - Concrete Aggregates.
 - 4. ASTM C94 - Ready-Mixed Concrete.
 - 5. ASTM C150 – Portland Cement.
 - 6. ASTM C260 - Air Entraining Admixtures for Concrete.
 - 7. ASTM C494 - Water Reducing Admixtures for Concrete.
 - 8. ASTM C618 - Fly Ash Mineral Admixture for Concrete.
 - 9. ASTM C672 - Scaling Resistance of Concrete Surfaces Exposed to Deicing Chemicals.
 - 10. ASTM C979 - Pigments for Integrally Colored Concrete
 - 11. ASTM C1059 - Standard Specification for Latex Agents for Bonding Fresh to Hardened Concrete
 - 12. ASTM-C1315 - Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete
- E. Concrete Reinforcing Steel Institute (CRSI) - Manual of Standard Practice.
- F. Colorado Department of Transportation (CDOT) - Standard Specifications for Road and Bridge Construction.
- G. National Ready Mixed Concrete Association (NRMCA)

1.4 QUALITY CONTROL

- A. Pre-Construction Conference: Conduct conference at location approved by the Project Manager.

1. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:
 - a. Contractor's superintendent.
 - b. Independent testing agency responsible for concrete design mixtures.
 - c. Ready-mix concrete manufacturer.
 - d. Concrete subcontractor.
 - e. Special concrete finish subcontractor.
2. Review special inspection and testing and inspecting agency procedures for field quality control, concrete finishes and finishing, cold- and hot-weather concreting procedures, curing procedures, construction contraction and isolation joints, joint-filler strips, semi-rigid joint fillers, forms and form removal limitations, shoring and reshoring procedures, vapor-retarder installation, anchor rod and anchorage device installation tolerances, steel reinforcement installation, concrete repair procedures, and concrete protection.

1.5 SUBMITTALS

- A. Qualification Data: Installer to document for Owner's Representative experience on projects of similar scope and scale successfully completed within the past five (5) years.
- B. Product Data and Material Certificates: For each type of product and material indicated on the plans and in this specification.
- C. Mix Designs:
 1. Submit substantiating data for each concrete mix design specified for use to the Project Manager not less than four (4) weeks prior to first concrete placement. Data for each mix shall, as a minimum, include the following:
 - a. Mix identification designation (unique for each mix submitted).
 - b. Statement of intended use for mix.
 - c. Mix proportions.
 - d. Admixtures (must be approved by the Project Manager).
 - e. Aggregates
 - f. Wet and dry unit weight.
 - g. Entrained air content.
 - h. Design slump.
 - i. Strength qualification data.
- D. Submit shop drawings for fabrication, bending and placement of concrete reinforcement. Comply with ACI Detailing Manual SP 66. Include all accessories specified and required to support reinforcement.

- E. Material Test Reports: For the following, from a qualified testing agency, indicating compliance with requirements:
 - 1. Aggregates. Include service record data indicating absence of deleterious expansion of concrete due to alkali aggregate reactivity.
- F. Field quality-control reports.
- G. Minutes of Pre-Construction conference.

1.6 DELIVERY, STORAGE AND HANDLING

- A. General: Materials handling and batching shall conform to applicable provisions of ASTM C94.
- B. Reinforcing: Unload and store reinforcing bars so they are kept free of mud and damage.
- C. Project-Site Mixing: Not allowed without prior approval from the Project Manager. If allowed, submit process description to the Project Manager for approval prior to construction.
- D. Hauling Time for Concrete: Deliver and discharge all concrete transmitted in a truck mixer, agitator, or other transportation device not later than one and one-half (1-1/2) hours, or three-hundred (300) revolutions of the drum after the initial mixing water has been added, whichever is earliest.
- E. Extra Water:
 - 1. Deliver concrete to site in exact quantities required by design mix.
 - 2. Should extra water be required for workability before depositing concrete, and the water/cement ratio of accepted mix design will not be exceeded, the General Contractor's superintendent shall have the sole authority to authorize addition of water. All additional water added to mix after leaving batch plant shall be indicated on truck ticket and signed by person responsible.
 - 3. Where extra water is added to concrete it shall be mixed thoroughly for thirty (30) revolutions of drum before depositing.
 - 4. Water may be added at the site only once for each batch.
 - 5. A full set of tests shall be performed after addition of water. Excessive slump or other out of range tests will be cause for rejection.

1.7 PROJECT CONDITIONS

- A. Environmental Requirements:
 - 1. Cold Weather Placement:

- a. When for three successive days prior to concrete placement the average daily outdoor temperature drops below forty degrees (40°) F or when the average outdoor temperature is expected to drop below forty degrees (40°) F on the day of concrete placement, preparation, protection and curing of concrete shall comply with ACI 306R.
 - b. Minimum temperature of concrete upon delivery shall conform to ACI 301 Table 7.6.1.1. Concrete at time of placement shall conform to minimum values of ACI 306R Table 1.4.1, and shall not exceed minimum values by more than twenty degrees (20°) F.
 - c. Subject to acceptance of the Project Manager an accelerating admixture may be used. Admixtures shall meet requirements of Part 2. Calcium Chloride and other chloride-type accelerating admixtures are not allowed.
2. Hot Weather Placement:
- a. When depositing concrete in hot weather, follow recommendations of ACI 305R.
 - b. When air temperatures on day of placement are expected to exceed ninety degrees (90°) F, mix ingredients shall be cooled before mixing. Flake ice or well-crushed ice of a size that will melt completely during mixing may be substituted for all or part of mix water.
 - c. Retarding admixture may be used subject to acceptance of the Project Manager. Admixtures shall meet requirements of Part 2.

1.8 RIGHT OF WAY WORK

- A. Contractor shall obtain all necessary permits when working with in the Right of Way.
- B. Contractor shall preserve and protect all permanent land survey control markers. Per the General Contract Conditions Article 319 "Preservation of Permanent Land Survey Control Markers".

1.9 WARRANTY/GUARANTEE

- A. All concrete work within the Park shall have a one (1) year warranty for material and installation from date of Final Acceptance.
- B. All concrete work within the Right of Way shall have a three (3) year warranty for material and installation from date of Final Acceptance.
- C. Expenses due to vandalism prior to Final Acceptance shall be the Contractor's responsibility.
- D. Any settling or cracking during warranty period shall be repaired at no expense to the City, including complete restoration of any adjacent damaged property.

PART 2 - PRODUCTS

2.1 FORM MATERIALS

- A. Hand Placed Steel Forms: Hand placed steel forms are only to be used for sections that are straight and have no bend, radii, or curvature in the sections to be used.
- B. Wood Forms: Forms shall be made of solid one side grade, sound, undamaged lumber with straight edges.
 - 1. Curved elements (bends, radii, or curvature) shown on plans are to be constructed with smooth-curved plywood forms. Faceted forms composed of straight sections will not be accepted.
- C. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.
 - 1. Formulate form-release agent with rust inhibitor for steel form-facing materials.

2.2 STEEL REINFORCEMENT

- A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60; deformed.
- B. Epoxy-Coated Reinforcing Bars: ASTM A 775/A 775M or ASTM A 934/A 934M; with ASTM A 615/A 615M, Grade 60 (Grade 420) deformed bars.
 - 1. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating, compatible with epoxy coating on reinforcement.
- C. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60 (Grade 420) plain-steel bars. Cut bars true to length with ends square and free of burrs.
- D. Epoxy-Coated, Joint Dowel Bars: ASTM A 775/A 775M; with ASTM A 615/A 615M, Grade 60 (Grade 420), plain-steel bars.
- E. Tie Wire: ASTM A1064, minimum sixteen (16) gauge annealed type.
- F. Hook Bolts: ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6), internally and externally threaded. Design hook-bolt joint assembly to hold coupling against paving form and in position during concreting operations, and to permit removal without damage to concrete or hook bolt.
- G. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete specified, and as follows:
 - 1. Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.

2. For concrete surfaces exposed to view where legs of wire bar support contact forms, use CRSI Class one (1) plastic-protected steel wire or CRSI Class two (2) stainless-steel bar supports.
3. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.
4. For zinc-coated reinforcement, use galvanized wire or dielectric-polymer-coated wire bar supports.

2.3 CONCRETE MATERIALS

- A. Provide materials in accordance with ACI 301, unless amended or superseded by requirements of this section or general notes on structural drawings.
 1. General: Ready-mixed Concrete: ASTM C94. On-site mixed concrete not allowed.
 2. Cement: ASTM C150. Type II
 3. Fly ash: ASTM C618 Class F.
 4. Aggregate: ASTM C33.
 - a. All sand and aggregates to meet C-33 Table 3 for Class 4S "Severe Weathering Region".
 - 1) Fine Aggregate: Clean, natural sand.
 - 2) Coarse Aggregate: Clean gravel or crushed stone.
 5. Water: ASTM C 94/C 94M, clean and not detrimental to concrete.

2.4 ADMIXTURES

- A. General: Unless specified, no admixtures may be used without specific approval of the Project Manager.
- B. Prohibited Products: Calcium chloride or admixtures containing more than one half of one percent (0.05%) chloride ions or thiocyanates are not permitted.
- C. Air-Entraining Admixture: ASTM C260.
- D. Water Reducing Admixture: ASTM C494, Type A.
- E. High Range Water Reducing Admixture (Superplasticizer): ASTM C494, Type F or G.
- F. Warm Weather Admixtures: ASTM C494. Use of admixtures will not relax warm weather placement requirements.
- G. Cold Weather Admixtures: ASTM C494. Use of admixtures will not relax cold weather placement requirements.

2.5 CONCRETE MIX

- A. Refer to the City and County of Denver Right of Way Services approved materials list of pre-approved concrete mixes at the following website:

<https://www.denvergov.org/content/denvergov/en/right-of-way-services/engineering-regulatory-analytics/engineering-plan-review/manuals-regulations.html>

All Concrete mixes from the approved list or submitted for approval shall meet the following criteria:

1. Mix concrete in accordance with ASTM C94 and ACI 301 Chapter 3.
2. Cement Content: Type II cement, minimum of five hundred twenty-eight (528) pounds per cubic yard.
3. Fly ash shall not exceed twenty (20%) of total cementitious material by weight unless approved by the Project Manager.
4. Maximum water-cement ratio: 0.44.
5. Slump: Four inches (4") maximum when hand placed.
6. Air Entrainment: Five percent (5%) to eight percent (8%).
7. Aggregate Size: three quarter inches (3/4"), maximum.
8. Concrete for Footings, Walls, and Interior Slabs-on-Grade shall be Class B or Class D, as approved by the Project Manager.

2.6 ACCESSORIES

- A. Expansion Joints:
1. Interior Use or Exterior Use Where Sealants are Specified: Bituminous saturated fiber conforming to ASTM D1751, one half inch (1/2") thick. Provide manufacturer's certification of compatibility with specified sealants where required.
 2. Exterior Use Where Sealants are not Specified: Pre-molded asphalt and fiber conforming to ASTM D994, one half inch (1/2") thick.
 3. Joint Sealant: Per CDOT's approved joint and crack sealant list. Where concrete color additive is used, sealant color to match adjacent concrete.
- B. Void Forms: Biodegradable paper surface, treated for moisture resistance, structurally sufficient to support weight of plastic concrete and other superimposed loads.
- C. Chamfer Strips: Wood, metal, PVC, or rubber strips, shaped as sized on the drawings.
- D. Rustication Strips: Wood, metal, PVC, or rubber strips, kerfed for ease of form removal.

- E. Form Ties: Factory-fabricated, removable or snap-off metal or glass-fiber-reinforced plastic form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete surface.
 - 1. Furnish units that will leave no corrodible metal closer than two inches (2") to the plane of exposed concrete surface, or as shown on the drawings.
 - 2. Furnish ties that, when removed, will leave holes no larger than 1 inch (1") in diameter in concrete surface.
 - 3. Furnish ties with integral water-barrier plates to walls indicated to receive damp proofing or waterproofing.
- F. Spray Curing and Sealing Compound: White, Waterborne, Membrane-Forming ASTM C 1315, Type two (2), Class B, dissipating.
- G. Bonding Agent: Latex bonding adhesive shall meet ASTM C 1059.

2.7 ANTI-GRAFFITI COATING

- A. Non-sacrificial anti-graffiti coating with five (5) year warranty minimum, or approved equal.

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

- A. Requirements of Regulatory Agencies: Comply with all applicable provisions of the state and local building and safety codes.
- B. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from single source, and obtain admixtures from single source from single manufacturer, unless otherwise approved by the Project Manager.
- C. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
 - 1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities".
- D. Testing: All testing shall be completed by the Contractor at their expense unless otherwise specified by the contract.
- E. Testing Agency Qualifications: Engage a qualified testing agency to perform material evaluation tests and to design concrete mixtures. Qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.

1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.
- F. Testing Frequency: Obtain at least one composite sample for each one hundred (100) cubic yards, or fraction thereof of each concrete mixture placed each day.
- a. When frequency of testing will provide fewer than five (5) compressive-strength tests for each concrete mixture, testing shall be conducted from at least five (5) randomly selected batches or from each batch if fewer than five (5) are used.
 2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one (1) test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
 3. Air Content: ASTM C 231, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
 4. Compression Test Specimens: ASTM C 31/C 31M; cast and laboratory cure one (1) set of four (4) standard cylinder specimens for each composite sample.
 5. Compressive-Strength Tests: ASTM C 39/C 39M; test one specimen at seven days and two specimens at twenty-eight (28) days. and keep one for backup in the event a sample should break.
 - a. A compressive-strength test shall be the average compressive strength from two specimens obtained from same composite sample and tested at twenty-eight (28) days.
- G. Strength of each concrete mixture will be satisfactory if average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than two-hundred (200) psi.
- H. Test results shall be reported in writing to Project Manager, concrete manufacturer, and Contractor within forty-eight (48) hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at twenty-eight (28) days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both seven (7) and twenty-eight (28) day tests.
- I. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Project Manager.
- J. Concrete work will be considered defective if it does not pass tests and inspections.
- K. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

- L. Prepare test and inspection reports.
- M. Record of Work: A record shall be kept by the Contractor listing the time and date of placement of all concrete for the structure. Such record shall be kept until the completion of the project and shall be available to the Project Manager for examination at any time.
- N. Mockups: If requested by the Project Manager, prior to starting any concrete work, provide a sample panel using materials indicated for project work. For each type, color and finish of concrete specified, build panel at the site of full thickness and approximately ten feet (10') by 10 feet (10'), including reinforcement, expansion joints, control joint, scales, fillers, and one radial edge. Provide the workmanship proposed for the work. Correct and replace sample panel until the Project Manager's acceptance of the work. Retain panel(s) during construction as a standard for completed paving work.
 - 1. Build panel approximately one-hundred (100) sq. ft. in the location indicated or, if not indicated, as directed by the Project Manager.
 - 2. Approved mockups may become part of the completed Work if approved prior to the construction of the mock up and is undisturbed at time of Substantial Completion.
 - 3. Notify the Project Manager a minimum of seven (7) days in advance of dates and times when mockups will be constructed.
 - 4. Obtain the Project Manager's written approval of the mockups before starting construction.
 - 5. If the Project Manager determines that the mockup does not meet the requirements, demolish and remove from the site and cast another until the mockup is approved.
 - 6. Maintain the mockups during construction in an undisturbed condition as a standard for judging the completed Work.
 - 7. Demolish and remove mockups when directed by the Project Manager.
- O. Tolerances:
 - 1. Formed Surfaces and Building Lines: Conform to ACI 301 4.3.
 - 2. Slab Finishing Tolerances:
 - a. Elevation and Cross-slope: In conformance with grading plans and ADA.
 - b. Thickness: Plus, three eighths-inch (3/8"), minus one quarter-inch (1/4").
 - c. Surface: Gap below ten feet (10') long, unlevelled straightedge not to exceed one eighth -inch (1/8").
 - d. Lateral Alignment and Spacing of Dowels: one-inch (1").
 - e. Vertical Alignment of Dowels: one quarter-inch (1/4").
 - f. Joint Spacing: three-inches (3").
 - g. Contraction Joint Depth: Plus, one quarter-inch (1/4"), no minus.
 - h. Joint Width: Plus, one eighth-inch (1/8"), no minus.

3. Embedded Items: Unless noted otherwise on drawings, tolerances shall be as follows:
 - a. Anchor Bolts:
 - 1) Adjacent anchor bolts in a group receiving a single fabricated setting piece: Plus or minus one-eighth inch (1/8").
 - 2) Location and alignment of anchor bolt groups from designated location and alignment: Plus or minus one-eighth inch (1/8").

3.2 PREPARATION OF SUBGRADE

- A. Excavate to required depth in accordance with geotechnical report. Remove soft, yielding material and replace with select fill. Compact to minimum ninety-five percent (95%) Standard Proctor within two percent (2%) of optimum moisture.
- B. Refer to 31 23 00 "Earthwork" for requirements for subgrade testing and proof-rolling.
- C. Maintain subgrade in a compacted condition until concrete is placed.

3.3 FORMS

- A. Construct formwork to maintain tolerances in accordance with ACI 301.
- B. Verify lines, levels, and measurement before proceeding with formwork.
- C. Limit concrete surface irregularities, designated by ACI 347 as abrupt or gradual, as follows:
 1. Class A, one eighth inch (1/8") for smooth-formed finished surfaces.
 2. Class B, one-quarter inch (1/4") for rough-formed finished surfaces.
- D. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.
- E. Form Tie Holes: Form tie holes are to be installed in locations shown on drawings and filled with grout and finished to match adjacent concrete surface.
- F. Elements shown as curved on plans are to be formed with flexible form material to form smooth curve transitions. Disjointed, poorly transitioned form alignments will not be accepted. Curved sections formed with straight facets will not be accepted.
- G. Contractor shall notify the Project Manager a minimum of forty-eight (48) hours in advance of placing concrete for review of formwork. Contractor shall make correction within twenty-four (24) hours of review. If formwork is not in place at time of the scheduled inspection, then the Contractor will be responsible for compensation of the Project Manager's time and expenses per the General Contract Conditions.

- H. Minimize form joints. Symmetrically align form joints and make watertight to prevent leakage of mortar.
- I. Provide chamfer strips on all exposed corners or as indicated on construction documents.
- J. Do not apply form release agent other than specified materials where concrete surfaces receive special finishes or applied coatings which may be affected by agent. Soak contact surfaces of untreated forms with clean water. Keep surfaces wet prior to placing concrete.
- K. Coordinate work of other Sections in forming and setting openings, slots, recesses, chases, sleeves, bolts, dowels, anchors, and other inserts and embedded materials.
- L. Do not remove forms, shoring and bracing until concrete has sufficient strength to support its own weight, and construction and design loads which may be imposed upon it.
- M. During cold weather, remove ice and snow from forms. **Do not** use deicing salts. Do not use water to clean out completed forms unless formwork and construction proceed within heated enclosure. Use compressed air to remove foreign matter.

3.4 REMOVING AND REUSING FORMS

- A. General: Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than fifty degrees (50°) F for twenty-four (24) hours after placing concrete. Concrete must be hard enough to not be damaged by form-removal operations and curing and protection operations need to be maintained.
 - 1. Leave formwork for structural elements that supports weight of concrete in place until concrete has achieved at least seventy percent (70%) of its twenty-eight (28) day design compressive strength.
 - 2. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.
- B. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.
- C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by the Project Manager.

3.5 SHORES AND RESHORES

- A. Comply with ACI 318 (ACI 318M) and ACI 301 for design, installation, and removal of shoring and reshoring.
 - 1. Do not remove shoring or reshoring until measurement of slab tolerances is complete.
- B. Plan sequence of removal of shores and reshore to avoid damage to concrete. Locate and provide adequate reshoring to support construction without excessive stress or deflection.

3.6 EMBEDDED ITEMS

- A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 1. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC's "Code of Standard Practice for Steel Buildings and Bridges."

3.7 STEEL REINFORCEMENT

- B. Install steel reinforcement only in locations shown on Contract Drawings.
- C. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
- D. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.
- E. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.

3.8 CONCRETE PLACEMENT

- A. Contractor's Review: Contractor shall inspect forms and reinforcing prior to concrete placement to assure accurate placement of embedded items and overall acceptability.
- B. Project Manager's Review: Contractor shall provide minimum of forty-eight (48) hours' notice to the Project Manager to allow review of forms and reinforcement before concrete is placed and to observe placing of concrete.

- C. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.
- D. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated.
 - 1. Deposit concrete in horizontal layers of depth to not exceed formwork design pressures and in a manner to avoid inclined construction joints.
 - 2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.
 - 3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least six inches (6") into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.
- E. Deposit and consolidate concrete for concrete pavements in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.
 - 1. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
 - 2. Maintain reinforcement in position on chairs during concrete placement.
 - 3. Screed slab surfaces with a straightedge and strike off to correct elevations.
 - 4. Slope surfaces as indicated on drawings.
 - 5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.
 - 6. Allow time for bleed water to appear, then scrape or push off all bleed water. Do not work water into surface.
 - 7. Final level, light bull float, but do not trowel surface.
 - 8. Broom or drag surface or other specified finish, per Subsection 3.8 this Section.
 - 9. Do not use evaporative retarders as finishing aid.
- F. Cold-Weather Placement: Comply with ACI 306R. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
 - 1. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
 - 2. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.

3. Comply with concrete protection temperature requirements of ACI 306R. Record concrete temperatures during specified protection period at intervals not to exceed sixteen (16) hours and no less than twice during any twenty-four (24) hour period.

- G. Hot-Weather Placement: Comply with ACI 305R.
 1. Spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.
 2. Protect to prevent rapid drying. Start finishing and curing as soon as possible.
- H. Ensure reinforcement, inserts, embedded parts and formed joints are not disturbed during concrete placement.

3.9 CONCRETE FINISHING

- A. Rough Form Finish: All texture imparted by form facing material, including tie holes and defective areas, shall be repaired and patched, and all fins and other projections exceeding one-quarter inch (1/4") shall be removed.
- B. Smooth Form Finish: Use form material to impart smooth, hard, uniform texture, and arrange form panels in orderly and symmetrical pattern with minimum seams. Repair and patch defective areas and completely remove and smooth all fins and other projections.
- C. Rubbed Finish: Apply the following to smooth-formed finished as-cast concrete where indicated:
 1. Smooth-Rubbed Finish: Not later than one day after form removal, moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.
 2. Grout-Cleaned Finish: Wet concrete surfaces and apply grout of a consistency of thick paint to coat surfaces and fill small holes. Mix one-part portland cement to one and one-half parts fine sand with a one-to one (1:1) mixture of bonding admixture and water. Add white portland cement in amounts determined by trial patches so color of dry grout will match adjacent surfaces. Scrub grout into voids and remove excess grout. When grout whitens, rub surface with clean burlap and keep surface damp by spraying for at least thirty-six (36) hours.
 3. Cork-Floated Finish: Wet concrete surfaces and apply a stiff grout. Mix one-part portland cement and one-part fine sand with a one-to-one (1:1) mixture of bonding agent and water. Add white portland cement in amounts determined by trial patches so color of dry grout will match adjacent surfaces. Compress grout into voids by grinding surface. In a swirling motion, finish surface with a cork float.

- D. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

3.10 CONCRETE CURING AND SURFACE TREATMENTS

A. General:

1. Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Maintain concrete with minimal moisture loss at a relatively constant temperature for the period necessary for hydration of the cement and hardening of concrete.
2. Curing shall commence as soon as free water has disappeared from the concrete surface after placing and finishing. The curing period shall be seven days for all concrete unless test cylinders, made and kept adjacent to the structure and cured by the same methods, are tested with the average compressive strength equal to seventy percent (70%) of the specified twenty-eight (28) day strength.
3. Curing shall be in accordance with ACI 301 procedures. Avoid rapid drying at the end of the curing period. During hot and cold weather, cure concrete in accordance with ACI 305R and ACI 306R.

- #### B. Curing Methods: Perform curing of concrete by moisture curing, by moisture-retaining cover curing, by curing compound, or by combinations thereof, as herein specified and in accordance with ACI 308.1. Coordinate with and choose a curing method that is compatible with the requirements for subsequent material usage on the concrete surface.

1. Provide moisture retaining cover curing as follows: Cover concrete surfaces with a moisture-retaining cover for curing concrete, placed in widest practical width with sides and ends lapped at least three inches (3") and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
2. Provide curing and sealing compound to interior slabs left exposed, and to exterior slabs, walks and curbs as follows:
 - a. Apply specified curing and sealing compound to concrete slabs as soon as final finishing operations are complete. Apply uniformly in continuous operation by power-spray or roller in accordance with manufacturer's directions. Recoat areas subjected to rainfall within three hours after initial application.
 - b. Maintain continuity of coating and repair damage during period.
 - c. Do not use membrane curing compounds on surfaces which are to be covered with materials applied directly to concrete: liquid floor hardener, waterproofing, damp proofing, painting, and other coating and finish materials.

- C. Curing Formed Surfaces: Where wooden forms are used, cure formed concrete surfaces by moist curing with forms in place for full curing period or until forms are removed. When forms are removed, continue curing by methods specified above for specified curing time.
- D. Curing Unformed Surfaces:
 - 1. Cure unformed surfaces, such as slabs, floor topping, and other flat surfaces by application of appropriate curing method.

3.11 JOINTS

- A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.
- B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by the Project Manager.
 - 1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of strip placements of floors and slabs.

3.12 FORM REMOVAL

- A. Removal of Forms: Supplement and Modify ACI 301 as follows:
 - 1. ACI 301 4.5.4: Formwork not supporting weight of concrete such as sides of grade beams, walls, and similar parts of the work, may be removed after cumulatively curing at not less than fifty degrees (50°) F for twenty-four (24) hours after placing the concrete provided:
 - a. The concrete is sufficiently cured to be undamaged by form removal.
 - b. Required shores and supports are so arranged that they will not be loosened or disturbed during form removal.
 - c. Supplemental curing and protection is provided for exposed concrete surfaces.

3.13 ANTI-GRAFFITI COATING

- A. Apply to surfaces/elements indicated on drawings. Install per manufacturer's instructions following manufacturer-recommended concrete cure period.

3.14 CONCRETE SURFACE REPAIRS

- A. Defective Concrete: Repair and patch defective areas when approved by the Project Manager. Remove and replace concrete that cannot be repaired and patched to the Project Manager's approval.
- B. Patching Mortar: Mix dry-pack patching mortar, consisting of one-part portland cement to two and one-half parts fine aggregate passing a Number sixteen (#16) sieve,

using only enough water for handling and placing. Achieve approval of the Project Manager prior to any patching as to location of patches and patch material.

- C. Patch Testing: On a portion of the work which will, in the finished condition, be concealed, test patch materials and methods and obtain the Project Manager's approval prior to patching concrete surfaces needing repair that will be visible in the final construction.
- D. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.
 - 1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than one half inch (1/2") in any dimension to solid concrete. Limit cut depth to three quarter inches (3/4"). Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
 - 2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement so that, when dry, patching mortar will match surrounding color and texture. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.
 - 3. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by the Project Manager.
- E. Repairing Unformed Surfaces: Test unformed surfaces, such tops of walls, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped for trueness of slope and smoothness; use a sloped template.
 - 1. After obtaining approval of the Project Manager, repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks more than one-one hundredths inch (0.01") wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
 - a. If, after repairs are complete, the Project Manager deems the repairs did not successfully correct the original deficiencies, the pavement or concrete element in question is to be removed and replaced per Subsection 3.13. E.1. above.
 - 2. After concrete has cured at least fourteen (14) days, test for low and high spots in finished surface. Areas that do not conform to the tolerances set forth in Division 32 and in other reference standards identified in this specification are to be sawcut to the nearest joint as approved by the Project Manager, defective concrete removed, and new conforming paving reinstalled. Color and finish is to match adjacent concrete.

3. If approved by the Project Manager, repair random cracks and single holes one inch (1") or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least seventy-two (72) hours.
 - F. Perform structural repairs of concrete, subject to the Project Manager's approval, using epoxy adhesive and patching mortar.
 - G. Repair materials and installation not specified above may be used, subject to Project Manager approval.
- 3.15 CLEANING
- A. Perform cleaning during installation of the Work and upon completion of the Work. Remove all excess materials, debris, and equipment from the site. Repair any damage resulting from installation of the concrete.
 - B. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.
- 3.16 PROTECTION
- A. Protect concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.
 - B. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material.
- 3.17 ACCEPTANCE
- A. Concrete work will be accepted when it meets the specified strength and all other requirements of this specification.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

- A. Measurement will be made by the contract unit specified for Cast-in-Place Concrete. Measurement shall include the actual number of units of specified material(s) placed and accepted at the locations shown on the Contract Drawings, or as directed by the Project Manager, and in accordance with the Specifications.

4.2 PAYMENT

- A. Payment will be made at the contract unit price, and shall include required materials, transportation, equipment, labor, excavation, stockpiling, disposing, hauling off, watering, dust control, erosion and sediment control, compaction, sub-grade preparation, formwork, placing of concrete, reinforcing, joints, curing, finishing and all other items required to complete the work as required in accordance with the Contract Drawings and Specifications.

END OF SECTION 03 30 00

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Contract Drawings and general provisions of the Contract, including General and Supplementary Conditions and the City and County of Denver Standard Specifications for Construction General Contract Conditions (2011).
- B. City and County of Denver Engineering Division, Wastewater Capital Project Management Standard Construction Specifications, dated March 15, 2016.
- C. Wastewater Capital Projects Management Special Project Provisions for Asbury & Tejon.
- D. Wastewater Capital Projects Management Supplemental Technical Specifications for Asbury & Tejon
- E. Denver Parks and Recreation Asbury and Tejon Specifications, OCT 2018.

1.2 SUMMARY

- A. This Section includes requirements for furnishing, hauling, and applying water required for compaction of embankments, backfills, sub-grade, and for landscaping, dust control, and other construction operations.
- B. Related Sections:
 - 1. WCPM Standard Construction Specification 2.0 Section "Site Preparation".
 - 2. WCPM Supplemental Technical Specification 31 23 00 "Earthwork".
 - 3. WCPM Supplemental Technical Specification 31 23 19 "Water Control and Dewatering".
 - 4. WCPM Standard Construction Specification 23.0 Section "Storm Water Management".
 - 5. DPR Division 32 15 40 Section "Crushed Stone Paving".
 - 6. DPR Division 32 92 19 Section "Turfgrass Seeding".
 - 7. DPR Division 32 92 20 Section "Native Seeding".
 - 8. DPR Division 32 92 23 Section "Sodding".
 - 9. DPR Division 32 93 00 Section "Trees Plants & Groundcovers".

PART 2 - PRODUCTS

2.1 WATER

- A. If water supply is from a hydrant, the Contractor shall supply a Denver Water approved and calibrated water meter to measure water usage. The contractor shall be responsible to pay all costs related to water usage. The cost of water shall be charged at the current City and County of Denver rate through Denver Water.
- B. Water applied for moisture density control, pre-wetting, and as dust palliative shall be free of debris, organic matter, and other objectionable substances.
- C. Water for landscaping shall be free from oils, acids, salts or any substance that may be harmful to plant life. Non-potable water may be accepted on a case-by-case basis as approved by Project Manager.
- D. When the water source proposed for use by the Contractor is not known, the Contractor shall provide an analysis of water samples from an approved testing laboratory. The analysis shall be provided to the Project Manager prior to use.

PART 3 - EXECUTION

3.1 WATER TRUCK

- A. At least one water truck shall be on site or as directed by Project Manager.
 - 1. Truck shall have capacity of at least one-thousand (1,000) gallons or be of adequate size related to the scope of work or as directed by the Project Manager.
 - 2. Water is to be metered for measurement, the Contractor shall provide and use an approved Denver Water metering device.
 - 3. Monthly water usage readings either from the vehicle or from a meter are to be provided to the Project Manager

3.2 APPLICATION

- A. Pressure type distributors or a pipeline equipped with sprinkler system.
- B. Moisture and Density Control: Ensure a uniform and controlled application of water without ponding or causing erosion for optimum moisture content.
- C. Pre-wetting: Pre-wetting material in excavation areas prior to or during removal; and for placement of fill in embankments will be allowed as approved by the Construction Project Manager. If required, and prior to excavation operations, the Contractor may drill, bore or dig test holes to the full depth of excavation to determine moisture requirements. The contractor will identify and confirm with the Construction Project

Manager the areas for pre-wetting, including equipment to be used for the pre-wetting operations.

- D. Landscape Watering: The Contractor shall provide water for seeding, mulching, planting, transplanting, sodding, herbicide treatment, maintenance operations including watering during warranty periods or any other landscape related activities when called out on the Contract Drawings or Specifications.
- E. If overwatering occurs during any of the above operations, the contractor de-water at no additional expense to the City.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

- A. There shall be no measurement for this item, as watering is incidental to all of the work as outlined in the Contract Documents and Plans.
- B. All costs associated with watering shall be included in the cost of the associated work and shall be borne by the Contractor.

END OF SECTION 31 32 50

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Contract Drawings and general provisions of the Contract, including General and Supplementary Conditions and the City and County of Denver Standard Specifications for Construction General Contract Conditions (2011).
- B. City and County of Denver Engineering Division, Wastewater Capital Project Management Standard Construction Specifications, dated March 15, 2016.
- C. Wastewater Capital Projects Management Special Project Provisions for Asbury & Tejon.
- D. Wastewater Capital Projects Management Supplemental Technical Specifications for Asbury & Tejon
- E. Denver Parks and Recreation Asbury and Tejon Specifications, OCT 2018.

1.2 SUMMARY

- A. This Section includes the requirements for furnishing and placing crushed aggregate, bonded with fine aggregate, constructed on a prepared underlying course in accordance with these specifications and in conformity with the dimensions, typical cross section, and the lines and grades shown on the Contract Drawings. The locations where aggregate base course will be used is shown on the Contract Drawings.
- B. Related Sections:
 - 1. General Contract Conditions Title 3, section 309 "Contractor Submittals and other Written Communications to the City"
 - 2. General Contract Conditions Title 4, section 405 "Shop Drawings, Product Data, and Samples"
 - 3. WCPM Standard Construction Specification 2.0 Section "Site Preparation".
 - 4. WCPM Standard Construction Specification 23.0 "Storm Water Management"
 - 5. WCPM Standard Construction Specification 47.0 "Construction Survey and Monumentation"
 - 6. WCPM Supplemental Technical Specification 31 23 00 "Earthwork".
 - 7. WCPM Supplemental Technical Specification 31 23 19 "Water Control and Dewatering".
 - 8. Division 01 45 16 Section "Contractor Quality Control".
 - 9. Division 03 30 00 Section "Cast-In-Place Concrete".
 - 10. Division 32 13 13 Section "Concrete Walks, Curbs, and Miscellaneous Flatwork".

1.3 SUBMITTALS

- A. Certification: Contractor shall provide a certificate of compliance for any imported Aggregate Base Course materials.
- B. Gradation and Standard Proctor Density Test Results: For imported backfill materials, at a minimum, submit results of gradation tests and standard proctor density test.
- C. Sample: Provide a 1-pound (1#) sample of material(s) for approval.

PART 2 - PRODUCTS

2.1 AGGREGATE BASE COURSE

- A. Aggregate base course shall meet the requirements of Item 703.03 of the Standard Specifications for Road and Bridge Construction of the Colorado Department of Highways, latest revision for Class five (5) or Class (6), or as specified by the Soils Engineer and on Contract Drawings.

2.2 RECYCLED CONCRETE

- A. May be substituted for five (5) or Class (6) Aggregate, if acceptable to the Project Manager.

2.3 AGGREGATE

- A. The use of this term implies the use of Aggregate Base Course within this Section only.

PART 3 - EXECUTION

3.1 EQUIPMENT

- A. All equipment necessary for the proper construction of this work shall be in working condition, and shall be free of fluid leaks. Project Manager reserves the right to have any piece of equipment removed from the site if it is deemed inoperable and/or is leaking fluids.

3.2 PREPARING SUBGRADE

- A. The underlying subgrade or base course shall be tested at the Contractors expense and accepted by the Project Manager before placing and spreading operations are started. See Division 01 Section "Contractor Quality Control".

3.3 METHOD OF SPREADING

- A. The aggregate material shall be placed on the prepared underlying course and compacted in layers not to exceed six-inches (6") in depth before compaction. The depositing and spreading of material shall commence where designated and shall progress continuously without breaks. The material shall be deposited and spread in a uniform layer and without segregation of size to a uniform thickness.
- B. The aggregate spread shall be of uniform grading with no pockets of fine or coarse materials. During the spreading process, sufficient caution shall be exercised to prevent the incorporation of underlying materials in the aggregate.

3.4 COMPACTION OF AGGREGATE BASE COURSE

- A. When aggregate base course is used as part of asphalt roadway system (asphalt and base course composite section), the aggregate base course shall be compacted to 95% of Modified Proctor per ASTM D-1557, within 2% of optimum moisture.
- B. Aggregate material shall be placed and mixed in evenly spread layers. After each fill layer has been placed, it shall be uniformly compacted. Fill materials shall be placed such that the thickness of loose material does not exceed eight-inches (8") and the compacted lift thickness does not exceed six-inches (6").
- C. Compaction shall be obtained by the use of vibratory rollers, multiple-wheel pneumatic-tired rollers, or other equipment approved by the Project Manager. Granular fill shall be compacted using vibratory equipment or other equipment approved by the Project Manager. Compaction of each layer shall be continuous over the entire area. Compaction equipment shall make sufficient passes to ensure that the required density is obtained.
- D. Prior to placement of any base or surfacing materials, one-hundred percent (100%) of the subgrade shall be proof rolled with a fully loaded tandem-axle truck.

3.5 CLEANING

- A. Perform cleaning during installation of the Work and upon completion of the Work. Remove all excess materials, debris, and equipment from site. Repair any damage resulting from installation of aggregate base course.

3.6 PROTECTION AND MAINTENANCE

- A. Spreading of aggregate shall not take place when temperatures are below freezing. When the aggregate base course contains frozen material or the underlying subgrade is frozen, construction shall not occur.

- B. Following the completion of the aggregate base course, the Contractor shall perform all maintenance work necessary to keep the aggregate in a satisfactory condition until final acceptance of the project. The surface shall be kept clean and free from foreign material. The aggregate base course shall be properly drained at all times. Any work, maintenance or necessary repairs shall be performed at the expense of the Contractor.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

- A. There shall be no measurement for this item
- B. All costs associated with aggregate shall be included in the cost of the appropriate bid item where aggregate is required.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Contract Drawings and general provisions of the Contract, including General and Supplementary Conditions and the City and County of Denver Standard Specifications for Construction General Contract Conditions (2011).
- B. City and County of Denver Engineering Division, Wastewater Capital Project Management Standard Construction Specifications, dated March 15, 2016.
- C. Wastewater Capital Projects Management Special Project Provisions for Asbury & Tejon.
- D. Wastewater Capital Projects Management Supplemental Technical Specifications for Asbury & Tejon
- E. Denver Parks and Recreation Asbury and Tejon Specifications, OCT 2018.

1.2 SUMMARY

- A. This Section includes requirements for furnishing, placing, shoring, bracing, and anchorage of formwork, concrete reinforcement, accessories, and placing concrete flatwork, including walks, curbs and gutters, ramps, and pans, including installation of control and expansion joints, concrete curing and concrete finishing.
- B. Related Sections:
 - 1. General Contract Conditions Title 3, section 309 "Contractor Submittals and other Written Communications to the City"
 - 2. General Contract Conditions Title 4, section 405 "Shop Drawings, Product Data, and Samples"
 - 3. WCPM Standard Construction Specification 2.0 Section "Site Preparation".
 - 4. WCPM Standard Construction Specification 23.0 "Storm Water Management"
 - 5. WCPM Standard Construction Specification 47.0 "Construction Survey and Monumentation"
 - 6. WCPM Supplemental Technical Specification 31 23 00 "Earthwork".
 - 7. WCPM Supplemental Technical Specification 31 23 19 "Water Control and Dewatering".
 - 8. Division 01 45 16 Section "Contractor Quality Control".
 - 9. Division 03 30 00 Section "Cast-In-Place Concrete".
 - 10. Division 32 11 16 Section "Aggregate Base Course"

1.3 REFERENCES

- A. Project Geotechnical Report (Kumar 2017).
- B. Note: All references below shall be from the most current edition.
- C. American Concrete Institute (ACI):
 - 1. ACI 117 - Standard Tolerances for Concrete Construction and Materials.
 - 2. ACI 301 - Specifications of Structural Concrete for Buildings.
 - 3. ACI 304 - Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete.
 - 4. ACI 305 and 306 - Hot and Cold Weather Protection for Concrete.
 - 5. ACI 315 - Details and Detailing of Concrete Reinforcement.
 - 6. ACI 318 - Building Code Requirements for Reinforced Concrete.
 - 7. ACI 347 - Recommended Practice for Concrete Formwork.
- D. American Society for Testing and Materials (ASTM):
 - 1. ASTM A615 - Deformed and Plain Billet-Steel for Concrete Reinforcement.
 - 2. ASTM C33 - Concrete Aggregates.
 - 3. ASTM C94 - Ready-Mixed Concrete.
 - 4. ASTM C150 - Portland Cement.
 - 5. ASTM C260 - Air Entraining Admixtures for Concrete.
 - 6. ASTM C494 - Water Reducing Admixtures for Concrete.
 - 7. ASTM C618 - Fly Ash Mineral Admixture for Concrete.
 - 8. ASTM C672 - Scaling Resistance of Concrete Surfaces Exposed to Deicing Chemicals.
 - 9. ASTM-C800 - Curing Compound, Concrete, for New and Existing Surfaces.
 - 10. ASTM C1059 - Standard Specification for Latex Agents for Bonding Fresh to Hardened Concrete
 - 11. ASTM-C1315 - Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete
- E. Concrete Reinforcing Steel Institute (CRSI) - Manual of Standard Practice.
- F. Colorado Department of Transportation (CDOT) – Standard Specifications for Road and Bridge Construction, latest edition
- G. National Ready Mixed Concrete Association (NRMCA)

1.4 QUALITY CONTROL

- A. Pre-Construction Conference: Conduct conference at location approved by the Project Manager.

1. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with concrete to attend, including the following:
 - a. Contractor's superintendent.
 - b. Independent testing agency responsible for concrete design mixtures.
 - c. Ready-mix concrete manufacturer.
 - d. Concrete subcontractor.
 - e. Special concrete finish subcontractor.
2. Review special inspection and testing and inspecting agency procedures for field quality control, concrete finishes and finishing, cold- and hot-weather concreting procedures, curing procedures, construction contraction and isolation joints, and joint-filler strips, semi-rigid joint fillers, forms and form removal limitations, shoring and reshoring procedures, vapor-retarder installation, anchor rod and anchorage device installation tolerances, steel reinforcement installation, concrete repair procedures, and concrete protection.

1.5 SUBMITTALS

- A. Qualification Data: Installer to document for Owner's Representative experience on projects of similar scope and scale successfully completed within the past five (5) years.
- B. Product Data and Material Certificates: For each type of product and material indicated on the plans and in this specification.
- C. Mix Designs:
 1. Submit substantiating data for each concrete mix design specified for use to the Project Manager not less than four (4) weeks prior to first concrete placement. Data for each mix shall, as a minimum, include the following per section 2.7.B:
 - a. Mix identification designation (unique for each mix submitted).
 - b. Statement of intended use for mix.
 - c. Mix proportions.
 - d. Aggregates.
 - e. Admixtures (must be approved by the Project Manager)
 - f. Wet and dry unit weight.
 - g. Entrained air content.
 - h. Design slump.
 - i. Strength qualification data.
- D. Material Test Reports: For the following, from a qualified testing agency, indicating compliance with requirements:
 1. Aggregates. Include service record data indicating absence of deleterious expansion of concrete due to alkali aggregate reactivity.

CONCRETE WALKS, CURBS, AND MISCELLANEOUS FLATWORK

32 13 13 - 3

Asbury and Tejon OCT 2018

- E. Field quality-control reports.
- F. Minutes of Pre-Construction conference.

1.6 DELIVERY, STORAGE AND HANDLING

- A. General: Materials handling and batching shall conform to applicable provisions of ASTM C94.
- B. Reinforcing: Unload and store reinforcing bars so they are kept free of mud and damage.
- C. Hauling Time for Concrete: Deliver and discharge all concrete transmitted in a truck mixer, agitator, or other transportation device not later than one and one-half (1-1/2) hours from batch time, or three hundred (300) revolutions of the drum after the initial mixing water has been added, whichever is earliest.
- D. Extra Water:
 - 1. Deliver concrete to site in exact quantities required by design mix.
 - 2. Should extra water be required for workability before depositing concrete, and the water/cement ratio of accepted mix design will not be exceeded, the General Contractor's superintendent shall have the sole authority to authorize addition of water. *All additional water added to mix after leaving batch plant shall be indicated on truck ticket and signed by person responsible.*
 - 3. Where extra water is added to concrete it shall be mixed thoroughly for thirty (30) revolutions of drum before depositing.
 - 4. Water may be added at the site only once for each batch.
 - 5. A full set of tests shall be performed after addition of water. Excessive slump or other out of range tests will be cause for rejection.

1.7 PROJECT CONDITIONS

- A. Environmental Requirements:
 - 1. Cold Weather Placement:
 - a. When for three successive days prior to concrete placement the average daily outdoor temperature drops below forty degrees (40°) F or when the average outdoor temperature is expected to drop below forty degrees (40°) F on the day of concrete placement, preparation, protection and curing of concrete shall comply with ACI 306R.
 - b. Minimum temperature of concrete upon delivery shall conform to ACI 301 Table 7.6.1.1. Concrete at time of placement shall conform to minimum values of ACI 306R Table 1.4.1, and shall not exceed minimum values by more than twenty degrees (20°) F.

- c. Subject to acceptance of the Project Manager an accelerating admixture may be used. Admixtures shall meet requirements of Part 2. Calcium Chloride and other chloride-type accelerating admixtures are not allowed.
- 2. Hot Weather Placement:
 - a. When depositing concrete in hot weather, follow recommendations of ACI 305R.
 - b. When air temperatures on day of placement are expected to exceed ninety degrees (90°) F, mix ingredients shall be cooled before mixing. Flake ice or well-crushed ice of a size that will melt completely during mixing may be substituted for all or part of mix water.
 - c. Retarding admixture may be used subject to acceptance of the Project Manager. Admixtures shall meet requirements of Part 2.

1.8 RIGHT OF WAY WORK

- A. Contractor shall obtain all necessary permits when working with in the Right of Way.
- B. Contractor shall preserve and protect all permanent land survey control markers. Per the General Contract Conditions Article 319 "Preservation of Permanent Land Survey Control Markers".

1.9 WARRANTY/GUARANTEE

- A. All concrete work within the Park shall have a one (1) year warranty for material and installation from date of Final Acceptance.
- B. All concrete work within the Right of Way shall have a three (3) year warranty for material and installation from date of Final Acceptance.
- C. Expenses due to vandalism prior to Final Acceptance shall be the Contractor's responsibility.
- D. Any settling, or cracking during warranty period shall be repaired at no expense to the City, including complete restoration of any adjacent damaged property.

PART 2 - PRODUCTS

2.1 FORM MATERIALS

- A. Hand Placed Steel Forms: Hand placed steel forms are only to be used for sections that are straight and have no bend, radii or curvature in the sections to be used.

CONCRETE WALKS, CURBS, AND MISCELLANEOUS FLATWORK

32 13 13 - 5

Asbury and Tejon OCT 2018

- B. Wood Forms: Forms shall be made of solid one side grade, sound, undamaged lumber with straight edges.
 - 1. Curved elements (bends, radii, or curvature) shown on plans are to be constructed with smooth-curved plywood forms. Faceted forms composed of straight sections will not be accepted.
- C. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.
 - 1. Formulate form-release agent with rust inhibitor for steel form-facing materials.

2.2 STEEL REINFORCEMENT

- A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60; deformed.
- B. Epoxy-Coated Reinforcing Bars: ASTM A 775/A 775M or ASTM A 934/A 934M; with ASTM A 615/A 615M, Grade 60 (Grade 420) deformed bars.
 - 1. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating, compatible with epoxy coating on reinforcement.
- C. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60 (Grade 420) plain-steel bars. Cut bars true to length with ends square and free of burrs.
- D. Epoxy-Coated, Joint Dowel Bars: ASTM A 775/A 775M; with ASTM A 615/A 615M, Grade 60 (Grade 420), plain-steel bars.
- E. Tie Wire: ASTM A1064, minimum sixteen (16) gauge annealed type.
- F. Hook Bolts: ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6), internally and externally threaded. Design hook-bolt joint assembly to hold coupling against paving form and in position during concreting operations, and to permit removal without damage to concrete or hook bolt.
- G. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete specified, and as follows:
 - 1. Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.
 - 2. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.

2.3 CONCRETE MATERIALS

- A. Provide materials in accordance with ACI 301, unless amended or superseded by requirements of this section or general notes on structural drawings.
 - 1. General: Ready-mixed Concrete: ASTM C94. On-site mixed concrete not allowed.
 - 2. Cement: ASTM C150. Type II
 - 3. Fly Ash: ASTM C618 Class F.
 - 4. Aggregate: ASTM C33.
 - a. All sand and aggregates to meet C-33 Table 3 for Class 4S "Severe Weathering Region".
 - 1) Fine Aggregate: Clean, natural sand.
 - 2) Coarse Aggregate: Clean gravel or crushed stone.
 - 5. Water: ASTM C 94/C 94M, clean and not detrimental to concrete.

2.4 ADMIXTURES

- A. General: Unless specified, no admixtures may be used without specific approval of the Project Manager.
- B. Prohibited Products: Calcium chloride or admixtures containing more than 0.05% chloride ions or thiocyanates are not permitted.
- C. Color Admixture: Color Pigment: ASTM C 979, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable, nonfading, and resistant to lime and other alkalis.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Davis Colors.
 - b. Dayton Superior Corporation.
 - c. Scofield, L. M. Company.
 - 2. Color: Match Architect's sample.
- D. Air-Entraining Admixture: ASTM C260.
- E. Water Reducing Admixture: ASTM C494, Type A.
- F. High Range Water Reducing Admixture (Superplasticizer): ASTM C494, Type F or G.
- G. Warm weather admixtures: ASTM C494. Use of admixtures will not relax warm weather placement requirements.
- H. Cold Weather Admixtures: ASTM C494. Use of admixtures will not relax cold weather placement requirements.

2.5 CONCRETE MIX

- A. Refer to the Denver Right of Way Services approved materials list of pre-approved concrete mixes at the following website:

<https://www.denvergov.org/content/denvergov/en/right-of-way-services/engineering-regulatory-analytics/engineering-plan-review/manuals-regulations.html>

- B. All Concrete mixes from the approved list or submitted for approval shall meet the following criteria.
1. Mix concrete in accordance with ASTM C94 and ACI 301 Chapter 3.
 2. Cement Content: Type II cement, minimum of five hundred twenty-eight (528) pounds per cubic yard.
 3. Fly ash shall not exceed twenty (20%) of total cementitious material by weight unless approved by the Project Manager.
 4. Maximum water-cement ratio: 0.44.
 5. Slump: Four inches (4") maximum when hand placed.
 6. Air Entrainment: five percent (5%) to eight percent (8%).
 7. Aggregate Size: three quarter-inch (3/4") maximum.
 8. Concrete for Exterior Flatwork, including Pavement, Curb and Gutter, and Drainage Pans shall be Class P, as approved by the Project Manager.

2.6 FIBROUS CONCRETE REINFORCEMENT

- A. Shall be one hundred percent (100%) virgin polypropylene, fibrillated fibers containing no reprocessed olefin materials and specifically manufactured to an optimum gradation utilizing twenty-five (25) individual fiber designs for use as concrete secondary reinforcement. Volume per cubic yard shall be one and one-half (1.5) pounds, or in accordance with manufacturer's recommendations. Fiber manufacturer must document evidence of five (5) year satisfactory performance history, compliance with applicable building codes and ASTM C1116 Type III 4.1.3 and ASTM C1116 Performance Level I.
1. Fibrous concrete reinforcement shall be utilized in all flatwork applications.

2.7 EXPANSION JOINT MATERIAL

- A. Interior Use or Exterior Use where sealants are specified: Bituminous saturated fiber conforming to ASTM D1751, one half-inch (1/2") thick. Provide manufacturer's certification of compatibility with specified sealants where required.
- B. Pre-molded closed cell polyethylene foam backer rod if required.

- C. Joint Sealant: ASTM D 5893 Type NS, Silicone per CDOT's approved joint and crack sealant list. Where concrete color additive is used, sealant color to match adjacent concrete.

2.8 SLIP JOINTS

- A. Speed Dowel Model PSD09/#4TX, 9" long sleeve to accommodate 18" smooth steel round bar, 5/8" diameter. Manufactured by Sika/Greenstreak, or approved equal.

2.9 CURING MATERIALS

- A. Absorptive Cover: AASHTO M 182, Class 3, burlap cloth made from jute or kenaf, weighing approximately nine (9) oz./sq. yd. dry.
- B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- C. White, Waterborne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type two (2), Class B, dissipating.

2.10 RELATED MATERIALS

- A. Chemical Surface Retarder: Water-soluble, liquid, set retarder with color dye, for horizontal concrete surface application, capable of temporarily delaying final hardening of concrete to a depth of one eighth-inch (1/8") to one quarter-inch (1/4") to match the Project Manager's sample.

2.11 TRUNCATED DOME INSERTS FOR RAMPS

- A. All truncated domes within Parks maintained areas shall be unpainted grey cast iron plates conforming ASTM A-48 class 30.

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

- A. Requirements of Regulatory Agencies: Comply with all applicable provisions of the state and local building and safety codes.
- B. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from single source, and obtain admixtures from single source from single manufacturer, unless otherwise approved by Project Manager.

- C. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
 - 1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities" (Quality Control Manual - Section 3, "Plant Certification Checklist").
- D. Testing: All testing shall be completed by the Contractor at their expense unless otherwise specified by the contract.
- E. Testing Agency Qualifications: Engage a qualified testing agency to perform material evaluation tests and to design concrete mixtures. Qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.
 - 1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.
- F. Testing Frequency: Obtain at least one composite sample for each one hundred (100) cubic yards, or fraction thereof of each concrete mixture placed each day.
 - a. When frequency of testing will provide fewer than five (5) compressive-strength tests for each concrete mixture, testing shall be conducted from at least five (5) randomly selected batches or from each batch if fewer than five (5) are used.
 - 2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one (1) test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
 - 3. Air Content: ASTM C 231, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
 - 4. Compression Test Specimens: ASTM C 31/C 31M; cast and laboratory cure one (1) set of four (4) standard cylinder specimens for each composite sample.
 - 5. Compressive-Strength Tests: ASTM C 39/C 39M; test one specimen at seven days and two specimens at twenty-eight (28) days and keep one for backup in the event a sample should break.
 - a. A compressive-strength test shall be the average compressive strength from two specimens obtained from same composite sample and tested at twenty-eight (28) days.
- G. Strength of each concrete mixture will be satisfactory if average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than two-hundred (200) psi.
- H. Test results shall be reported in writing to Project Manager, concrete manufacturer, and Contractor within forty eight (48) hours of testing. Reports of compressive-

CONCRETE WALKS, CURBS, AND MISCELLANEOUS FLATWORK

32 13 13 - 10

Asbury and Tejon OCT 2018

strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at twenty eight (28) days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both seven (7) and twenty eight (28) day tests.

- I. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Project Manager.
- J. Concrete work will be considered defective if it does not pass tests and inspections.
- K. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
- L. Prepare test and inspection reports.
- M. Record of Work: A record shall be kept by the Contractor listing the time and date of placement of all concrete for the structure. Such record shall be kept until the completion of the project and shall be available to the Project Manager for examination at any time.
- N. Mockups: If requested by the Project Manager, prior to starting any concrete work, provide a sample panel using materials indicated for project work. For each type, color and finish of concrete specified, build panel at the site of full thickness and approximately ten feet (10') by 10 feet (10'), including expansion joints, control joint, scales, fillers, and one radial edge. Provide the workmanship proposed for the work. Correct and replace sample panel until Project Manager's acceptance of the work. Retain panel(s) during construction as a standard for completed paving work.
 - 1. Build panel approximately one-hundred (100) sq. ft. in the location indicated or, if not indicated, as directed by Project Manager.
 - 2. Approved mockups may become part of the completed Work if approved prior to the construction of the mock up and is undisturbed at time of Substantial Completion.
 - 3. Notify the Project Manager a minimum of seven (7) days in advance of dates and times when mockups will be constructed.
 - 4. Obtain the Project Manager's written approval of the mockups before starting construction.
 - 5. If the Project Manager determines that the mockup does not meet the requirements, demolish and remove from the site and cast another until the mockup is approved.
 - 6. Maintain the mockups during construction in an undisturbed condition as a standard for judging the completed Work.
 - 7. Demolish and remove mockups when directed by Project Manager.

CONCRETE WALKS, CURBS, AND MISCELLANEOUS FLATWORK

32 13 13 - 11

Asbury and Tejon OCT 2018

- O. Tolerances: Comply with tolerances in ACI 117, the Contract Drawings, and as follows:
 - 1. Elevation and Cross-slope: In conformance with grading plans and ADA.
 - 2. Thickness: Plus, three eighths-inch (3/8"), minus one quarter-inch (1/4").
 - 3. Surface: Gap below ten feet (10') long, unlevelled straightedge not to exceed one eighty -inch (1/8").
 - 4. Lateral Alignment and Spacing of Dowels: one-inch (1").
 - 5. Vertical Alignment of Dowels: one quarter-inch (1/4").
 - 6. Joint Spacing: three-inches (3").
 - 7. Contraction Joint Depth: Plus, one quarter-inch (1/4"), no minus.
 - 8. Joint Width: Plus, one eighth-inch (1/8"), no minus.

3.2 PREPARATION OF SUBGRADE

- A. Excavate to required depth in accordance with geotechnical report. Remove soft, yielding material and replace with select fill. Compact to minimum ninety-five percent (95%) Standard Proctor within two percent (2%) of optimum moisture.
- B. Refer to WCPM Supplemental Technical Specification 31 23 00 "Earthwork" for requirements for subgrade testing and proof-rolling.
- C. Maintain subgrade in a compacted condition until concrete is placed.

3.3 FORMS

- A. Metal, plastic or uniform warp free lumber, coated with form release agent. Slope forms to give slabs positive drainage and stake securely. Obtain approval of Project Manager for alignment and grade of forms a minimum of forty-eight (48) hours prior to placing concrete. Any concrete work installed without obtaining approval from the Project Manager shall be subject to removal and replacement at the discretion of the Project Manager, at no cost to the City.
- B. Radii shall be continuous and flowing to avoid angular intersections in the horizontal alignment, radial forming shall use bender board or approved equal as directed by Project Manager.

3.4 STEEL REINFORCEMENT

- A. Install steel reinforcement only in locations shown on Contract Drawings.
- B. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
- C. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.

- D. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.

3.5 CONCRETE PLACEMENT

- A. Prior to placing any new sections of concrete pavement, the entire subgrade shall be scarified to a depth of 6-inches and recompact. In areas where existing pavement is to be removed and replaced the existing compacted subgrade may be reused if the subgrade meets specified compaction. In areas of existing subgrade that do not meet the specified compaction, materials shall be removed, replaced and compacted to meet the specified proctor density. Adjust moisture content and compact as hereinafter specified.
- B. Before placing concrete, inspect and complete formwork installation, steel reinforcement (if present), and items to be embedded or cast-in.
- C. Do not place concrete on frozen surfaces.
- D. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.
- E. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.
- F. Do not add water to concrete during delivery.
- G. Deposit and spread concrete in a continuous operation between transverse joints. Do not use vibratory equipment to move concrete into place.
- H. Consolidate concrete according to ACI 301 by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.
 - 1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating reinforcement, dowels, and joint devices.
- I. Screed paving surface with a straightedge and strike off.
- J. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

- K. Curbs and Gutters: Use design mixture for automatic machine placement. Produce curbs and gutters to required cross section, lines, grades, finish, and jointing.
- L. Slip-Form Paving: Use design mixture for automatic machine placement. Produce paving to required thickness, lines, grades, finish, and jointing.
 - 1. Compact subbase and prepare subgrade of sufficient width to prevent displacement of slip-form paving machine during operations.
- M. Cold-Weather Placement: Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures. Comply with ACI 306.1 and the following:
 - 1. When air temperature has fallen to or is expected to fall below forty degrees (40°) F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than fifty degrees (50°) F and not more than eighty degrees (80°) F at point of placement.
 - 2. If subgrade is frozen, as determined by Geotechnical Engineer and/or Project Manager, thaw subgrade to depth of eight (8") prior to placing concrete.
 - 3. Do not use frozen materials or materials containing ice or snow.
 - 4. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in design mixtures.
- N. Hot-Weather Placement: Comply with ACI 301 and as follows when hot-weather conditions exist:
 - 1. Cool ingredients before mixing to maintain concrete temperature below ninety degrees (90°) F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated in total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
 - 2. Cover steel reinforcement with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
 - 3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

3.6 CONCRETE FINISHING

- A. Allow time for bleed water to appear, then scrape or push off all bleed water. Do not work water into surface.
- B. Final level, light bull float, but do not trowel surface.
- C. After darbying or bullfloating, stop finishing until bleeding has ceased and until concrete can support foot pressure with only about one eighth-inch (1/8") indentation.

CONCRETE WALKS, CURBS, AND MISCELLANEOUS FLATWORK

32 13 13 - 14

Asbury and Tejon OCT 2018

During or after the first floating, check planeness of surface with a ten foot (10') straightedge applied at not less than two different angles, and then cut down all high spots and fill all low spots to achieve a true plane within one eighth-inch (1/8") in ten feet (10').

D. Finishes:

1. Medium Broom Finish: Provide a medium broom finish for all exterior concrete unless otherwise noted. Immediately after float finishing and tool work, roughen surface with fiber-bristle broom to match the approved mockup panel. Confirm direction or pattern of broom finish with the Project Manager prior to commencing slab placement.
2. Monolithic Exposed-Aggregate Finish: Expose coarse aggregate in paving surface as follows:
 - a. Immediately after float finishing, spray-apply chemical surface retarder to paving according to manufacturer's written instructions.
 - b. Cover paving surface with plastic sheeting, sealing laps with tape, and remove when ready to continue finishing operations.
 - c. Without dislodging aggregate, remove mortar concealing the aggregate by lightly brushing surface with a stiff, nylon-bristle broom. Do not expose more than one-third of the average diameter of the aggregate and not more than one-half of the diameter of the smallest aggregate.
 - d. Fine-spray surface with water and brush. Repeat cycle of water flushing and brushing until cement film is removed from aggregate surfaces to depth required.
3. Seeded Exposed-Aggregate Finish:
 - a. Immediately after initial floating, spread a single layer of aggregate uniformly on paving surface. Tamp aggregate into plastic concrete and float finish to entirely embed aggregate with mortar cover of one sixteenth-inch (1/16").
 - b. Spray-apply chemical surface retarder to paving according to manufacturer's written instructions.
 - c. Cover paving surface with plastic sheeting, sealing laps with tape, and remove sheeting when ready to continue finishing operations.
 - d. Without dislodging aggregate, remove mortar concealing the aggregate by lightly brushing surface with a stiff, nylon-bristle broom. Do not expose more than one-third of the average diameter of the aggregate and not more than one-half (1/2) of the diameter of the smallest aggregate.
 - e. Fine-spray surface with water and brush. Repeat cycle of water flushing and brushing until cement film is removed from aggregate surfaces to depth required.

- E. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a three eighths-inch (3/8") radius. Final concrete finish to completed following jointing. Surface/edging tool marks are not acceptable.
- F. Accessible Ramps:
 - 1. Install per the Denver Public Works Transportation Standards and Details.
 - a. Install cast iron truncated plates in all Parks maintained areas in accordance with Denver Public Works Standards.
- G. Do not use evaporative retarders as finishing aid.

3.7 CONCRETE CURING AND SURFACE TREATMENTS

- A. General:
 - 1. Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Maintain concrete with minimal moisture loss at a relatively constant temperature for the period necessary for hydration of the cement and hardening of concrete.
 - 2. Curing shall commence as soon as free water has disappeared from the concrete surface after placing and finishing. The curing period shall be seven days for all concrete unless test cylinders, made and kept adjacent to the structure and cured by the same methods, are tested with the average compressive strength equal to seventy percent (70%) of the specified twenty-eight (28) day strength.
 - 3. Curing shall be in accordance with ACI 301 procedures. Avoid rapid drying at the end of the curing period. During hot and cold weather, cure concrete in accordance with ACI 305R and ACI 306R.
- B. Curing Methods: Perform curing of concrete by curing and sealing compound, by moisture curing, by moisture-retaining cover curing, or by combinations thereof, as herein specified. Coordinate with and choose a curing method that is compatible with the requirements for subsequent material usage on the concrete surface.
 - 1. Provide curing and sealing compound to exterior slabs, walks, curbs, etcetera as follows:
 - a. Apply specified curing and sealing compound to concrete slabs as soon as final finishing operations are complete. Apply uniformly in continuous operation by power-spray or roller in accordance with manufacturer's directions. Recoat areas subjected to rainfall within three hours after initial application.
 - b. Maintain continuity of coating and repair damage during period.
 - 2. Provide moisture curing by one of the following methods:
 - a. Keep concrete surface continuously wet by covering with water.
 - b. Continuous water-fog spray.
 - c. Covering concrete surface with specified absorptive cover, thoroughly saturating cover with water and keeping it continuously wet. Place

CONCRETE WALKS, CURBS, AND MISCELLANEOUS FLATWORK

32 13 13 - 16

Asbury and Tejon OCT 2018

absorptive cover to provide coverage of concrete surfaces and edges, with 4-inch lap over adjacent absorptive covers.

3. Provide moisture retaining cover curing as follows: Cover concrete surfaces with a moisture-retaining cover for curing concrete, placed in widest practical width with sides and ends lapped at least 3-inches and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.

- C. Curing Formed Surfaces: Where wooden forms are used, cure formed concrete surfaces by moist curing with forms in place for full curing period or until forms are removed. When forms are removed, continue curing by methods specified above for specified curing time.

3.8 JOINTS

- A. Construct joints true to line with faces perpendicular to surface.
- B. Expansion Joints: Expansion joint material shall be provided at the following locations and shall be in place prior to the placing of concrete:
 1. As shown on the Contract Drawings; or
 2. At each end of curb return.
 3. Between sidewalk and driveway slabs or service walks.
 4. Between new concrete and existing concrete.
 5. Between new concrete and fixed vertical objects.
 6. At maximum one hundred twenty foot (120') spacing.
 7. Provide half-inch (1/2") thick by depth of the slab material, allow half-inch (1/2") thickness for joint sealer.
 8. As directed by Project Manager.
 9. Thoroughly clean all surfaces prior to installation of sealant material.
- C. Slip Joints:
 1. To be used at all Expansion Joints except at buildings, curbs, ramps and stairs.
 2. Dowels to be placed no closer than twelve-inches (12") from edge of concrete and twenty-four-inches (24") on-center.
 3. Attach bases to the face of concrete forms using a double-headed nail or self-tapping screw.
 4. Center of base shall be centered on form.
 5. Prior to placing concrete, Speed Dowel sleeve shall be slipped over base.
 6. Concrete shall not be placed directly over the Speed Dowel System. Place concrete minimum eighteen-inches (18") from Speed Dowel system and work concrete around the Speed Dowel System.
 7. Concrete forms shall be removed with bases still attached. Bases may be reused.
 8. Install slip dowels to the full depth of the embedded Speed Dowel sleeve and proceed with next concrete pour.

CONCRETE WALKS, CURBS, AND MISCELLANEOUS FLATWORK

32 13 13 - 17

Asbury and Tejon OCT 2018

9. Greasing of dowels is not required. Embedded Speed Dowel Sleeve accommodates expansion and shrinkage movements that may occur.
 10. Bent or badly sheared slip dowels shall not be used. Saw cut dowels recommended, deburr ends.
 11. Place edge forms plumb. Out of plumb forms may result in misaligned dowels.
- D. Contraction (Control) Joints in Walks: Contraction joints shall be formed with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut one eighth-inch (1/8") wide joints into concrete that has hardened sufficiently that cutting action will not tear, abrade, or otherwise damage surface, but before development of random contraction cracks. Saw cut joints shall be spaced at a distance equal to the width of the walk, but not over ten feet (10') unless approved by the Project Manager. Depth of joints shall be one-fourth (1/4) the slab thickness.
1. Tooled joints will not be allowed on concrete trails, unless directed by the Project Manager.
- E. Curb and Gutter Contraction (Control) Joints: Space curb and gutter joints not more than twelve foot six-inches (12'-6") on center, and align them with sidewalk joints. Contraction joints shall be tooled. Form plane of weakness by inserting and later removing a metal divider, finish with an edger or groover, or by saw cutting a previously tooled joint.

3.9 FORM REMOVAL

- A. Remove forms after concrete surface is hard enough so as not to be damaged in any way. Reasonable care is to be used in removing forms. Repair minor defects with high strength grout as per Project Managers direction. Plastering will not be permitted on exposed faces.

3.10 CLEANING

- A. Perform cleaning during installation of the Work and upon completion of the Work. Remove all excess materials, debris, and equipment from the site. Repair any damage resulting from installation of the concrete.
- B. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

3.11 REPAIRS AND PROTECTION

- A. Remove and replace concrete paving that is broken, damaged, or defective or that does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Project Manager.

- B. Drill test cores, where directed by the Project Manager, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory paving areas with portland cement concrete bonded to paving with epoxy adhesive.
- C. Protect concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.
- D. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material.

3.12 ACCEPTANCE

- A. Concrete work will be accepted when it meets the specified strength and all other requirements of this specification.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

- A. Measurement will be made by the contract unit specified for Concrete Walks, Curbs and Miscellaneous Flatwork. Measurement shall include the actual number of units of specified material(s) placed and accepted at the locations shown on the Contract Drawings, or as directed by the Project Manager, and in accordance with the Specifications.

4.2 PAYMENT

- A. Payment will be made at the contract unit price, and shall include required materials, transportation, equipment, labor, excavation, stockpiling, disposing, hauling off, watering, dust control, erosion and sediment control, compaction, sub-grade preparation, formwork, placing of concrete, reinforcing, joints, curing, finishing and all other items required to complete the work as required in accordance with the Contract Drawings and Specifications.

END OF SECTION 32 13 13

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Contract Drawings and general provisions of the Contract, including General and Supplementary Conditions and the City and County of Denver Standard Specifications for Construction General Contract Conditions (2011).
- B. City and County of Denver Engineering Division, Wastewater Capital Project Management Standard Construction Specifications, dated March 15, 2016.
- C. Wastewater Capital Projects Management Special Project Provisions for Asbury & Tejon.
- D. Wastewater Capital Projects Management Supplemental Technical Specifications for Asbury & Tejon
- E. Denver Parks and Recreation Asbury and Tejon Specifications, OCT 2018.

1.2 SUMMARY

- A. This Section includes requirements for demolition, earthwork, grading, furnishing and placement of crushed stone paving.
 - 1. Furnish and place crushed stone paving, bonded with fine aggregate, constructed on a prepared underlying base course in accordance with these specifications and in conformity with the dimensions, typical cross section, and the lines and grades shown on the Contract Drawings. The locations where crushed stone paving will be used are shown on the Contract Drawings.
- B. Related Sections:
 - 1. WCPM Standard Construction Specification 2.0 Section "Site Preparation".
 - 2. WCPM Supplemental Technical Specification 31 23 00 "Earthwork".
 - 3. Denver Parks and Recreation Specification 32 33 00 "Site Furnishings"

1.3 REFERENCES

- A. ASTM C117 – Test Method for Materials Finer than No. 200 (75-um) Sieve in Mineral Aggregates by Washing.
- B. ASTM C136 – Method for Sieve Analysis of Fine and Coarse Aggregates.
- C. ASTM D4318 – Test Method for Liquid Limit, Plastic Limit and Plasticity Index of Soils.

1.4 SUBMITTALS

- A. Material Analysis: Contractor shall provide copies of the following test data required by ASTM:
 - 1. ASTM C136 - Sieve Analysis.
 - 2. ASTM C127 - Specific Gravity and Absorption.
 - 3. ASTM C131 - L.A. Abrasion.
- B. Samples: Provide a one (1) quart sample of material for approval.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of conformance with state and federal laws if applicable.
- B. Bulk Materials:
 - 1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas, plant materials or within critical root zones.
 - 2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
 - 3. Accompany each delivery of bulk materials with appropriate certificates.
- C. Rejection of material.
 - 1. Evidence of inadequate protection or improper handling or storage shall be cause for rejection.
 - 2. Any product or material exhibiting signs of damage due to nonconformity to specifications or due to delivery, storage or handling shall be rejected by the Project Manager. Contractor shall be responsible for hauling off-site and disposing of according to general conditions and codes of the governing jurisdiction.

1.6 PROJECT CONDITIONS

- A. Environmental requirements: Work shall occur only when weather and soil conditions permit in accordance with locally accepted practice.
- B. Field Measurements: Verify actual grade elevations, service and utility locations, irrigation system components, and dimensions of plantings and construction contiguous with proposed crushed stone paving areas by field measurements before proceeding with work.
- C. Interruption of Existing Services or Utilities: Do not interrupt services or utilities to facilities occupied by Owner or others.

- D. Existing Conditions:
 1. Utilities: Determine location of existing and proposed underground utilities. Perform work in a manner to avoid damage. Hand excavate, as required.
 2. Excavation: Maintain grade stakes set by others until removal is mutually agreed upon by parties concerned.

- E. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit Work to be performed when beneficial and optimum results may be obtained.

1.7 MAINTENANCE SERVICE

- A. General: Maintain Work
 1. Maintenance Period: Begin maintenance immediately after Work is completed. Maintain areas until the letter of acceptance.

1.8 WARRANTY

- A. Warranty shall be for installation defects identified for one (1) year, after Final Acceptance.

PART 2 - PRODUCTS

2.1 CRUSHED STONE PAVING

- A. Type: Crushed granite stone or gravel. Shall be unused material free of shale, lay, friable materials, organics and debris.
 1. Size Range: 3/8 inch maximum

<u>Sieve Size</u>	<u>Percent Passing</u>
2 inch	100
3/8 inch	100
No. 4	85
No. 8	63
No. 16	50
No. 30	39
No. 50	29
No. 100	18

2. Color: Uniform grey, tan-beige or as approved by the Project Manager.

2.2 SOIL STABILIZER

- A. Soil stabilizer or binder: Natracil by Gail Materials or approved equal.
 1. Local supplier:

2. Swell volume: 35 ml/gm minimum in accordance with USP procedures.
 3. 90% minimum shall pass a No. 40 mesh screen.
- B. Factory blended stabilized crushed stone paving. Provide in all locations shown on the drawings.
1. Mix crushed stone paving material with Natracil with a pug mill that includes a weigh-belt feeder.
 - a. Mix fourteen (14) pounds of binder per two thousand (2,000) pounds of aggregate.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas where the Work of this Section will be performed for compliance with requirements and conditions affecting installation and performance.
1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within the work area.
 2. Verify that final grades are completed in accordance with the drawings.
- B. Proceed with installation only after unsatisfactory conditions have been corrected and approved by Project Manager.

3.2 QUALITY CONTROL

- A. Mock-up: Provide field constructed sample installation of crushed stone paving, and prepared subgrade.
1. Mock-up to be ten-foot (10') x ten-foot (10') and located where directed by Project Manager. Mock-up shall include proposed edge and banding, and surface stabilization if specified.
 2. Project Manager shall review mock up within forty-eight (48) hours of notification by the contractor.
 3. Make necessary adjustments as directed by Project Manager.
 4. Obtain approval from Project Manager before proceeding with the Work.
 5. Retain and protect mock-up during construction as a standard for judging completed crushed stone paving work. Do not remove or destroy mock-up until work is completed.
 6. Accepted and properly maintained sample installations may remain in completed work if approved in writing by Project Manager.
 7. All work shall match accepted field mock-up.

3.3 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities, turf areas, existing landscape areas, and trees from damage.
- B. Install erosion-control measures to prevent erosion or displacement of soils.
- C. Install edging of type and in locations shown on drawings. Obtain acceptance of layout by Project Manager before excavating or installing. Make minor adjustments as required.

3.4 PLACEMENT OF CRUSHED STONE PAVING

- A. Cut earthwork to width of trail/area to receive crusher fines paving to approximate depth section as specified on the Contract Drawings. Remove, haul and dispose of excess material off site, or use on-site with approval of Project Manager.
- B. Complete excavation required in sub-grade before fine grading and final compaction of sub-grade is performed. Extend sub-grade compaction one foot (1') beyond proposed edge of crushed stone paving or as indicated on drawings.
 - 1. Where earthwork is required, the sub-grade shall be compacted to ninety five percent (95%) standard proctor within two percent (2%) of the optimum moisture.
 - 2. Keep areas being graded or compacted shaped and drained during construction. Ruts greater than or equal to one inch (1") deep in sub-grade shall be graded out and reshaped as required, and re-compacted before crushed stone paving placement.
 - 3. If the trail is part of a cross slope it should drain in the direction of the slope no greater than two percent (2%). Ensure that no low spots exist so that ponding does not occur.
- C. Prior to placement of Crushed Stone Paving material, the sub-grade shall be proof rolled. Where soft spots are detected, scarify subgrade beneath Crushed Stone Paving trail to a minimum of six-inch (6") depth. Moisture treat and compact to a minimum ninety five percent (95%) proctor density as determined by ASTM D698 or AASHTO T-99. Take moisture density tests every two hundred fifty (250) lineal feet of trail or proof roll. Treat and compact sub-grade, leaving it 5-inches below final grade for placement of Crushed Stone Paving. Compact material and retest by proof rolling to achieve approval of Project Manager.
- D. Install crushed stone paving only after excavation and construction work which might injure it have been completed, and after edging has been completely installed on the compacted sub-grade. Install crushed stone paving, over compacted base course in areas indicated on plan.

- E. Spread crushed stone evenly in 2" lifts. Compact each lift per 3.4.F. Avoid segregation of aggregate and contamination with lower courses or sub-grade.
- F. Compact to ninety five percent (95%) of maximum density as determined by ASTM D1557.
 - 1. Maintain surface course moisture content within plus/minus three percent ($\pm 3\%$) of optimum. Add water to crushed stone paving as required to achieve optimum moisture content and a uniform, compacted surface conforming to the finish grades indicated.
 - 2. Compact areas inaccessible to rolling by mechanical tamping.
- G. Protect crushed stone paving from soil or other contaminants during and following installation.
- H. Spread and compact additional crushed stone paving to achieve the required minimum compacted thickness. Compact per 3.4.F above.

3.5 PLACEMENT OF STABILIZED CRUSHED STONE PAVING

- A. Complete items 3.4.A through H above using specified crusher fines material with pre-incorporated specified binder at specified application rates.
- B. Do not allow traffic on stabilized crushed stone paving for two days.

3.6 MAINTENANCE AND REPAIRS:

- A. Crushed Stone Paving:
 - 1. Areas that do not compact, become eroded or are degraded in visual quality and/or performance as determined by the Project Manager are to be removed and/or repaired. Obtain approval of repair methods from Project Manager prior to affecting repairs.
- B. Stabilized Crushed Stone Paving:
 - 1. To repair, excavate damaged area leaving a minimum one-inch depth of existing stabilized crushed stone paving. Apply stabilized crusher fines to existing surface as described above. Compact per 3.4.F above.
 - 2. Do not allow traffic on repaired stabilized crushed stone paving for two days or until paving has fully cured.

3.7 CLEANUP AND PROTECTION

- A. All areas shall be clean at the end of each workday.
- B. The contractor shall maintain protection during installation, curing, and maintenance periods.

1. Erect temporary fencing or barricades and warning signs as required protecting newly installed Crushed Stone Paving areas from traffic, other trades, and trespassers. Maintain fencing and barricades throughout initial maintenance period and remove with approval of Project Manager.
- C. Project completion: All debris, soil, trash, and excavated and/or stripped material resulting from Crushed Stone Paving operations and unsuitable for or in excess of requirements for completing work of this Section shall be disposed of in accordance with Executive Order 115.
- D. Maintain protection during installation and maintenance periods. Treat, repair or replace damaged work as required.

3.8 QUALITY ASSURANCE

- A. Reference General Conditions as listed:
 1. Article 1701 "Construction Inspection by the City".
 2. Article 1702 "Authority of Inspectors".
 3. Article 1703 "Observable Defects".
 4. Article 1704 "Defects – Uncovering Work".
 5. Article 1705 "Latent Defects".
 6. Article 1706 "Removal of Defective Materials and Work".

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

- A. Measurement will be made by the contract unit specified for Crushed Stone Paving. Measurement shall include the actual number of units of specified material(s) placed and accepted at the locations shown on the Contract Drawings, or as directed by the Project Manager, and in accordance with the Specifications.

4.2 PAYMENT

- A. Payment will be made at the contract unit price, and shall include required materials, transportation, equipment, labor, excavation, grading, stockpiling, disposing, hauling off, watering, dust control, erosion and sediment control, landscape renovation as required in accordance with the Contract Drawings and Specifications.

END OF SECTION 32 15 40

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Contract Drawings and general provisions of the Contract, including General and Supplementary Conditions and the City and County of Denver Standard Specifications for Construction General Contract Conditions (2011)
- B. City and County of Denver Engineering Division, Wastewater Capital Project Management Standard Construction Specifications, dated March 15, 2016.
- C. Wastewater Capital Projects Management Special Project Provisions for Asbury and Tejon
- D. Wastewater Capital Projects Management Supplemental Technical Specifications for Asbury & Tejon.
- E. Denver Parks and Recreation Asbury and Tejon Specifications, OCT 2018

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Engineered Wood Fiber surface system.
- B. Related Sections:
 - 1. Wastewater Capital Projects Management 2.0 Section "Site Preparation".
 - 2. Wastewater Capital Projects Management Supplemental Technical Specification 31 23 00 "Earthwork".
 - 3. Denver Parks and Recreation Specification 01 56 39 "Tree Retention and Protection".
 - 4. Denver Parks and Recreation Specification 32 15 40 "Crushed Stone Paving".
 - 5. Denver Parks and Recreation Specification 32 13 13 Section "Concrete Walks, Curbs, and Miscellaneous Flatwork".
 - 6. Denver Parks and Recreation Specification 33 46 00 "Subdrainage System"

1.3 DEFINITIONS

- A. CPSC: U.S. Consumer Products Safety Commission
- B. Critical Height: Standard measure of shock attenuation. According to Consumer Products Safety Commission (CPSC) No. 325, this means "the fall height below which a life-threatening head injury would not be expected to occur."

- C. SBR: Styrene-butadiene rubber.
- D. EPDM: Ethylene propylene diene terpolymer rubber.
- E. EWF: Engineered Wood Fiber; natural processed wood product manufactured expressly for use as a playground surface.
- F. IPEMA: International Play Equipment Manufacturer's Association.

1.4 PERFORMANCE REQUIREMENTS

- A. Impact Attenuation: According to ASTM F 1292.
- B. Accessibility of Surface Systems: According to ASTM F 1951.
- C. Minimum Characteristics for EWF Surfaces: According to ASTM F 2075.

1.5 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Qualification Data: For qualified Installer and testing agency.
- C. Contract Record Drawings provided for in Subdrainage systems 33 46 00 shall be used for preparation of any design or layout documents.
- D. Shop Drawings: For each playground surface system, include materials, plans, cross sections, drainage, installation, penetration details, and edge termination including loose fill edgings.
- E. Samples for Initial Selection: For each type of playground surface system indicated.
 1. Include similar samples of playground surface system and accessories involving color selection.
- F. Samples for Verification: For each type of playground surface system indicated.
 1. Minimum 1-quart loose-fill surface sealed in a container.
 2. Twelve-inch (12") long by full-size cross section of border edging.
 3. Minimum twelve-inch (12") by- twelve-inch (12") Sample of geosynthetic fabric.
 4. Minimum six-inch (6") by six-inch (6") Sample of geosynthetic, molded-sheet drainage panel.
 5. Subdrainage materials as required by Division 33 46 00 Section "Subdrainage".
- G. Product Schedule: For playground surface systems.
- H. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:

1. Extent of surface systems and use zones for equipment.
 2. Critical heights for playground surfaces and fall heights for equipment.
- I. Material Certificates: For each type of playground surface system, from manufacturer.
 - J. Material Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each playground surface system.
 - K. Product Certificates: For each type of unitary synthetic playground surface system, from manufacturer.
 - L. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each unitary synthetic playground surface system.
 - M. Warranty:
 1. Manufacturer's Special warranty for all materials used for the protective surfacing
 2. Installer's special warranty.
 - N. Maintenance Data: Maintenance manuals to include manufacturer's data on maintenance of playground surface system.

1.6 QUALITY CONTROL

- A. Installer Qualifications: An employer of workers trained and approved by manufacturer. Installer's Site Superintendent is to have a minimum of five (5) years of experience installing similar materials on similarly scaled projects.
- B. Source Limitations: Obtain playground surface system materials, including primers and binders, from single source from single manufacturer.
 1. Provide secondary materials including adhesives, primers, and geosynthetics, and repair materials of type and from source recommended by manufacturer of playground surface system materials.
- C. Standards and Guidelines: Comply with CPSC No. 325, "Handbook for Public Playground Safety"; ASTM F 1292; and ASTM F 1487.

1.7 PROJECT CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit playground surface system installation to be performed according to manufacturers' written instructions and warranty requirements.

1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of playground surface system that fail in materials or workmanship within the specified a one year warranty period.

1. Failures include, but are not limited to, the following:
 - a. Reduction in impact attenuation.
 - b. Deterioration of surface and other materials beyond normal weathering.
 - c. Warranty Period: 1 year from date of acceptance of the Asbury & Tejon project.

PART 2 - PRODUCTS

2.1 ENGINEERED WOOD FIBER SURFACE

- A. Engineered Wood Fiber:
 1. Random-sized wood fibers, in manufacturer's standard fiber size, approximately ten (10) times longer than wide; containing no bark, leaves, twigs, or foreign or toxic materials according to ASTM F 2075; in conformance with ASTM F 1292; graded according to manufacturer's standard specification for material consistency for playground surfaces and for accessibility according to ASTM F 1951.
 2. Certified to be in conformance with IPEMA materials standards for EWF.
 3. Products: Subject to compliance with requirements, provide one of the following or an approved equal.
 - a. Fibar Group LLC (The); Fibar System 300.
 - b. GameTime, a PlayCore, Inc. company; GT Impax Fiber.
 - c. Sof'Solutions Inc.; Sof'Fall.
 - d. Zeager Bros., Inc.; Wood Carpet.
 4. Critical Height: 8' max.
 5. Uncompressed Material Depth: Not less than 15".

2.2 ACCESSORIES

- A. Stabilizing Mats: See Division 32 33 50, Section "Playground Equipment."

2.3 DRAINAGE

- A. See Division 33 46 00 Section "Subdrainage Systems".

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for maximum moisture content, subgrade and substrate conditions, drainage, and other conditions affecting performance of the Work.

- B. Surface Substrates: Verify that substrates are satisfactory for unitary playground surface system installation and that substrate surfaces are dry, cured, and uniformly level or sloped to drain within recommended tolerances according to playground surface system manufacturer's written requirements for cross-section profile.
 - 1. Concrete Substrates: Verify that substrates are dry, free from surface defects, and free of laitance, glaze, efflorescence, curing compounds, form-release agents, hardeners, dust, dirt, loose particles, grease, oil, and other contaminants incompatible with playground surface system or that may interfere with adhesive bond. Determine adhesion, dryness, and acidity characteristics by performing procedures recommended in writing by playground surface system manufacturer.
 - 2. Gravel Substrate: Three quarter-inch (3/4") angular gravel drainage stone, clean and washed; depth as indicated on Contract Drawings.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. General: Prepare substrates to receive surfacing products according to playground surface system manufacturer's written instructions. Verify that substrates are sound and without high spots, ridges, holes, and depressions.
- B. Concrete Substrates: Provide sound supportive surface for playground surface system.
 - 1. Repair unsatisfactory surfaces and fill holes and depressions.
 - 2. Mechanically scarify or otherwise prepare concrete substrates to achieve recommended degree of roughness.
 - 3. Saw cut concrete for terminal edges of playground surface systems as indicated.
 - 4. Treat control joints and other nonmoving substrate cracks to prevent telegraphing through playground surface system.
- C. Gravel Substrates: Provide sound supportive surface for playground surface system.
 - 1. Gravel substrate is to be an approved substrate as stated by the manufacturer of the final play surface. Provide documentation from manufacturer prior to construction of play surface.
 - 2. Edge boundary structures and drainage systems are to be installed prior to placement of gravel substrate.
 - 3. Place and consolidate gravel substrate within edge boundary structures shown on Contract Drawings. Depth as shown on Contract Drawings.
 - 4. Smooth gravel surface by raking. Obtain Project Manager's approval prior to placing surface.
 - 5. Repair any damage to gravel surface from foot traffic prior to placing final surface.

3.3 INSTALLATION, GENERAL

- A. General: Comply with playground surface system manufacturer's written installation instructions. Install playground surface system over area and in thickness indicated.

3.4 DRAINAGE SYSTEMS

- A. Install drainage systems as indicated on Drawings, Details, and per Division 33 46 00 Section "Subdrainage Systems".

3.5 INSTALLATION OF SEAMLESS PLAYGROUND SURFACE SYSTEMS

- A. Seamless Surface: Mix and apply components of playground surface system according to manufacturer's written instructions to produce a uniform, monolithic wearing surface and impact-attenuating system of total thickness indicated.
 1. Substrate Primer: Apply over prepared substrate at manufacturer's standard spreading rate for type of substrate.
 2. Poured Cushion Course: Spread evenly over primed substrate to form a uniform layer applied at manufacturer's standard spreading rate in one continuous operation, with a minimum of cold joints.
 3. Intercoat Primer: Over cured cushion course, apply primer at manufacturer's standard spreading rate.
 4. Wearing Course: Spread over primed base course to form a uniform layer applied at manufacturer's standard spreading rate in one continuous operation and, except where color changes, with minimal cold joints. Finish surface to produce manufacturer's standard wearing-surface texture.
 - a. Where colored patterns or graphics are indicated, place adjacent colored material as soon as placed colored material is sufficiently cured, using primer or adhesive if required by manufacturer's written instructions.
 5. Lacquer Topcoat: Spray or roller applied at manufacturer's standard coating rate in one continuous operation.
 6. Edge Treatment: Fully adhere surface system to edges and substrate while maintaining full thickness of surface system to comply with safety performance and accessibility requirements, as indicated on Contract Drawings.

3.6 INSTALLATION OF ENGINEERED WOOD FIBER PLAYGROUND SURFACE SYSTEMS

- A. Engineered Wood Fiber: Place playground surface system materials including manufacturer's standard amount of excess material for compacting naturally with time to required depths after installation of playground equipment support posts and foundations, in conformance with ASTM F 1292.

1. Stabilizing Mats: Coordinate installation of mats and mat anchoring system with placement of Engineered Wood Fiber, under and in front of slide exits, and under swings.

B. Finish Grading: Hand rake to a smooth finished surface and to required elevations, graded according to manufacturer's standard specification for materials consistency for playground surfaces and for accessibility according to ASTM F 1951.

3.7 CLEANING

A. Perform cleaning during installation of the Work and upon completion of the Work. Remove all excess materials, debris and equipment from the site. Repair any damage resulting from installation of surfacing.

3.8 PROTECTION

A. Prevent vehicular traffic in total and pedestrian traffic over play surfacing for not less than forty-eight (48) hours after installation, or per manufacturer's recommendations, whichever is longer.

B. Protect play areas from construction debris, including dust, dirt, runoff, trash and equipment following installation for the duration of construction.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

A. Engineered Wood Fiber Surface: Measurement will be made by the contract unit specified for Playground Protective Surfacing. Measurement shall include the actual number of units of specified material(s) placed and accepted at the locations shown on the Contract Drawings, or as directed by the Project Manager, and in accordance with the Specifications.

4.2 PAYMENT

A. Payment will be made at the contract unit price, and shall include retention of a certified installer to install the required materials; transportation, equipment, labor, earthwork (*commencement of the work, implies acceptance of existing grades, all earthwork required after installation of subdrainage system is included in this item), preparation of sub-grade, as required in accordance with the Contract Drawings and Specifications; and all maintenance required until Final Acceptance of the work as required in accordance with the Contract Drawings and Specifications.

- B. Subdrainage systems associated with play areas beneath surfaces specified in this Section will be measured and paid under Division 33 46 00 Section "Subdrainage Systems".

END OF SECTION 32 18 16

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Contract Drawings and general provisions of the Contract, including General and Supplementary Conditions and the City and County of Denver Standard Specifications for Construction General Contract Conditions (2011)
- B. City and County of Denver Engineering Division, Wastewater Capital Project Management Standard Construction Specifications, dated March 15, 2016.
- C. Wastewater Capital Projects Management Special Project Provisions for Asbury & Tejon.
- D. Wastewater Capital Projects Management Supplemental Technical Specifications for Asbury & Tejon.
- E. Denver Parks and Recreation Asbury and Tejon Specifications, OCT 2018

1.2 SUMMARY

- A. This Section includes consists of furnishing and installing site furnishings per the drawings.
- B. Related Sections:
 - 1. Wastewater Capital Projects Management 2.0 Section "Site Preparation".
 - 2. Wastewater Capital Projects Management Supplemental Technical Specification 31 23 00 "Earthwork".
 - 3. Denver Parks and Recreation Specification 32 15 40 "Crushed Stone Paving".
 - 4. Denver Parks and Recreation Specification 32 13 13 Section "Concrete Walks, Curbs, and Miscellaneous Flatwork".

1.3 SUBMITTALS

- A. See General Contract Conditions Title 3, section 309 " Contractor Submittals and other Written Communications to the City" and Title 4, section 405 "Shop Drawings, Product Data, and Samples"
- B. Prior to construction, the contractor shall create a submittal log for review by the Construction Project Manager. The Construction Project Manager shall review and make recommendations for additional submittal items.

- C. The contractor shall allow a minimum cycle of ten (10) working days for review of each submittal by the City.
 - D. All submittals shall be delivered to the Construction Project Manager.
 - E. PRODUCT DATA for the following:
 - 1. Picnic Table
 - 2. Bench
 - 3. Custom Log Play Features (Stairs, Ghost Grove, Flume) – as called out on the plan sheets.
- 1.4 QUALITY CONTROL
- A. Contractor is responsible for Quality Control procedures.
- 1.5 PRODUCT HANDLING AND STORAGE
- A. Upon receipt at the job site, all materials shall be checked to ensure that no damage occurred during shipping or handling.
 - B. Materials shall be stored in such a manner to ensure proper ventilation and drainage and to protect against damage, weather, vandalism and theft.
- 1.6 SITE CONDITIONS
- A. Site Access: The Contractor shall access each project site at locations designated by the Project Manager for work for the installation of furnishings. No heavy trucks are allowed on turf areas or concrete flatwork.
 - B. Field Measurements: Verify layout information for all site furnishings shown on Contract Drawings in relation to property survey and existing structures. Verify dimensions by field measurements.
- 1.7 WARRANTY/GUARANTEE
- A. Provide a one (1) year written warranty for material and installation from date of Final Acceptance.
 - B. Expenses due to vandalism prior to Final Acceptance shall be the Contractor's responsibility.

- C. Any settling that occurs during warranty period shall be repaired at no expense to the City, including complete restoration of damaged property.

PART 2 - PRODUCTS

- 2.1 See Furnishing Schedule as shown on drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install furnishings in accordance with manufacturer's instructions and as shown on the drawings.
- B. Workmanship: All furnishings shall be installed in keeping with good standard of furnishing installation.

3.2 CLEAN UP

- A. Maintain a neat and orderly work site at all times.
- B. Upon completion of site work, clean up area, remove tools, equipment, materials and debris.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

- A. Measurement will be made by the contract unit specified for Site Furnishings. Measurement shall include the actual number of units of specified material(s) placed and accepted at the locations shown on the Contract Drawings, or as directed by the Project Manager, and in accordance with the Specifications.

4.2 PAYMENT

- A. Payment will be made at the contract unit price, and shall include required materials, transportation, equipment, labor, earthwork, loading, transporting, stockpiling, disposing, hauling off, watering, dust control, erosion and sediment control, fine grading, subgrade preparation, concrete footing, hardware, paint, and all maintenance

required until Final Acceptance of the work as required in accordance with the Contract Drawings and Specifications.

END OF SECTION 32 33 00

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. Contract Drawings and general provisions of the Contract, including General and Supplementary Conditions and the City and County of Denver Standard Specifications for Construction General Contract Conditions (2011)
- B. City and County of Denver Engineering Division, Wastewater Capital Project Management Standard Construction Specifications, dated March 15, 2016.
- C. Wastewater Capital Projects Management Special Project Provisions for Asbury & Tejon.
- D. Wastewater Capital Projects Management Supplemental Technical Specifications for Asbury & Tejon.
- E. Denver Parks and Recreation Asbury and Tejon Specifications, OCT 2018.

1.2 RELATED SECTIONS:

- A. Related Work: Contractor shall comply with the requirements of the following Sections when installing Playground Equipment.
 - 1 Denver Parks and Recreation Specification 01 56 39 "Tree Retention and Protection".
 - 2 Denver Parks and Recreation Specification 32 18 16 "Playground Protective Surfacing".
 - 3 Denver Parks and Recreation Specification 33 46 00 "Subdrainage System"
 - 4 WCPM Supplemental Technical Specification 31 23 19 "Dewatering".
 - 5 WCPM Standard Construction Specification 23.0 Section "Storm Water Management".
 - 6 WCPM Standard Construction Specification 47.0 "Construction Survey and Monumentation".

1.3 DESCRIPTION

- A. The work in this section consists of installing playground equipment furnished through bid item 01-21.26.001 Parks Product Allowance

1.4 QUALITY ASSURANCE

- A. Material and craftsmanship for play equipment shall conform to recognized association standards.
- B. Contractor to field locate each proposed item and associated Playground Protective Surfacing or paving prior to any installation and/or construction and shall have Project Manager review.
- C. Materials shall be stored in such a manner to ensure proper ventilation and drainage and to protect against damage, weather, vandalism and theft. Upon receipt at the job site, all materials shall be checked to ensure that no damage occurred during shipping or handling.
- D. Installer Qualifications: An experienced installer who has specialized in installing work similar in material, design and extent to that indicated for this Project and who is acceptable to the manufacturer of the playground equipment to be installed.
- E. Testing Agency Qualifications: An independent testing agency with the experience and capability to conduct the testing indicated, as documented according to ASTM E 548.
- F. Subdrainage System: Coordinate the installation of Playground Equipment with the installation of the Subdrainage System to ensure that neither has a detrimental or adverse effect on the proper functioning. Damage to the Subdrainage System by the Play Equipment contractor will be repaired at the Play Equipment Contractor's expense.

1.5 REFERENCES

- A. Safety:
 - 1 American Society for Testing and Materials (ASTM) designation F1487 98 (or current issue) "Standard Consumer Safety Performance Specification for Playground Equipment for Public Use."

- 2 U.S. Consumer Product Safety Commission (CPSC) Handbook for Public Playground Safety (Publication No. 325) (based on ASTM F 1487).
- 3 CPSC Playground Surfacing Materials (Publication No. 3005).

1.6 SUBMITTALS

- G. Contractor to provide Installer Certificates, signed by manufacturer certifying that all installers comply with requirements.
- H. Product data for each item of play equipment listed in 2.1
- I. Playground Equipment area Contract Record Drawings, including elevations; as required in the Subdrainage system specification.
- J. Playground equipment area layout plans from certified installer: Include all equipment, fall zones, stabilizing mats, footings and drainage systems with connections on as-built play pit drawings for review and approval prior to installation.
- K. Playground equipment area design using the Contract Record Drawings
- L. Operations and Maintenance: Provide tools, maintenance recommendations, recommendations for graffiti removal and spare parts.

1.6 WARRANTY

- A. Installer's Special Warranty: Installer agrees to repair or replace any related materials that fail within the one (1) year warranty period after acceptance of the Asbury & Tejon Project.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures of equipment unrelated to vandalism or mis-use.
 - b. Failure to install equipment according to manufacturer's instructions.

PART 2 - PRODUCTS

2.1 PLAY EQUIPMENT – to be procured through bid item 01-21.26.001

Qty	Model #	Description	Supplier
1	TC001	Bear Cub	ID Sculpture, 970-641-

			1747
1	1650-61-EMB	Embankment Slide Chute, 6' Drop	Columbia Cascade Company 503-223-1157
1	RDU	Custom PT Structure 5-12	Gametime, 800-235-2440
1	90777	Kidnetix Twirl	Gametime, 800-235-2440
1	6248	Deco Spring Rider Double	Gametime, 800-235-2440
1	RDU	Custom PT Structure 2-5	Gametime, 800-235-2440
2	8696	Enclosed Seat 3 ½"	Gametime, 800-235-2440
2	8910	Belt Seat 3 ½" OD	Gametime, 800-235-2440
1	18826	Primetime Swing 3 ½" x 8'	Gametime, 800-235-2440
1	18827	Primetime Swing Add-a-bay 3½" x 8'	Gametime, 800-235-2440

2.2 ACCESSORIES

- A. Stabilizing Mats: Manufacturer's standard, water-permeable PVC or rubber mats tested for impact attenuation according to ASTM F 1292, and rated for use in the following locations, with anchoring system designed to anchor mat securely to subgrade through engineered wood:
1. Under and in front of slide exits, and under swings
 2. Size: thirty six-inches square (36" by 36").

PART 3 - EXECUTION

3.1 INSPECTION

- A. The City and County of Denver shall inspect Playground Equipment area, the design and layout prior to approving installation of any Playground Equipment. The Construction Project Manager shall accept subgrade as well as concrete flatwork adjacent to play equipment area. The Contractor shall provide verification of gradients and elevations of base. Incidental earthwork to meet the intent of the certified installer's layout plans shall not be paid for separately after approval to begin installation.

3.3 INSTALLATION

- A. Drainage system bid item 33-46.00.01: Coordinate installation of Subdrainage System with Playground Equipment. Install as shown on plans and in accordance with manufacturer's direction
- B. Fine grading: Fine grade all areas to receive play surfacing materials. Remove all sticks, stones or clods over 1" in diameter and grade soil smoothly and evenly.

- C. Stabilizing Mats: Install per manufacturer's specifications, and as directed in Part 2.2: Accessories, above.
- D. All play equipment shall be installed at locations and as shown on certified installer's layout plans and drawings and per manufacturer's instructions.

3.3 FIELD QUALITY CONTROL

- A. All items must be protected from staining, cracking, chipping, vandalism, and other damage during progress of the work and left in a first-class condition upon completion.

3.4 CLEANING

- A. After completing playground equipment installation, inspect components. Remove spots, dirt, concrete spatter, and debris. Repair damaged finishes to match original finish or replace component.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

- A. No quantity of measurement shall be made for any of the work required to accomplish this aspect of the project and payment will be based upon a percentage of the lump sum price for the work item completed in accordance with the plans and specifications and as approved by the City Construction Project Manager.

PAYMENT

- A. Payment will be made under bid item Playground Equipment Installation per Manufacturer's Specifications – Qualified Installer 32-33.50.01; and shall include the retention of a certified installer to layout and install the equipment; all labor, certifications, earthwork (*commencement of the work, implies acceptance of existing grades, all earthwork required after installation of subdrainage system is included in this item), loading, transporting, stockpiling, disposing, hauling off, watering, dust control, erosion and sediment control, fine grading, testing, concrete footings, hardware, paint, and all maintenance required until Final Acceptance of the work as required in accordance with the Contract Drawings and Specifications.
- B. All cost for this work shall be included within this bid item and no additional payment will be made. At the option of the Construction Project Manager, payment may be made in percentage installments based upon type, location and

PLAYGROUND EQUIPMENT

32 33 50 - 5

Asbury and Tejon OCT 2018

scope of work in relation to the period of performance. The total payment for this bid item shall not exceed seventy-five percent (75%) of the lump sum price during construction. The remaining twenty-five percent (25%) shall be paid after final site cleanup, completion of all punch list items and demobilization from site.

END OF SECTION 32 33 50

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Contract Drawings and general provisions of the Contract, including General and Supplementary Conditions and the City and County of Denver Standard Specifications for Construction General Contract Conditions (2011).
- B. City and County of Denver Engineering Division, Wastewater Capital Project Management Standard Construction Specifications, dated March 15, 2016.
- C. Wastewater Capital Projects Management Special Project Provisions for Asbury & Tejon.
- D. Wastewater Capital Projects Management Supplemental Technical Specifications for Asbury & Tejon
- E. Denver Parks and Recreation Asbury and Tejon Specifications, OCT 2018.

1.2 SUMMARY

- A. This Section includes the requirements for the installation of an underground irrigation system including the following:
 - 1. Trenching, stockpiling excavation materials, refilling and compacting trenches.
 - 2. Complete irrigation system including but not limited to piping, valves, fittings, heads and wiring, sensors, backflow preventers, Automatic Irrigation Controllers and final adjustments to insure complete coverage.
 - 3. Water connections.
 - 4. Replacement of unsatisfactory materials.
 - 5. Cleanup, inspections, and approval.
 - 6. Testing.
- B. Related Sections:
 - 1. WCPM Standard Construction Specification 2.0 Section "Site Preparation".
 - 2. WCPM Standard Construction Specification 4.0 "Utility Trenching and Excavation"
 - 3. WCPM Standard Construction Specification 5.0 "Bedding and Backfilling".
 - 4. WCPM Standard Construction Specification 23.0 "Storm Water Management"
 - 5. WCPM Supplemental Technical Specification 31 23 00 "Earthwork".
 - 6. WCPM Supplemental Technical Specification 31 23 19 "Water Control and Dewatering".
 - 7. Division 01 45 16 Section "Contractor Quality Control".
 - 8. Division 01 56 39 Section "Tree Retention and Protection".
 - 9. Division 31 32 50 Section "Watering".
 - 10. Division 32 13 13 Section "Concrete Walks, Curbs, and Miscellaneous Flatwork".

11. Division 32 84 33 Section "Automatic Irrigation Controllers"
12. Division 32 91 13 Section "Soil Preparation".
13. Division 32 91 20 Section "Topsoil".
14. Division 32 92 20 Section "Native Seeding".
15. Division 32 92 23 Section "Sodding".
16. Division 32 93 00 Section "Trees, Plants, and Groundcovers".

1.3 REFERENCES

- A. Conform to requirements of reference information listed below except where more stringent requirements are shown or specified in Contract Documents.
 1. American Society for Testing and Materials (ASTM) - Specifications and Test Methods specifically referenced in this Section.
 2. Underwriters Laboratories (UL) - UL Wires and Cables.
 3. National Sanitation Foundation (NSF) – Piping and backflow prevention.
 4. American Water Works Association – Piping and backflow prevention.

1.4 QUALITY CONTROL

- A. Special Requirements.
 1. Tolerances: Specified depths of mains and laterals and pitch of pipes shall be installed per the Contract Drawings and specifications.
 2. Compaction: Settlement of trenches is cause for removal of finish grade treatment, refilling, compaction, and repair of finish grade treatment.
 3. Coordination with Other Contractors: Protect, maintain, and coordinate work with work under other Sections.
 4. Damage to other Improvements: Contractor shall replace or repair damage to grading, soil preparation, seeding, sodding, planting and/or new site features done under other Sections during Work associated with installation of irrigation system at no additional cost to the City.
 5. Damage or Disturbance to the Existing Irrigation Components: Damage to existing components as a result of work being performed by the Contractor will require the Contractor to replace the damaged components to the City's current standards, at no additional cost to the City.
 6. Water Delivery Interruption: When working on an existing irrigation system, the Irrigation Contractor shall contact the Project Manager and inform them seventy-two (72) hours in advance of any water interruption that is required. The maximum irrigation system interruption is to be no more than seventy-two (72) hours during the growing season. The contractor shall make all necessary provisions including material, equipment, labor, delivery and scheduling as required to complete all points of connection, upgrades, and improvements within seventy-two (72) hours.
 7. Watering: The Contractor is responsible for following all Denver Water rules and regulations for sod and seed establishment, available at

<http://www.denverwater.org>. The Contractor shall post signage per Denver Water in a visible location(s) on site indicating "IRRIGATION TESTING AND MAINTENANCE IN PROGRESS" when Work (establishment, construction or warranty) requires irrigation system operation between the hours of 10 AM to 6 PM. The signs are to be used are available from Denver Water.

8. Permits: Work involving plumbing for installation of copper piping, ductile iron piping, backflow preventer(s), and related Work shall be executed by licensed and bonded plumber(s). Secure a permit at least forty-eight (48) hours prior to start of installation. Work involving high voltage electrical wiring, grounding and related Work shall be executed by licensed and bonded electrician. Secure a permit at least forty-eight (48) hours prior to start of installation

B. Pre-Construction Conferences and Site Meetings:

1. Contractor shall schedule and conduct a pre-construction conference to review in detail quality control and construction requirements for equipment and materials used to perform the Work. Conference shall be scheduled not less than ten (10) days prior to commencement of Work. All parties required to be in attendance shall be notified no later than seven (7) days prior to date of conference. Contractor shall notify qualified representatives of each party concerned with that portion of Work to attend conference, including but not limited to the Project Manager, Denver Parks Superintendent, Operations Supervisor, Water Conservation, Contractor's Superintendent, and Installer.
2. Prior to commencement of Work, Contractor shall schedule an on-site conference with Project Manager, Denver Forestry and any other parties designated by Project Manager to discuss tree protection requirements, marshalling locations, traffic control, and equipment access. Provide a minimum of seven (7) days' notice prior to date of conference.
3. Contractor shall schedule on-site conferences the frequency of which is to be determined by the Project Manager and any other parties designated by the Project Manager to review project progress.
4. Contractor shall record Minutes of each conference and distribute to all parties in attendance within three (3) days of conference.

1.5 SUBMITTALS

- A. Prepare and make submittals in accordance with conditions of the Contract prior to installation of any irrigation equipment:
- B. Material List: Submit a PDF file of complete list of materials, and cut sheets indicating manufacturer, model number and description of all materials and equipment to be used. Show appropriate dimensions and adequate detail to accurately portray intent of construction.

- C. Shop Contract Drawings: If applicable, submit shop Contract Drawings for pumps, backflows and assemblies. Include plumbing and foundation/support systems if the installation differs from the manufacturer's recommended installation.
- D. Mock Ups:
 - 1. Valve assembly: Provide a completely built electrical valve assembly. This mockup, to include electric valve, service tee, lateral valve riser length as required for mainline depth, and male thread by spigot outlet adapter. The mock up may be incorporated into the work toward the end of the project.
 - 2. Swing joints: Provide a pre-manufactured or constructed swing joint assembly for each detail shown (e.g. - quick coupler, rotors and pop-up spray head) or as directed by the Project Manager
 - 3. Drain valves: Provide a mock up including the service tee, required fittings, and drain valve.
 - 4. Other: Mock ups that may be requested by the Project Manager.
- E. Operation and Maintenance Manual: Coordinate scheduling/precipitation instructions with the City's operations staff. Submit one (1) digital copy in PDF format to the Project Manager including:
 - 1. Winterization and spring start-up procedures.
 - 2. Cut sheets of products.
 - 3. Manufacturer's inspection and maintenance instructions for backflow preventer (if applicable).
 - 4. Manufacturer's maintenance and operation instructions for pump station (if applicable).
- F. Warranty: Submit one (1) year written warranty, in accordance with WARRANTY/GUARANTEES section.

1.6 CONTRACT RECORD DRAWINGS

- A. Prior to the installation of irrigation system, the Contractor will provide on-site copies of original irrigation design Contract Drawings "Record Contract Drawings". Contractor to revise Record Contract Drawings in red ink as Work progresses to show any changes to the plan and include field dimensions. Record Contract Drawings shall be brought up-to-date prior to any Pay Application Submittals that contain irrigation installation. Should the Contractor choose to utilize GPS for the purposes of documenting Work in progress, a hard copy print will need to be provided prior to Pay Application Submittal. A print of Record Contract Drawings shall be available at Project Site for review by the Project Manager at any time during the project.
- B. Record Contract Drawings shall encompass entire scope of work including any altered existing equipment and altered zones, and notate the Automatic Irrigation Controller zone number, type of irrigation, GPM, operating PSI for any altered or added zone.

- C. Preparation of Contract Record Drawings: Dimension from two permanent points of reference (building corners, sidewalk, road intersections or permanent structures) the location of the following items:
1. Point of connection.
 - a. Meters and vault dimensions
 - b. Curb Stops
 - c. Isolation Valves
 - d. Drain Valves
 - e. Backflows
 - f. Service lines
 2. Routing of irrigation mainline. Provide dimensions for each one-hundred linear feet (100 L.F.) maximum along each routing and for each change of direction.
 3. Routing of non-pressure lateral lines, layout and size.
 4. Sprinkler control valves.
 5. Quick coupling valves.
 6. Drain valves
 7. Hydrometer
 8. Rain sensors/weather station
 9. Wire splice boxes
 10. Control wire routing if not with pressure mainline.
 11. Gate valves.
 12. Sleeves.
 13. Flush valves.
 14. Power service drop.
 15. Two-wire grounding rods
 16. Other related equipment as directed.
- D. Make dimensions accurately at the same scale used in the original Contract Drawings, or larger. Notes and dimension lettering must be legible.
- E. The irrigation legend must be changed to accurately reflect the irrigation equipment installed, if such equipment is not the same as originally specified on the contract documents. This includes flow rates, effective spray diameter/radius and operating pressure of all sprinkler heads.
- F. The Project Manager will not certify any pay request submitted by the Contractor if the Contract Record Drawings are not current, and processing of pay request will not occur until Contract Record Drawings are updated.
- G. Final Submittal: Upon completion of Project, prior to final acceptance, secure digital copy of irrigation design from the Project Manager and record installation information that reflects all changes made over the course of the construction project, prepared by a qualified draftsman. Contract Record Drawings shall include details of any

revisions as per actual installation. Deliver and submit to the Project Manager for review the following items:

1. Digital Contract Record Drawings in both PDF and AutoCAD release 2010 bound format (include any related X-ref files, plot files and pen settings.) Make any additional changes to the file as directed by the Project Manager prior to final submittal and approval.

H. Request for final payment will not be certified or processed until all Contract Record Drawing prints and digital files have been received and approved.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Packing and Shipping: Deliver all components to job site in original unopened packaging containers prominently displaying manufacturer's name, volume, quantity, contents, instructions, and conformance to local, state, and federal law. Remove and replace cracked, broken, or contaminated items or elements prematurely exposed to moisture, inclement weather, snow, ice, temperature extremes, fire, or jobsite damage.

B. Handling, Storage, and Delivery of PVC Pipe:

1. Exercise care in handling, loading and storage of PVC pipe.
2. Provide forty-eight (48) hours advance notice of delivery to the Project Manager for observation of unloading and handling of PVC materials during delivery.
3. All PVC pipe shall be transported in a vehicle which allows length of pipe to lie flat so as not to subject it to undue bending or concentrated external loads. All sections of pipe that have been dented or damaged shall be discarded, and shall be replaced with new piping.

C. Storage and Protection: Deliver, unload, store, and handle materials, packaging and bundling products in dry, weatherproof condition in manner to prevent damage, breakage, deterioration, intrusion, ignition, and vandalism.

D. Only materials and equipment meeting project specifications and to be used as part of Project shall be stored on site. Project Manager to may verify at any time during construction period.

1.8 JOBSITE CONDITIONS

A. Existing Conditions:

1. Soil Conditions: The Contractor is responsible for investigating the type of soil and conditions in which lines are to be installed. No extra payment will be allowed due to difficulty in trenching, unless approved by the Project Manager.
2. Contractor is responsible for understanding the scope of related operations as specified and indicated in the Contract Drawings and Specifications before beginning Work under this Section.

3. Report unsatisfactory conditions in writing to the Project Manager within twenty-four (24) hours of discovery. Commencement of installation means acceptance of existing conditions by the Contractor.
- B. Protection of Property:
1. Protect buildings, walks, walls, and other property from damage. Erect and maintain barricades, warning signs and lights, and provide guards as necessary or required to protect all persons on the site. Damage caused to asphalt, concrete, monuments, structures or other building material surfaces shall be repaired or replaced at no cost to the City. Restore disturbed areas to original condition.
 2. The Contractor is responsible for potholing of all existing utilities, irrigation lines or any other underground improvements that may be damaged due to the installation of Irrigation Systems.
- C. Protection of Existing Trees:
1. Refer to Division 01 56 39 Section "Tree Retention and Protection".
 2. Consult with the Office of the City Forester as requested by the Project Manager prior to trenching or boring within tree drip-lines. All trenching or work under drip line of any tree shall be dug by hand or by other methods as directed by the Forester or the Project Manager so as to prevent damage to limbs or branches and root system.
 3. Directional boring that is permitted within tree protection area must occur at thirty-six inches (36") below grade and may not take place anywhere within four feet (4') of the drip line. Any exception must be agreed upon by the Office of the City Forester or the Project Manager.
- D. Protection and Repair of Underground Lines:
1. Request utility locates seventy-two (72) hours in advance of any excavations by calling the Utility Notification Center of Colorado at 811. Take whatever precautions are necessary, including pot holing to verify location and depth to protect these underground lines from damage. If damage does occur, all damage shall be repaired by the Utility Owner. All costs of such repairs shall be paid by Contractor.
 2. The Contractor is required to contact all private utility companies including City and County of Denver departments to locate all private utilities. The request for locates shall be a minimum of seventy two (72) hours prior to proceeding with any excavation. If, after such requests private utilities are encountered and damaged by the Contractor these shall be repaired at no cost to the City. If the Contractor damages staked or located private utilities, they shall be repaired by the Utility Owner at the Contractor's expense.
- E. Replacement of Paving and Curbs: Any damage due to work that occurs adjacent to or crosses existing roadways, paths, trails, curbing, sidewalks, etc. shall be restored to

original condition at the contractors expense, and the satisfaction of the Project Manager.

1.9 WARRANTY/GUARANTEE

- A. Provide a one (1) year written warranty for material and installation from date of Final Acceptance
- B. Expenses due to vandalism prior to Final Acceptance shall be the Contractor's responsibility.
- C. Any settling of backfilled trenches that occurs during warranty period shall be repaired at no expense to the City, including complete restoration of damaged property.
- D. Once Final Acceptance is granted, the City will maintain turf and planting areas during warranty period, unless maintenance by the Contractor is specified in the contract. The Contractor is responsible to monitor and coordinate Automatic Irrigation Controller scheduling and maintenance with the Project Manager for any seeding, sodding or planting areas under the Contractor's warranty.
- E. Project Manager reserves the right for Parks Operations Staff to make temporary repairs during the warranty period as necessary to keep systems in operating condition without voiding the Contractor's warranty, nor relieving the Contractor of their responsibilities.
- F. The Contractor shall make repairs and replacements within three days of notification. If the Contractor fails to make repairs within three days, the City will make such repairs at the Contractor's expense.

1.10 TURN OVER ITEMS

- A. Where applicable, furnish the following maintenance items to City prior to Final Acceptance:
 - 1. Two (2) sprinkler heads for each size and type specified.
 - 2. Two (2) nozzles for each type of head.
 - 3. Two (2) head adjustment tools for each type of head installed.
 - 4. Two (2) valve keys for operating each type of manual valve. (Manual drain valves, isolation valves).
 - 5. Two (2) valve keys and hose swivels for each type of quick coupling valve.

1.11 MAINTENANCE DURING PROJECT CONSTRUCTION

- A. Within Limits of Construction: Contractor shall fence, water, and keep weed free any turf, trees and any plantings within the limits of construction. Contractor is responsible for maintenance which includes picking up trash, weed control and mowing of turf and native areas within the limits of construction. Contractor is responsible for watering

existing landscape within limits of construction. Turf and plants affected by mainline work or irrigation water service shutdown during irrigation season shall receive watering per Parks' schedule, with no interruption of watering greater than seventy-two (72)-hours. Contractor is responsible for maintenance until final acceptance is granted.

- B. Outside Limits of Construction: Coordinate Automatic Irrigation Controller scheduling and maintenance operations with Project Manager for portions of City property unaffected by construction.
- C. Additional Maintenance During Warranty Period:
 - 1. Make repairs and replacements needed due to defective workmanship and materials.
 - 2. Winterization: Include cost in bid for winterizing complete system at conclusion of irrigation season (during which system received final acceptance) within three (3)-days of notification by the City. System shall be voided of water using compressed air. Coordinate with the Denver Parks Operations Supervisor and the Project Manager to be present during the winterization procedures. The Contractor shall notify all persons that are to be present a minimum of forty eight (48) hours prior to the winterization of the system.
 - 3. Spring Start Up: To take place the following season within three (3) days of notification by the City. Open, operate, adjust system and make any necessary repairs. Coordinate with the Denver Parks Operations Supervisor and the Project Manager to be present during the spring start up procedures. The Contractor shall notify all persons that are to be present at the spring start up a minimum of forty-eight (48) hours prior to starting of the system.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Equipment must have performance characteristics to operate per the design conditions indicated. If any discrepancy or conflict exists between the quantities of equipment listed in the schedule and quantities shown on the Contract Drawings, the greater quantity shall govern.
- B. All material shall be of the highest grade possible and where applicable, shall be marked accordingly and shall be new.

2.2 PIPE AND PIPE FITTINGS

- A. Ductile Iron Fittings
 - 1. All ductile iron fittings shall be made of class 350 ductile iron and shall have slanted, deep bell, rubber gasket style made in accordance with ASTM A-536,

- Grade 65-45-12 & AWWA C153. All fittings shall have a minimum of five (5) degree freedom of pipe deflection within the bell end.
2. All ductile iron pipe fittings, joint restraints and mainline isolation gate valves shall carry a minimum 10-Year warranty on any defective replacement products and labor replacement costs. Prior to install, the pipe fitting, joint restraint and mainline gate valve Manufacture shall provide documentation stating the above warranty information in writing and signed by the Manufactures Representative.
 3. All ductile iron fittings and joint restraints shall have a fusion bonded epoxy coating on interior and exterior of the product surface, average of ten to twelve mm (10-12) thickness. Epoxy coating shall conform to the requirements of CSA Z245.20-20 and NSF 61 for water services. Tar/bitumen coating will not be approved.
- B. Copper Pipe and Fittings:
1. Pipe: Type K, rigid, hard tempered.
 2. Fittings - Wrought copper, solder joint type. Joints - Soldered with solder, forty five percent (45%) silver, fifteen percent (15%) copper, sixteen percent (16%) zinc, and twenty four percent (24%) cadmium and solidus at 1125° F and liquids at 1145° F.
- C. Main and Lateral Lines:
1. Main Lines (pressurized, downstream of backflow prevention units):
 - a. Class 200 PVC RT/Gasketed, size two and one-half inches (2-1/2") and larger.
 - b. Velocities in PVC mainline shall not exceed five feet (5') per second.
 - c. All PVC pipe shall conform to the requirements of Type 1-ASTM-D-2241.
 2. HDPE pipe
 - a. Pressure rating DR 11 two hundred (200) PSI may be used by approval of the Project Manager for portions of mainline that require boring such as below trees and paving.
 - b. HDPE to PVC mainline requires epoxy coated repair coupler with joint restraints and stainless-steel pipe stiffener.
 3. PVC Lateral Lines
 - a. Class 200 PVC BE, size one-inch (1") to three-inch (3") inch.
 - b. Velocities in PVC mainline shall not exceed five feet (5') per second.
 - c. All PVC pipe shall conform to the requirements of Type 1-ASTM-D-2241.
- D. Sleeving:
1. Horizontal sleeves under paved surfaces: Class 200 PVC.
 2. Vertical sleeves for access to drains and valves: Class 160 PVC.
 3. Horizontal sleeving for boring applications: HDPE.
- E. Brass Pipe and Fittings:
1. Brass Pipe: Eighty-five percent (85%) red brass, ANSI Schedule 40 screwed pipe.
 2. Fittings: Medium brass, screwed one hundred twenty five (125) pound class.

- a. Mainline larger than three (3") inch to be installed using tapping saddles.
- F. PVC Pipe and Fittings:
1. Identification Markings: Identify all pipe with following indelible markings:
 - a. Manufacturer's name.
 - b. Nominal pipe size.
 - c. Schedule of class.
 - d. Pressure rating.
 - e. NSF (National Sanitation Foundation) seal of approval.
 - f. Date of extrusion.
 2. Class 200 PVC Pipe (pressurized main line two and one-half inches (2-1/2") and larger):
 - a. Manufactured from virgin Polyvinyl Chloride compound in accordance with ASTM D2241 and ASTM D1784; cell classification 1254-B, Type 1, Grade 1.
 - b. All fittings, service tees and pipe restraints shall be ductile iron fittings.
 3. Class 200 PVC Pipe (all lateral lines)
 - a. Pipe will be assembled with Schedule 40 PVC fittings and solvent welded using ASTM-F-656 purple primer followed with heavy bodied ASTM-D-2564 cement.
 4. Flexible Plastic Pipe (non-pressure lateral lines):
 - a. Risers for Pop-up Heads: Shall be swing pipe, 0.49 ID, operating pressure of eighty (80) PSI.

2.3 VALVES

- A. Gate Valve or Isolation Valve:
1. Valve for two inch (2") and larger mainline: Shall be cast iron body, push-on, left-hand opening, square nut operated, rubber resilient seated, mechanical joint AWWA gate valve with clear waterway equal to full diameter of pipe. Able to withstand continuous working pressure of one hundred fifty (150) PSI. Wheel type handle is unacceptable.
- B. Automatic Control Valve:
1. Automatic Valve for Potable Water System: Rain Bird PEB Series Valve having manual flow adjustment and both internal and external manual bleed. PRS-D shall be used if pressure at the heads is greater than ten pounds over the optimal pressure as stated on the plans or measured in the field.
 2. Valve Riser: Epoxy coated ductile iron riser with integral stainless-steel angle valve or approved equal.
 3. Install one flexible marker tag on each valve. Mark each tag with inedible ink indicating zone number. Tags shall be: Potable water systems (yellow).
- C. Manual Drain Valve:
1. Drain Valve: Mueller Oriseal #H-10283 or AY McDonald, one inch (1") 3061 with brass swing joint assembly, or approved equal.

- D. Quick Coupling Valves:
1. Buckner QB44RCAR10 brass two-piece body with winged stabilizer, designed for working pressure of one hundred fifty (150) PSI; one inch (1") FIP. Size as shown on drawing.
 2. Quick Coupling Valves immediately after the backflow shall be used for winterization and shall be constructed of all brass swing joint and fittings. All other Quick Coupling Valve swing joints shall be constructed as shown on the details.
- E. Hydrometer:
1. Netafim normally open hydrometer with reed switch register of one (1) pulse per ten (10) gallons
- F. Valve Boxes:
1. All valve boxes will have a stainless steel hex bolt locking system.
 2. Isolation Valves, Quick Coupling Valves, Drain Valves, Wire Splices and Ground Rods: Carson, Model #910-4, ten inch (10") round box.
 3. Electric Control Valve Box: Shall have locking cover branded with the zone numbers.
 - a. Three-quarter inch (3/4") through one-inch (1") valves: Carson, Model #1015 standard box with bolt down T-cover.
 - b. One and one-half inch (1-1/2") and two-inch (2") valves: Carson 1220 jumbo valve box with bolt down T-cover
 4. Box color for valves:
 - a. Green for potable systems.
 5. Gravel Leveling Bed and Drainage Sump in Valve Boxes: three quarters inch (3/4") crushed gravel covered in geo-textile fabric, as indicated on Contract Drawings.
- G. Backflow Preventer:
1. High hazard, reduced pressure type, approved by University of Southern California (USC) or other approved testing laboratory; fully ported, ball-type gate valves on units 2-inch or smaller, as manufactured by Febco Model 825YA or approved equal. Resilient gate valves on units larger than two inch (2"); as manufactured by Febco Model 880V or approved equal.
 2. Backflow Preventer Cover: Guardshack enclosure of appropriate size, equipped with Lock Shield Brackets, manufactured by BPD, phone: 800-266-5411. Color: forest green.
 3. Concrete Pad: Comply with Division 32-13.13 Section "Concrete Walks, Curbs and Miscellaneous Flatwork".

2.4 SPRINKLER HEADS

- A. Heads: Provide fabricated riser units of the type and size as indicated on the Contract Drawings. Heads of a specific type or function in the system shall be of the same manufacturer and shall be marked with the manufacturer's name and identification in such a position that they can be identified without being removed from the system.
1. Pop-Up Sprinkler Heads in turf areas: RD-1806 SAM-PRS.
 2. Pop-Up Sprinkler Heads in native grass areas and flower bed areas: Rain Bird RD-1812 SAM-PRS.
 3. Pop-Up Sprinkler Nozzles shall be Rain Bird MPR Series nozzle. Strip series, rotary, and VAN nozzles may be used for specific approved applications at the direction of the Project Manager.
 4. Gear Driven Heads: Hunter I-20, I-25, I-40, or Rain Bird 8005 series with stainless steel risers, internal check valve, PRS and MPR as specified per Contract Drawings. Riser height shall be five inches (5") in turf areas, and twelve inches (12") in native areas.
- B. Flexible Connectors to Lateral Pipe:
1. Pop-up Heads: Shall be one-half inch (1/2") swing pipe
 2. Gear Driven Heads: Shall be manufactured PVC swing joints as per detail.

2.5 AUTOMATIC CONTROL SYSTEM

- A. See Division 32 84 33 Section "Automatic Irrigation Controllers".
- B. Electrical Control Wiring:
1. Two Wire Systems:
 - a. Two-Wire Decoder Cable – Two (2), #12 to #14 AWG UL. parallel wires each with single, solid copper conductors with polyethylene insulation. Wires shall be contained within separate polyethylene jacket. Cable shall be Paige Electric P7072D with red jacket (NO SUBSTITUTIONS).
 - b. Two-wire single station decoders Toro SB-DAC-1 to be installed in each valve box, one per valve in each box. Decoders shall have a serial number engraved on each decoder for future identification.
 - c. Two-wire decoder cable shall have surge arrestors Toro SB-BLA installed every five hundred (500) ft. along two-wire path or every eight decoders whichever is the shortest distance. Surge arrestors are to be placed in valve box containing valve cluster or in separate ten-inch (10") round valve box.
 - d. Surge arrestor Ground rods are to have a minimum diameter of five-eighths of an inch (5/8") and a minimum length of eight feet (8'). Ground rod shall be located a minimum of 9 feet from two-wire cable located in mainline trench such that six (6) gauge copper wire connecting surge arrestor to ground rod is perpendicular to two-wire cable in mainline trench.

- e. Copper wire shall be six (6) gauge bare solid copper wire connected to the ground rod using a Cadweld GR1161GPLUS "Plus One Shot" welding kit.
- f. Two-Wire Splice Box: Carson #1419-12 box with bolt-down lid.

C. Miscellaneous control wiring materials:

- 1. Materials for both standard and two wire systems.
 - a. Data Wires: Paige 7171D-A direct burial shielded and armored signal cable with polyethylene jacket (NO SUBSTITUTIONS)
 - 1) Data Wire connections and splices shall be made with Ranger Servi-Seal.
 - b. Control Wire and Two-Wire Decoder Cable connections and splices shall be made with 3M DBR/Y-6M direct bury splice, or approved equal, UL listed dry splice methods.
 - c. Spare Wire and wire ends shall be capped with 3M DBR/Y.
 - d. Mainline Tracer Wire: One (1) continuous AWG UL #12 tracer wire as detailed above all mainline
 - e. Splice Box: Carson ten-inch (10") round box.

2.6 MISCELLANEOUS MATERIALS

- A. Rain Sensor: Hunter wireless Rain-Click with by-pass or approved equal. Rain sensor shall be installed per manufacturer's recommendations.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Utility Locates: Contact Utility Notification Center of Colorado at or 8-1-1 or 1-800-922-1987 prior to any excavation, for the marking of underground member utilities. The indication of utilities on the Contract Drawings does not relieve the Contractor of the responsibility for utility location. Contractor is responsible for potholing all utility locations to verify the depth and locations. Potholing related to irrigation installation shall be considered incidental to irrigation installation and will not be paid for separately. Route trenches to avoid existing utilities. Verify with the Project Manager any required relocation prior to installation.
- B. Landscape Plan Review and Coordination: Contractor will be held responsible for coordination between landscape and irrigation system installation. Landscape material locations shown on the Landscape Plan shall take precedence over the irrigation system equipment locations. If irrigation equipment is installed in conflict with the landscape material locations shown on the landscape plan, the Contractor will be required to relocate the irrigation equipment, as necessary, at Contractor's expense.

- C. Pressure Verification: Contractor shall field verify the tap size, static pressure and verify Gallons Per Minute flow at the project site, prior to commencing Work or ordering irrigation materials, and submit findings in writing to the Project Manager. If Contractor fails to verify tap size, static water pressure and flow prior to commencing Work or ordering irrigation materials, Contractor shall assume responsibility for all costs required to make system operational and the costs required to replace any damaged landscape material. Damage shall include all required material costs, design costs, labor costs and plant replacement costs.
- D. Inspection: Examine areas and conditions under which Work of this Section is to be performed. Do not proceed with Work until unsatisfactory conditions have been corrected.
 - 1. Grading operations, with the exception of fine grading, shall be completed and approved by Project Manager before staking or installation of any irrigation system begins.
- E. Layout: Layout and stake system before beginning installation. Staking shall occur as follows:
 - 1. Mark, with paint, routing of pressure supply line and flag heads for all new zones. Contact the Project Manager forty-eight (48) hours in advance and request review of staking. The Project Manager will review staking and direct changes if required. Review does not relieve installer from coverage problems due to improper placement of heads after staking.
 - 2. Valve boxes and mainline will not be located in ball fields, and multi-use sport fields, recovery zones, or below playground equipment.
 - 3. If project has significant topography, free form planting beds, or other amenities which could require alteration of irrigation equipment layout as deemed necessary by the Project Manager, do not install irrigation equipment in these areas until the Project Manager has reviewed equipment staking.
 - 4. The Project Manager may request the City Forester's approval of proposed trenching prior to start of trenching.
 - 5. Review backflow prevention device location and operation with the Project Manager prior to mainline installation.

3.2 EXCAVATION AND BACKFILL

- A. Install mainline pipe and wire sleeving under existing asphalt paving, concrete walks and critical root zones by directional boring. Pot-hole existing utilities for location and depth in advance of boring operations. When pot-holing in cross streets: include all permits, traffic control, backfill, compaction and surface restoration as required by the City and County of Denver Transportation Engineering Standards and Specifications. Compact backfill at bore pits around the end of sleeves to ninety-five percent (95%) compaction in landscape areas.
- B. Excavation:

1. Trenching:
 - a. Trench excavation shall follow, as much as possible, the layout shown on Drawing. Dig trenches straight and support pipe continuously on bottom of trench. Trench bottom shall be clean and smooth with all rock and organic debris removed. Comply with OSHA standards for all trenching and excavation.
 - b. Trenching under limb spread of existing trees: Accomplish by hand or other method that will not damage limbs or branches. Refer to Division 01 "Tree Retention and Protection" for additional precautions.
2. Clearances and Depths:
 - a. Main pressure line: Make trenches of sufficient width to properly assemble and position pipe in trench. Clearances:
 - 1) Mainline and Lateral Piping clearance: Minimum clearance shall be one inch (1") horizontally on both sides of the pipe.
 - 2) Line Clearance: Provide minimum six inches (6") of clearance between each line, and minimum twelve inches (12") of clearance between lines of other trades.
 - 3) Installation of multiple runs of piping in common trench is prohibited.
 - b. Pipe and Wire Depth to finish grade:
 - 1) Pressure Supply Piping: Twenty-seven inches (27") from the top of pipe, maximum variation +/- one inch (1").
 - 2) PVC Sleeving: At specified pipe or wire depth.
 - 3) Non-pressure Piping (gear driven heads): Eighteen inches (18") from top of pipe, maximum variation two inches (2").
 - 4) Non-pressure Piping (pop-up heads):
 - a) Turf zones: eighteen inches (18") from top of pipe.
 - b) Native seed zones: Twenty-four inches (24") from top of pipe, maximum variation two inches (2")
 - 5) Control Wiring and Two-Wire Decoder Cable: Side of pressure main when installed in the same trench; twenty-four (24) inches deep when installed separately from the mainline trench.
3. Vibratory Plow: Not permitted without written authorization of the Project Manager.

3.3 INSTALLATION OF IRRIGATION EQUIPMENT

- A. Locate all equipment as near as possible to locations designated. Deviations shall be reviewed and approved by the Project Manager prior to installation.

- B. Service Line Piping (copper piping from water meter to connection to backflow prevention device) - When pipe installation is not in progress, or at the end of each day, close pipe ends with tight plug or cap.
1. Copper piping – Installation shall match specifications for copper service line as required by Denver Water and in accordance with City and County of Denver Building Codes.
- C. Sleeving:
1. Install sleeving under any hard surface prior to surface being installed to accommodate piping and wiring.
 2. Minimum depth to top of pipe shall be determined by depth of mainline and lateral lines.
 3. Provide for a minimum cover of twenty-four (24) inches between the top of the sleeve and the bottom of the aggregate base for all pressure and non-pressure piping installed under asphaltic concrete or concrete paving.
 4. Sleeving located under areas where asphalt or concrete paving will be installed shall be bedded with a sand layer six inches (6") below the pipe and six inches (6") above the pipe.
 5. Sleeving under existing walks or concrete pavement shall be done by boring or hydraulic driving. Where cutting of asphalt and/or concrete is necessary, it shall be done per the Contract Drawings and Details and or per the City and County of Denver Right of Way Standards. Where cutting of concrete is necessary remove the entire concrete section or "stone". Obtain permission to cut walks from the Project Manager.
 6. Compact backfill material in three uniform lifts at ninety-five percent (95%) determined in accordance with ASTM D698 using mechanical tamping devices under pavement.
 7. Do not allow sleeves to become filled with soil or other undesirable material. Tape ends of sleeves until commencement of pipe installation.
 8. Mark sleeves on hard surfaces with a three inch (3") by three inch (3") "X" as per plans in a manner to ensure easy location in the future.
 9. Sleeve size requirements for wire and pipe, control wire shall be placed in sleeving separate from pipe sleeving:
 - a. 1" Pipe: 2" PVC
 - b. 1-1/2" to 2" Pipe: 4" PVC
 - c. 2-1/2" to 3" Pipe: 6" PVC
 - d. 4" Pipe: 8" PVC
 - e. Two-Wire Decoder Cable: 2" PVC
 10. HDPE pipe shall be used for sleeving purposes when directional boring takes place under any existing hard surfaces, walks, roadways, trees, etc. HDPE pipe may be used as the irrigation mainline under existing hard surfaces, walks, roadways, trees, etc in lieu of sleeving.
 - a. Install HDPE pipe to ensure that the end section of the HDPE pipe is a minimum of two feet (2') beyond any hard surface or tree dripline.

- b. All connections between HDPE pipe sections are to be made with fusion welded fittings per the manufactures recommendations.
- c. All connection fittings between HDPE and PVC or any other pipe material being used are to be made a minimum of twenty-four inches (24") away from any hard surface or tree drip line.
 - 1) Fittings to be used as couplings between HDPE and PVC shall be an epoxy coated repair coupler with joint restraints and stainless-steel pipe stiffener, installed as specified per the Contract Drawings and Manufacturer's recommendations.

D. Installation of Piping:

1. PVC Mainlines:

- a. Ensure that pipe is placed at a consistent depth and on a level base free of rocks and stones. Place manual drain valves at low points and dead ends of pressure supply piping to insure complete drainage of system. When pipe laying is not in progress, or at end of each day, close pipe ends with tight plug or cap. Perform Work in accordance with good practices prevailing in piping trades.
- b. Install mainlines a minimum of twenty-four inches (24") off any hard surface.
- c. Solvent Weld PVC Pipe (required on all pipe two inch (2") or smaller): Lay pipe and make all plastic to plastic joints in accordance with manufacturer's recommendations. Do not install pipe when air temperature is below forty degrees (40°) F.
- d. Gasketed End Pipe (required on all pipe two and one-half inches (2-1/2") or larger): Lay pipe and make pipe-to-fitting or pipe-to-pipe joint, following the manufacturer's recommendations. Install joint restraint fittings and pipe restraints on all fittings and adjacent pipe runs per manufacturer's recommendations and per the Approved Plan.

E. Joint restraints on all gasketed PVC mainline pipe two and one-half inches (2 1/2") and larger: Install joint restraints per the plans and or manufacturer's recommendations.

- 1. Joint restraints shall be installed as shown on the plans or per the manufacturer's recommendations. Prior to backfilling any joint restraints the Project Manager shall be present to verify that the restraints were installed in the proper locations and that all bolts have been tightened to the manufacturer's recommendations. Any restraints that are buried prior to inspection shall be excavated to allow for review and inspection at no additional cost to the City.

F. Flexible Plastic (Polyethylene) Pipe: Lay pipe and assemble fittings according to manufacturer's recommendations and per Contract Drawings and Details.

G. Control Wiring:

1. Two-wire control wiring:
 - a. Bury two-wire decoder cable between Automatic Irrigation Controller and electric valves in pressure supply line trenches, strung as close as possible to mainline with such cable to be consistently located to one side of pipe, or in separate trenches.
 - b. Make wire/cable splices at electric control valve connections as follows:
 - 1) Two-wire cable to two-wire cable - 3M Co. DBR/Y watertight connectors.
 - 2) Two-wire cable to electric valve solenoid wires - 3M Co. DBR/Y watertight connectors.
 - 3) Install all two-wire decoder cable splices not occurring at control valve in a separate Carson Industries Model #1419-12 body with bolt down T-cover wire splice valve box.
2. Provide an expansion loop at every mainline change of direction, every electric control valve location (in valve box), and every five hundred feet (500').
 - a. Form expansion loop in each control valve box by coiling twenty-four inches (24") of cable and laying coil in trench.
3. Install all Two-Wire cable splices not occurring at control valve in a separate Carson Industries Model #910-10 body with 910-4 bolt down T-cover wire splice valve box.
4. Wire Testing:
 - a. Existing wiring indicated to remain on documents is to be ohm-tested for continuity prior to construction. Contractor to produce report and copy the Project Manager of the results of such testing.
 - b. New wiring: All new wiring to be tested for proper resistance prior to connection to valves and controller(s) for continuity. The Contractor is to produce the report and copy the Project Manager of the results of such testing.

H. Installation of Valves:

1. Electric Control Valves: Install electric control valves as detailed on the Contract Drawings.
 - a. Electric Control Valves for two-wire system: Install electric control valves as detailed on the Drawings. Install one valve decoder module (Toro SB-DAC series) per valve box, sized to operate all valves located within same box.
2. All low volume irrigation shall be zoned independently from turf, and product applications may not be mixed within zone.
3. Quick Coupling Valves: Install quick coupling valves as detailed on the Contract Drawings.
4. Drain Valves: Install manual drain valves at all low points in pressure supply line, whether indicated on the Contract Drawings or necessitated by actual conditions, to ensure proper drainage of the mainline.
5. Isolation/Gate Valves: Install as detailed in locations shown on the Contract Drawings.

6. Valve Boxes: Install one valve box for each type of valve as detailed. Install compacted gravel leveling bed after compaction of subgrade and prior to setting of valve box.
 - a. Install filter fabric over gravel prior to setting valves boxes. Ensure that filter fabric extends a minimum of six inches (6") from the bottom and no more than six inches (6") from the top of box. Secure the filter fabric to the side of box with grey tape.
 - b. Install valve boxes flush with finish grade and square to adjacent surface features and one another
 - c. When valve boxes are grouped together, allow at least twenty-four inches (24") between valve box sides.
 - d. Install valve boxes a minimum of eighteen inches (18") away from any hard surface.
 - e. Cutting of valve box to give clearance for piping or valves is not permitted.
- I. Valve Box Identification Branding:
 - a. Brand Lids as follows in two inch (2") high minimum letters:
 - 1) Isolation/Gate Valve "GV"
 - 2) Quick Coupler Valve "QC"
 - 3) Wire Splice Box "SB"
 - 4) Grounding Rod "GR"

3.4 BACKFLOW PREVENTION

- A. Backflow Prevention Device: Contractor must meet all applicable laws, rules and codes, including but not limited to Uniform Building codes and applicable amendments Plumbing Codes and State Water Regulations. Assemblies must be installed per the manufacturer's specifications. Backflow devices shall not be installed within the public right-of-way.
 1. Install in strict accordance with current requirements of Denver Water. Connections to the Denver Water System are to have an approved assembly for the type of protection they provide, either isolation or containment.
 2. Successful Testing of backflow assembly by a certified Backflow Prevention Assembly Tester is Contractor's responsibility and any cost shall be considered incidental. Test reports shall be forwarded to Denver Water in accordance with the State of Colorado regulations. Copies of the report, the tester's certification and the certification of the testing equipment used are to be forwarded to the Project Manager.
 3. Request for final payment will not be certified or processed until certification reports have been filed with Denver Water and received by the Project Manager.

3.5 INSTALLATION OF SPRINKLER HEADS

- A. Install sprinkler heads where designated after the Project Manager has approved staking. Set to finish grade as detailed.
 - 1. Spacing of heads shall not exceed the maximum indicated on the Contract Drawings unless re-staked or as directed by the Project Manager. In no case shall the spacing exceed maximum recommended by manufacturer.
 - 2. Install gear driven heads on swing-joint risers as detailed. Swing joints to non-pressure lines shall be set at no more than forty-five degrees (45°) or less than ten degrees (10°).
 - 3. Install pop-up heads on swing pipe as detailed.
 - 4. Adjust part circle heads for proper coverage. Adjust heads to correct height after sod is installed. Plant placement shall not interfere with intended sprinkler head coverage, piping, or other equipment. The Project Manager may request nozzle changes or adjustments without additional cost to the City.

3.6 BACKFILLING

- A. Do not begin backfilling operations until all piping and system components have been inspected by authorized Denver Parks Operations Staff or by the Project Manager. Backfilling shall not be done in freezing weather unless authorized by the Project Manager.
 - 1. Leave trenches slightly mounded to allow for settlement after backfilling is completed.
 - 2. Trenches shall be finish graded and sodded or seeded prior to walk-through of system by the Project Manager.
 - 3. Materials: Excavated material is generally considered satisfactory for backfill purposes. Backfill material shall be free of trash, organic matter, frozen materials, and stones larger than one inch (1") in maximum dimension. Material not suitable for backfill shall be hauled away. Contractor shall be responsible for providing suitable backfill if excavated material is unacceptable or not sufficient to meet backfill, compaction, and final grade requirements.
 - 4. Do not leave trenches open for a period of more than forty-eight (48) hours. Open excavations shall be protected in accordance with OSHA regulations.
 - 5. Compact backfill to ninety-five percent (95%), determined in accordance with ASTM D698 utilizing the following methods in landscape areas:
 - a. Mainline Pipe: Backfill and mechanically compact in three uniform lifts to a ninety-five percent (95%) compaction, utilizing optimum moisture content for the soil type.
 - b. Secondary Pipe: Backfill in two uniform lifts and hydraulically or mechanically compact each.
 - c. Puddling or ponding and/or jetting is prohibited within twenty feet (20') of building or foundation walls.

3.7 RAIN SENSOR

- A. Rain Sensor: Install in accordance with manufacturer's instructions, and as shown on the Contract Drawings.
 - 1. Install rain sensor(s) prior to starting any irrigation schedules for new sod or seed programs.
 - 2. Install rain sensor(s) a minimum of fifteen (15) feet above grade, mount to a light pole, building or approved structure that is not shielded by tree canopies or structures and not effected by irrigation overspray.
 - 3. All rain sensor(s) to be set at one eighth inch (1/8") inch prior to being installed or irrigation begins.

3.8 ADJUSTING

- A. Upon completion of installation, "fine-tune" entire system by regulating valves, adjusting arcs and radius, and setting pressure reducing valves at proper and similar pressure to provide optimum and efficient coverage. Flush and adjust all sprinkler heads for optimum performance and to prevent overspray onto walks, roadways, and buildings as much as possible. Heads of same type shall be operating at same pressure within plus or minus ten percent (10%).
- B. If it is determined by the Project Manager or Denver Parks Operations Staff that irrigation adjustments will provide improved coverage and water distribution, the Contractor shall make such adjustments prior to Final Acceptance. Adjustments may include but not limited to changes in nozzle sizes, degrees of arc, and control valve flow control regulations. Adjustments shall be completed at no additional costs to the City.
- C. All sprinkler heads shall be set perpendicular to finish grade or within allowable limits shown on Contract Drawings.
- D. Areas that do not conform to designated operation requirements, due to unauthorized changes or poor installation practices, shall be immediately corrected at no additional cost to the City.

3.9 FIELD QUALITY CONTROL

- A. Flushing: After piping, risers, and valves are in place and connected, but prior to installation of sprinkler heads, quick coupler assemblies, and hose valves, thoroughly flush piping system under full head of water pressure from dead end fittings. Maintain flushing for five (5) minutes through furthest valves. Cap risers after flushing.
- B. Testing Pressurized Mainline: Prior to installing any plant materials (sod, seed, trees, shrubs, perennials) arrange and conduct pressure test(s) in the presence of the Project Manager. Arrange for testing a minimum of forty eight (48) hours in advance. The

contractor is responsible to supply the hydrostatic test pump and all other equipment required to complete the test.

1. Set in place, cap and pressure test all piping under paving, in presence of the Project Manager prior to backfilling and paving operations.
2. After backfilling and installation of all control valves, fill pressure supply line with water, and pressurize to forty (40) PSI over the designated static pressure or one hundred twenty (120) PSI, whichever is greater, for a test period of two (2) hours.
3. All isolation valves, angle valves, ball valves and zone valve flow controls are to remain open during testing.
4. Leakage, Pressure Loss:
 - a. Solvent welded PVC Pipe: Test is acceptable if zero pounds of pressure is evident during the test period.
 - b. Ring Tight Pipe: Test is acceptable if two (2) pounds of pressure or less is evident during the test period.
5. Leaks: Detect and repair leaks. Replace defective PVC pipe with new full length pipe section. No pipe splices will be accepted within pipe sleeve. No PVC pressure couplings or slip-fix repair couplings will be allowed.
6. Retest system until test pressure can be maintained for duration of test.

3.10 COMPLETION INSPECTION

- A. Arrange for the Project Manager to be present. Provide a minimum of forty-eight (48) hours of notice in advance of walk-through.
- B. Entire system shall be completely installed and operational and trenches shall be finish graded and sod and seed in place prior to scheduling of walk-through.
- C. Electrically operate each zone in its entirety for the Project Manager the time of walk-through.
- D. A project inspection walk through shall include but is not limited to the following:
 1. Contractor shall adjust, straighten and nozzle all heads prior to walk through. Review operation, coverage, head/nozzle adjustment, and system adjustment per specifications.
 2. Contractor shall have all valves boxes unlocked prior to walk through. Open valve boxes to confirm materials, filter fabric, gravel bedding, wire splices, compaction, elevation, workspace access within boxes, clearance from lid and bedding, locking mechanisms, and zone branding. Interior of boxes should be free of foreign material, only filter fabric shall be visible in the bottom of boxes. All valves must be tagged with zone identification, Christy's valve marker tags or equal and valve box lids must be branded with zone valve identification. Verify connections in all valve and wire splice boxes.

3. Contractor shall provide documentation that resistance tests for all spare common and hot wires has been performed and the results for ohms reading on each wire tested.
4. Confirm irrigation heads are at specified elevation and distance(s) from paved surfaces and curbs, plumb and soil compacted.
5. Inspect concrete size and elevation of pads for backflow assembly, hydrometer, and enclosure pads. Confirm quality of concrete, finishes, access to the Irrigation Controller and spare conduit/sleeving as required for wiring.
6. Review trench and related excavation repair including backfill, compaction, fine grade, seed, and sod installation.
7. Review appropriate use of purple valve lids and other product as required for reuse water applications.
8. Generate a punch list of items to be corrected prior to Final Completion.
9. Furnish all materials and perform all work required to correct all inadequacies of coverage due to deviations from Contract Documents.

3.11 CLEANING

- A. Maintain continuous cleaning operation throughout duration of Work. Dispose of, all trash, waste materials, debris and excess soil generated by installation of irrigation system, off-site, at no additional cost to the City. Contractor shall clear all debris, including, soil, from all paths, walks, roads, and other hard surface areas.

3.12 PROTECTION

- A. Restrict vehicular and pedestrian traffic from areas where irrigation has been installed. Erect temporary fencing or barricades and install warning signs as required or directed by the Project Manager at no additional cost to the City.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

- A. Measurement will be based on the percentage complete for the lump sum contract amount for Irrigation Systems.

4.2 PAYMENT

Payment will be made at the lump sum contract price, and shall include required materials, transportation, equipment, labor, earthwork, concrete, trenching, stockpiling, disposing, watering, dust control, erosion and sediment control, fine grading, as required in accordance with the Contract Drawings and Specifications. *All cost for this work shall be included within this bid item and no additional payment will be made.* At the option of the Construction Project Manager, payment may be made in percentage installments based upon type, location and scope of work in relation to the period of performance.

The total payment for this bid item shall not exceed seventy-five percent (75%) of the lump sum price during construction. The remaining twenty-five percent (25%) shall be paid after final site cleanup, completion of all punch list items and demobilization from site.

END OF SECTION 32 80 00

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Contract Drawings and general provisions of the Contract, including General and Supplementary Conditions and the City and County of Denver Standard Specifications for Construction General Contract Conditions (2011)
- B. City and County of Denver Engineering Division, Wastewater Capital Project Management Standard Construction Specifications, dated March 15, 2016.
- C. Wastewater Capital Projects Management Special Project Provisions for Asbury & Tejon.
- D. Wastewater Capital Projects Management Supplemental Technical Specifications for Asbury & Tejon.
- E. Denver Parks and Recreation Asbury and Tejon Specifications, OCT 2018.

1.2 SUMMARY

- A. This Section includes requirements for the installation of automatic landscape irrigation controllers including the following:
 - 1. Trenching, stockpiling excavation materials, refilling and compacting excavations.
 - 2. Irrigation system components including but not limited to Automatic Irrigation Controller(s), associated wiring, timing and final adjustments.
 - 3. Testing.
- B. Related Sections:
 - 1. WCPM Standard Construction Specification 2.0 Section "Site Preparation".
 - 2. WCPM Standard Construction Specification 4.0 "Utility Trenching and Excavation"
 - 3. WCPM Standard Construction Specification 5.0 "Bedding and Backfilling".
 - 4. WCPM Standard Construction Specification 23.0 "Storm Water Management"
 - 5. WCPM Supplemental Technical Specification 31 23 00 "Earthwork".
 - 6. WCPM Supplemental Technical Specification 31 23 19 "Water Control and Dewatering".
 - 7. Division 01 45 16 Section "Contractor Quality Control".
 - 8. Division 01 56 39 Section "Tree Retention and Protection".
 - 9. Division 31 32 50 Section "Watering".
 - 10. Division 32 13 13 Section "Concrete Walks, Curbs, and Miscellaneous Flatwork".
 - 11. Division 32 80 00 Section "Irrigation System".
 - 12. Division 32 91 13 Section "Soil Preparation".
 - 13. Division 32 91 20 Section "Topsoil".

14. Division 32 92 20 Section "Native Seeding".
15. Division 32 92 23 Section "Sodding".
16. Division 32 93 00 Section "Trees, Plants, and Groundcovers".

1.3 REFERENCES

- A. Conform to requirements of reference information listed below except where more stringent requirements are shown or specified in Contract Documents.
 1. American Society for Testing and Materials (ASTM) - Specifications and Test Methods specifically referenced in this Section.
 2. Underwriters Laboratories (UL) - UL Wires and Cables.
 3. National Sanitation Foundation (NSF) – Piping and backflow prevention.
 4. American Water Works Association – Piping and backflow prevention.

1.4 QUALITY CONTROL

- A. Special Requirements.
 1. Tolerances: Specified depths of mains and laterals and pitch of pipes shall be installed per the drawings and specifications.
 2. Compaction: Settlement of excavations is cause for removal of concrete controller pads, finish grade treatment, refilling, compaction, and repair of finish grade treatment.
 3. Coordination with Other Contractors: Protect, maintain, and coordinate work with work under other Sections.
 4. Damage to other Improvements: Contractor shall replace or repair damage to grading, soil preparation, seeding, sodding, planting and/or new site features done under other Sections during Work associated with installation of irrigation system at no additional cost to the City.
 5. Damage or Disturbance to the Existing Irrigation Components: Damage to existing components as a result of work being performed by the Contractor will require the Contractor to replace the damaged components to the Cities current standards, at no additional cost to the City. This includes boxes, manifolds, valves, angle valves, risers, wire, heads, pipe, and controllers.
 6. Water Delivery Interruption: When working on an existing irrigation system, the Irrigation Contractor shall inform the Project Manager seventy-two (72) hours in advance of any water interruption that is required. The maximum irrigation system interruption is to be no more than seventy-two (72) hours during the growing season. The contractor shall make all necessary provisions including material, equipment, labor, delivery and scheduling as required to complete all points of connection, upgrades, and improvements within seventy-two (72) hours.
 7. Watering: The Contractor is responsible for following all Denver Water rules and regulations for sod and seed establishment, available at

<http://www.denverwater.org>. The Contractor shall post signage per Denver Water in a visible location(s) on site indicating "IRRIGATION TESTING AND MAINTENANCE IN PROGRESS" when Work (establishment, construction or warranty) requires irrigation system operation between the hours of 10 am to 6 pm. The signs are to be used are available from Denver Water.

8. Permits: Secure a permit at least forty eight (48) hours prior to start of installation. Work involving high voltage electrical wiring, grounding and related Work shall be executed by licensed and bonded electrician(s). Secure a permit at least forty eight (48) hours prior to start of installation.
9. Pre-Construction Conferences and Site Meetings:
 - a. Contractor shall schedule and conduct a pre-construction conference to review in detail quality control and construction requirements for equipment and materials used to perform the Work. Conference shall be scheduled not less than ten (10) days prior to commencement of Work. All parties required to be in attendance shall be notified no later than seven (7) days prior to date of conference. Contractor shall notify qualified representatives of each party concerned with that portion of Work to attend conference, including but not limited to the Project Manager, Denver Parks Superintendent, Operations Supervisor, Water Conservation, Contractor's Superintendent, Toro factory representative, and Installer.
 - b. Prior to commencement of Work, Contractor shall schedule an on-site conference with Project Manager, Parks Forestry and any other parties designated by Project Manager to discuss tree protection requirements, marshalling locations, traffic control, and equipment access. Provide a minimum of seven (7) days' notice prior to date of conference.
 - c. The Contractor shall schedule on-site conferences, the frequency of which is to be determined by the Project Manager, and any other parties designated by the Project Manager to review project progress.
 - d. The Contractor shall record Minutes of each conference and distribute to all parties in attendance within three (3) days of conference.

1.5 SUBMITTALS

- A. Prepare and make submittals in accordance with conditions of the Contract prior to installation of any irrigation equipment.
- B. Material List: Submit a PDF file of complete list of materials, and cut sheets indicating manufacturer, model number and description of all materials and equipment to be used. Show appropriate dimensions and adequate detail to accurately portray intent of construction.
- C. Shop Drawings: If applicable, submit shop drawings for Automatic Irrigation Controllers indicating electrical wiring design, and assembly. Include shop drawings for Automatic Irrigation Controller foundation/support systems.

1. Operation and Maintenance Data: Coordinate scheduling/precipitation instructions with the City's Operations Staff. Submit three (3) bound manuals and one (1) digital copy to the Project Manager including:
2. Cut sheets of products.
3. Manufacturer's maintenance and inspection instructions for Automatic Irrigation Controller and related equipment.

D. Written warranty.

1.6 CONTRACT RECORD DRAWINGS

- A. Prior to the installation of irrigation system, the Contractor will provide on-site copies of original irrigation design drawings "Record Drawings". Contractor to revise Record Drawings in red ink as Work progresses to show any changes to the plan and include field dimensions. Record Drawings shall be brought up-to-date prior to any Pay Application Submittals that contain irrigation installation. Should the Contractor choose to utilize GPS for the purposes of documenting Work in progress, a hard copy print will need to be provided prior to Pay Application Submittal. A print of Record Drawings shall be available at Project Site for review by the Project Manager at any time during the project.
1. Record Drawings shall encompass entire scope of work including any altered existing controllers and/or wiring.
 2. Preparation of Record Drawings: Dimension from two permanent points of reference (building corners, sidewalk, road intersections or permanent structures) the location of the following items:
 3. Automatic Irrigation Controller location.
 - a. Rain sensors/weather station
 - b. Power service drop.
 - c. Other related equipment as directed.
 4. Make dimensions accurately at the same scale used in the original drawings, or larger. Notes and dimension lettering must be legible.
 5. The irrigation legend must be changed to accurately reflect the irrigation equipment installed, if such equipment is not the same as originally specified on the contract documents. The Project Manager will not certify any pay request submitted by the Contractor if the Record Drawings are not current, and processing of pay request will not occur until Record Drawings are updated.
 6. Final Submittal: Upon completion of the Automatic Irrigation Controller installation, prior to final acceptance, secure digital copy of documents associated with the Automatic Irrigation Controller design from the Project Manager and record as installed information that reflects all changes made over the course of the construction project, prepared by a qualified draftsman. Record Drawings shall include details, including any revisions as per actual installation. Deliver and submit to the Project Manager for review the following items:

- a. Digital Contract Record Drawings in both PDF and Auto CAD release 2010 bound (include any related X-ref files, plot files and pen settings.) Make any additional changes to the file as directed by the Project Manager prior to final submittal and approval.
7. Request for final payment will not be certified or processed until all Record prints and digital files have been received and approved.
8. Controller Zone Maps and Programming Schedule:
9. Do not prepare zone maps or irrigation controller charts until record drawings have been reviewed and approved by the Project Manager. The Project Manager shall provide an example of Automatic Irrigation Controller Charts and zone map required.
10. Provide one controller zone map for each Automatic Irrigation Controller installed.
 - a. Zone Map shall be reproduction of record drawing, one page sized eleven inches by seventeen inches (11" X 17").
 - b. Zone Map shall be print of actual record drawing of the system, showing the entire area covered by that Automatic Irrigation Controller on one sheet.
 - c. Identify Automatic Irrigation Controller, all remote valves and lateral lines of each remote-control valve, using a distinctly different color for each zone. Include the entire area of the Automatic Irrigation Controller's coverage. Provide a legend showing equipment being used.
 - d. Submit digital copies in the original program format as well as PDF format to the Project Manager
11. Provide one zone map for the entire project.
 - a. Zone Map shall be reproduction of record drawing, one page maximum twenty-four by thirty-six inch (24" x 36"), photo-reduced to maximum size and legibility.
 - b. Identify all Automatic Irrigation Controllers, remote valves and lateral lines using different colors to distinguish adjacent zones.
 - c. Submit digital copies in the original program format as well as PDF format to the Project Manager
12. The contractor is responsible for programming new and modified Automatic Irrigation Controllers to operate the irrigation system in conformance with all Denver Water restrictions and establishment rules for new landscapes per Denver Water, rules and regulations at: <http://www.denverwater.org>.
13. The Contractor shall be responsible for providing an Establishment Watering Schedule, Transition Watering Schedule and a Maintenance Watering Schedule to the Project Manager, Operation Supervisor and the Toro Factory Representative (when applicable). All irrigation schedules and zone controller charts shall ensure that there will be no ponding or runoff of water during any of the scheduled times. Prior to any plant material being installed all schedules shall be provided to the Project Manager and Operations Supervisor. The water schedule templates are available from Water Conservation and the Project

Manager. Contractor shall make any modifications to the programming as requested by Project Manager or Operations Supervisor.

- a. Establishment Irrigation (Days 1-21): Plants shall be adequately watered for the first twenty-one (21) days after installation or until seeds have germinated and emerged or sod has become firmly rooted. Exact timing of irrigation cycles will depend on weather conditions, soil conditions, and speed of emergence of grass seed. Short, frequent irrigation cycles shall be used. Split cycles or the 'cycle and soak' feature must be employed to reduce erosion or run off in seeded areas. Do not exceed three inches (3") of total water per week. Coordinate with irrigation system schedule and programming with the Project Manager, Operations Staff, and local Toro Field Representative. Contractor shall submit a meter reading before and after establishment to verify water use.
 - b. Transition Irrigation (Days 21-56): Less frequent, but longer watering cycles will provide moisture at depths that will encourage seedlings to continue to develop and sod to develop deeper roots. Allow the surface soils to dry slightly between watering to encourage deeper rooting. Watering shall be done utilizing historic evapotranspiration rates for the current watering month(s).
 - c. Maintenance Irrigation: Irrigate as needed to maintain an optimum stand of turf while minimizing water use. Irrigation frequency shall be adjusted at a minimum, based on monthly historical evapotranspiration rates and plant (turf and tree) water requirements.
 - 1) It is the responsibility of the Contractor to coordinate with Project Manager, Operations Staff, and local Toro Field Representative. The local Toro Field Representative will assist the Contractor in the setup of the controller(s), but Contractor is responsible for the actual programming of Automatic Irrigation Controllers as needed to properly irrigate plant materials and turfgrass.
 - 2) Provide Toro Field Representative with the following:
 - a) Zone gallons-per-minute (GPM)w schedule from documents.
 - b) Zone map to compare GPMs when setting up system flows.
14. Once sod has been laid, begin watering to build up the sub-soil moisture. This will be the most critical time to apply water. Water up to one and one-half inch (1-1/2") of water per day for the first two to three days. Probe the soil to determine if the moisture has penetrated down to a minimum of four inches (4"). During the next three weeks the amount of water needed will be similar to that of the historical evapotranspiration rates for the season per day. Each day may require more than one application depending on wind and temperature in order to keep the root zone and blades moist.
15. Provide one Programming Schedule for each Automatic Irrigation Controller installed, one page maximum, 8-1/2- by 11-inches. Project Manager shall provide an example of Controller Programming Schedule required and the scheduling templates.

16. Following review of Zone Maps and Schedules by the Project Manager, provide two additional color duplicates of Zone Maps and Schedules. One set of Zone Maps and Schedules shall be laminated between two layers of 3-mil plastic sheet. Provide digital copies of Zone Maps and Schedules in PDF format.
17. Zone Maps and Schedules shall be completed and reviewed prior to final review of irrigation system.
18. Request for final payment will not be certified or processed until all prints and files for Zone Maps and Schedules have been received and approved.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Per the Contract Drawings, Denver Parks and Recreation will be supplying these controllers.
- B. Packing and Shipping: Deliver all components to job site in original unopened packaging containers prominently displaying manufacturer's name, contents, instructions, and conformance to local, state, and federal law. Remove and replace damaged items or elements prematurely exposed to moisture, inclement weather, snow, ice, temperature extremes, fire, or jobsite damage.
- C. Storage and Protection: Deliver, unload, store, and handle materials, packaging and bundling products in dry, weatherproof condition in manner to prevent damage, breakage, deterioration, intrusion, ignition, and vandalism.
- D. Only materials and equipment meeting project specifications and to be used as part of Project shall be stored on site. Project Manager to may verify at any time during construction period.

1.8 JOBSITE CONDITIONS

- A. Existing Conditions:
 1. Soil Conditions: Investigate the type of soil and conditions in which lines are to be installed and allow for same type of soil in the proposal. No extra payment will be allowed due to difficulty in trenching, unless approved by the Project Manager.
 2. Contractor is responsible for understanding the scope of related operations as specified and indicated in the Drawings and Specifications before beginning Work under this Section.
 3. Report unsatisfactory conditions in writing to the Project Manager within twenty four (24) hours of discovery. Commencement of installation means acceptance of existing conditions by the Contractor.
- B. Protection of Property:
 1. Protect buildings, walks, walls, and other property from damage. Erect and maintain barricades, warning signs and lights, and provide guards as necessary or

required to protect all persons on the site. Damage caused to asphalt, concrete, monuments, structures or other building material surfaces shall be repaired or replaced at no cost to the City. Restore disturbed areas to original condition.

2. Preserve and protect all trees and plants as shown on plans or as directed by the Project Manager or the City Forester. In the event damage does occur, all damage to plant material shall be brought to the attention of the Project Manager immediately for review by the City Forester. All damage to plant material shall be repaired or replaced per the direction of the City Forester at no cost to the City.

C. Protection of Existing Trees:

1. Refer to Division 01 56 39 Section "Tree Retention and Protection".

D. Protection and Repair of Underground Lines:

1. Request utility locates seventy-two (72) hours in advance of any excavations by calling the Utility Notification Center of Colorado at 811. Take whatever precautions are necessary, including pot holing to verify location and depth to protect these underground lines from damage. If damage does occur, all damage shall be repaired by the Utility Owner. All costs of such repairs shall be paid by Contractor.
2. The Contractor is required to contact all private utility companies including Denver City Departments to locate all private utilities. The request for locates shall be a minimum of seventy-two (72)-hours prior to proceeding with any excavation. If, after such requests private utilities are encountered and damaged by the Contractor these shall be repaired by the no cost to the City. If the Contractor damages staked or located private utilities, they shall be repaired by the Utility Owner at the Contractor's expense.

- E. Replacement of Paving and Curbs: Any damage due to work that occurs adjacent to or crosses existing roadways, paths, trails, curbing, sidewalks, etc. shall be restored to original condition at the contractor's expense, and the satisfaction of the Project Manager.

1.9 WARRANTY/GUARANTEES

- A. Provide a one (1) year written warranty for material and installation from date of Final Acceptance.
- B. Expenses due to vandalism before Final Acceptance shall be the contractor's responsibility.
- C. Any settling or displacement of concrete support pad for Automatic Irrigation Controller that occurs during warranty period shall be repaired at no expense to the City, including complete restoration of damaged property.

- D. Once final acceptance is granted, the City will maintain turf and planting areas during warranty period, unless maintenance by Contractor is specified in the contract. Contractor is responsible to monitor and coordinate Automatic Irrigation Controller scheduling and maintenance with Parks' maintenance staff and or the Automatic Irrigation Controller factory certified technician for any seeding, sodding, or planting areas under Contractor's warranty.
- E. Project Manager reserves the right to make temporary repairs during the warranty period as necessary to keep systems in operating condition without voiding the Contractor's warranty, nor relieving the Contractor of his responsibilities. The City reserves the right to change Automatic Irrigation Controller schedules should the contractor not respond within seventy-two (72) hours of a written request to make changes to programming. Doing so does not relieve the contractor of their contractual obligations.
- F. Contractor shall make repairs and replacements within three (3) days of notification. If Contractor fails to make repairs within three (3) days, the City will make such repairs at Contractor's expense.

1.10 MAINTENANCE

- A. Where applicable, furnish the following maintenance items to City prior to Final Acceptance:
 - 1. Four (4) Automatic Irrigation Controller cabinet keys. (If applicable).
 - 2. One (1) remote control device for each Automatic Irrigation Controller installed on the project.

1.11 MAINTENANCE DURING PROJECT CONSTRUCTION

- A. Within Limits of Construction: Contractor shall fence, water, and keep weed free any turf, trees and any plantings within the limits of construction. Contractor is responsible for maintenance which includes picking up trash, weed control and mowing of turf and native areas within the limits of construction. Contractor is responsible for watering existing landscape within limits of construction. Turf and plants affected by mainline work or irrigation water service shutdown during irrigation season shall receive watering per Parks' schedule, with no interruption of watering greater than seventy-two (72) hours. Contractor is responsible for maintenance until final acceptance is granted.
- B. Outside Limits of Construction: Coordinate Automatic Irrigation Controller scheduling and maintenance operations with Project Manager for portions of City property unaffected by construction.
- C. Additional Maintenance During Warranty Period:

1. Make repairs and replacements needed due to defective workmanship and materials.
2. Winterization and Spring Start Up: See Division 32 80 00 Section "Irrigation Systems".

PART 2 - PRODUCTS

2.1 GENERAL

- A. Equipment must have performance characteristics to operate per the design conditions indicated. If any discrepancy or conflict exists between the quantities of equipment listed in the schedule and quantities shown on the Contract Drawings, the greater quantity shall govern.
- B. All material shall be of the highest grade possible and where applicable, shall be marked accordingly and shall be new.

2.2 AUTOMATIC CONTROL SYSTEM

- A. Automatic Irrigation Controller: [to be provided by Denver Parks and Recreation](#).
 1. Central Control systems shall be Toro Sentinel special build, AC 2-Wire, SBTW204AC-U2/SB18SS-PC-DG/VRA-GFI-FK. Update to Sentinel central control is required on all projects unless a variance is granted by Denver Parks Water Conservation.
 - a. Sentinel satellite Automatic Irrigation Controller in prefabricated enclosure with pedestal is available exclusively through C.P.S. Distributors. Contractor shall purchase fully assembled enclosure including back panel, terminal strips, power supply unit, interior fused disconnect with 120-volt GFI duplex outlet, heavy duty transient surge protection boards, antenna(s) with cable, louvers and fan kit. Enclosure and pedestal shall be stainless steel with factory applied powder coating finish, Color #6005 Tiger Drylack color chart. Enclosure shall have a heavy-duty hasp for locking. Model number is per plan as specified by Toro.
 - b. 450 MHz radio communication shall be fully compatible with Denver Parks and Recreation frequency required by the Operations District.
 2. If variance is granted, Automatic Irrigation Controller must have the following minimum characteristics:
 - a. Solid state, fourteen (14) day clocks, with multiple programming capabilities.
 - b. Capable of opening normally closed electric solenoid type valve.
 - c. Automatic Timing: Capable of incremental units from three (3) to at least sixty (60) minutes per station.
 - d. Water Budgeting: Capable of global program run time changes in percentage increments.

- e. Ability to provide repeat and/or syringe cycle capabilities and ability to eliminate or isolate one station without disturbing remaining Automatic Irrigation Controller features.
 - f. Flow sensing capability with automatic shut-down or alarm signal.
 - g. Minimum 40 VA transformer rating.
 - h. Automatic Irrigation Controller cabinets shall be stainless steel Strongbox or Hoffman enclosure with factory-applied Federal Green powder-coat finish and heavy duty locking hasp. Size cabinet per specification from manufacturer.
 - i. Automatic Irrigation Controller and cabinet require grounding per manufacturer recommendations, outside disconnect, inside fused disconnect, interior duplex GFI outlet.
 - j. Automatic Irrigation Controller shall have capability to interface with normally-open master valve.
- 3. Automatic Irrigation Controller and remote control equipment: Manufacturer and Model shall be noted on Drawing.
 - 4. Contractor shall provide concrete pad, 120V electrical power, conduits, grounding and control wire connections to terminal surge strips.
 - 5. Concrete Pad: Comply with plan detail and Division 2 13 13 Section "Concrete Walks, Curbs, and Miscellaneous Flatwork".
- B. Electrical Control Wiring: See Division 32 80 00 Section "Irrigation Systems".

PART 3 - EXECUTION

3.1 PREPARATION

- A. Utility Locates: Contact Utility Notification Center of Colorado at or 8-1-1 or 1-800-922-1987 prior to any excavation, for the marking of underground member utilities. The indication of utilities on the Contract Drawings does not relieve the Contractor of the responsibility for utility location. Contractor is responsible for potholing all utility locations to verify the depth and locations. Potholing related to irrigation installation shall be considered incidental to irrigation installation and will not be paid for separately. Route trenches to avoid existing utilities. Verify with the Project Manager any required relocation prior to installation.
- B. Automatic Irrigation Controller Location: Contractor will be held responsible for coordination between existing and proposed landscape improvements, Automatic Irrigation Controller location, and installation. Landscape material locations shown on the Landscape Plan shall take precedence over the location of the Automatic Irrigation Controller location(s). If Automatic Irrigation Controller is installed in conflict with the landscape material locations shown on the landscape plan, the Contractor will be required to relocate the Automatic Irrigation Controller, as necessary, at Contractor's expense.

- C. Inspection:
 - 1. Examine areas and conditions under which Work of this Section is to be performed. Do not proceed with Work until unsatisfactory conditions have been corrected.
 - 2. Grading operations, with the exception of fine grading, shall be completed and approved by the Project Manager before staking or installation of any irrigation system equipment begins.
 - 3. Layout: Stake Automatic Irrigation Controller location before beginning installation and obtain the Project Manager's approval prior to installation.

3.2 INSTALLATION OF IRRIGATION EQUIPMENT

- A. High Voltage Wiring for Automatic Irrigation Controller:
 - 1. Provide one hundred twenty (120) volt power connection to Automatic Irrigation Controller.
 - 2. All electric work shall conform to local codes, ordinances, and authorities having jurisdiction. All high voltage electrical work shall be performed by licensed electrician.
- B. Automatic Control System:
 - 1. Sentinel Central Control:
 - a. Contractor is to arrange and pay for C.P.S. Distributors to conduct a signal test and survey to maximize signal quality of any antenna and each Sentinel controller installed, and maximize layout for flow sensing. Contact Brandon Gully, with C.P.S Distributors at (303) 961-6959 or gullyb@cpsdistributors.com. Signal test and survey is to be conducted or verified prior to construction during full tree leaf-out when possible. Location of the controller shall be based on the field test. Contractor is responsible to coordinate optimization of central control with the Toro Factory Representative, Denver Parks Water Conservation, Denver Parks Operations Supervisor, and the Project Manager.
 - b. All irrigation schedules during establishment period and warranty period are to be submitted via email to the Toro Factory Representative, Denver Parks Water Conservation, Denver Parks Operations Supervisor and the Project Manager. Upon approval of the schedule the Toro Factory Representative will input schedules and make all changes, corrections, or updates within forty-eight (48)-hours.
- C. Field Wiring Testing Requirements:
 - 1. Contractor shall provide a pre-installation Ohm test report of all field wires located within an existing controller prior to removing any wires from the terminals in the Automatic Irrigation Controller. Provide a report to the Project Manager of each zone wire tested, the Ohm readings for each wire, date of test, Automatic Irrigation

Controller location. Please indicate in the report any wires or solenoids that do not meet standards for the operating ranges of the specified or existing materials.

2. Contractor shall provide an Ohm test report of all field wires prior to installing any wires at the Automatic Irrigation Controller terminals. Provide a report to the Project Manager of each zone wire tested, the Ohm readings for each wire, date of test, Automatic Irrigation Controller location. Please indicate in the report any wires or solenoids that do not meet standards for the operating ranges of the specified or existing materials. The report shall include the Ohm readings prior to removal of the existing controller and after relocation or installation of new Automatic Irrigation Controllers.
 3. All field wiring issues must be resolved prior to the connection of wires at the Automatic Irrigation Controller terminal strips.
 4. Install Automatic Irrigation Controller and enclosure in accordance with the Contract Drawings and per the manufacturer's instructions. All work including but not limited to concrete pad, 120v electrical power, conduits, grounding and control wire connections to terminal surge strips shall be by the Contractor.
 5. Provide Automatic Irrigation Controller to earth ground as per manufacturer recommendations. Central Control Satellite: Provide Automatic Irrigation Controller to earth ground in accordance with Article 250 of the National Electrical Code (NEC). Earth ground shall be ten (10) OHMS or less as measured by a Megger® or similar instrument, or as per manufacturer recommendation. Contractor shall arrange with the Toro Factory Representative and perform testing in presence of Denver Parks Operations Staff and the Project Manager.
 - a. Ground rods are to have a minimum diameter of five-eighths-inch (5/8") and a minimum length of eight feet (8').
 - b. Copper wire shall be six (6) gauge bare copper wire connected to the ground rod using a Cadweld GR1161GPLUS "Plus One Shot" welding kit.
 6. Install above ground wiring in rigid conduit in accordance with applicable codes.
- D. Coordinate installation with electrical work to insure electrical power supply line(s) are provided to Automatic Irrigation Controller location(s).
1. Permanently engrave date of installation and Xcel service pole number inside Automatic Irrigation Controller enclosure.
- E. Wire control valves as shown on Contract Drawings.
- 3.3 FIELD QUALITY CONTROL
- A. Testing Controller Operations:
1. Functional test of the control system shall be performed and demonstrate that all parts of the control system function as specified or intended, as per Parks' Central Control Certification Checklist. The functional test for each system shall consist of not less than thirty (30) days of continuous, satisfactory operation of the complete system serviced by a controller.

- a. Contractor to coordinate with the Project Manager to arrange Central Control Certification meeting.
 - 2. Required attendees are the Toro Factory Representative, Denver Parks Water Conservation, Denver Parks Operations Supervisor and the Project Manager.
 - 3. Any materials determined to be faulty as part of the installation shall be replaced or corrected by the Contractor at his expense in a manner respective to the Plans, Details, and other sections of this Specification. In the event of a system failure due to faulty installation, programming or workmanship, the thirty (30) day period will be repeated until testing is complete.
- B. System Operations Orientation:
- 1. System Operation Training Session: A training and orientation session for City staff shall be required.
 - a. The Contractor, the irrigation subcontractor, a representative of the manufacturer or distributor, and representatives of the City's maintenance and Denver Parks Water Conservation shall be present. The date and time of the session and attendees present shall be subject to approval by the Project Manager.
 - b. The completed Record Drawings, Automatic Irrigation Controller Zone Maps and Automatic Irrigation Controller Program Schedule shall be reviewed for approval by Denver Parks Water Conservation.
 - c. Automatic Irrigation Controller features, flow sensing, alarms and programming shall be reviewed.
 - d. Hand held operation of field units shall be demonstrated.

3.4 COMPLETION INSPECTION

- A. A project inspection walk through shall include but is not limited to the following:
 - 1. Confirm quality of controller enclosure and mounting (there must be no gap between Automatic Irrigation Controller and concrete), grounding, high voltage installation, low voltage wiring, ID tagging of wires in Automatic Irrigation Controller, and communication set up. Each controller must have a color-coded zone chart and programming chart as per Specifications.
 - 2. Contractor shall submit to the Owner written certification of testing that proper grounding for all controllers has been installed per the manufactures recommendations.
- B. Certify Central Control Operation: Central control operation will be verified by Denver Parks' **Certification of Central Control Checklist**.

3.5 CLEANING

- A. Maintain continuous cleaning operation throughout duration of Work. Dispose of all trash, waste materials, debris, and excess soil generated by installation of the

controller, off-site, at no additional cost to the City. Contractor shall clear all debris, including, soil from all paths, walks, roads, and other hard surfaces.

3.6 PROTECTION

- A. Restrict vehicular and pedestrian traffic from installation site. Erect temporary fencing or barricades and install warning signs as required or directed by the Project Manager at no additional cost to the City.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

- A. Measurement will be based on the contract unit price for installation of the Automatic Irrigation Controllers.

4.2 PAYMENT

Payment will be made at the contract price, and shall include required materials, transportation, equipment, labor, earthwork, stockpiling, disposing, hauling off, watering, dust control, erosion and sediment control, fine grading, temporary protection by fencing or other means, all maintenance required, specified controller charts, zone maps, Record Drawings and verification checklist until Final Acceptance of the work as required in accordance with the Contract Drawings and Specifications. All cost for this work shall be included within this bid item and no additional payment will be made

END OF SECTION 32 84 33

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Contract Drawings and general provisions of the Contract, including General and Supplementary Conditions and the City and County of Denver Standard Specifications for Construction General Contract Conditions (2011).
- B. City and County of Denver Engineering Division, Wastewater Capital Project Management Standard Construction Specifications, dated March 15, 2016.
- C. Wastewater Capital Projects Management Special Project Provisions for Asbury & Tejon.
- D. Wastewater Capital Projects Management Supplemental Technical Specifications for Asbury & Tejon
- E. Denver Parks and Recreation Asbury and Tejon Specifications, OCT 2018.

1.2 SUMMARY

- A. This Section includes requirements for the preparation of soil for seeding, sodding, or planting operations. Soil preparation consists of ripping, fertilizing, soil conditioning, and fine grading the topsoil. Soil preparation as specified herein must precede all seeding, sodding, and planting.
- B. Related Sections:
 - 1. WCPM Standard Construction Specification 2.0 Section "Site Preparation".
 - 2. WCPM Standard Construction Specification 23.0 Section "Storm Water Management".
 - 3. WCPM Supplemental Technical Specification 31 23 00 "Earthwork".
 - 4. WCPM Supplemental Technical Specification 31 23 19 "Water Control and Dewatering".
 - 5. Division 31 32 50 Section "Watering".
 - 6. Division 32 91 20 Section "Topsoil".
 - 7. Division 32 92 19 Section "Turfgrass Seeding".
 - 8. Division 32 92 20 Section "Native Seeding".
 - 9. Division 32 92 23 Section "Sodding".
 - 10. Division 32 93 00 Section "Trees, Plants, and Groundcovers".

1.3 DEFINITIONS

- A. Fertilizer: A substance that is added to soil to help the growth of plants.

- B. Soil Amendment: Any substance which is intended to improve the physical, chemical, or other characteristics of the soil.
- C. Soil Conditioner: Combination of slow-release fertilizer, hummate, and Mycorrhiza.

1.4 SUBMITTALS

- A. Testing Agency Qualifications: Project Manager to approve prior to construction.
- B. Soils Test Data: See Quality Control 1.5
- C. Product Data (for each type of product):
 - 1. Include recommendations for application and use.
 - 2. Include test data substantiating that products comply with requirements.
 - 3. Material Certificates: For each type of soil conditioner, soil amendment, and fertilizer before delivery to the site, according to the following:
 - a. Manufacturer's qualified testing agency's certified analysis of standard products.
 - b. State, Federal and other inspection certificates shall accompany invoice for materials showing source or origin.
- D. Samples: For each bulk-supplied material, one (1) quart volume of each in sealed containers labeled with content, source, and date obtained. Each Sample shall be typical of the lot of material to be furnished; provide an accurate representation of composition, color, and texture.

1.5 QUALITY CONTROL

- A. Testing Agency: Retain an independent, state-operated, or university operated laboratory experienced in soil science, soil testing, and plant nutrition; with the experience and capability to conduct the testing indicated and that specializes in the types of tests to be performed.
 - 1. Laboratories: Subject to compliance with requirements, provide testing of materials in the Section by a qualified testing laboratory approved by the Project Manager.
 - 2. Multiple Laboratories: Work may be divided among qualified testing laboratories specializing in physical testing, chemical testing, and fertility testing.
- B. Testing: Contractor is responsible for performing the following tests:
 - 1. Soil texture.
 - 2. Soil fertility.
 - 3. Testing in accordance with Division 32 Section "Topsoil."
- C. Preconstruction Testing

1. Engage the approved testing agency to perform preconstruction soil analyses on existing on-site soil, imported topsoil, and pre-amended imported soil.
2. Notify Project Manager seventy-two (72) hours in advance of the dates and times when laboratory samples will be taken.

D. Soil Sampling Requirements

1. Sample existing soil only in areas where existing soil shall remain after completion of grading and site improvements.
2. Sample Collection and Labeling: Have samples taken and labeled by the Contractor in the presence of the Project Manager and under the direction of the testing agency.
3. Number and Location of Samples: Minimum of five (5) samples per acre collected randomly throughout the areas to receive similar soil preparation, including seed/sod, native seeding, planting beds, and gardens. Provide a site plan of the sampling locations to the Project Manager for approval, prior to sampling.
4. Procedures and Depth of Samples: Collect samples to a depth of six inches (6") and combine in a clean plastic container.
5. Mixing of Samples: Mix samples together thoroughly, removing plant debris and breaking up clods.
6. Labeling: Label each sample with the date, location keyed to a site plan or other location system, visible soil condition, and sampling depth.

E. Testing Requirements

1. Soil Texture: Soil-particle, size-distribution analysis by the following methods according to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods":
 - a. Sieving Method: Report sand-gradation percentages for very coarse, coarse, medium, fine, and very fine sand; and fragment-gradation (gravel) percentages for fine, medium, and coarse fragments; according to USDA sand and fragment sizes.
 - b. Hydrometer Method: Report percentages of sand, silt, and clay.
2. Fertility Testing: Soil-fertility analysis shall, include the following:
 - a. Percentage of organic matter.
 - b. Cation exchange capacity (CEC), calcium percent of CEC, and magnesium percent of CEC.
 - c. pH value.
 - d. Buffered acidity or alkalinity.
 - e. Lime estimate.
 - f. Soil texture estimate.
 - g. Nitrogen ppm.
 - h. Phosphorous ppm.
 - i. Potassium ppm.
 - j. Manganese ppm.

- k. Zinc ppm.
 - l. Iron ppm.
 - m. Boron ppm.
 - n. Copper ppm.
 - o. Sodium ppm.
 - p. Sodium absorption ratio (SAR).
 - q. Soluble-salts ppm.
 - r. Presence and quantities of problem materials including salts and metals cited in the Standard protocol. If such problem materials are present, provide additional recommendations for corrective action.
 - s. Other deleterious materials, including their characteristics and content of each.
- F. Recommendations: Based on the test results, provide recommendations for soil treatments, amendments, and conditioners to be incorporated to produce a soil suitable for healthy viable plant growth for the species indicated in the Contract Documents. Include, at a minimum, recommendations for nitrogen, phosphorous, and potassium fertilization, and for micronutrients.
- 1. Fertilizers and Soil Amendment Rates: State recommendations in weight per one thousand (1,000) sq. ft. for six inch (6") depth of soil.
 - 2. Soil Reaction: State the recommended liming rates for raising pH or sulfur for lowering pH according to the buffered acidity or buffered alkalinity in weight per one thousand (1,000) sq. ft. for six inch (6") depth of soil.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and compliance with State and Federal laws if applicable.
- B. Bulk Materials:
- 1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
 - 2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
 - 3. Do not move or handle materials when they are wet or frozen.
 - 4. Accompany each delivery of bulk fertilizers and soil amendments with appropriate certificates.
- C. Notify Project Manager of delivery schedule in advance so material can be inspected upon arrival at the project site. Immediately remove unacceptable material from the project site.

1.7 PROJECT/SITE CONDITIONS

- A. General: Do not perform work when climate and existing site conditions will not provide satisfactory results.
- B. Vehicular site access shall be limited to the area(s) indicated on the Contract Drawings or as defined by the Project Manager.
- C. Damage to turf, natural areas, pavements, irrigation systems, underground utilities, and other improvements shall be repaired by the contractor at no cost to the City and County of Denver.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Topsoil: Shall be as specified under Division 32 91 20 Section "Topsoil".
- B. Soil Amendments:
 - 1. In general, turf and planting areas shall receive Soil Amendments unless otherwise noted or specified by the Construction Project Manager. For the purpose of bidding, the Contractor shall assume all areas to receive soil amendments will be at four (4) cubic yards per one thousand (1,000) square feet. Once soils tests have been received and determination is made on the proper amount to be added the site-specific soils the rate to be applied may be adjusted per the price based on the Schedule of Values for Soil Amendment.
 - 2. Composted material shall consist of aged organic matter, free of weed or other noxious plant seeds, lumps, stones, or other foreign contaminants harmful to plant life, and having the following characteristics based on a nutrient test performed no longer than 3 months prior to its incorporation into the project:
 - a. Organic matter: twenty-five (25%) percent maximum.
 - b. Salt content: Five (5.0) mmhos/cm maximum.
 - c. pH: 7.5, maximum.
 - d. Carbon to nitrogen ratio shall be less than 20:1, but greater than 10:1.
 - 3. Mountain peat, aspen humus, gypsum and sand will not be accepted.
 - 4. Acceptable product: Class I compost, such as Ecogro or Bio-comp, as produced by A1 Organics, Eaton, CO, or approved equal.
- C. Soil Conditioners:
 - 1. In general, native seed areas shall receive Soil Conditioners unless otherwise noted or specified by the Construction Project Manager. For the purpose of bidding the contractor shall assume the products listed below will be applied at the rate specified by the manufacturer for each planting type identified in the Construction Documents. Once soils tests have been received and a

determination is made on the proper amount to be added to the site-specific soils, the rate to be applied may be adjusted per the price based on the Schedule of Values for Soil Conditioner.

- a. Organic slow release fertilizer (6-1-1), acceptable product: "Biosol" or approved equal.
- b. Granular Humic Acid soil conditioner, acceptable product: "Menefee Humate Soil Conditioner".
- c. Mycorrhizal Fungi: Dry, granular inoculant containing at least 5300 spores per lb (0.45 kg) of vesicular-arbuscular mycorrhizal fungi and 95 million spores per lb (0.45 kg) of ectomycorrhizal fungi, thirty-three percent (33%) hydrogel, and a maximum of five and one half percent (5.5%) inert material.
- d. Mycorrhizal Inoculant: MycoApply Micronized Endo/Ecto, as manufactured by Mycorrhizal Applications, locally available from Arkansas Valley Seed, Denver, CO, (303) 320-7500.
- e. Acceptable substitution.

2.2 FERTILIZER

- A. General: Fertilizer shall conform to applicable State fertilizer laws. It shall be uniform in composition, dry, and free flowing, and shall be delivered to the site in the original, unopened containers, each bearing the manufacturer's guaranteed analysis. Fertilizer that has become caked or damaged will not be accepted.
- B. Turf Grass Lawns: Diamonium phosphate (18-46-0). Nitrogen shall be composed of sulphur-coated Urea only. Provide in sufficient quantity to apply at the rate of one hundred (100) pounds nitrogen per acre, unless otherwise indicated by the soils tests.
- C. Native Grass Areas: Fertilizer shall only be applied as specified in Soil Conditioners.

2.3 PESTICIDE

- A. Post Emergent Pesticide: Roundup (Glyphosate) as manufactured by Monsanto Company, or approved equal.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. General: Verify that existing site conditions are as specified and indicated on the Contract Drawings before beginning work under this Section.
- B. Grades: Inspect to verify rough grading is within +/- one tenth of one foot (0.1') of grades indicated and specified.

- C. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within the work area.
- D. Unsatisfactory Conditions: The General Contractor shall notify the Construction Project Manager in writing of any known unsatisfactory site conditions. If the soil is found to be unfit to support planting as described above, it is to be removed and replaced with clean soil from a source approved by the Project Manager.
- E. Beginning of soil preparation work means acceptance of existing conditions by the installer.

3.2 PREPARATION

- A. Locate all utilities (sewer, water, irrigation, gas, electric, phone, and other conduits and subsurface equipment) prior to commencing work.
- B. Contractor shall be responsible for the protection of all new and existing infrastructure, and repair of any damages caused by work under this section, at no cost to the Owner.
- C. Weed Seed Eradication: Perform pesticide treatment over the entire area to be planted. Allow sufficient time to successfully complete the entire pesticide treatment process (germinate / terminate) before proceeding with planting.
 1. For turf areas to be converted to native grass, complete pesticide application in accordance with 32 92 20 Native Seeding and Wetland Sod.
 2. Pesticide treatment must be completed during the growing season.
 3. Water surface one half (1/2") inch per week for two weeks prior to application if natural precipitation does not supply this amount to encourage weed seed germination.
 4. Notify Project Manager forty-eight (48) hours in advance of each pesticide treatment.
 5. Apply pesticide in accordance with manufacturer's recommendations.
 6. Water surface one half (1/2") inch per week if natural precipitation does not supply this amount to encourage weed seed germination.
 7. Fourteen (14) days after the first pesticide application, review surface for evidence of plant growth.
 8. If there is no evidence of plant growth, obtain Project Manager approval of surface conditions to proceed with Soil Preparation.
 9. If more than 10% of the area to be planted contains new plant growth, the pesticide and watering application shall be repeated until new plant growth is satisfactorily eradicated.
 10. Remove plant debris from treated area.

- D. Areas of Compacted Topsoil: Areas within the work limits, or as defined on Contract Drawings or by the Project Manager, that have vegetation that is sparse, stunted, anemic, weedy or was used as construction staging, a parking area, and/or subjected to heavy use will require ripping to prepare the soil for planting. Scarify compacted soil to an eight-inch (8") minimum depth to loosen topsoil.
- E. Areas of Disturbed Topsoil: Areas disturbed but not severely compacted, as determined by the Project Manager, shall be deep tine aerated or shattered to prepare the soil for revegetation.
- F. Areas of Undisturbed Natural Topsoil: Undisturbed sites that are or were supporting healthy plant growth need only surface seedbed preparation prior to sowing seed.

3.3 INSTALLATION

- A. Install topsoil as required WCPM Supplemental Technical Specification 31 23 00 "Earthwork" and Division 32 91 20 Section "Topsoil".
- B. Timing: Perform soil preparation just prior to planting operations and in accordance with final planting schedule. Coordinate with irrigation system installation to avoid damage.
- C. Soil Preparation in Turf Grass and Planting Bed Areas:
 - 1. Apply Soil Amendments at the following rates:
 - a. Soil Amendments: Bid quantity to be four (4) cubic yards per one thousand (1,000) square feet, or per soil test recommendations.
 - b. Fertilizer: Diamonium phosphate, Bid quantity to be two (2) pounds of nitrogen per one thousand (1,000) square feet. Apply per manufactures recommendations for the type of planting area, or per soil test recommendations.
 - c. Mycorrhizal inoculants: Apply per manufacturer's instructions and quantities appropriate to the planting type.
 - 2. After applying Soil Amendments, thoroughly till area to depth of six inches (6") minimum by plowing, rototilling, harrowing, or disking until soil is well pulverized and thoroughly mixed. Soil Conditioners and Fertilizer shall be applied topically once final grade has been established and just prior to sodding or seeding.
 - 3. Take soil samples, in similar locations to pre-construction testing, and test amended soil to ensure the final product meets the laboratory recommendations prior to planting.
- D. Soil Preparation in Native Grass Areas:
 - 1. Soil Conditioners: Apply per manufactures recommendations for the type of planting area, or per soil test recommendations.
 - 2. Mycorrhizal inoculants: Apply per manufacturer's instructions and quantities appropriate to the planting type.

3. Thoroughly till the area to depth of six inches (6") minimum by plowing, rototilling, harrowing, or disking until soil is well pulverized and thoroughly mixed.
 4. Take soil samples, in similar locations to pre-construction testing, and test amended soil to ensure the final product meets the laboratory recommendations prior to planting.
- E. Fine Grading in all Landscape Areas:
1. Complete fine grading for all areas prior to seeding or planting. Allow for natural settlement.
 2. For ground surface areas surrounding buildings to be landscaped, maintain required positive drainage away from buildings.
 3. Establish finish grades to within plus or minus one tenth (0.10') foot of grades indicated, in order to prevent "bird-baths" or ponding.
 4. Finish grade shall be below edge of pavement prior to sodding, seeding or planting.
 - a. Sodded Areas: Allow one and one half inches (1-1/2") for sod.
 - b. Seeding Areas: Allow one inch (1") for seed.
 - c. Planting Beds: Allow four inches (4") for mulch.
 5. Compaction of Surface Grade Prior to Landscape Installation: Firm, but not hard, eighty five percent (85%) standard Proctor density within two percent (2%) optimum moisture.
 6. Turfgrass Lawn Areas: Prior to acceptance of grades, hand rake to smooth, even surface, free of debris, clods, rocks and organic matter greater than one inch (1").
 7. Native Seed Areas: Area shall not be graded smooth but left in a rough condition after tilling. Tilling shall occur parallel to the contours only.
 8. Restore planting areas to specified condition if eroded or otherwise disturbed after fine grading and prior to planting.

3.4 CLEANING

- A. Protect areas adjacent to soil preparation and planting areas from contamination. Keep adjacent paving and construction clean and work area in an orderly condition.
- B. Remove debris and excess materials from site. Clean out drainage inlet structures. Clean paved and finished surfaces soiled as a result of work under this Section, in accordance with Section 208 of the General Specifications or as directed by the Project Manager.

3.5 PROTECTION

- A. Provide and install barriers as required and as directed by Project Manager to protect completed areas against damage from pedestrian and vehicular traffic until acceptance by the City.

- B. Protect areas of in-place soil from additional compaction, disturbance, and contamination. Prohibit the following practices within these areas except as required to perform planting operations:
 - 1. Storage of construction materials, debris, or excavated material.
 - 2. Parking vehicles or equipment.
 - 3. Vehicle traffic.
 - 4. Foot traffic.
 - 5. Erection of sheds or structures.
 - 6. Impoundment of water.
 - 7. Excavation or other digging unless otherwise indicated.
- C. If prepared soil or subgrade is disturbed or contaminated prior to planting, the Contractor shall restore or replace the planting soil as directed by Project Manager at no cost to the Owner.

3.6 ACCEPTANCE

- A. Inspection: Provide notice to the Project Manager requesting inspection at least seventy-two (72) hours prior to anticipated date of completion.
- B. Contractor shall be responsible for coordinating soil preparation inspections with Denver Water, call (303) 628-6682 at least seventy-two (72) hours prior to installing sod, seed, or landscape plantings.
- C. Deficiencies: The Project Manager will specify deficiencies to the Contractor who shall make satisfactory adjustments and shall again notify Project Manager for final inspection.

PART 4 - MEASUREMENT & PAYMENT

4.1 MEASUREMENT

- A. Measurement will be made by the contract unit specified for Soil Preparation Measurement shall include the actual number of units of specified material(s) removed or demolished for disposal at the locations shown on the Contract Drawings, or as directed by the Project Manager, and in accordance with the Specifications.

4.2 PAYMENT

- A. Payment will be made at the contract unit price, and shall include required materials, transportation, equipment, labor, earthwork, loading, transporting, stockpiling, disposing, hauling off, watering, dust control, erosion and sediment control, fine grading, maintenance of temporary protection by fencing or other means, watering and all maintenance required until Final Acceptance of the work as required in accordance with the Contract Drawings and Specifications.

At the option of the Construction Project Manager, when the unit price is lump sum, payment may be made in percentage installments based upon type, location and scope of work in relation to the period of performance. The total payment for this bid item shall not exceed seventy-five percent (75%) of the lump sum price during construction. The remaining twenty-five percent (25%) shall be paid after final site cleanup, completion of all punch list items and demobilization from site.

END OF SECTION 32 91 13

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Contract Drawings and general provisions of the Contract, including General and Supplementary Conditions and the City and County of Denver Standard Specifications for Construction General Contract Conditions (2011)
- B. City and County of Denver Engineering Division, Wastewater Capital Project Management Standard Construction Specifications, dated March 15, 2016.
- C. Wastewater Capital Projects Management Special Project Provisions for Asbury & Tejon
- D. Wastewater Capital Projects Management Supplemental Technical Specifications for Asbury & Tejon.
- E. Denver Parks and Recreation Asbury and Tejon Specifications, OCT 2018.

1.2 SUMMARY

- A. This Section includes requirements for furnishing, stockpiling, and placing topsoil on a previously prepared subgrade.
- B. Related Sections:
 - 1. WCPM Standard Construction Specification 2.0 Section "Site Preparation".
 - 2. WCPM Standard Construction Specification 4.0 "Utility Trenching and Excavation"
 - 3. WCPM Standard Construction Specification 5.0 "Bedding and Backfilling".
 - 4. WCPM Standard Construction Specification 23.0 "Storm Water Management"
 - 5. WCPM Supplemental Technical Specification 31 23 00 "Earthwork".
 - 6. WCPM Supplemental Technical Specification 31 23 19 "Water Control and Dewatering".
 - 7. Division 01 45 16 Section "Contractor Quality Control".
 - 8. Division 01 56 39 Section "Tree Retention and Protection".
 - 9. Division 31 32 50 Section "Watering".
 - 10. Division 32 13 13 Section "Concrete Walks, Curbs, and Miscellaneous Flatwork".
 - 11. Division 32 84 33 Section "Automatic Irrigation Controllers"
 - 12. Division 32 91 13 Section "Soil Preparation".
 - 13. Division 32 92 20 Section "Native Seeding".
 - 14. Division 32 92 23 Section "Sodding".
 - 15. Division 32 93 00 Section "Trees, Plants, and Groundcovers".

1.3 DEFINITIONS

- A. Duff Layer: The surface layer of native topsoil that is composed of mostly decayed leaves, twigs, and detritus.
- B. Finish Grade: Elevation of finished surface of planting soil.
- C. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.
- D. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.
- E. Planting Area: Areas to be planted.
- F. Planting Soil: Standardized topsoil; existing, native surface topsoil; existing, in-place surface soil; imported topsoil; or manufactured topsoil that is modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.
- G. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.
- H. Subsoil: All soil beneath the topsoil layer of the soil profile and typified by the lack of organic matter and soil organisms.
- I. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil; but in disturbed areas such as urban environments, the surface soil can be subsoil.

1.4 SUBMITTALS

- A. See General Contract Conditions Title 3, section 309 "Contractor Submittals and other Written Communications to the City" and Title 4, section 405 "Shop Drawings, Product Data, and Samples"
- B. Prior to construction, the contractor shall create a submittal log for review by the Construction Project Manager. The Construction Project Manager shall review and make recommendations for additional submittal items.
- C. The contractor shall allow a minimum cycle of ten (10) working days for review of each submittal by the City.
- D. All submittals shall be delivered to the Construction Project Manager.

- E. Testing Agency Qualifications: Project Manager to approve prior to construction.
- F. Soil Analysis Report: See Quality Control 01 45 16.
- G. Samples: One (1) quart volume per five hundred (500) cubic yards for each type of soil used. Soil shall be in sealed containers with content, source, and date obtained. Each Sample shall be typical of the lot of material to be furnished and provide an accurate representation of composition, color, and texture and be accompanied by the results of the analysis.

1.5 QUALITY CONTROL

- A. Existing On-Site Topsoil:
 - 1. Shall be disposed of in accordance with Executive Order 115 and the project specific Draft Materials Management Plan.
 - 2. Should the Contractor desire to re-use soil from this job site the Contractor shall follow the soil re-use guidelines according to the Denver Department of Public Health and Environment. All testing for re-use shall be at the expense of the Contractor.
- B. Imported Topsoil:
 - 1. Submit source location for topsoil to be imported to site for approval by the Project Manager.
 - 2. Submit soil analysis report for topsoil imported to site, from the State University Agricultural Extension Service or other approved soil testing laboratory. Report shall cover soil textural classification (percentages of sand, silt, and clay), pH, percentage organic matter, and soluble salts (electric conductivity in millimos/centimeter) and shall include additive recommendations.
 - a. One 1-quart sample per five hundred (500) cubic yards of imported soil is required, with individual tests completed for each sample.
 - b. Follow instructions from soil testing laboratory when collecting samples.
 - 3. Testing will be at the expense of the Contractor.
- C. Manufactured Topsoil:
 - 1. Submit source of manufactured topsoil to be imported to site for approval by the Project Manager.
 - 2. Submit soil analysis report for stockpiled on-site topsoil from the State University Agricultural Extension Service or other approved soil testing laboratory. Report shall cover soil textural classification (percentages of sand, silt, and clay), pH, percentage organic matter, and soluble salts (electric conductivity in millimos/centimeter).
 - a. Test is to be completed within sixty (60) days preceding delivery to site. Report shall cover soil textural classification (percentages of sand, silt, and clay), pH, percentage organic matter, and soluble salts (electric conductivity in millimos/centimeter).

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Do not deliver or place topsoil in a frozen, wet, or muddy condition.
- B. Protect stored and placed topsoil from vehicular traffic, equipment storage, material storage, or from contaminants or pollution sources. Topsoil that is compacted or tainted during construction is to be removed from site and disposed of at a licensed landfill at no additional cost to the City.

PART 2 - PRODUCTS

2.1 ON-SITE TOPSOIL

- A. Topsoil previously stripped shall not be re-used unless tested by the Contractor for re-use according to Denver Department of Public Health and Environment guidelines.

2.2 IMPORTED TOPSOIL

- A. All topsoil shall be a loam or sandy loam conforming to ASTM D 5268. At least ten (10) days prior to topsoil delivery, notify Project Manager of the source(s) from which topsoil is to be furnished. Topsoil shall be furnished by the Contractor and shall be a natural, friable soil representative of productive soils and shall meet the following conditions.
- B. It shall be obtained from the top six-inches (6") of well drained areas.
- C. Fertile, friable, loamy soil, reasonably free from subsoil, refuse, roots, heavy or stiff clay, stones larger than one-inch (1"), coarse sand, noxious seeds, sticks, brush, litter, and other deleterious substances; suitable for the germination of seeds and the support of vegetative growth. The pH value shall be between 6.5 and 7.5.
- D. Soil Texture:
 - 1. Sand: thirty percent (30%) – fifty percent (50%)
 - 2. Silt: thirty percent (30%) – fifty percent (50%)
 - 3. Clay: five percent (5%) – thirty percent (30%)
- E. Additives: As determined by soil fertility tests.
- F. Percent Organic Content:
 - 1. Turf grass shall be three to five percent (3-5%) maximum after amending or conditioning.
 - 2. Native grass shall be one to three percent (1-3%) minimum after amending or conditioning.

- G. Soluble Salts: Electric conductivity (EC) shall be less than two (2.0) mmhos/cm for turf grass areas, dryland areas, and planting beds.

2.3 MANUFACTURED TOPSOIL

- A. "Amended Topsoil" as manufactured by A1 Organics, 16350 WCR 76, Eaton, CO 80615 Ph: (970) 454-3492, (800) 776-1644 Fax: (970) 454-3232 www.a1organics.com, or substitution as approved by the Project Manager.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas where the Work of this Section will be performed for compliance with requirements and conditions affecting installation and performance.
 - 1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within the work area.
 - 2. Verify that final grades are completed in accordance with the Contract Drawings.
- B. Proceed with installation only after unsatisfactory conditions have been corrected and approved by Project Manager.

3.2 PLACING TOPSOIL

- A. Scarify compacted subgrade to a six-inch (6") depth to bond topsoil to subsoil. Place topsoil to a minimum depth of six-inches (6") after settlement. Topsoil shall be free from weeds, sod, and material larger than 1-inch (1"), toxic substances, litter or other deleterious material. Spread evenly and grade to elevations and slopes shown on Contract Drawings. Hand rake areas inaccessible to machine grading.
- B. Utilize salvaged topsoil as the top layer to the extent available. If sufficient on-site material is not available, the Contractor shall furnish and install imported topsoil in the manner described above. Topsoil shall be mixed thoroughly with the salvaged topsoil prior to placement.
- C. Utilize manufactured topsoil as the top layer, placing over scarified subgrade to a depth of six-inches (6").

3.3 PROTECTION AND REPAIR

- A. Protect completed areas where topsoil has been spread from traffic which will compact the soil volume. Any areas that, as determined by Project Manager, become compacted due to Contractor's construction traffic shall be reconstructed to specified requirements and approved by the Project Manager.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

- A. Imported Topsoil: Measurement will be made by the contract unit specified for Topsoil. Measurement shall include the actual number of units of specified material(s) placed and accepted at the locations shown on the Contract Drawings, or as directed by the Project Manager, and in accordance with the Specifications.
- B. Manufactured Topsoil: Measurement will be made by the contract unit specified for Topsoil. Measurement shall include the actual number of units of specified material(s) placed and accepted at the locations shown on the Contract Drawings, or as directed by the Project Manager, and in accordance with the Specifications.

4.2 PAYMENT

- A. Payment will be made at the contract unit price, and shall include required materials, transportation, equipment, labor, earthwork, stripping, stockpiling and placing of topsoil, loading, transporting, re-transporting to new locations (from onsite or off site stockpiles) spreading to specified depth disposing of unusable materials, hauling off, watering, dust control, erosion and sediment control, finish grading required to bring the site to the required lines and grades as required in accordance with the Contract Drawings and Specifications.

END OF SECTION 32 91 20

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Contract Drawings and general provisions of the Contract, including General and Supplementary Conditions and the City and County of Denver Standard Specifications for Construction General Contract Conditions (2011).
- B. City and County of Denver Engineering Division, Wastewater Capital Project Management Standard Construction Specifications, dated March 15, 2016.
- C. Wastewater Capital Projects Management Special Project Provisions for Asbury & Tejon.
- D. Wastewater Capital Projects Management Supplemental Technical Specifications for Asbury & Tejon
- E. Denver Parks and Recreation Asbury and Tejon Specifications, OCT 2018.

1.2 SUMMARY

- A. This Section includes requirements for pesticide application, the installation of native seed and wetland sod, mulch, erosion control material (if applicable), and maintenance of the seeded areas, to be achieved as outlined in the "Maintenance" section below.
- B. Related Sections:
 - 1. WCPM Standard Construction Specification 23.0 "Storm Water Management"
 - 2. WCPM Supplemental Technical Specification 31 23 00 "Earthwork".
 - 3. WCPM Supplemental Technical Specification 31 23 19 "Water Control and Dewatering".
 - 4. Division 01 45 16 Section "Contractor Quality Control".
 - 5. Division 01 56 39 Section "Tree Retention and Protection".
 - 6. Division 31 32 50 Section "Watering".
 - 7. Division 32 13 13 Section "Concrete Walks, Curbs, and Miscellaneous Flatwork".
 - 8. Division 32 84 33 Section "Automatic Irrigation Controllers"
 - 9. Division 32 91 13 Section "Soil Preparation".
 - 10. Division 32 91 20 Section "Topsoil".
 - 11. Division 32 93 00 Section "Trees, Plants, and Groundcovers".

1.3 DEFINITIONS

- A. Finish Grade: Elevation of finished surface of planting soil.

- B. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, herbicide, defoliant, or desiccant.
- C. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.
- D. Planting Soil: Standardized topsoil; existing, native surface topsoil; existing, in-place surface soil; imported topsoil; or manufactured topsoil that is modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.
- E. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or top surface of a fill or backfill before planting soil is placed.
- F. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.
- G. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil, but in disturbed areas such as urban environments, the surface soil can be subsoil.
- H. Weeds: Including but not limited to Puncturevine, Field Bindweed, Twitch, Dandelion, Jimsonweed, Diffuse, Spotted and Russian Napweed, Quackgrass, Horsetail, Morning Glory, Rush Grass, Mustard, Lambsquarter, Chickweed, Cress, Crabgrass, Canada Thistle, Nutgrass, Blackberry, Tansy Ragwort, Bermuda Grass, Johnsongrass, Poison Ivy, Nut Sedge, Nimble Weed, Bent Grass, Garlic Mustard, Perennial Sorrel, and Broom Grass or any weed listed on Colorado Noxious Weed List and Watch List.

1.4 REFERENCES

- A. Comply with U.S. Department of Agriculture Rules and Regulations under the Federal Seed Act and be equal to or better in quality than the standards for Certified Seed.
- B. Colorado Department of Transportation (CDOT) – Standards Specifications for Road and Bridge Construction.

1.5 SUBMITTALS

- A. See General Contract Conditions Title 3, section 309 “Contractor Submittals and other Written Communications to the City” and Title 4, section 405 “Shop Drawings, Product Data, and Samples”

- B. Prior to construction, the contractor shall create a submittal log for review by the Construction Project Manager. The Construction Project Manager shall review and make recommendations for additional submittal items.
- C. The contractor shall allow a minimum cycle of ten (10) working days for review of each submittal by the City.
- D. All submittals shall be delivered to the Construction Project Manager.
- E. Materials: The Contractor shall submit to the Project Manager for approval a complete list of all materials to be used during this portion of the work prior to delivery of any materials to the site. Include complete data on source, amount and quality. This submittal shall in no way be construed as permitting substitution for specific items described on the plans or in these specifications unless approved in writing by the Project Manager.
 - 1. Certification of Seed: From seed vendor for each seed monostand or mixture stating the botanical and common name, percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.
 - 2. Native Grass Species (supplied as pure live seed): Submit lab germination test results for all grass species. Submit an affidavit that describes estimated purity for all forb species that are not typically tested.
 - 3. Pesticides: Include product label and manufacturer's application instructions specific to this Project.
 - 4. Product Certificates: For wetland sod, soil amendments, and fertilizers, from manufacturer.
- F. Qualification Data: For qualified landscape Installer.
- G. Material Test Reports: For existing in-place surface soil.
 - 1. Soil Analysis: See Division 32 91 13 Section "Soil Preparation"
 - 2. Analysis for each soil amendment.
 - 3. Analysis for each amended planting soil.
- H. Analysis and standards: Wherever applicable, for non-packaged materials, provide two copies of analysis by recognized laboratory made in accordance with methods established by the Association of Official Agriculture Chemists.
- I. Pesticide application schedule: Submit, in writing, two (2) copies of proposed pesticide application schedule, indicating dates for site preparation and pesticide application. Once accepted, revise dates only as approved in writing, after documentation of reasons for delays.
- J. Seeding schedule: Submit, in writing, two (2) copies of proposed seeding schedule, indicating dates for site preparation, seeding, mulching, erosion control, and

coordination with plant procurement, planting soil preparation, plant delivery and planting. Schedule all Work during specified planting seasons. Once accepted, revise dates only as approved in writing, after documentation of reasons for delays.

- K. Maintenance Instructions: Recommended procedures for maintenance of irrigated and non-irrigated native seed areas during a calendar year. Submit before expiration of required initial maintenance periods.
- L. Contract Closeout Submittals:
 - 1. Operating and Maintenance Data: At completion of work, submit one (1) digital copy and two (2) hard copies to the Project Manager in accordance Contract Closeout requirements. Include directions for irrigation, aeration, mowing, fertilizing, and spraying as required for continued and proper maintenance through full growing season and dormant period.
 - 2. Warranty for Native Seed Areas: At completion of work, furnish written warranty to Parks Project Manager based upon specified requirements.
- M. The Project Manager reserves the right to reject the seed at any time prior to acceptance and that fails to meet specification requirements. Promptly remove rejected seed from the site.

1.6 QUALITY CONTROL

- A. Installer Qualifications: A qualified landscape Installer whose work has resulted in successful native grass establishment.
 - 1. Experience: Five years' experience in native seed installation in addition to requirements in Division 01 45 16 Section "Quality Control".
 - 2. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
 - 3. Personnel Certifications: Installers shall have certification the following categories from the NALP:
 - a. Landscape Industry Certified Technician - Exterior, with installation maintenance irrigation specialty area(s).
 - 4. Maintenance Proximity: Not more than two hours' normal travel time from Installer's place of business to Project site.
 - 5. Pesticide Applicator: State licensed, commercial, with a minimum five years' experience with similar applications.
- B. Soil-Testing Laboratory Qualifications: An independent laboratory or university laboratory, recognized by the State Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.

- C. Preinstallation Conference: Conduct conference at Project site to coordinate the process with other trades, to coordinate equipment movement within planting areas and to avoid soil compaction, to review proposed methods of installation, performance criteria, and maintenance procedures. Review underground utility location maps and plans. This meeting shall be coordinated by the Contractor, and comply with requirements in Division 01.
- D. Standards: All materials and methods used during this portion of the work shall meet or exceed applicable federal, state, county, and local laws and regulations. All seed shall be free from insects and disease. Species shall be true to their scientific name as specified.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Seed: Shall be furnished in bags or containers clearly labeled to show the name and address of the supplier, the seed name, the lot number, net weight, origin, the percent of weed seed content, the guaranteed percentage of purity and germination, pounds of pure live seed (PLS) of each seed species, and the total pounds of PLS in the container. Seed that has become wet, moldy or damaged in transit or in storage will not be acceptable.
- B. Wetland Sod: Shall be delivered, handled, and store in accordance with manufacturer's written instructions.
- C. Other Packaged Materials: Deliver packaged materials in original unopened containers bearing weight, analysis and name of supplier.
- D. Fertilizer: Deliver organic or chemical fertilizer to site in original unopened container bearing manufacturer's guaranteed chemical analysis, name, trade name, trademark and conformance to state law, and bearing name and warranty of producer.
- E. Bulk Materials:
 - 1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
 - 2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
 - 3. Accompany each delivery of bulk fertilizers and soil amendments with appropriate certificates.
 - 4. Seed: Deliver seed materials in original unopened containers, showing bearing weight, analysis and name of supplier.
 - 5. Fertilizer: Deliver inorganic or chemical fertilizer to site in original unopened container bearing manufacturer's guaranteed chemical analysis, name, trade name, trademark and conformance to state law, and bearing name and warranty of producer.

- F. Material will be inspected upon arrival at project site. Project Manager will reject any opened or unacceptable materials as described above. Store all materials in a manner to prevent wetting and deterioration.
- G. Immediately remove unacceptable material from job site.

1.8 PROJECT/SITE CONDITIONS

- A. Work scheduling: Proceed with and complete landscape work rapidly, as portions of the site become available, working within the specified planting season and approved schedule.
- B. Pesticide application restrictions: Variance from the proposed schedule shall be permitted only with written approval from the Project Manager. Complete pesticide application only during suitable weather conditions to prevent over-spray and potential damage to adjacent vegetation, and to provide maximum effectiveness of application.
- C. Planting Restrictions: Planting is preferred in spring but may be performed during one of the periods noted below. Variance from the schedule shall be permitted only with written approval from the Project Manager. Coordinate planting periods with initial maintenance periods to provide required maintenance from date of Substantial Completion.
- D. Vehicular accessibility on site shall be as directed by Project Manager. Repair damage to prepared topsoil and existing surfaces, caused by vehicular access and movement during work under this section, to original condition at no additional cost to the City.
- E. Do not drill or sow seed during windy, rainy weather or when ground is frozen or otherwise unable to be tilled.
- F. Seeding Season: Seeding shall occur as specified below. Verify with local producers and contractors prior to finalizing.

<u>Seed Type</u>	<u>Irrigated Areas Only</u>	<u>Non-irrigated Areas</u>
Native Grasses	April 15-Sept.1	November 15-April 15

- G. Existing conditions:
 1. Existing Plants: Install sod only after all other landscape and irrigation items have been installed and accepted by the Project Manager.
 2. Utilities: Determine location of underground utilities. Perform work in a manner to avoid possible damage. Hand excavate, as required.

3. Excavation: Maintain grade stakes set by others until removal is mutually agreed upon by parties concerned. When conditions detrimental to plant growth are encountered, such as rubble fill, adverse drainage conditions, noxious materials or obstructions, notify Project Manager before planting.
4. If weeds are present on site, treat with pesticide prior to preparing soil for installing seed or sod as specified below.

H. Coordination:

1. Coordinate with construction of utilities on site. Do not begin placing topsoil until underground work is completed in the area.
2. Coordinate with seeding and landscape Contractor(s) approved schedule. Limit construction access to areas where topsoil has been placed if placement is completed more than three (3) days prior to commencement of landscaping in the area. Limit fine grading to areas that can be prepared for planting within twenty-four (24) hours after fine grading.
3. Coordinate with Contractors work requiring access to site over seeded areas.
4. Coordinate with installation of underground irrigation system.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Topsoil: See Division 32 91 20 Section "Topsoil".

B. General:

1. The selected seed mix must be approved by the City Naturalist, and the Parks Project Manager prior to its incorporation into the project.
2. All seed brands shall be free from Colorado prohibited noxious weed seeds, including but not limited to Canada Thistle, Field Bindweed, Johnsongrass, and Leafy Spurge. The Contractor shall furnish to the Project Manager a signed statement certifying that the seed is from a lot that has been tested by a recognized laboratory for seed testing within six months prior to the date of delivery.
3. Computation for quantity of seed required on the project is based on Pure Live Seed (PLS).
4. The formula used for determining the quantity of PLS shall be:
Pounds of Seed x (Purity x Germination) = Pounds of PLS.
5. If seed available on the market does not meet the minimum purity and germination specified, the Contractor must compensate for a lesser percentage of purity or germination by furnishing sufficient additional seed to equal the specified product. Product comparison shall be made on the basis of PLS in pounds, stated on each seed bag.

C. Seed Mixes:

1. Seed mixes and application rates shall be as specified in the Contract Drawings.
- D. Wetland Sod:
 1. Wetland sod shall be North Fork Native Plants or approved equal, comprised of the plant species specified in the Contract Drawings.
- E. Mulch: Comply with Section 213 – Mulching of the CDOT Standards and Specifications for Road and Bridge Construction.
- F. Fertilizer: None required unless otherwise specified by soils test.
- G. Water: Contractor to utilize the existing irrigation system and or quick coupler(s) when available. If irrigation or quick coupler(s) are not available then the contractor is responsible for watering. Water shall be free of substances that may be harmful to seed growth. Hoses and other watering equipment necessary to water the seed to be furnished by Contractor.
- H. Tackifier: Comply with Section 213 – Mulching of the CDOT Standards and Specifications for Road and Bridge Construction.

2.2 PESTICIDES

- A. General: Pesticide, registered and approved by EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by Project Manager and authorities having jurisdiction.
- B. Pre-Emergent Pesticide (Selective and Non-Selective): Journey pesticide, as manufactured by BASF, 800-545-9525, or equal as approved by Project Manager. Use only with approval by Project Manager and in strict compliance with manufacturer's instructions.
- C. Post-Emergent Pesticide: "Round-up" by Monsanto, or approved equal.

2.3 EROSION-CONTROL MATERIALS

- A. Erosion-Control Blankets: Biodegradable wood excelsior, straw, or coconut-fiber mat. Include manufacturer's recommended steel wire staples, 6 inches long.
- B. Erosion-Control Fiber Mesh: Biodegradable burlap or spun-coir mesh, a minimum of 0.92 lb/sq. yd., with 50 to 65 percent open area. Include manufacturer's recommended steel wire staples, 6 inches (6") long.
- C. Erosion-Control Mats: Cellular, non-biodegradable slope-stabilization mats designed to isolate and contain small areas of soil over steeply sloped surface, of 3 inch (3")

nominal mat thickness. Include manufacturer's recommended anchorage system for slope conditions.

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Invisible Structures, Inc.; Slopetame 2.
 - b. Presto Products Company, a business of Alcoa; Geoweb.
 - c. Tenax Corporation - USA; Tenweb.

2.4 SUBSTITUTIONS

- A. All substitutions shall be submitted to and approved by the Project Manager prior to construction.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to be seeded for compliance with requirements and other conditions affecting performance.
 1. Verify that finish grades are consistent with the slopes and grades indicated on the Contract Drawings. Verify grades are in conformance with WCPM Supplemental Technical Specification 31 23 00 "Earthwork".
 2. Obtain Project Manager's approval of finished grade prior to proceeding with seeding operations.
 3. Verify soil preparation of all areas to be seeded is in accordance with the requirements of Division 32 91 13 Section "Soil Preparation". When completed, the soil shall be firmed by float dragging, followed by steel raking, to provide for the proper seeded surface. The seed bed shall be totally free from rock or clay clods over one inch (1") in diameter.
 4. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a seeding area. If contamination is present in soil, remove the soil and contamination as directed by the Project Manager and replace with new soil.
- B. Verify that irrigation system is operable and provides adequate coverage prior to seeding.
- C. Proceed with seeding only after unsatisfactory conditions have been corrected and approved by the Project Manager.

- D. Proceed with pesticide application only under satisfactory conditions approved by the Project Manager.
- E. Acceptance: Beginning of installation means acceptance of existing conditions by the Contractor.

3.2 PREPARATION

- A. Notify the Project Manager at least seven (7) working days prior to start of pesticide application and seeding operations.
- B. Protect existing utilities, paving, planting and other facilities from damage caused by pesticide application and seeding operations. Contractor shall repair any damage at no additional cost to the City.
- C. Locate, protect and maintain the irrigation system during seeding operations. Repair irrigation system components damaged during seeding operations shall be replaced or repaired to current City irrigation standards at Contractor's expense.
- D. Utilize equipment having low unit pressure ground contact within seeding areas.
- E. Limit preparation to areas that can be seeded within twenty-four (24) hours of preparation.
- F. Moisten prepared area before seeding if soil is dry. Water thoroughly and allow surface to dry before seeding. Do not create muddy soil.
- G. Erosion Control: Take measures and furnish equipment and labor necessary to control and prevent soil erosion, blowing soil and accumulation of wind-deposited materials on the site throughout the duration of work.

3.3 PESTICIDE APPLICATION

- A. Apply Roundup or approved equal to all turf areas to be converted to native grass areas outside of the limits of grading.
- B. Complete multiple applications of Roundup or approved equal as necessary to achieve complete eradication of turf grass, and in accordance with pesticide application schedule approved by Project Manager.
- C. Retain dead turf grass and root mat in place for erosion control.

3.4 SEEDING

- A. Seeding shall be performed with drill seeder except in locations where seeded area is too small or too steep for drill seeding.

- B. Seed within twenty-four (24) hours after preparation of seed bed. Seeding at other times may only be done if approved by the Project Manager.
- C. Areas outside Contract Limits disturbed as a result of construction operations shall be restored at Contractor's expense.
- D. Seed shall be uniformly applied at the specified rate, (half in one direction and the other half perpendicular to the first application). The direction of the final application shall always be perpendicular to the slope or running in the direction of the contour. Seed shall be installed at a depth between one-quarter inch (1/4") and one-half inch (1/2").
- E. Areas that are too small or steep for mechanical seeding may be hand seeded. Seed shall be uniformly applied at the specified rate utilizing a broadcast spreader and then hand raked in to a depth of no more than one-half inch (1/2"), then roll seed bed to ensure proper contact to the soil.
- F. Dormant Seeding: Upon approval of the Project Manager, dormant seeding may be accomplished between November 15 and April 15. No seeding shall be done when the ground is frozen, muddy, covered with snow, or otherwise in a condition unsuitable for seeding. Dormant seeding will not relieve the Contractor from the warranty or the acceptance requirements specified elsewhere in this specification.
- G. Seeding in turf-to-native conversion areas: Commence seeding only upon approval of Project Manager. Seed directly into treated turf grass.

3.5 WETLAND SOD

- A. Wetland sod shall be installed in accordance with manufacturer's written instructions and as directed and approved by Project Manager.

3.6 EROSION CONTROL MATERIALS

- A. Review erosion control measures with Project Manager prior to installation.
- B. For erosion control mats, install planting soil in two lifts, with second lift equal to thickness of erosion control mats. Install erosion control mat and fasten as recommended by material manufacturer.
- C. Fill cells of erosion control mat with planting soil and compact before planting.
- D. Install erosion control blanket on slopes exceeding 3:1, and in swales or other areas of concentrated runoff. As shown on the Contract Drawings or as directed by the Project Manager. Install in accordance with manufacturer's instructions.

- E. For erosion-control blanket or mesh, install from top of slope, working downward, and as recommended by material manufacturer for site conditions. Fasten as recommended by material manufacturer.

3.7 MULCHING

- A. Straw Mulch Application: Comply with Section 213 – Mulching of the CDOT Standards and Specifications for Road and Bridge Construction.
- B. Hydromulch Application: Utilize an approved hydromulcher to apply cellulose fiber at a rate of two-thousand (2,000) pounds per acre. Apply tackifier to comply with CDOT Section 213.02 – Mulching. Contractor shall provide verification of application rates in the form of ship tickets.
- C. Mulching shall not be installed when surface water is present resulting from rains, melting snow irrigation or other causes.
- D. Areas not properly mulched, or any damage that may occur during construction is the responsibility of the Contractor and shall be repaired and re-mulched in an acceptable manner at the Contractor's expense. Mulching removed by wind, rain or other causes prior to acceptance shall be re-established by the Contractor at its own expense.
- E. The seeded area shall be mulched within eight (8) hours of seeding. Areas not mulched within twenty-four (24) hours after seeding must be re-prepped and re-seeded with the specified seed mix at the Contractor's expense.
- F. Contractor shall remove all hydromulch from surface areas not specified for seeding, including but not limited to plant materials, fences, paved areas, signs, mulch beds, irrigation components and all other objects as directed by the Project Manager.

3.8 PROTECTION

- A. Restrict vehicular and pedestrian traffic from seeded areas until vegetation is established. Erect signs and barriers as required or directed by the Project Manager at no additional cost to the City.

3.9 MAINTENANCE

- A. Refer to Landscape Maintenance section 32 97 00
- B. If no native seed maintenance is required per the contract, then establishment is per the native seed warranty. Maintenance of the native seed area is the responsibility of the contractor until Substantial Completion.

3.10 WARRANTY

- A. Warranty for Native Seed Areas: Warrant areas in seed to be in a healthy, vigorous growing condition, and for consistency and completion of coverage for a minimum period of one (1) year from date of final acceptance.
- B. Irrigated native seed areas shall meet the following satisfactory criteria:
1. Total vegetation cover in all zones seeded with cover crop shall exceed fifty percent (50%) by aerial cover. Native grass shall be free of weeds, foreign grasses, disease and harmful insects.
 2. By the end of the first full growing season after seeding, total vegetation cover including cover crop shall exceed seventy percent (70%) by aerial cover and ten percent (10%) of all species present shall be native.
 3. By the end of the first full growing season, seedling from twenty percent (20%) of planted forb species shall be present.
 4. At any time during the contract period no more than ten percent (10%) by aerial cover of the seeded area should be dominated by aggressive exotic species such as, but not limited to, red clover (*Trifolium* spp.), white or yellow sweet clover (*Melilotus* spp.), Canada thistle (*Cirsium arvense*), tall fescue (*Festuca elatior*), field bindweed (*Convolvulus arvensis*) etc.
 5. Until final acceptance seeded areas that fail after having been replaced previously, shall be replaced until it meets establishment as required above. Replacement materials shall be identical to those originally specified. Provide seed tags to the Project Manager for verification.
 6. Remedial action: If seeded areas greater than ten (10) square feet fail to meet the terms of the guarantee shown above, the Landscape Contractor will develop and submit to the Owner's Representative a remedial action plan that takes into consideration the site goals and specific deficiencies causing the remedial action. Contractor will implement the remedial action plan and submit a report that describes the remedial action taken. If remedial seeding or planting is required, Contractor will not be required to perform additional remedial seeding or planting in the same area for a minimum of two growing seasons. After two growing seasons following the remedial planting, the performance criteria must be met for the second growing season or additional remedial action must be taken. This guarantee remains in effect until all zones meet the third growing season criteria.
 7. Seeded areas will not be accepted in parts. Each time any portion or section of the entire seeded area requires replacement or remedial action, the maintenance period shall extend until all seeded areas meet the minimum establishment requirements stated above.
 8. All expense incurred including repairs from vandalism for the replacement and or establishment of the seed areas are the responsibility of the Contractor.
 9. If seeded in the fall, review for establishment shall be no later than June 15 of the following year.

- C. Non-irrigated native seed areas shall meet the following satisfactory criteria:
 - 1. Total vegetation cover in all zones seeded with cover crop shall exceed seventy percent (70%) by aerial cover. Native seed shall be free of weeds, foreign grasses, disease and harmful insects.
 - 2. During the original warranty period, reseed at once with comparable blend/mix, those areas that have failed to achieve a stand of grass or which in the Project Manager's opinion are unhealthy.
 - 3. Reseeding will not be allowed in any season considered unfavorable for seeding by the Project Manager.
 - 4. Reseed in a manner to achieve quality as originally specified.

3.11 CLEANING

- A. Perform cleaning during installation of the work and upon completion of the work. Remove from all excess materials, debris and equipment from site. Repair any damage resulting from seeding operations.
- B. Erect temporary fencing or barricades and warning signs as required to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.
- C. Remove non-degradable erosion-control measures after grass establishment period.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

- A. Measurement will be made by the contract unit specified for Native Seeding and Wetland Sod. Measurement shall include the actual number of units of specified material(s) placed and accepted at the locations shown on the Contract Drawings, or as directed by the Project Manager, and in accordance with the Specifications.

4.2 PAYMENT

- A. Payment will be made at the contract unit price, and shall include required materials, transportation, equipment, labor, earthwork, stockpiling, disposing, hauling off, watering, dust control, erosion and sediment control, fine grading, soil preparation, furnishing and installation of seeds and mulches installation and maintenance of temporary protection by fencing or other means, watering and all maintenance required until Final Acceptance of the work as required in accordance with the Contract Drawings and Specifications.

END OF SECTION 32 92 20

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Contract Drawings and general provisions of the Contract, including General and Supplementary Conditions and the City and County of Denver Standard Specifications for Construction General Contract Conditions (2011)
- B. City and County of Denver Engineering Division, Wastewater Capital Project Management Standard Construction Specifications, dated March 15, 2016.
- C. Wastewater Capital Projects Management Special Project Provisions for Asbury & Tejon.
- D. Wastewater Capital Projects Management Supplemental Technical Specifications for Asbury & Tejon.
- E. Denver Parks and Recreation Asbury and Tejon Specifications, OCT 2018.

1.2 SUMMARY

- A. This Section includes requirements for furnishing and installation of bluegrass sod, and maintenance of sodded areas as outlined in Maintenance Section 1.8.B. until Final Acceptance.
- B. Related Sections:
 - 1. WCPM Standard Construction Specification 2.0 Section "Site Preparation".
 - 2. WCPM Supplemental Technical Specification 31 23 00 "Earthwork".
 - 3. Division 31 32 50 Section "Watering".
 - 4. Division 32 80 00 Section "Irrigation System".
 - 5. Division 32 84 33 Section "Automatic Irrigation Controllers"
 - 6. Division 32 91 13 Section "Soil Preparation".
 - 7. Division 32 91 20 Section "Topsoil".
 - 8. Division 32 93 00 Section "Trees, Plants, and Groundcovers".

1.3 DEFINITIONS

- A. Finished Grade: Elevation of finished surface of planting soil.
- B. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, pesticides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, herbicide, defoliant, or desiccant.

- C. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.
- D. Planting Soil: Standardized topsoil; existing, native surface topsoil; existing, in-place surface soil; imported topsoil; or manufactured topsoil that is modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.
- E. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or top surface of a fill or backfill before planting soil is placed.
- F. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.
- G. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil, but in disturbed areas such as urban environments, the surface soil can be subsoil.
- H. Weeds: Including but not limited to Goathead, Bindweed, Twitch, Dandelion, Jimsonweed, Knapweed, Quackgrass, Horsetail, Morning Glory, Rush Grass, Mustard, Lambsquarter, Chickweed, Cress, Crabgrass, Canadian Thistle, Nutgrass, Poison Oak, Blackberry, Tansy Ragwort, Bermuda Grass, Johnson Grass, Poison Ivy, Nut Sedge, Nimble Weed, Bent Grass, Wild Garlic, Perennial Sorrel, and Broom Grass.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Sod Certificates:
 1. State, Federal and other inspection certificates for sod shall be provided to the Project Manager a minimum of 10 working days prior to anticipated date of sod delivery.
 2. Submit a list of varieties contained in the sod, and include the source and origin for approval by the Project Manager.
- C. Analysis and standards: Wherever applicable, for non-packaged materials, provide two copies of analysis by recognized laboratory made in accordance with methods established by the Association of Official Agriculture Chemists.
- D. Planting schedule: Submit in writing two copies of proposed planting schedule, indicating dates for topsoil placing, site preparation, pesticide treatments, soil preparation, sodding, seeding, and coordination with plant procurement, planting soil preparation, plant delivery and planting. Schedule all Work during specified planting

seasons. Once accepted, revise dates only as approved in writing, after documentation of reasons for delays.

- E. Contract Closeout Submittals:
 - 1. Operating and Maintenance Data: At completion of work, submit one digital copy and two hard copies to the Project Manager in accordance.
 - 2. Include any training and/or directions for irrigation, aeration, mowing, fertilizing and spraying as required for continued and proper maintenance through full growing season and dormant period.
 - 3. Warranty for Turfgrass Sod Areas: At completion of work, furnish written warranty to Project Manager based upon specified requirements.
- F. List of Suppliers and Subcontractors: Submit a list of suppliers and subcontractors, including items to be supplied by each supplier and/or subcontractor. Identify work to be performed by each subcontractor. The list shall be updated and resubmitted as required.

1.5 QUALITY CONTROL

- A. Installer Qualifications: A qualified landscape Installer whose work has resulted in successful turf establishment.
 - 1. Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.
 - 2. Experience: Five years' experience in turf installation.
 - 3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
 - 4. Sod Producer: Company specializing in sod production and harvesting with minimum five (5) years' experience, and certified by the State of Colorado Department of Agriculture.
 - 5. Personnel Certifications: Installers shall have certification the following categories from the Professional Landcare Network:
 - a. Certified Landscape Technician - Exterior, with installation maintenance irrigation specialty area(s), designated CLT-Exterior.
 - 6. Maintenance Proximity: Not more than two hours' normal travel time from Installer's place of business to Project site.
 - 7. Pesticide Applicator: State licensed, commercial.
- B. Provide a general description of Quality Control monitoring to be performed until final acceptance by the City. Include monitoring activities of Work and the worksite during times no construction activity is scheduled to take place
- C. The Contractor shall designate an employee as the Quality Control Representative, qualified to perform quality control monitoring of the Work. The designated individual shall have the authority to direct work changes required to bring the Work into

- D. Soil-Testing Laboratory Qualifications: An independent laboratory or university laboratory, recognized by the State Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.
- E. Soil Analysis: See Division 32 91 13 Section "Soil Preparation".
- F. Preinstallation Conference: Conduct conference at Project site to coordinate the process with other trades, to coordinate equipment movement within planting areas and to avoid soil compaction, to review proposed methods of installation, performance criteria, and maintenance procedures. Review underground utility location maps and plans.
- G. Standards: All materials and methods used during this portion of the work shall meet or exceed applicable federal, state, county, and local laws and regulations. All sod shall be free from insects and disease. Species shall be true to their scientific name as specified.
- H. Materials: The Contractor shall submit to the Project Manager for approval a complete list of all materials to be used during this portion of the work prior to delivery of any materials to the site. Include complete data on source, amount and quality. This submittal shall in no way be construed as permitting substitution for specific items described on the plans or in these specifications unless approved in writing by the Project Manager.
- I. Source Quality Control:
 - 1. Sod Materials: Subject to inspection and acceptance. The Project Manager reserves the right to reject at any time or place prior to acceptance, any work and sod which in the Project Manager's opinion fails to meet these specification requirements.
 - 2. Inspection will be made periodically during sodding, at completion and at end of warranty period by the Project Manager. Primarily for quality; however, other requirements are not waived even though visual inspection results in acceptance.
 - 3. Promptly remove rejected sod from site.
- J. Sod Standards:
 - 1. Sod shall consist of healthy, thick turf having undergone a program of regular fertilization, mowing and weed control; free of weeds; uniform in green color, leaf texture and density; healthy, vigorous root system; inspected and found free of disease, nematodes, pests and pest larvae by the State Department of Agriculture.
 - 2. Each piece of Sod shall consist of a sandy-loam soil base that will not break, crumble or tear during sod installation.

3. Sod thickness shall be a minimum three quarters inch (3/4") thick, excluding top growth and thatch.
4. Thatch layer shall not exceed one half inch (1/2"), uncompressed.
5. Sod shall be delivered and installed within twenty four (24) hours of being cut.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Sod: Harvest, deliver, store, and handle sod according to requirements in the attached "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" in TPI's "Guideline Specifications to Turfgrass Sodding." Deliver on pallets properly loaded on vehicles with root system protected from exposure to sun, wind, and heat in accordance with standard practice. Sod that has been damaged by poor handling or improper storage is subject to rejection by the Project Manager.
 1. Protect from dehydration, contamination, freezing and heating at all times. Keep stored sod moist and under shade or covered with moistened burlap.
 2. Do not drop sod rolls from carts, trucks or pallets.
 3. Do not deliver more sod than can be installed within twenty four (24) hours.
- B. Fertilizer: Deliver inorganic or chemical fertilizer to site in original unopened container bearing manufacturer's guaranteed chemical analysis, name, trade name, trademark, warranty and conformance to state law.
- C. Bulk Materials:
 1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
 2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
 3. Accompany each delivery of bulk fertilizers and soil amendments with appropriate certificates.
 4. Fertilizer: Deliver inorganic or chemical fertilizer to site in original unopened container bearing manufacturer's guaranteed chemical analysis, name, trade name, trademark and conformance to state law, and bearing name and warranty of producer.
- D. Material will be inspected upon arrival at project site. Project Manager will reject any opened or unacceptable materials as described above.
- E. Immediately remove unacceptable material from job site.

1.7 PROJECT/SITE CONDITIONS

- A. Work scheduling: Proceed with and complete landscape work as rapidly as portions of the site become available, working within the specified planting season and approved schedule.
- B. Vehicular accessibility on site shall be as directed by Project Manager. Repair damage to prepared topsoil and existing surfaces, caused by vehicular access and movement during work under this section, to original condition at no additional cost to the City.
- C. Install sod between April 15 and October 1 or when irrigation is available for twenty one (21) days per Denver Water's guidelines for sod establishment.
- D. Schedule work for periods of favorable weather. Do not install sod on saturated or frozen soil. The Project Manager reserves the right to deny sod installation on days that are deemed to be unfavorable for installation.
- E. Existing conditions:
 - 1. Existing Plants: Install sod only after all other landscape and irrigation items have been installed and accepted by the Project Manager.
 - 2. Utilities: Determine location of underground utilities. Perform work in a manner to avoid possible damage. Hand excavate, as required.
 - 3. Excavation: Maintain grade stakes set by others until removal is mutually agreed upon by parties concerned. When conditions detrimental to plant growth are encountered, such as rubble fill, adverse drainage conditions, noxious materials or obstructions, notify Project Manager before planting.
 - 4. If weeds are present on site, treat with pesticide prior to preparing soil for installing sod as specified in this or other Sections.
- F. Coordination:
 - 1. Coordinate with construction of utilities on site. Do not begin placing topsoil and sod until underground work is completed in the area.
 - 2. Coordinate sodding with Contractor(s) approved schedule. Limit construction access to areas where topsoil has been placed if placement is completed more than 3 days prior to commencement of landscaping in the area. Limit fine grading to areas that can be prepared for planting within twenty four (24) hours after fine grading.
 - 3. Coordinate with Contractors work requiring access to site over sodded areas.
 - 4. Coordinate with installation of underground irrigation system.

1.8 WARRANTY

- A. Warrant sod areas to be in a healthy, vigorous growing condition, and for consistency and completion of coverage for a period of one (1) year from date final acceptances as

a full stand of grass. Re-sod any areas where sod has failed due to disease or other inadequate installation, as defined in this Section.

1. During the original warranty period, immediately replace the sod with a comparable sod blend/mix in the areas that have failed to achieve a stand of grass or which are unhealthy in the Project Manager's opinion.
2. Re-sodding will not be allowed in any season considerable unfavorable for sod installation by the Project Manager.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Topsoil: See Division 32 91 20 Section "Topsoil".
- B. Soil Preparation: See Division 32 91 13 Section "Soil Preparation.
- C. Sod:
 1. Colorado grown Kentucky Bluegrass blend having a healthy, vigorous root system. Blend shall contain a minimum of three (3) improved varieties, of which at least one variety is an aggressive type.
 2. Sod to be produced in accordance with requirements in "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" in TPI's "Guideline Specifications to Turfgrass Sodding."
 3. Harvesting: Sod shall be fertilized 2–3 weeks prior to harvesting. Mow sod to a height of one and one-half inches (1-1/2") before the sod is lifted. Sod shall be harvested in rolls, and shall not be cut more than 24 hours prior to planting.
 4. Size: Machine cut to a minimum pad thickness of three quarters inch (3/4), excluding top growth and thatch. Provide sod of uniform pad sizes eighteen inches (18") maximum width by twenty four (24") minimum length, with maximum five percent (5%) deviation in either length or width. Broken pads or pads with uneven ends will not be acceptable. Sod pads incapable of supporting their own weight when suspended vertically from upper ten percent (10%) of pad will be rejected. Sod which has dried out, sod with adhering soil which breaks, tears, or crumbles away will not be accepted. Sod cut for more than twenty-four (24) hours will not be accepted.
 5. Plastic netting: Sod to be free of plastic netting used during establishment by sod grower.
- D. Fertilizer: Inorganic mixture with following chemical composition: (20-5-10) with fifty percent (50%) sulfur coated urea (no iron), or as recommended by testing lab based on soil sample results.

2.2 PESTICIDES

- A. General: Pesticide, registered and approved by EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by Project Manager and authorities having jurisdiction.
 - 1. Pre-Emergent Herbicide (Selective and Non-Selective): Use only with approval by Project Manager. Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.
 - 2. Post-Emergent Herbicide: Glyphosate or 2,4-D, or approved equal.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to be planted for compliance with requirements and other conditions affecting performance.
 - 1. Verify that finish grades are consistent with the slopes and grades indicated on the Contract Drawings. Verify grades are in conformance with WCPM Supplemental Technical Specification 31 23 00 "Earthwork".
 - 2. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
 - 3. Do not mix or place soils and soil amendments in frozen, wet, or muddy conditions.
 - 4. Suspend soil spreading, grading, and tilling operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
 - 5. Uniformly moisten excessively dry soil that is not workable and which is too dusty.
- B. Proceed with installation only after unsatisfactory conditions have been corrected and approved by the Project Manager.
- C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Engineer and replace with new planting soil.

- D. Beginning of installation means acceptance of existing conditions by the Contractor.

3.2 PREPARATION

- A. Work notification: Notify the Project Manager at least seven (7) working days prior to start of sodding operations.
- B. Limit turf subgrade preparation to areas that can be sodded within twenty four (24) hours.
- C. Newly Graded Subgrades: Prepare soil as required by Division 32 91 13 Section "Soil Preparation".
- D. Unchanged Subgrades: If turf is to be planted in areas unaltered or undisturbed by excavating, grading, or surface-soil stripping operations, prepare surface soil as follows:
 - 1. Remove existing grass, vegetation, and turf. Do not mix into surface soil.
 - 2. Loosen surface soil to a depth of at least 8 inches. Apply soil amendments and fertilizers according to planting soil mix proportions and mix thoroughly into top six inches (6") of soil. Till soil to a homogeneous mixture of fine texture.
 - 3. Remove stones larger than one-half ($\frac{1}{2}$) inch in any dimension and sticks, roots, trash, and other extraneous matter.
 - 4. Legally dispose of waste material, including grass, vegetation, and turf, off City property.
- E. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.
- F. Verify that all areas are graded to drain at a minimum of two percent (2%) or as indicated on the Contract Drawings. Verify that subsurface drainage system and drain inlets if any, are operative.
- G. Verify that irrigation system is operable and provides adequate coverage prior to planting.
- H. Adjustment: Adjust irrigation heads to proper watering height according to depth of sod material but lower than compacted blade height to enable lawn mowers to cut grass freely without damage to the sprinkler system.
- I. When completed, the soil shall be firmed by float dragging, followed by steel raking, to provide for the proper sodded subgrade. The sod bed shall be totally free from rock or clay clods over one-half inch ($\frac{1}{2}$) inch in diameter.
- J. Repair: Re-establish grade and specified conditions to damaged sod areas prior to placing sod.

3.3 INSTALLATION

- A. Sodding:
1. Sod within twenty-four (24) hours after preparation of bed.
 2. If plastic netting is present within sod, remove all netting during sod installation and discard from site.
 3. Subgrade on which sod is laid shall be slightly moist during installation.
 4. Lay sod with longest dimension parallel to contours and in continuous rows.
 5. Tightly butt ends and sides of sod together. Stagger and compact vertical joints between sod strips.
 6. Sod shall not be overlapped or stretched during placement. Exposed joints due to shrinkage will require replacement of sod in affected areas.
- B. Topsoil: Where new sod abuts an existing turf area topsoil shall be placed along seams and or joints to provide a smooth transition.
- C. Rolling: Sod shall be rolled after installation to ensure proper contact with the subgrade, and to ensure tight joints between adjacent pieces. Sod shall be moist prior to rolling. Once rolling is complete additional watering shall occur. Roller shall weigh one-hundred (100) pounds.
- D. Drainage: Contractor shall ensure that finished areas are graded so that positive drainage of storm and irrigation water is achieved.
- E. Water: Contractor to utilize the existing irrigation system and or quick coupler(s) when available. If irrigation or quick coupler(s) are not available then the contractor is responsible for watering. Refer to Division 31 32 50Section "Watering". Water shall be free of substances that may be harmful to sod growth. Hoses and other watering equipment necessary to water the sod to be furnished by Contractor.
1. Water thoroughly with a fine spray as laying progresses and immediately after planting. Saturate sod with fine water spray within two hours of planting. During first week after planting, water daily or more frequently as necessary to maintain moist soil to a minimum depth of 1-1/2 inches (1-1/2 ") below sod.
- F. After sod and soil have dried, roll sodded areas to ensure a good bond between sod and soil and to remove minor depressions and irregularities. Roller shall not exceed one hundred (100) pounds.

3.4 CLEANING

- A. Perform cleaning during installation of the Work and upon completion of the Work to the satisfaction of the Project Manager. Remove all excess materials, debris, and equipment from site. Repair any damage resulting from sodding operations.

3.5 PROTECTION

- A. Protect existing utilities, paving and other facilities from damage caused by sodding operations, the Contractor shall repair any damage at no additional cost to the City.
- B. Restrict vehicular and pedestrian traffic from sodded areas until grass is established. Erect signs and barriers as required or directed by the Project Manager at no additional cost to the City.
- C. Locate, protect and maintain the irrigation system during sodding operations. Repair irrigation system components damaged during sodding operations shall be replaced or repaired to current Denver Parks irrigation standards at the Contractor's expense.
- D. Erosion Control: Take measures and furnish equipment and labor necessary to control and prevent soil erosion, blowing soil and accumulation of wind-deposited materials on the site throughout the duration of work.

3.6 MAINTENANCE

- A. General: The maintenance period shall begin immediately after each area is sodded and continue for Sixty (60) days or as determined by the Project Manager. During this time, the Contractor is responsible for watering, mowing, spraying, weeding, fertilizing and all related work as necessary to ensure that sodded areas are in a vigorous growing condition. Provide all supervision, labor, material and equipment to develop and maintain sodded areas from time of installation.
- B. Mowing and Trimming: When turfgrasses reach three and one-half inches (3-1/2") in height, begin weekly mowing program to maintain turf at two and one-half inches (2-1/2") to three inches (3") in height. Do not remove more than 1/3 the height of the grass blade in single mowing. Do not mow when grass is wet. All clippings from adjacent paved areas shall be removed and clippings from mowed turf areas shall be removed to the satisfaction of Project Manager.
- C. Fertilizing: Within thirty (30) days of sodding and every sixty (60) days thereafter until Acceptance, apply specified fertilizer to maintain optimal turf vigor or per the direction of the Project Manager.
- D. Weed Control: Control annual weeds by mowing. Do not use pesticides unless approved by the Project Manager and Denver Parks Operations Supervisor.
- E. Insect and Disease Control: As needed, apply insecticide and fungicide approved by the Project Manager and the Parks Operations Supervisor.

3.7 ACCEPTANCE

- A. Substantial Completion of sod areas will not be given until the Project Manager is satisfied with establishment and a full stand of grass, in a vigorous growing condition, and thoroughly rooted to the soil and absence of visible joints. The sodded areas shall be accepted on the basis of having a healthy, uniform stand of turf over the entire sodded area.
 - 1. Sixty (60) days after sodding, the sodded areas shall be reviewed by the Project Manager and the Contractor. Any areas as determined by the Project Manager where the sod has failed to establish shall be re-sodded.
- B. Final Acceptance will be defined as a healthy uniform turf that does not contain any stressed or bare spots greater than one (1) square foot.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

- A. Measurement will be made by the contract unit specified for Sodding. Measurement shall include the actual number of units of specified material(s) placed and accepted at the locations shown on the Contract Drawings, or as directed by the Project Manager, and in accordance with the Specifications.

4.2 PAYMENT

- A. Payment will be made at the contract unit price, and shall include qualified installer, qualified pesticide professional, all required materials, transportation, equipment, labor, earthwork, loading, transporting, stockpiling, disposing, hauling off, watering, dust control, erosion and sediment control, fine grading, temporary protection by fencing or other means, watering and all maintenance required until Final Acceptance of the work as required in accordance with the Contract Drawings and Specifications.

END OF SECTION 32 92 23



Guideline Specifications To Turfgrass Sodding

**Revised
2006**

Turfgrass Producers International
2 East Main Street
East Dundee, IL 60118

Preface

These guideline specifications have been prepared in response to the need for information regarding soil preparation, turfgrass sodding and post-installation maintenance over wide geographic/climatic areas.

With recent research results and production experience, it is commonly understood that consideration must be given to the region where turfgrass sod installation is to be accomplished. Quality performance of turfgrass sodded areas depends on a number of closely related and inter-dependent factors. These include the selection of adapted turfgrasses, adequate preparation of the site, proper transplanting of sod and good cultural practices which will result in rapid establishment and good turfgrass growth.

These specifications have been prepared to provide architects (both structural and landscape), landscape contractors, builders and owners information that will fulfill the objectives they envision. The materials and methods suggested are applicable, or can be adapted, for the vast majority of landscape work being undertaken.

It is recommended that areas with highly specialized requirements, such as major sports complexes, highly erodible or flood prone areas be addressed by a combination of specialized experts because of the unique situations and requirements that may be present at the site.

These specifications neither imply, suggest nor guarantee satisfaction in results because of the extremely wide variety of localized conditions that might exist. As stated in this publication's title, the following pages are intended as "guidelines" only.

Acknowledgements

Turfgrass Producers International is an independent, not-for-profit trade association of professional turfgrass sod producers. Since its formation in 1967 as the American Sod Producers Association, it has served three objectives stated in its official bylaws. These include, "To better acquaint the public with the product of the Association and to provide suggestions and instructions for the planting and culturing thereof." One of the earliest projects of the organization was the development and publication of its "*Guideline Specifications to Turfgrass Sodding*." First published in 1972, this booklet has provided a common basis upon which business has been reasonably conducted between educated and informed producers and consumers of turfgrass sod.

The turfgrass sod production industry is indebted to numerous individuals and organizations for their many contributions to the information contained in this publication. While there are too many to identify individually, TPI extends its appreciation to all who contributed to the updating and success of this invaluable publication.

Foreword

Turfgrass sod has gained universal recognition and world-wide acceptance as the most effective technique to establish lawns and other turf areas. While the immediate project completion and/or beautification of an area with turfgrass are the most readily acknowledged advantages of using mature turfgrass sod, there are a number of very valid environmental and economic reasons to select turfgrass as the plant-material of choice.

Environmental benefits of turfgrass, as carefully documented in the scientific report by Dr. James B. Beard and Dr. Robert L. Green, in "The Role of Turfgrasses in Environmental Protection and Their Benefits to Humans," published in the peer-reviewed *Journal of Environmental Quality*, January, 1994 (Volume 23, Number 3, Pages 452-460) by the American Society of Agronomy, Crop Science Society of America and the Soil Science Society of America, include:

1. **Functional benefits** such as soil erosion control, dust prevention, heat dissipation, noise abatement, air pollution control and nuisance animal reduction;
2. **Recreational benefits** such as low cost surfaces, physical health, safety and spectator entertainment; and,
3. **Aesthetic benefits** such as beauty, quality of life, mental health, social harmony, community pride, increased property values and a compliment to trees and shrubs in the landscape.

Economic benefits of turfgrass sodding, as analyzed by Dr. Eliot Roberts, former executive director of the Lawn Institute, and others, would include such factors as:

1. **Known, visible results** in the form of a mature turf, as opposed to an unpredictable product that typically results from other forms of turf establishment such as seeding, or hydro-seeding.
2. **Reduced input requirements** such as water, herbicides, fungicides and insecticides and the associated increased labor costs that would be required to establish turf by any means other than through the use of turfgrass sod.
3. **Near-immediate use** of the turfed area resulting from the installation of sod, as opposed to lengthy periods of time where a seeded area would be unavailable for use.
4. **One-time establishment** of the turf area is accomplished with turfgrass sodding, thus eliminating the time-consuming, frustrating and costly requirement of re-seeding or patching of areas that are washed out or otherwise deemed unacceptable as a result of seedling failure.

Immediacy and beauty are significant benefits of turfgrass sodding, but they are not the only reasons to rely on turfgrass sod for a wide variety of landscape and sportsfield projects. The many advantages of turfgrass sod that are made available with a high quality product are also an added benefit. The conscientious efforts of the turfgrass sod production industry have contributed immeasurably to the availability of high quality sod of the best turfgrass varieties available.

Turfgrass Producers International, TPI, (formerly the American Sod Producers Association), is organized to represent the progressive turfgrass sod producer. The members are dedicated to continuing efforts in the production of improved turfgrass sod for a better and more enjoyable environment. This publication has been prepared to help assure that the finest quality turf is obtained and properly installed on a variety of sites, by an equally wide variety of individuals or companies.

Local turfgrass producer members of TPI should be consulted on all turfgrass sodding projects to gain information related to "micro-climates" and other localized conditions that could affect selection, installation and overall satisfaction with the newly sodded area.

How To Use This Publication

These specification guidelines are presented in six specific sections, and produced in a manner that will permit the use of all or selected sections with tremendous ease and maximum flexibility. Each section can stand alone, be incorporated into an overall set of specifications for an entire turfgrass sodding project, or used in any combination. For example, firms that specialize in a certain type of activity may use these guideline specifications when bidding only on a portion of a project, such as supply or placement of topsoil, etc. On the other hand, a general contractor, architect or owner may present these specifications as a means of establishing comparable bidding considerations.

The specifications are divided into the following six major areas:

- Section I. Specifications for Subsoil Preparation
(Where Topsoil Is To Be Added)**

- Section II. Specifications for Topsoil Material
and Application**

- Section III. Specifications for Fertilizer pH Correction
Materials and Final Soil Preparation**

- Section IV. Specifications for Turfgrass
Sod Materials**

- Section V. Transplanting and Installing
Turfgrass Sod**

- Section VI. Specifications for Maintenance of
Transplanted Turfgrass Sod**

Specifying the Class/Grade and Composition Of Turfgrass Sod

“**Turfgrass sod**” and “**sod**” are used somewhat interchangeably throughout this publication; however, because the term “sod” is objectionable in some cultures, TPI is encouraging the use of the term “turfgrass sod” to be properly descriptive of the product. In those instances where the term “sod” is used in this publication it is because other words would not “sound” appropriate to the North American audience.

Advancements and improvements in turfgrass sod harvesting equipment and post-harvesting techniques have increased by a considerable margin the variety of available sizes and conditions of the finished product. Where turfgrass sod was once available only in one square yard or a meter piece, either in a strip or as a roll, today’s producers may also offer turf in rolls that are upwards of 48-inches wide (1.3 meters) and many upwards of 100 feet (30 meters) long. In some markets, there may also be “washed sod,” where the soil has been removed after harvesting, or “soil-less sod,” that has been grown in a non-soil medium, usually on plastic or some other surface, or “thick-cut” sod (upwards of 2-inches /5 cm thick) for use on sportsfields and other areas requiring high levels of immediate use. Custom-grown turfgrass sod, meeting the purchaser’s exact specifications for variety and growth medium (such as technical sand mixtures) may also be produced at some farm locations.

In some geographic areas, the soil types may be termed “mineral,” “muck,” “peat,” or “organic,” in reference to the basic composition of the farm’s soils. When combined with turfgrass sod, the product may be called “Mineral Sod,” “Muck Sod,” “Peat Sod,” or “Organic Sod.” While this may cause some initial confusion, the overall condition of the turfgrass sod and its basic classification, as defined elsewhere in this publication, is generally considered to be of much greater importance. These terms do not refer to the class of turfgrass sod, or the composition of its plant materials.

Factors to consider in determining the appropriate class/grade of turfgrass and its composition can be quite extensive. The following factors should be kept in mind:

- A. The ultimate purpose of, or use for the turfgrass area being specified can affect the proper selection of turfgrass sod;
- B. Local consumer preference demands will strongly influence what grasses will be grown for turfgrass sod.
- C. Varietal improvements continually occur, permitting the turfgrass sod producer greater flexibility in selecting blends and mixtures that are appropriate for a particular purpose or area.
- D. Composition of turfgrass sod differs widely over any major geographic area because climatic conditions and/or other variables.

To assist in determining the best specifications for the turfgrass sod required for each site, the following examples of quality definitions are provided. Please note, that the criteria most typically included would be the quality of the original seed or plant material, the presence or absence of noxious or other weeds, the degree of maintenance involved during growing and the overall uniformity of the finished product. Recognizing that not all sites require the same quality standard of products and that local market practices will prevail, the following examples are provided as a guideline.

Within the U.S. many states have Crop Improvement Associations, Seed Commissions or other agencies which administer voluntary programs to inspect and certify certain crops, including turfgrasses. "Certified," used in this context means that the variety of grass is adapted to the climatic region, has been grown from seed or planting stock of known origin and has been inspected for varietal purity and freedom from noxious weeds. However, not all varieties and/or species that are adaptable or perhaps commonly used in the area may be included in these certification programs. Additionally, these programs do not establish standards for quality of the turfgrass sod related to strength or ability to be handled and installed without coming apart. Furthermore, many State Departments of Agriculture inspect soil grown crops such as turfgrass sod and then issue certificates for freedom from insects, diseases or other pests. This is usually required by state or federal law and does not require specification.

It should also be noted that while independent turfgrass sod certification programs establish uniform quality standards, there may well be producers in a certification area, or other areas where no certification program exists, whose turfgrass sod may meet or exceed certification standards.

The following definitions of turfgrass sod quality standards should help guide in the specification of the required level of product appropriate to the site.

- A. Certified Turfgrass Sod:** Certified turfgrass sod is superior sod grown from certified, high quality seed of known origin or from plantings of certified grass sprigs or stolons. It is inspected by the certification agency of the area to assure satisfactory varietal identity and purity, overall high quality and freedom from noxious weeds or excessive amounts of other crop and weedy plants at time of harvest. It may be of either one variety or composed of a mixture of two or more varieties or species. However, all seed in a mixture must be certified. The turfgrass sod must meet the area's published standards for certification.
- B. Approved Turfgrass Sod:** Approved turfgrass sod is superior sod, grown from approved seed of known origin or from plantings of approved grass sprigs or stolons. Field standards for approved sod are similar to those of certified sod. It is inspected by the official certification agency of the area to assure overall high quality and freedom from noxious weeds or excessive amounts of other crop and weedy plants at time of harvest. It may be either one variety or composed of a mixture of two or more varieties of species. However, all seed in a mixture must be approved.
- D. Nursery Turfgrass Sod:** Any turfgrass sod planted on cultivated agricultural land and grown specifically for turfgrass sod purposes. It shall have been mowed regularly and carefully and otherwise maintained from planting to harvest to assure reasonable quality and uniformity. May also be termed "Cultivated Turfgrass Sod."
- E. Field Turfgrass Sod:** This class of sod may include all turf not covered in the above classes. It may consist of turf lifted from pastures or meadows, which may have been grown primarily for forages. May also be termed "Pasture Turfgrass Sod."

Alternate Standards for Specifying Turfgrass Sod Quality are presented on the next two pages.

Alternate Standards of Turfgrass Sod Quality

The following standards considerably reduce the complexity of the specifications previously outlined and in many instances will be adequate for a given project's needs.

Sample 1: Standards of Quality

Labeling: Every shipment of turfgrass sod shall be accompanied by an invoice or sales slip indicating whether the material is of a single variety, a blend or a mixture and the quality.

- A. Any turfgrass sod in which one variety of any species makes up in excess of 90% of the turf shall be sold as that variety.
- B. Turfgrass sod classified as a "Bluegrass Blend" shall have been seeded using a blend of two or more varieties of Kentucky bluegrass. The names of these varieties and the percentages in the original seed blend shall be available on request.
- C. Turfgrass sod grown from a mixture of turfgrass species, such as Kentucky bluegrass and turf-type tall fescues, shall be labeled as such and the species identified. Percentages by weight of each sown variety shall be available on request.
- D. Any turfgrass sod that has not been sown and maintained as a nursery sod crop shall be labeled as "Pasture Sod."

Quality Definition(s):

- A. **Number 1 Quality/Premium:** The turf shall be of sufficient density so that no surface soil is visible when mowed to a height of 1.5 inches (40 mm). Maximum mowing height shall be 2.5 inches (60 mm). At the time of sale, the turf shall contain no more than one percent undesirable grasses or clover and not more than two weeds per 50 square yards (50 sq m). The thickness of the soil portion of the turfgrass sod should not exceed one-half inch (15mm).
- B. **Commercial Grade:** Turfgrass sod being sold as "Commercial Grade," shall meet the density and mowing requirements of No. 1 sod. It may however contain up to 10 percent undesirable grass species and 10 weeds per 50 square feet (50 sq m). Any grass other than the species shown on the invoice/sales slip shall be deemed as an undesirable. Annual bluegrass (*Poa annua*) shall be included in this classification. The thickness of the soil portion of the turfgrass sod should not exceed one-half inch (15 mm).

IMPORTANT

Research concludes that the thinner the soil layer, the more rapidly rooting will occur after installation; however, installers should be aware that thin soil layers tend to dry-out more quickly than thicker soil layers. Attention to adequate post-installation watering is very important to the success of any turfgrass sod project.

Sample 2: Standards of Quality

Labeling: Every shipment of turfgrass sod shall be accompanied by an invoice/sales slip indicating the variety, species and quality grade of the shipment.

Quality Grades:

- A. Premium Grade** turfgrass sod shall contain only the species and variety of turfgrass shown on the invoice/sales slip, and contain no weeds or foreign grasses (i.e., no other varieties or species). It may have no visible signs of disease or insect stress. The turfgrass sod shall be neatly mowed and be mature enough that when grasped at one end, it can be picked-up and handled without damage.
- B. Standard Grade** turfgrass sod may have no visible broadleaf weeds when viewed from a standing position and the turf shall be visibly consistent, with no obvious patches of foreign grasses. In no case may the total amount of foreign grasses or weeds exceed two percent of the total canopy. The turfgrass sod shall be neatly mowed and be mature enough that when grasped at one end it can be picked up and handled without damage.
- C. Commercial Grade** turfgrass sod shall be any material that fails to meet the Standard Grade specifications.

SECTION I

Specifications For Subsoil Preparation (Where Topsoil Is To Be Added)

(NOTE: This specification applies only if additional topsoil will be placed over existing soil.)

A. General: The area(s) to which these specifications apply and on which topsoil is to be placed shall be as indicated on the drawings or as otherwise specified. Equipment, labor and materials necessary for the preparation of the specified area(s) shall be furnished by the grading contractor.

B. Grading: Grades on the area(s) to be topsoiled, which have been previously established in conformance with the drawings and/or other applicable specifications, shall be maintained in a true and even grade.

C. Low pH Correction: Where the subsoil is highly acid, it shall be tested by a reputable laboratory and a pH correction material shall be spread at a rate sufficient to correct the pH to a range of 6.0 to 7.0. The material shall be distributed uniformly over the designated area(s) and worked into the soil in conjunction with an expanded tillage operation as described in Paragraph E below.

D. High pH Correction: Saline and alkali soils may be found in arid and semiarid regions and in areas near sea water. In many of these areas the salts can be leached, but other soils will require special amendments or management. In areas where these soil characteristics may occur, subsoil samples shall be tested by a reputable laboratory and subsequent recommendations, to include a possible delay in topsoil addition, shall be followed.

E. Tilling: After the area(s) to be topsoiled have been brought to grade, compacted where necessary and immediately prior to the dumping and spreading of topsoil, the subgrade shall be loosened by disking or by scarifying to a depth of at least 2 inches (50 mm) to permit bonding of the topsoil to the subsoil.

F. Acceptance: Acceptance shall be given by the general contractor, owner, architect or their agent, upon satisfactory completion of each section or area(s), as indicated on the drawings or as otherwise specified.

G. Payment: Specifications of method of payment, retainer and final payment shall be as customary to the industry in this area.

SECTION II

Specifications For Topsoil Material And Application

NOTE: Topsoil on the existing site may often be used; however, it should meet the same standards as set forth in these specifications.

A. General: The grading contractor shall furnish all topsoil, labor, material and equipment required to complete the work described herein in strict accordance with the drawings and/or terms of the contract.

B. Materials: Topsoil shall be a loamy sand, sandy loam, clay loam, loam, silt loam, sandy clay loam or other soil approved by the architect. It shall not have a mixture of subsoil and shall contain no slag, cinders, stones, lumps of soil, sticks, roots, trash or other extraneous materials larger than 1.5 inches (40 mm) in diameter. Topsoil must also be free of viable plants or plant parts of common bermudagrass, quackgrass johnsongrass, nutsedge, poison ivy, Canada thistle, or others as may be specified. All topsoil shall be tested by a reputable laboratory for pH and soluble salts. If needed, pH correction material shall be applied at a rate sufficient to correct the pH to a range of 6.0 to 7.0. Soluble salts shall not be higher than 500 parts per million.

No turfgrass sod shall be placed on soil which has been chemically treated until sufficient time has elapsed to permit dissipation of all toxic materials. The general contractor shall assume full responsibility for any loss or damage to turfgrass sod arising from improper use of chemicals or due to his failure to allow sufficient time to permit dissipation of toxic residues, whether or not such materials are specified herein.

C. Grading: The topsoil shall be uniformly distributed on the designated area(s) and it shall be a minimum of 3 inches (75 mm) deep after firming. Spreading shall be performed in such a manner that sod installation can proceed with a minimum of additional soil preparation and tillage. Any irregularities in the surface resulting from topsoiling or other operations shall be corrected in order to prevent the formation of depressions or water pockets. Topsoil shall not be placed while in a frozen or muddy condition, when the subgrade is excessively wet, or in a condition that may otherwise be detrimental to proper grading or proposed for turfgrass sod installation.

D. Clean Up: After the topsoil has been spread and the final grade approved, it shall be cleared of all grade stakes, surface trash or other objects that would hinder installation and/or maintenance of turfgrass sod and other plantings. Paved areas over which hauling operations are conducted shall be kept clean and any soil which may be brought upon the surfacing shall be promptly removed. The wheels of all vehicles shall be kept clean to avoid tracking soil on the surfacing of roads, walks or other paved areas.

E. Acceptance: Acceptance will be given by the general contractor, owner, architect or their agent, upon satisfactory completion of each section or area(s), as indicated on the drawings or as otherwise specified.

F. Payment: Specifications of method of payment, retainer and final payment shall be customary to the industry in this area.

SECTION III

Specifications For Fertilizer, pH Correction Materials and Final Soil Preparation

NOTE: Specifications given in this section apply both to areas where topsoil has been added and to areas where soil from the existing site is used.)

A. General: The general contractor shall furnish, or have furnished by others, all labor, material and equipment required to complete the work described herein, in strict accordance with the drawings and/or terms of the contract.

B. Materials: Soil tests shall be made to determine the exact requirements for any amendments. Soil tests shall be conducted by a reputable laboratory.

(Note: For the next three items, use appropriate recommendations of the state agricultural experiment station, extension service, or other reputable agent, for the variety of turfgrass being specified.)

1. **Fertilizers:** All fertilizers (either granular or liquid) shall be uniform in composition, free flowing and suitable for application with approved equipment. Fertilizers shall be delivered to the site fully labeled, according to applicable fertilizer laws and shall bear the name, trade name or trademark, and warranty of the producer or manufacturer.

Fertilizer applications shall be determined by soil tests. If soil testing is waived where there is insufficient time for complete soil tests, fertilizer materials that supply the following levels of nutrients can be applied:

- a. _____ lbs actual N per 1000 sq ft (____ kg/100 sq m)
- b. _____ lbs actual P₂O₅ per 1000 sq ft (____ kg/100 sq m)
- c. _____ lbs actual K₂O per 1000 sq ft (____ kg/100 sq m)

Fertilizers shall be distributed uniformly over the entire area(s) where turfgrass sod is to be installed.

2. **Low pH Correction Materials:** Lime material shall be ground limestone (hydrated or burnt lime may be substituted), which contains at least 50% total oxides (calcium oxide plus magnesium oxide). Ground limestone shall be ground to such fineness that at least 50% shall pass through a 100-mesh sieve and 98% to 100% shall pass through a 20-mesh sieve.

Application rates for liming materials shall be determined by soil tests. If soil testing is waived, when there is insufficient time for a complete soil test, **lime shall be applied at a minimum rate of _____ lbs of ground limestone or its equivalent per 1000 sq ft (____ kg/100 sq m).**

Lime shall be distributed uniformly over the entire area(s) where turfgrass sod is to be installed.

3. High pH Correction Materials: Materials and application rates shall be determined by appropriate soil tests performed by a reputable laboratory. If leaching or special management is necessary, final grading will be delayed as specified.

C. Grading:

1. Tillage: Soil amendments, such as fertilizer and lime, shall be uniformly incorporated into the top 4 inches (100 mm) of soil by discing, harrowing or other approved method.

2. Final Grading: Any undulations or irregularities in the surface, resulting from fertilizing, liming, tilling or other causes, shall be smoothed prior to turfgrass installation. Flooded, washed out areas, damaged or otherwise, shall be reconstructed and all grades re-established by the grading contractor in accordance with the drawings and/or other applicable specifications.

D. Clean-Up: Prior to installation of the turf, the surface shall be cleared, to a depth of 4 inches (100 mm), of all trash, debris, stones larger than 1.5 inches (40 mm) in diameter, and of all roots, brush, wire, grade stakes and other objects that would interfere with planting or maintenance operations.

E. Acceptance: Acceptance shall be given by the general contractor, owner, architect or their agent, upon satisfactory completion of each section or area(s) as indicated on the drawings or as otherwise specified.

F. General Contractor's Responsibility: The general contractor shall be responsible for maintaining the accepted area(s) which are to be sodded until the effective date to begin installation. The effective turfgrass sod installation date shall be specified in a written notice from the general contractor.

G. Payment: Specifications or method of payment, retainer and final payment shall be customary to the industry in this area.

SECTION IV

Specifications For Turfgrass Sod Materials

A. General: The turfgrass sod supply contractor shall furnish all labor, material and equipment required to complete the work described herein, in strict accordance with the drawings and/or terms of the contract.

B. Materials:

1. Class/Grade of Sod and Composition:

- a. Class of the turfgrass sod shall be _____
- b. This turfgrass sod shall be composed of _____
(designate variety/type/blend/mixture above)

2. Thickness of Cut: Turfgrass sod shall be machine cut at a uniform soil thickness of 0.60 inch (15 mm), plus or minus 0.25 inch (6 mm), at the time of cutting. Measurement for thickness shall exclude top growth and thatch.

3. Pad Size: Individual pieces of turfgrass sod shall be cut to the supplier's standard width and length. Maximum allowable deviation from standard widths and lengths shall be plus or minus 0.5 inch (15 mm) on width and plus or minus five percent on length. Broken pads and torn or uneven ends will not be acceptable.

4. Strength of Turf Sod Sections: Standard size sections of turfgrass sod shall be strong enough that it can be picked up and handled without damage.

5. Moisture Content: Turfgrass sod shall not be harvested or transplanted when its moisture content (excessively dry or wet) may adversely affect its survival.

6. Mowing Height: Before harvesting, the turfgrass shall be mowed uniformly at a height of 1 to 2.5 inches (25 to 60 mm) on cool season grasses (i.e., bluegrass, bentgrass, rye and fescue), and 0.75 to 1.50 inches (20 to 40 mm) on warm season grasses (i.e., zoysiagrass, bermudagrass, St. Augustinegrass, etc.)

7. Time Limitations: Turfgrass sod shall be harvested, delivered and installed/transplanted within a period of 24 hours, unless a suitable preservation method is approved prior to delivery. Turfgrass sod not transplanted within this period shall be inspected and approved by the inspecting officer or his representative prior to its installation.

(NOTE: Items 8 through 10 of the following “Materials Standards” may also be specified when not using certified or approved turfgrass sod.)

8. Thatch: Turfgrass sod shall be relatively free of thatch, up to 0.5-inch (15 mm) allowable (uncompressed).

9. Diseases, Nematodes and Insects: Turfgrass sod shall be reasonably free of diseases, nematodes and soil-borne insects. Specific nursery and/or plant materials laws may require that all sod entering inter-state commerce be inspected and approved for sale. The inspections and approval must be by the appropriate government representative of the agriculture department or office of entomologist.

10. Weeds:

a. Nursery Grown Turfgrass Sod: shall be free of objectionable grassy and broad leaf weeds. Turfgrass sod shall be considered free of such weeds if less than 5 such plants are found per 100 square feet (10 sq m) of area. Turfgrass sod will not be acceptable if it contains any of the following weeds: common bermudagrass (wiregrass), quackgrass, johnsongrass, poison ivy, nutsedge, nimblewill, Canada thistle, bindweed, bentgrass, wild garlic, ground ivy, perennial sorrel and/or brome grass.

b. Field Turfgrass Sod: may contain no more than 10 weeds per 100 square feet (10 sq m) of area. Turfgrass sod will not be acceptable if it contains any of the weeds listed in 10-a above.

C. Delivery and Off-Loading: Turfgrass sod shall be delivered to the site specified in this contract and off-loaded using equipment furnished by the turfgrass sod supply contractor. Palletized or large-roll turfgrass sod shall be off-loaded at the location(s) designated for this purpose at the installation site.

D. Damage Disclaimer:

1. The general contractor, owner, architect or their agent shall accept full responsibility and hold harmless the turfgrass sod supply contractor for any and all damage that may be caused by the sod delivery truck driving onto a driveway and/or walkway, if the driver of the loaded sod truck has been instructed to position the truck in an area where such damage might occur.

2. The turfgrass sod supply contractor shall not be held liable for damages incurred to the turfgrass sod as a result of de-icing compounds, fertilizers, pesticides or other materials not applied by him or under his supervision, nor for those caused by acts of God or vandalism.

E. Acceptance: Acceptance will be given by the general contractor, owner, architect or their agent, upon satisfactory completion of each delivery to the area(s) as indicated on the drawings or as otherwise specified.

G. Payment: Specifications of method of payment, retainer and final payment shall be customary to the industry in this area.

SECTION V

Specifications For Turfgrass Sod Transplanting and Installation

- A. General:** The installation contractor shall furnish all labor, material and equipment required to complete the work described herein, in strict accordance with the drawings and/or terms of the contract.
- B. Grading:** All previously established grades shall be maintained in conformance with the drawings and/or applicable specifications.
- C. Time Limitations:** Turfgrass sod shall be transplanted/installed within a period of 24 hours following harvesting, unless a suitable preservation method is approved prior to delivery. Turfgrass sod not transplanted within this period shall be inspected and approved by the inspecting officer or his representative prior to its installation.
- D. Transplanting:**
- 1. Moistening the Soil:** During periods of higher than optimal temperature for the species being specified, and after all unevenness in the soil surface has been corrected, the soil shall be lightly moistened immediately prior to installation of the turfgrass sod.

 - 2. Starter Strip:** The first row of turfgrass sod shall be laid in a straight line, with subsequent rows placed parallel to and tightly against each other. Lateral joints shall be staggered to promote more uniform growth and strength. Care shall be exercised to insure that the pieces are not stretched or overlapped and that all joints are butted tightly to prevent voids that would cause air drying of the roots.

 - 3. Sloping Surfaces:** On 3:1 or greater slopes, traditional size (1 sq yd / 1 sq m) turfgrass sod shall be laid across the angle of the slope (perpendicular), with staggered joints and secured by tamping, pegging, stapling or other approved methods of temporarily securing each piece. Large-roll turfgrass sod shall be laid in the direction of the slope, with temporary securing being at the discretion of the installation contractor.

 - 4. Swales and Intermittent Waterways:** The installation of turfgrass sod within drainways or intermittent waterways shall be determined after considering maximum channel velocities for storms of a designated intensity. Traditional size turfgrass sod shall be laid perpendicular to the direction of flow and pegged to resist washout during the establishment period, while large-roll pieces shall be laid in the direction of the flow, with temporary securing being at the discretion of the installation contractor.

 - 5. Watering and Rolling:** The installation contractor shall water the turfgrass sod immediately after transplanting to prevent drying. As sodding is completed in any one section, the entire area shall be lightly rolled. It shall then be thoroughly watered to a depth sufficient to ensure the underside of the new sod pad and soil immediately below the pad are thoroughly wet. The general contractor shall be responsible for having adequate water available at the site prior to and during installation.

- E. Acceptance:** Acceptance of the transplanted turfgrass sod shall be on a daily basis, within 12 hours of completion of an area or section, unless other wise specified.
- F. Disclaimer:** The installation contractor shall not be held liable for damages incurred to the turfgrass sod as a result of de-icing compounds, fertilizers, pesticides or other materials not applied by him or under his supervision, nor for those caused by acts of God or vandalism.
- G. Guarantee:** The installation contractor shall guarantee work covered by this specification to the extent that all transplanted turfgrass sod shall be uniform in color, leaf texture and shoot density and be reasonably free of visible imperfections at acceptance.
- H. General Contractor's Responsibility:** The general contractor shall be responsible for maintaining the accepted sodded area until the effective date for turfgrass maintenance operations. The effective date shall be specified in a written notice from the general contractor.
- H. Payment:** Specifications of methods of payment, retainer and final payment shall be customary to the industry in this area.

SECTION VI

Specifications For Maintenance of Transplanted Turfgrass Sod

- A. General:** The contractor shall furnish all labor, material and equipment required to complete the work described herein, in strict accordance with the drawings and/or terms of the contract.
- B. Watering:** The general contractor shall supply adequate water to the site. The single-most important factor in the successful rooting of newly installed turfgrass sod is adequate, regular watering. Watering should begin immediately after installation. The amount of water required will vary depending upon season, weather, temperature, wind, slope and turfgrass variety. The general contractor shall designate the party responsible to ensure adequate water supply and application.
- 1. First Week:** The contractor shall provide all labor and arrange for all watering necessary for rooting of the turfgrass sod. Soil on sod pads shall be kept moist at all times. In the absence of adequate rainfall, watering shall be performed daily or as often as necessary during the first week and in sufficient quantities to maintain moist soil to a depth of at least 4 inches (100 mm). Watering should be done during the heat of the day to prevent wilting.
- 2. Second and Subsequent Weeks:** The contractor shall water the turfgrass sod as required to maintain adequate moisture in the upper 4 inches (100 mm) of soil, necessary for the promotion of deep root growth.
- B. Mowing:** The first mowing shall not be attempted until the turfgrass sod is firmly rooted and securely in place. Not more than 30 percent of the grass leaf shall be removed by the initial or subsequent mowings. Care shall be taken to assure cutting blades are maintained in a sharp condition.
- Bluegrass and other cool season grasses shall be maintained between 1.5 and 2.5 inches (40-60 mm), unless otherwise specified.
- Stoloniferous grasses shall be maintained between 0.75 and 1.50 inches (20 - 40 mm), unless other specified.
- D. Time Limitations:** Duration of maintenance responsibilities shall be for 30 days unless otherwise specified.
- E. Disclaimer:** The contractor shall not be held liable for damages incurred to the turfgrass sod caused by de-icing compounds, fertilizers, pesticides and other materials not applied by him or under his supervision, nor those caused by acts of God or vandalism.
- F. Guarantee:** The contractor shall guarantee work covered by this specification to the extent that all turfgrass sod shall be uniform in color, leaf texture and shoot density and shall be reasonably free of weeds, diseases and other visible imperfections at acceptance.
- G. Payment:** Specifications for method of payment, retainer and final payment shall be customary for this industry in this area.

“Guideline Specifications to Turfgrass Sodding”

is another valuable publication of

TURFGRASS PRODUCERS INTERNATIONAL

2 East Main Street
East Dundee, IL 60118

“Guideline Specifications to Turfgrass Sodding” is a non-copy-righted publication of **Turfgrass Producers International**. This publication may be copied in part or whole, with the implied permission of TPI. The organization would appreciate receiving acknowledgment in the form of a credit line where appropriate, such as: “Reprinted with permission of Turfgrass Producers International, excerpted from the organization’s publication, ‘Guideline Specifications to Turfgrass Sodding.’”

Requests for individual complimentary copies of this publication should be accompanied by a self-addressed, stamped envelope. (Postage should be sufficient for 3 ounces.)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Contract Drawings and general provisions of the Contract, including General and Supplementary Conditions and the City and County of Denver Standard Specifications for Construction General Contract Conditions (2011)
- B. City and County of Denver Engineering Division, Wastewater Capital Project Management Standard Construction Specifications, dated March 15, 2016.
- C. Wastewater Capital Projects Management Special Project Provisions for Asbury & Tejon.
- D. Wastewater Capital Projects Management Supplemental Technical Specifications for Asbury & Tejon.
- E. Denver Parks and Recreation Asbury and Tejon Specifications, OCT 2018.

1.2 SUMMARY

- A. This Section includes requirements for furnishing, installing, and maintaining live woody plant material.
- B. Related Sections:
 - 1. WCPM Standard Construction Specification 2.0 Section "Site Preparation".
 - 2. WCPM Standard Construction Specification 4.0 "Utility Trenching and Excavation"
 - 3. WCPM Standard Construction Specification 5.0 "Bedding and Backfilling".
 - 4. WCPM Standard Construction Specification 23.0 "Storm Water Management"
 - 5. WCPM Supplemental Technical Specification 31 23 00 "Earthwork".
 - 6. WCPM Supplemental Technical Specification 31 23 19 "Water Control and Dewatering".
 - 7. Division 01 45 16 Section "Contractor Quality Control".
 - 8. Division 01 56 39 Section "Tree Retention and Protection".
 - 9. Division 31 32 50 Section "Watering".
 - 10. Division 32 80 00 13 Section "Irrigation Systems"
 - 11. Division 32 84 33 Section "Automatic Irrigation Controllers"
 - 12. Division 32 91 13 Section "Soil Preparation".
 - 13. Division 32 91 20 Section "Topsoil".
 - 14. Division 32 92 23 Section "Sodding".
 - 15. Division 32 97 00 Section "Landscape Maintenance".

1.3 DEFINITIONS

- A. ANSI: American National Standards Institute. Z60.1 is the national standard for nursery stock.
- B. Backfill: The earth used to replace or the act of replacing earth in an excavation.
- C. Balled and Burlapped Stock: Plants dug with firm, natural balls of earth in which they were grown wrapped with burlap, tied, rigidly supported, and drum laced with twine with the root flare visible at the surface of the ball as recommended by ANSI Z60.1.
- D. Bare-Root Stock: Plants with a well-branched, fibrous-root system developed by transplanting or root pruning, with soil or growing medium removed, and with not less than the minimum root spread according to ANSI Z60.1 for type and size of plant required.
- E. Diameter at Breast Height (DBH): Defined as the diameter at four and one-half inches (4 ½") above the soil line.
- F. Caliper: Trunk diameter is measured six-inches (6") from the ground; if the caliper is greater than four-inches (4"), the measurement is taken at twelve-inches (12") from the ground.
- G. Cane: A cane shall be considered a primary stem which starts from the ground or at a point close to the ground at a point not higher than one-fourth (1/4) the height of the plant, and which reaches the minimum height stated in the plant size specification.
- H. Central leader: Also referred to as leader or the dominant leader. A continuation of the main trunk located more or less in the center of the crown, beginning at the lowest main scaffold branch and extending to the top of the tree.
- I. Circling root(s): One or more roots whose diameter is greater than ten percent (10%) of the trunk caliper circling more than one-third of the trunk. Circling roots are unacceptable.
- J. Clear Trunk: The portion of the trunk below the main crown which may include shortened temporary branches.
- K. Co-dominant: Two or more vigorous, upright branches or stems of relatively equal diameter that originate from a common point, usually where the leader was lost or removed. Co-dominant stems are unacceptable.
- L. Container-Grown: Healthy, vigorous, well-rooted plants grown in a container, with a well-established root system reaching sides of container and maintaining a firm ball when removed from container. Container shall be rigid enough to hold ball shape and

protect root mass during shipping and be sized according to ANSI Z60.1 for type and size of plant required.

- M. Crown: The portion of a tree beginning at the lowest main scaffold branch extending to the top of the tree. On younger trees, the crown may be comprised of temporary branches.
- N. Cultivar: A named plant selection from which identical or nearly identical plants can be produced, usually by vegetative propagation or cloning.
- O. Drip Zone: The outermost edge of the tree's canopy or branch spread. The area within a tree's drip line is all the ground under the total branch spread.
- P. Finish Grade: Elevation of finished surface of planting soil.
- Q. Included Bark: Bark embedded in the union between a branch and the trunk or between two or more stems that prevents the formation of a normal branch bark ridge. Included bark is unacceptable.
- R. Kinked Root: A main root that is sharply bent. Kinked roots are unacceptable.
- S. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. Pesticides include insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. They also include substances or mixtures intended for use as a plant regulator, defoliant, or desiccant. Some sources classify herbicides separately from pesticides.
- T. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. Pests include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.
- U. Root Collar: Also referred to as the root flare. The base of a tree where the main roots and trunk meet.
- V. Scaffold Branches: Large main branches that form the main structure of the crown.
- W. Stem-girdling Root: A circling, bent, or straight root that touches or rests on the trunk or root flare that can become a permanent root. Stem-girdling roots are unacceptable.
- X. Subgrade: The surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.
- Y. Temporary Branch: A small branch that is temporarily retained along the lower trunk of young trees.

- Z. Tree Protection Zone: The zone equal to eighteen inches (18") radially from the tree for every one-inch (1") of trunk diameter at breast height.
- AA. Trunk: The main stem of a tree, beginning at the root collar and ending at the lowest main scaffold branch.
- BB. Taper: The thickening of a trunk or branch toward its base.

1.4 SUBMITTALS

- A. See Division 01 Section "Submittals" for submittal requirements.
- B. Product Data: For each type of product.
 - 1. Plant Materials: Include quantities, sizes, quality, and sources for plant materials.
- C. Product Samples: At a minimum provide the following samples for approval by the Project Manager, additional product samples may be required at the direction of the Project Manager.
 - 1. Mulch: one (1) gallon bag minimum of each type of mulch.
 - 2. Tree Stakes: one (1) of each type.
 - 3. Tree Straps: one (1) each.
 - 4. Guy Material: one (1) linear foot.
 - 5. Guy Signal: one (1) linear foot.
 - 6. Tree Wrap: one (1) linear foot.
- D. Pesticides: Product label, Safety Data Sheet (SDS) labels and manufacturer's application instructions specific to Project.
- E. Proper Identification: All plants shall be true to name as ordered or shown on planting plans and shall be labeled individually or in groups by species and cultivar (as appropriate).
- F. Contractor shall provide a complete list of all plant material for approval by the Project Manager a minimum of ten (10) days prior to delivery. Any substitutions of plant material, including but not limited to size, type, species and variety shall be listed and submitted to the Project Manager for approval.
- G. Tree Planting Permit: The contractor shall obtain a planting permit request form available at denvergov.org/Forestry and submit the completed form to the Office of the City Forester and the Project Manager.
- H. Contractor shall provide the following certificates:
 - 1. State Inspection Certificate from the origin nursery.
 - 2. Certificate from origin state.
 - 3. Quarantine Certificate from origin state.

4. Any Certificates required by the USDA Animal and Plant Health Inspection Service (APHIS) and ANSI-Z-160 and accompanying Rules and Regulations.
- I. Analysis of existing soil shall be per Division 32 91 20 Section "Topsoil" and 32 91 13 "Soil Preparation".
- J. Contract Close Out Submittals:
 1. Operating and Maintenance Data: At completion of work, submit One (1) digital copy and two (2) hard copies to the Project Manager in accordance with "Contract Closeout". Include recommended procedures for continued and proper maintenance during a full calendar year.
 2. Warranty for Trees, Plants, and Groundcovers: At completion of work, furnish written warranty to the Project Manager based upon specified requirements.

1.5 QUALITY CONTROL

- A. The Project Manager reserves the right to reject, at any time or place prior to final acceptance, all plant materials that fail to meet these specifications in the Project Manager's opinion. Inspection of materials is primarily for quality, size, and variety, but other requirements are not waived even though visual inspection results in approval. Plants are to be inspected where available; however, inspection at the places of supply shall not preclude the right of rejection at the site or at a later time prior to Final Acceptance. Rejected material shall be removed from the site within twenty-four (24) hours.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Materials: Deliver materials in original containers with tags showing genus, species and size. Protect materials from damage during delivery and while stored at site. The Project Manager reserves the right to inspect containers before or after installation to verify compliance with Specifications.
- B. Bulk Materials:
 1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants or in tree protection zones.
 2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
 3. Accompany each delivery of bulk materials with appropriate certificates.
- C. Trees: Nursery stock shall be harvested and planted during the same growing season. Do not prune, except as approved by the City Forester and the Project Manager. Protect bark, branches, and root systems from sun scald, drying, sweating, whipping, and other handling and tying damage. Do not bend or tie trees in such a manner as to destroy natural shape. Provide protective covering during delivery. Plant materials

delivered without protective covering may be rejected. Do not drop trees during delivery. All trees shall be labeled with a securely attached waterproof tag bearing a legible plant name. Remove all tags and flagging as directed by the Project Manager.

- D. Deliver bare-root stock plants within twenty-four (24) hours of digging. Immediately after digging up bare-root stock, pack root system in wet straw, hay, or other suitable material to keep root system moist until planting. Transport in covered, temperature-controlled vehicles, and keep plants cool and protected from sun and wind at all times.
- E. Store bulbs, corms, and tubers in a dry place at sixty degrees to sixty-five degrees (60° to 65°) F until planting.
- F. Handle planting stock by the root ball only.
- G. Deliver trees after preparations for planting have been completed and install immediately. If planting is delayed more than six (6) hours after delivery, set planting materials in shade, protect from weather and mechanical damage, and keep roots moist.
 - 1. Set balled stock on ground and cover ball with wood chips, or other acceptable material.
 - 2. Do not remove container-grown stock from containers before planting.
 - 3. Water root systems of trees stored on site with a fine-mist spray. Water as often as necessary to maintain root systems in a moist condition.

1.7 PROJECT/SITE CONDITIONS

- A. Vehicular accessibility on site shall be as directed by the Project Manager. Repair damage to prepared topsoil and existing surfaces, caused by vehicular access and movement during work under this section, to original condition at no additional cost to the City.
- B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions and warranty requirements.

1.8 COORDINATION AND SCHEDULING

- A. Coordinate installation of planting materials during normal planting seasons for each type of plant material required. Planting materials should be planted between April 15 and October 1, or at the direction of the Project Manager. If irrigation is not available at the time of planting then the Contractor is responsible for watering of all plant material and no additional cost to the City, refer to Division 31 32 50 Section "Watering".

- B. Plant trees after final grades have been accepted and prior to seeding or sodding, unless otherwise authorized by the Project Manager.

1.9 WARRANTY

- A. Warranty: The warranty specified in this Article shall not deprive the City of other rights the City may have under other provisions of the Contract Documents and shall be in addition to, and run concurrently with, other warranties made by the Contractor under requirements of the Contract Documents.
- B. Trees, Plants, and Groundcovers shall be warranted for a period of one (1) year after date of Final Acceptance, against defects including death, structural failures, dieback as determined by the City Forester and the Project Manager. Warranty shall not cover defects resulting from lack of adequate maintenance, neglect or abuse by City staff, hail, or incidents that are beyond Contractor's control.
- C. The Warranty shall not be enforced should any plant die due to vandalism after Final Acceptance.
- D. Remedial Actions:
 - 1. Replace any plant materials that have been excessively pruned, more than twenty percent (20%) percent dead, or in an unhealthy or declining condition immediately upon notice from the Project Manager during warranty period.
 - 2. Immediately remove dead plants and replace unless required to plant in the succeeding planting season.
- E. All plants shall be true to name and meet all conditions of these specifications. Any plant that is not true to name as indicated by form, leaf, flower, or fruiting characteristics shall be replaced at the Contractor's expense.

PART 2 - PRODUCTS

2.1 PLANT MATERIALS

- A. General: Furnish and install nursery-grown trees and shrubs conforming to the requirements of ANSI-Z-160, with healthy root systems developed by transplanting or root pruning. Provide well shaped, symmetrical, fully branched, healthy, and vigorous stock free of disease, insects, eggs, larvae, girdling, and defects such as sun scald, injuries, abrasions, and disfigurement. Trees of a larger size than that specified in the plant list may be used with a proportionate increase in size of roots and balls, if acceptable to the Project Manager. The use of larger plants shall be covered by the Contractor at no additional cost to the City.
- B. Label all plants of each size, caliper and variety and caliper with a securely attached waterproof tag bearing legible designation of botanical and common name.

TREES, PLANTS, AND GROUNDCOVERS

32 93 00 - 7

Asbury and Tejon OCT 2018

- C. All plants shall be the genus, species, and variety designated on the Contract Drawings. No substitutions will be accepted without the prior written approval of the City Forester and the Project Manager. Contractor must provide proof of non-availability.

2.2 TREES

- A. These specifications shall apply to deciduous, broadleaf evergreen and coniferous species. Note that leaf characteristics will not be evident on deciduous trees during the dormant season.
- B. Crown: The form and density of the crown shall be typical for a young specimen of the species/cultivar. Changes in form caused by wind, pruning practices, pests, or other factors shall not substantially alter the form for the species/cultivar. These crown specifications do not apply to plants that have been specifically trained in the nursery to be: topiary, espalier, multi-stem, or clump; or unique selections such as contorted or weeping cultivars.
 - 1. Trees shall have a single, relatively straight trunk, and central leader, unless noted on plans to be "Multi-trunk" or "Clump". They shall be free of co-dominant stems and vigorous, upright branches that compete with the central leader. If the original leader has been headed, a new leader at least one-half of the diameter of the original leader shall be present.
 - 2. Main branches shall be evenly distributed along the central leader, not clustered together. They shall form a balanced crown appropriate for the age of the species/cultivar.
 - 3. Branch diameter shall be no larger than one-half the diameter of the central leader measured one-inch (1") above where the branch is attached.
 - 4. The attachment of the largest scaffold branches shall be free of included bark.
 - 5. Temporary branches, unless otherwise specified, should be present along the lower trunk below the lowest scaffold branch, particularly for trees less than one-inch (1") in caliper. These branches should be no greater than three-eighths-inch (3/8") diameter. Clear trunk shall be no more than thirty percent (30%) of the total height of the tree, unless otherwise noted
- C. Trunk: The tree trunk shall be relatively straight, vertical, and free of wounds, except properly made pruning cuts, which shall be closed over or less than three-quarters-inch (3/4") diameter open, sunburned areas, conks (fungal fruiting bodies), wood cracks, bleeding areas, signs of boring insects, galls, cankers, stem-girdling ties, or lesions (mechanical injury).
 - 1. Trunk caliper and taper shall be sufficient so that the tree will remain vertical without a stake. Trunk caliper at six-inches (6") above the soil media (substrate) surface shall be within the diameter range shown for each container size below and as specified in current edition of ANSI Z60.1.
 - 2. The cut made when re-growing the top should be just above the major structural roots. The "shank" that results from this procedure should be at a consistent

height above the structural roots and no longer than five-inches (5"), to ensure that the trees are consistently planted at the correct depth. The base of the trunk should not have a large pruning cut from re-growing the top.

- D. Roots: The root system shall be substantially free of injury from biotic (e. g., insects and pathogens) and abiotic (e. g., pesticide toxicity and salt injury) agents.
1. The uppermost roots or root collar shall be within the upper two-inches (2") of the soil media (substrate). Depth of the root-ball shall be measured from the top of the ball, which in all cases shall begin at the root flare. Soil above the root flare shall not be included in the root-ball depth measurement, and shall be removed.
 2. The root collar and the inside portion of the root-ball shall be free of defects, including circling, kinked, and stem-girdling roots. Soil removal or root washing near the root collar may be necessary to inspect for the aforementioned root defects.
 3. Roots on the periphery and bottom of the root-ball shall be less than one-eighth-inch (1/8") diameter.
 4. The tree shall be well rooted in the soil media (substrate). Root distribution shall be uniform throughout the soil or media. Structure and growth shall be appropriate for the species/cultivar. When the burlap or container is removed, the root-ball shall remain intact. Trees should have several lateral roots or many fibrous roots spaced evenly around the trunk to provide support so the trees are stable when planted. Trees should have as many small roots as possible. These roots are key to the uptake of sufficient water and nutrients. Fibrous roots can be achieved by root-pruning, using air-pruning containers, or under-cutting or root pruning and transplanting at any stage of production.
 5. As a general rule for young nursery-grown trees, there should be two or more structural roots within one- to three-inches (1" – 3") of the soil surface. "First order lateral roots" is another term that has been used for these roots. If the roots are deeper than three-inches (3") , the stock shall be rejected.
 6. Root-balls that are undersized as specified in current edition of ANSI Z60.1. shall be rejected. Field grown trees for balled and burlap delivery shall have the roots pruned at least six-inches (6") inside the final root-ball size performed within adequate time for the tree to develop fibrous roots at the outer edge of the root-ball prior to harvest and delivery.
- E. Leaves: The size, color, and appearance of leaves shall be typical for the time of year and stage of growth of the species or cultivar. Trees shall not show signs of prolonged moisture stress or extended drought as indicated by wilted, shriveled, or dead leaves.
- F. Branches: Shoot growth (length and diameter) throughout the crown shall be appropriate for the age and size of the species/cultivar. Trees shall not have dead, diseased, broken, distorted, or otherwise injured branches.

- G. All deciduous trees of one species used in formal rows or groupings shall exhibit cultural uniformity, i.e. "matched" in height, crown width and shape, height to first branch, and trunk taper. For this reason, it is desired that these trees be produced by a single grower.
- H. Collected Stock: Do not use plants harvested from the wild, from native stands, from an established landscape planting, or not grown in a nursery unless otherwise indicated, and only if approved by the City Forester and the Project Manager.

2.3 SHRUBS

- A. Container Grown Shrubs: All specifications for container grown plants shall include both plant size and container size. Plant size intervals and reference to height or spread shall be in accordance with the guidelines for the appropriate plant type set forth in ANSI Z60.1; Section 2.2 - Types of Deciduous Shrubs.
- B. Container size shall be by container classification (i.e., not by container volume) as set forth in the ANSI Z60.1 Container Class Table.
- C. In all cases, container grown nursery stock shall meet the following general requirement:
 - 1. All container grown nursery stock shall be healthy, vigorous, well rooted, and established in the container in which it is growing. Container grown nursery stock shall have a well-established root system reaching the sides of the container to maintain a firm ball when the container is removed, but shall not have excessive root growth encircling the inside of the container.
- D. The container shall be sufficiently rigid to hold the ball shape and to protect the root mass during shipping.
- E. Minimum shrub sizes shall conform to the following standards:
 - 1. Tender shrubs (Type 0) that do not produce top growth that is winter hardy:

Height or Spread	Minimum number of canes	Minimum spread of roots
fifteen-inches (15")	three (3) canes	Nine-inches (9")

- 2. Small shrubs (Type 1) that grow to a mature height of not more than three feet (3'):

Height or Spread	Minimum number of canes	Minimum spread of roots
fifteen-inches (15")	four (4) canes	Nine-inches (9")

3. Intermediate shrubs (Type 2) that grow to a mature height between three feet (3') and seven feet (7'):

Height or Spread	Minimum number of canes	Minimum spread of roots
Two feet (2')	four (4) canes	twelve-inches (12")

4. Large shrubs (Type 3) that grow to a mature height exceeding seven feet (7'):

Height or Spread	Minimum number of canes	Minimum spread of roots
four feet (4')	six canes (6)	twenty-inches (20")

2.4 PERENNIALS, GRASSES, GROUNDCOVERS, AND VINES

- A. All container grown plants shall be healthy, vigorous, well rooted, and established in the container in which they are growing and be in conformance with ANSI Z60.1. A container grown plant shall have a well-established root system reaching the sides of the container to maintain a firm root ball but shall not have excessive root growth encircling the inside of the container. Top growth is to be in conformance with established nursery standards.

2.5 TREE-STABILIZATION MATERIALS

- A. Trunk-Stabilization Materials:
 1. Deciduous Tree Stakes: Rough-sawn, sound, new softwood with specified wood preservative treatment by pressure process, free of knots, holes, cross grain, and other defects, two-inch (2") diameter by six feet (6'), pointed at one end.
 2. Evergreen Tree Stakes: Two foot (2') steel T-posts; green color.
 3. Guys and Tie Wires: ASTM A 641/A 641M, Class 1, #14 galvanized-steel wire, two-strand, twisted.
 4. Tree-Tie Webbing: UV-resistant nylon webbing with brass grommets, size as indicated.
 5. Safety Signals for Guy and Staking Wire: One-half inch (1/2") diameter PVC pipe, length as indicated.
- B. Tree-Wrap:
 1. Two layers of crinkled paper cemented together with bituminous material, four-inches (4") wide minimum, with stretch factor of thirty-three percent (33%).
 2. Tree wrap tape: Tape as approved by the City Forester and the Project Manager.

2.6 PLANT PIT BACKFILL MATERIAL

- A. Unless otherwise directed by the Project Manager, the plant pit backfill material shall consist of the following, thoroughly mixed:

1. Soil originally excavated from the pit: two thirds (2/3) proportion of total mix.
2. Soil Amendment as specified in Division 32 91 13 Section "Soil Preparation"; one-third (1/3) proportion of total mix.

B. If imported topsoil is required, it shall meet the requirements specified in Division 32 91 20 Section "Topsoil", Article 2.2.

2.7 MULCH

A. Organic Mulch: Organic mulch, free from deleterious materials and suitable as a top dressing of trees and shrubs, consisting of chipped wood material not larger than four-inches (4") in length. Mulch is to be weed-free.

2.8 MISCELLANEOUS MATERIALS

A. Antidesiccant: Water-insoluble emulsion, permeable moisture retarder, film forming, for trees, as approved by the City Forester and the Project Manager. Deliver in original, sealed, and fully labeled containers. Mix and apply according to manufacturer's instructions.

B. Pre-Emergent Pesticide: As approved by the City Forester and the Project Manager.

C. Pesticides: EPA registered and approved, and as approved by the City Forester and the Project Manager.

D. Subdrainage: See Division 33 46 00 Section "Subdrainage Systems".

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify actual grade elevations and dimensions of plantings and construction contiguous with new plantings by field measurements before proceeding with planting work.

B. Examine areas to receive landscaping for compliance with requirements and for conditions affecting performance of work of this Section. Do not proceed with installation until unsatisfactory conditions have been corrected.

1. When conditions detrimental to plant growth are encountered, such as rubble fill, adverse drainage conditions, or obstructions, notify the Project Manager before planting.
2. Verify that adequate overhead clearance exists to planting locations.
3. Suspend planting operations during periods of excessive moisture until acceptable planting conditions exist.
4. Uniformly moisten excessively dry soil that is not workable.

- C. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within the work area. If contamination is present in the soil within a planting area, notify the Project Manager immediately.
 - 1. If contamination is discovered during Construction the Project Manager will determine the best course of action to remediate the contamination, which may include requesting the Contractor perform the removal of contamination and replacement of clean material.
 - 2. If contamination is determined to be the result of construction operations, Contractor is to remove contaminated material and replace with clean material at the direction of the Project Manager.
- D. Proceed with installation only after unsatisfactory conditions have been corrected and approved by the Project Manager.
- E. Cooperate with any other contractors and trades, who may be working in and adjacent to the landscape work areas. Examine the Contract Drawings which show the development of the entire site and become familiar with the scope of all work required.

3.2 FINISH GRADING

- A. See WCPM Supplemental Technical Specification 31 23 00 "Earthwork" and 32 91 13 Section "Soil Preparation" and 32 91 20 Section "Topsoil".

3.3 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities, turf areas and existing plants from damage caused by planting operations. Repair damage to surrounding areas and site elements noted above resulting from planting operations at no additional cost to the City.
- B. Utilities: Contractor shall be responsible locating utilities and, repair of utilities damaged during the work. Determine location of overhead and underground utilities and perform work in a manner that will avoid damage. Hand excavate, as required. Maintain markings until their removal is mutually agreed upon by the Contractor and the Project Manager.
- C. Layout, stake and label all individual tree locations for approval by the Project Manager prior to installing trees.
- D. Outline planting beds and mark plant locations within the bed(s) for approval by the Project Manager prior to installing any plant material or mow bands. Make adjustments as directed by the Project Manager at no additional cost to the City.

1. If formal arrangements or consecutive order of plants is indicated on Contract Drawings, select stock for uniform height and spread, and number the labels to assure symmetry in planting.

- E. Prepare planting area for soil placement and mix planting soil according to Division 32 Section "Soil Preparation".

3.4 FIELD QUALITY CONTROL

- A. Provide quantity, size, genus, species, and variety of trees indicated, complying with current applicable requirements of ANSI Z60.1 "American Standard for Nursery Stock", and all applicable state and local rules and regulations.

- B. Inspection: Contractor shall arrange for the City Forester and the Project Manager to select and/or inspect plant material at the nursery or grow site or upon delivery to the site, for compliance with requirements for genus, species, variety, cultivar, size, and quality. Selection and approval of plant material shall be at the discretion of the City Forester and the Project Manager.

1. The Contractor shall schedule inspection of the plants, at either the supplier or on-site, to be completed in one visit. Any further inspection required due to plants being unavailable, rejected, and or not meeting specifications shall be charged to the Contractor at the current hourly rate for the City personnel performing the inspection.

- C. Measurements: Measure trees according to the requirements of the ANSI Z-160, with branches and trunks in their normal position. Do not prune to obtain required sizes. Measure main body of tree for height and spread; do not measure branches or roots tip-to-tip.

3.5 WEED CONTROL

- A. Do not proceed with landscape work until weed growth has been controlled and eliminated, per Division 32 91 13 Section "Soil Preparation".
- B. See Division 32 91 13 Section "Soil Preparation" for detailed weed control measures.
- C. Use pesticides only with the written approval of the Project Manager, and in strict accordance with manufacturer's instructions.

3.6 EXCAVATION FOR TREES AND SHRUBS

- A. Planting Pits: Excavate by hand or with a backhoe. Scarify sides of tree pit. Tree spade may not be used to dig tree pits.
 1. Balled and Burlapped Trees: Excavate a minimum two times (2X) as wide as ball diameter at base of pit. The base of the root collar shall be three-inches (3")

higher than the grade at which the tree originally grew and finished grade. Slope sides of the pit as shown on the detail.

2. Container-Grown Trees and Shrubs: Excavate approximately two times (2X) times as wide as container diameter. Plants shall be set one-inch (1") higher than finished grade.
3. Do not excavate deeper than depth of the root ball, measured from the base of the root flare to the bottom of the root ball.
4. If area under the plant was initially dug too deep, add soil to raise it to the correct level and thoroughly compact the added soil to prevent settling.

B. Obstructions:

1. Utilities: Notify the Project Manager immediately of utilities that conflict or may potentially conflict with proposed plant locations. In such cases, alternative plant locations will be determined by the Project Manager.
2. Notify the Project Manager prior to planting if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavation.

C. Drainage: Notify the Project Manager if subsoil conditions show evidence of water seepage or retention in tree or shrub pits.

1. Fill the pit with water and allow it to completely drain before planting occurs.
2. If water does not drain out of pit within twenty-four (24) hours, notify the Project Manager.

3.7 PLANTING TREES AND SHRUBS

A. Balled and Burlapped Stock:

1. Set balled and burlapped stock plumb and in center of pit with base of root flare three-inches (3") above adjacent finish grades as indicated.
2. Remove burlap from top two-thirds (2/3) of balls and partially from sides, but do not remove from under balls. Remove wire baskets and all twine entirely. Remove pallets, if any, before setting. Do not use planting stock if ball is cracked or broken before or during planting operation.
3. Place backfill around ball in layers, tamping to settle backfill and eliminate voids and air pockets. When pit is approximately one-half backfilled, water thoroughly before placing remainder of backfill. Repeat watering until no more is absorbed. Water again after placing and tamping final layer of backfill.

B. Container Grown Stock:

1. Carefully remove containers so as not to damage root balls.
2. Lightly scratch sides of exposed root ball to loosen surface roots.
3. Set plants plumb and in center of pit with top of ball raised one-inch (1") above adjacent finish grades or as indicated.
4. Place backfill around ball in layers, tamping to settle backfill and eliminate voids and air pockets. When pit is approximately one-half backfilled, water

thoroughly, then place remainder of backfill. Repeat watering until no more is absorbed. Water again after placing and tamping final layer of backfill.

- C. Bare-Root Stock: Set and support each plant in center of planting pit or trench with root flare two-inches (2") above adjacent finish grade.
 - 1. Backfill: As specified in Part 2 of this Section.
 - 2. Spread roots laterally without tangling or turning toward surface. Plumb before backfilling, and maintain plumb while working.
 - 3. Carefully work backfill in layers around roots by hand eliminating air pockets. Bring roots into close contact with the soil.
 - 4. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
 - 5. Continue backfilling process. Water again after placing and tamping final layer of soil.

3.8 TREE WRAP

- A. Inspect tree trunks for injury, improper pruning, and insect infestation and take corrective measures required before wrapping. Wrap trees starting at the base of the trunk and spiral cover trunk to height of first branches. Overlap wrap, exposing half the width, and securely attach without causing girdling. Use black electrical tape to secure. Do not use staples.
 - 1. All deciduous trees shall be wrapped by November 1st or per the direction of the City Forester and the Project Manager. All tree wrap shall be removed by May 15.
 - 2. Contractor shall be responsible for wrapping and unwrapping trees during the warranty period.

3.9 PRUNING OF PLANTS

- A. Prune only damaged or dead branches as directed by the City Forester and the Project Manager.

3.10 TREE STABILIZATION

- A. Install site-fabricated trunk stabilization as follows, unless otherwise indicated on Contract Drawings.
 - 1. Drive stakes into undisturbed grade outside tree pit. Avoid penetrating root balls or root masses.
 - 2. Securely attach specified wire to stakes.
 - 3. Support trees with specified wire and tree tie webbing from the tree trunk to each stake. Allow enough slack to avoid rigid restraint of the tree.
 - 4. For guyed trees: Attach thirty-six inch (36") long by one-half inch (1/2") diameter PVC pipe flagging to each wire.

5. For staked trees: Attach twenty-four inch (24") long by one-half inch (1/2") diameter PVC pipe flagging to each wire.

3.11 MULCHING

- A. Trees: Create a forty-eight-inch (48") diameter formed soil berm around tree and fill with three-inch (3") deep specified wood mulch. Mulch shall be kept four to six-inches (4"-6") away from tree trunk.
- B. Shrubs:
 1. Mulch backfilled surfaces of pits, planting beds areas, and other areas indicated or as directed by the Project Manager.
 2. Mulch in shrub bed areas: Apply three-inch (3") thick layer of mulch and finish level with adjacent finish grades. Do not place mulch against stems of plants.

3.12 ANTIDESICCANT

- A. Apply antidesiccant using power spray to provide an adequate film over trunks, branches, stems, twigs, and foliage.
- B. When deciduous plants are moved in full-leaf, the Project Manager may direct the use of an antidesiccant at nursery before moving and again two (2) weeks after planting. Antidesiccant to be supplied and applied by Contractor at no additional cost to the City.

3.13 CLEANING

- A. Perform cleaning during installation of the work and upon completion of the Work, to the satisfaction of the Project Manager. Remove all excess materials, debris, and equipment from site. Repair any damage resulting from planting operations.
- B. Remove surplus soil, excess subsoil, unsuitable soil, and waste material including trash and debris generated during installation at no additional cost to the City.

3.14 PROTECTION

- A. Protect existing utilities, paving and other facilities from damage caused by planting operations. The Contractor shall repair any damage at no additional cost to the City.
- B. Restrict vehicular and pedestrian traffic from planted areas. Erect signs and barriers as required or directed by the Project Manager at no additional cost to the City.
- C. Erosion Control: Take measures and furnish equipment and labor necessary to control and prevent soil erosion, blowing soil and accumulation of wind-deposited materials on the site throughout the duration of work.

3.15 MAINTENACE

- A. The Contractor shall be responsible for maintaining all trees, shrubs, and groundcover until substantial completion is issued.
- B. Maintain trees by pruning, cultivating, watering, mulching, winter watering, weeding, wrapping, unwrapping, restoring planting saucers, and resetting to proper grades or vertical position, as required to establish healthy, viable plantings. Control as required to keep trees free of insects and disease. Restore or replace damaged tree wrappings, stakes, guying.
- C. During the irrigation season (generally May through September), water may be available from on-site quick couplers. When the system is not charged, it shall be the Contractor's responsibility to supply adequate amounts of water from a water truck or other approved source. Hoses and other watering equipment shall be supplied by Contractor.
 - 1. Watering Amount: Ten (10) gallons per caliper-inch.
- D. At time of Substantial Completion, verify that tree-watering devices are in good working order and leave them in place. Replace improperly functioning devices.
- E. If Landscape Maintenance is included in the contract then the Contractor shall continue maintenance of all trees, shrubs, and groundcovers after Substantial Completion as specified in Section 32 97 00.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

- A. Measurement will be made by the contract unit specified for Trees, Plants, and Groundcovers. Measurement shall include the actual number of units of specified material(s) placed and accepted at the locations shown on the Contract Drawings, or as directed by the Project Manager, and in accordance with the Specifications.

4.2 PAYMENT

- A. Payment will be made at the contract unit price, and shall include required materials, transportation, equipment, labor, earthwork, loading, transporting, stockpiling, disposing, hauling off, watering, dust control, erosion and sediment control, fine grading, maintenance of temporary protection by fencing or other means, watering and all maintenance required until Final Acceptance of the work as required in accordance with the Contract Drawings and Specifications.

END OF SECTION 32 93 00

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Contract Drawings and general provisions of the Contract, including General and Supplementary Conditions and the City and County of Denver Standard Specifications for Construction General Contract Conditions (2011)
- B. City and County of Denver Engineering Division, Wastewater Capital Project Management Standard Construction Specifications, dated March 15, 2016.
- C. Wastewater Capital Projects Management Special Project Provisions for Asbury & Tejon.
- D. Wastewater Capital Projects Management Supplemental Technical Specifications for Asbury & Tejon.
- E. Denver Parks and Recreation Asbury and Tejon Specifications, OCT 2018.

1.2 SUMMARY

- A. This Section includes requirements for furnishing all labor, equipment, and materials required to transplant trees from the site to new locations on the site, and restore tree excavation area as directed by the Project Manager.
- B. Related Work:
 - 1. WCPM Standard Construction Specification 2.0 Section "Site Preparation".
 - 2. WCPM Supplemental Technical Specification 31 23 00 "Earthwork".
 - 3. Division 01 56 39 Section "Tree Retention and Protection".
 - 4. Division 32 91 13 Section "Soil Preparation".
 - 5. Division 32 92 20 Section "Native Seeding".
 - 6. Division 32 92 23 Section "Sodding".
 - 7. Division 31 32 50 Section "Watering".
 - 8. Division 32 80 00 Section "Irrigation System".
 - 9. Division 32 84 33 Section "Automatic Irrigation Controllers"
 - 10. Division 32 91 20 Section "Topsoil".
 - 11. Division 32 93 00 Section "Trees, Plants, and Groundcovers".

1.3 DEFINITIONS

- A. Project Consulting Arborist: An independent consultant working on behalf of the City and County of Denver; with a degree in forestry, horticulture, or arboriculture, an American Society of Consulting Arborists (ASCA) registered consulting arborist, an International Society of Arboriculture (ISA) Certified Arborist, and / or a consultant

with at least five years (5) field experience in tree preservation or on-site monitoring of public works or construction projects involving tree retention and protection.

- B. Contractor's Consulting Arborist: A consultant working on behalf of the Contractor; with a degree in forestry, horticulture, or arboriculture, an American Society of Consulting Arborists (ASCA) registered consulting arborist, an International Society of Arboriculture (ISA) Certified Arborist, and / or a consultant with at least five years (5) field experience in tree preservation or on-site monitoring of public works or construction projects involving tree retention and protection.
- C. General: See definitions in ANSI A300 (Part 6) and in ANSI Z60.1 pertaining to field-grown trees, except as otherwise defined in this Section.
- D. Caliper: Diameter of a trunk as measured by a diameter tape at a height six-inches (6") above the root flare for trees up to, and including, four-inch (4") size at this height; and as measured at a height of twelve-inches (12") above the root flare for trees larger than four-inch (4") size.
- E. Caliper (DBH): Diameter breast height; diameter of a trunk as measured by a diameter tape at a height 54-inches (54") above the ground line for trees with caliper of eight-inches (8") or greater as measured at a height of twelve-inches (12") above the root flare.
- F. Root-Ball Depth: Measured from bottom of trunk flare to the bottom of root ball.
- G. Root-Ball Width: Measured horizontally across the root ball with an approximately circular form or the least dimension for non-round root balls, not necessarily centered on the tree trunk, but within tolerance according to ANSI Z60.1.
- H. Root Flare: Also called "trunk flare". The area at the base of the tree's stem or trunk where the stem or trunk broadens to form roots; the area of transition between the root system and the stem or trunk.

1.4 SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples for Verification: For each of the following:
 - 1. Weed-control barriers.
 - 2. Proprietary Root-Ball-Stabilization Device: One unit.
 - 3. Slow-Release Watering Device: One unit of each size required.
- C. Pruning Schedule: Written schedule prepared by the Contractor's Consulting arborist detailing scope and extent of pruning each tree in preparation for and subsequent to transplanting.
 - 1. Species and size of plant.

2. Location on site plan. Include unique identifier for each.
 3. Reason for pruning.
 4. Seasonal limitations on pruning.
 5. Preparatory Pruning: Time schedule and description of preparatory pruning to be performed.
 - a. Indicate time in months preceding the extraction of the tree.
 - b. Indicate diameter of root ball and depth of root pruning for each tree.
 6. Description of root and crown pruning during and subsequent to transplanting.
 7. Description of maintenance following pruning.
- D. Qualification Data: For qualified tree-service firm and the Contractor's Consulting arborist.
- E. Certification: From the Contractor's Consulting arborist, certifying that transplanted trees have been protected during construction and that trees were promptly and properly treated and repaired when damaged.
- F. Maintenance Recommendations: From the Contractor's Consulting arborist, recommended procedures to be established by Owner for care and protection of trees after completing the Work.
 1. Submit before completing the Work.
- G. Existing Conditions: Documentation of existing trees indicated to be transplanted, which establishes preconstruction conditions that might be misconstrued as damage caused by construction activities.
 1. Use sufficiently detailed color photographs or video recordings. Color shall accurately depict hue condition of foliage and bark.
 2. Include drawings and notations to indicate specific wounds and damage conditions of each tree designated to be transplanted.
- H. Tree-Transplanting Program: Submit before work begins.
- I. Sample Warranties: For special warranties. See below for requirements.
- J. Tree-maintenance reports. See below for requirements.

1.5 QUALITY CONTROL

- A. Preinstallation Conference: Conduct conference at project site.
1. Review methods and procedures related to transplanting work include, but are not limited to, the following:
 - a. Construction schedule. Verify availability of materials, personnel, equipment, and unimpeded access needed to make progress and avoid delays.

- b. Tree and plant protection.
 - c. Tree maintenance.
 - d. Contractor's Consulting Arborist's responsibilities.
 - B. Tree-Service Firm Qualifications: An experienced landscaping contractor or tree-moving firm that has successfully completed transplanting work similar to that required for this Project and that will assign an experienced, qualified arborist to Project site during execution of the Work.
 - C. Contractor's Consulting Arborist's qualifications.
 - D. Tree-Transplanting Program: Prepare a written plan by the Contractor's Consulting arborist for transplanting trees for the whole Project, including each phase or process, tree maintenance, and protection of surrounding materials during operations. Describe in detail the materials, methods, and equipment to be used for each phase of the transplanting work.
 - 1. Include transplanting times appropriate for each species at the Project location unless otherwise indicated on Contract Drawings or directed by Project Manager.
 - 2. Include a transplanting schedule for each species to be transplanted, coordinated with the Project schedule. Accommodate demolition and removals schedule to facilitate planting of transplanted tree in location of existing tree to be removed.
 - 3. Include site plans clearly marked to show tree-moving routes from extraction to planting locations. Indicate proposed equipment, weight, and turning radii.
 - 4. Show details of temporary protective barriers where needed.
 - 5. Include diagrams showing clearances to utility lines and other encumbrances along route.
 - 6. Include care and maintenance provisions, and eventual removal of tree stabilization.
 - E. Pruning work must be determined and completed by a licensed arborist according to standards established by the National Arborists Association: ANSI A300, part 1.
- 1.6 DELIVERY, STORAGE, AND HANDLING
- A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of conformance with state and federal laws if applicable.
 - B. Bulk Materials:
 - 1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or trees.

2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
 3. Accompany each delivery with appropriate certificates.
- C. Protect bark, branches, and root systems from sun scald, drying, wind burn, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees in such a manner as to destroy their natural shape.
 - D. Completely cover foliage when transporting trees while they are in foliage.
 - E. Handle trees by root ball. Do not drop trees.
 - F. Move trees after preparations for planting have been completed, and install immediately. If planting is delayed more than six hours after moving, set trees in their appropriate aspect (sun, filtered sun, or shade), protect from weather and mechanical damage, and keep roots moist.

1.7 SITE CONDITIONS

- A. Transplanting operations shall be conducted under favorable weather conditions and during the tree's dormant period (November 1 to March 31), unless otherwise approved by City Forestry and the Project Manager.
- B. Weather Limitations: Proceed with transplanting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Do not transplant during excessively wet or frozen conditions, or overly hot, dry and/or windy conditions. Apply products during favorable weather conditions according to manufacturer's written instructions and warranty requirements.
- C. At least seventy-two (72) hours prior to beginning transplanting work, the Contractor shall contact UNCC at 811 for location of respective underground utilities and Project Manager for location of irrigation system. No transplanting shall occur until all utilities have been located.

1.8 DAMAGE TO SITE CONDITIONS

- A. Damage to lawns, natural areas, pavements, irrigation systems, underground utilities and other improvements shall be repaired by the Contractor at no additional cost to the City.
 1. Coordination with Turf Areas (Lawns): Perform transplanting before planting turf areas unless otherwise indicated or otherwise approved by Project Manager.
 2. Coordination with Planting Beds: Perform transplanting before planting bedded areas unless otherwise indicated.

1.9 WARRANTY

- A. Installer's Special Warranty: Tree-service firm agrees to repair or replace trees and related materials that fail within the one (1) year warranty period.
1. Failures include, but are not limited to, the following:
 - a. Death and unsatisfactory growth except for defects resulting from abuse, lack of adequate maintenance, or neglect by City, or incidents that are beyond Contractor's control.
 - b. Death and unsatisfactory growth is defined as more than twenty-five percent (25%) dead or in an unhealthy condition or failure to meet general performance requirements at end of warranty period.
 - c. Structural failures including tree(s) falling or blowing over.
 - d. Faulty performance of materials and devices related to tree plantings including tree stabilization and watering equipment.
 2. Warranty Periods from Date of Final Acceptance:
 - a. Trees: 12 months.
 3. Include the following remedial actions as a minimum
 - a. Remove dead trees and trees with unsatisfactory growth at end of warranty period; replace when directed.
 - b. A limit of one replacement of each tree will be required except for losses or replacements due to failure to comply with requirements.
 - 1) The monetary value of a transplanted tree which needs to be replaced following transplanting, as determined by the Project Manager, due to damage and/or die-back will be determined using Guide for Plant Appraisals, by the Council of Tree and Landscape Appraisers (CLTA), latest edition. Contractor shall be responsible for the monetary reimbursement to the City for this amount.
 - c. Replace materials and devices related to tree plantings.
 - d. Provide extended warranty for period equal to original warranty period, for replaced trees.

1.10 MAINTENANCE SERVICE

- A. Initial Maintenance Service: Provide tree maintenance by skilled employees of tree-service firm and as required in Part 3. Begin maintenance immediately after preparatory pruning and continue until plantings are healthy and well established but for not less than maintenance period below.
1. See section 3.10 (A).

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General Performance: Transplanted trees shall be healthy and resume vigorous growth within two (2) years of transplanting without dieback due to defective extracting, handling, planting, maintenance, or other defects in the Work.

2.2 TREES TO BE TRANSPLANTED

- A. Trees to be transplanted shall be indicated on the Contract Drawings and as directed by Denver Forestry and the Project Manager.

2.3 WATER

- A. Water shall be supplied by Contractor at planting time and as necessary until irrigation system is operational. Water shall contain no substances harmful to plant life.

2.4 PLANTING MATERIALS

- A. Backfill Soil: Excavated soil mixed with planting soil conditioner of suitable moisture content and granular texture for placing and compacting in planting pit around tree, and free of stones, roots, plants, sod, clods, clay lumps, pockets of coarse sand, concrete slurry, concrete layers or chunks, cement, plaster, building debris, and other extraneous materials harmful to plant growth.
 1. Mixture: Well-blended mix of two parts excavated soil to one-part soil conditioner.
 2. Soil Conditioner: Well-composted material as specified in Section 329113 "Soil Preparation".

2.5 TREE-STABILIZATION MATERIALS

- A. Trunk-Stabilization Materials:
 1. Upright and Guy Stakes: Rough-sawn, sound, new softwood with specified wood preservative treatment by pressure process, free of knots, holes, cross grain, and other defects, 2-inch (2") diameter by length indicated, pointed at one end.
 2. Wood Deadmen: Timbers measuring eight inches (8") in diameter and forty-eight inches (48") long, treated with specified wood preservative treatment by pressure process.
 3. Guys and Tie Wires: ASTM A 641/A 641M, Class 1, #14 galvanized-steel wire, two-strand, twisted.
 4. Guy springs: Submit manufacturer's product information for approval.
 5. Tree-Tie Webbing: UV-resistant nylon webbing with brass grommets, size as indicated.
 6. Flags: One-half-inch (1/2") diameter PVC pipe, length as indicated.

2.6 MISCELLANEOUS PRODUCTS

- A. Organic mulch, free from deleterious materials and suitable as a top dressing of trees and shrubs, consisting of chipped bark and/or wood material not larger than four-inches (4") in length. Submit 1.0 cubic foot sample for approval. Mulch is to be weed-free.
- B. Antidesiccant: Water-insoluble emulsion, permeable moisture retarder, film forming, for trees. Deliver in original, sealed, and fully labeled containers and mix according to manufacturer's written instructions.
- C. Burlap: Non-synthetic, biodegradable.

PART 3 - EXECUTION

3.1 GENERAL

- A. Proposed locations for trees to be transplanted shall be staked and approved by Denver Forestry and the Project Manager prior to beginning planting operations. New locations shall be on site as shown on Contract Drawings, or as directed by Project Manager.
Prior to transplanting any trees, the Denver Forester shall determine if the tree is suitable for transplanting. Unsuitable trees shall be cleared and grubbed in accordance with **WCPM Supplemental Bid Item 3-5a: Clearing and Grubbing**

3.2 EXAMINATION

- A. Examine areas where the Work of this Section will be performed for compliance with requirements and conditions affecting installation and performance.
 - 1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within the work area.
 - 2. Verify that final grades are completed in accordance with the drawings.
- B. Erosion and Sedimentation Control: Examine the site to verify that temporary erosion- and sedimentation-control measures are in place. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross transplanting areas.
- C. For the record, prepare written report, endorsed by the Contractor's Consulting arborist, listing conditions detrimental to transplanting work and tree protection and health.

- D. Proceed with transplanting only after unsatisfactory conditions have been corrected and approval to proceed given by Project Manager.

3.3 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, other facilities, turf areas, and other plants and planting areas from damage caused by transplanting operations. Repair damage to site elements noted above that result from construction activities at no additional cost to City.
- B. Utility Locator Service: Notify utility locator service before beginning excavation. All utilities are to be marked and a hard-copy diagram of utility locations from the utilities locator service given to Project Manager prior to excavation.
- C. Locate and clearly identify trees for transplanting. Tie a one-inch (1") blue-vinyl tape around each tree at fifty-four (54")-inches above the ground.
- D. Lay out individual transplant locations and areas for multiple plantings. Stake locations, outline areas, adjust locations when requested, and obtain Project Manager's acceptance of layout before transplanting. Make minor adjustments as required.
- E. Dig pits immediately prior to moving plants to their respective locations for planting to ensure that they will not be unnecessarily exposed to drying elements or to physical damage.
 - 1. Circular pits with vertical sides hard-trimmed shall be excavated with tree spade to a depth such that tree, when planted, will sit two-inches (2") to four-inches (4") above surrounding grade.
 - 2. Sides of pit shall be scarified to not have a slick surface.
- F. It is not anticipated that planting shall be done where the depth of soil over rock or other underground obstructions is insufficient to accommodate the roots or where pockets in rock or impervious soil will require drainage. If such conditions are encountered in the excavation of planting areas, and if the stone, boulders or other underground obstructions cannot be broken and removed by hand methods in the course of digging plant pits of the usual size, other locations for the planting may be designated by Project Manager. Removal of rock or other underground obstructions and relocation of plant materials shall be done only as directed by the Project Manager. If changes in the location of the work or if the removal of rock or other obstructions, other than existing underground utilities, involves additional work, the Contractor shall notify Denver Forestry and Project Manager for approval of extra payment.
- G. Seepage: Notify Project Manager if subsoil conditions evidence unexpected water seepage into tree-planting pits.

- H. Drainage: Fill planting pit half full of water and time the infiltration rate of the soil. If the drainage rate is less than 1-inch per hour, notify Project Manager to determine need for subsurface drainage.
- I. The Contractor shall dispose of excess excavated planting pit material by filling and compacting the holes created by moving the trees.

3.4 SIZE OF TREE SPADE

- A. The size of the mechanical tree spade to be used for transplanting shall be 10-inches (10") (minimum) in size for every 1-inch of tree caliper. Minimum size spade shall be 48-inches (48").

3.5 EXTRACTING TREES

- A. General: Extract trees under supervision of the Contractor's Consulting arborist.
- B. Orientation Marking: Mark the north side of each tree with non-permanent paint before extracting.
- C. Root-Ball Width: Minimum ten-inches (10") of root-ball diameter, or least dimension for non-round root balls, for each-inch of tree caliper being transplanted.
 - 1. Out-of-Season Planting: If planting before or after the in-season period for tree, provide a minimum root-ball diameter of twelve-inches (12") for each-inch of tree caliper being transplanted.
- D. Root-Ball Depth: As determined by the Contractor's Consulting arborist for each species and size of tree and for site conditions at original and planting locations.
- E. Extracting with Tree Spade: Obtain Project Manager's approval to use tree spade for tree transplanting.
 - 1. Use the same tree spade to extract the tree as will be used to transport and plant the tree
 - 2. Do not use tree spade to move trees larger than the manufacturer's maximum size recommendation for the tree spade being used.
 - 3. When extracting the tree, center the trunk within the tree spade and move tree with a solid ball of earth.

3.6 SETTING TREES

- A. Planting Standard: Perform planting according to ANSI A300 (Part 6) unless otherwise indicated.
- B. Relocate trees to be transplanted to locations approved by Denver Forestry and the Project Manager.

- C. Before planting, verify that root flare is visible at top of root ball. If root flare is not visible, carefully remove soil in a level manner from the root ball to where the top-most root emerges from the trunk. After soil removal to expose the root flare, verify that root ball still meets size requirements.
- D. Ensure that root flare is visible after planting.
- E. Orientation: Position the tree so that its north side, marked before extracting, is facing north in its new location.
- F. Trees shall be planted in pits to such a depth that the root flare at the plant after settlement will be two-inches (2") above that at which the plant is currently growing. Trees shall be planted upright with trunks plumb and faced areas as described in the "Orientation" article above.
- G. A saucer shall be formed at the perimeter of the pit as indicated.
- H. Slopes: When planting on slopes, set the tree so the root flare on the uphill side is flush with the surrounding soil on the slope; the edge of the root ball on the downhill side will be above the surrounding soil. Apply enough soil to cover the downhill side of the root ball.
- I. Trees shall be thoroughly watered immediately after planting.

3.7 TREE STABILIZATION

- A. Trunk Stabilization by Staking and Guying: Install trunk stabilization as follows unless otherwise indicated on Contract Drawings or directed by Project Manager.
 - 1. Site-Fabricated Staking Method: Stake transplanted trees sized up to four-inch (4") caliper. Install number of stakes as indicated.
 - a. Retain options for compression springs in subparagraphs below to provide more line flexibility than turnbuckles.
 - b. Drive stakes into undisturbed grade outside tree pit as indicated. Avoid penetrating root balls or root masses.
 - c. Securely attach specified wire to stakes.
 - d. Support trees with specified wire and tree tie webbing at contact points with tree trunk, reaching to specified stake. Allow enough slack to avoid rigid restraint of tree.
 - e. Attach thirty-six (36") long x one-half-inch (1/2") diameter PVC pipe flagging to each wire.
 - 2. Site-Fabricated Guying Method: Buy transplanted trees four-inch (4") caliper and larger. Install no fewer than three (3) guys spaced equally around tree.

- a. For trees four-inches (4") to six-inches (6") caliper, securely attach guys to specified anchor thirty-inches (30") long, driven in to undisturbed soil outside tree pit as indicated. Avoid penetrating root balls or root masses.
- b. Install one (1) compression spring approved by Project Manager in each guy assembly.
- c. For trees larger than six-inches (6") in caliper, anchor guys to wood deadmen buried at least thirty-six (36")-inches below grade.
- d. Support trees with specified wire and tree tie webbing at contact points with tree trunk and reaching to specified anchor. Allow enough slack to avoid rigid restraint of tree.
- e. Attach thirty-six (36") long x one-half-inch (1/2") diameter PVC pipe flagging to each wire.

3.8 CROWN PRUNING

- A. Prune branches only as directed by the City Forester or City's Project Consulting Arborist.
 - 1. Prune to remove only injured, broken, dying, or dead branches. Do not prune for shape.
 - 2. Do not remove or reduce living branches to compensate for root loss caused by cutting root system or to improve natural tree form
 - 3. Pruning Standards: Perform pruning according to ANSI A300 (Part 1).
- B. Unless otherwise directed by Contractor's Consulting Arborist and acceptable to Denver Forestry, do not cut tree leaders.
- C. Cut branches with sharp pruning instruments; do not break or chop.
- D. Do not paint or apply sealants to wounds.
- E. Provide subsequent maintenance during Contract period as recommended by Contractor's Consulting Arborist, Denver Forestry or the Project Consulting Arborist.
- F. Remove pruned material from site and dispose of in legally acceptable manner.

3.9 MULCHING

- A. Organic Mulch: Apply three-inch (3") average thickness of organic mulch extending twelve-inches (12") beyond edge of individual planting pit, and finish level with adjacent finish grades. Do not place mulch within three-inches (3") of trunks or stems.

3.10 MAINTENANCE OF TRANSPLANTED TREES

- A. Tree plantings shall be protected and maintained by the Contractor until Final Acceptance, after which the City will assume responsibility for the maintenance.

- B. Maintenance shall include watering, weeding, cultivating, mulching, removal of dead branches, resetting plants to proper grade or upright position and restoration of tree planting saucers and other necessary operations.
- C. Apply treatments as required to keep tree materials, planted areas, and soils free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards. Treatments include physical controls such as hosing off foliage, mechanical controls such as traps, and biological control agents.
 - 1. Pesticide Application: Apply pesticides and other chemical products and biological control agents as directed and approved by the Contractor's Consulting Arborist and the Project Manager. Coordinate applications with City's operations and others in proximity to the Work. Notify Project Manager before each application is performed.
- D. Pruning work shall be completed according to standards established by the National Arborist's Association and ANSI A300.
- E. Reports: Have Contractor's Consulting arborist prepare quarterly inspection reports and submit to Project Manager.

3.11 REPAIR AND REPLACEMENT

- A. General: Repair or replace transplanted trees and other plants indicated to remain or be relocated that are damaged by construction operations, in a manner recommended by the Contractor's Consulting arborist and approved by Project Manager, and with 1.10.A.3 of this Section.
 - 1. Submit details of proposed pruning and repairs.
 - 2. Perform repairs of damaged trunks, branches, and roots within 24 hours according to Contractor's Consulting arborist's written instructions.
 - 3. Replace trees and other plants that cannot be repaired and restored to full-growth status, as determined by Project Manager, and per 1.10.A.3 of this Section

3.12 CLEANUP AND PROTECTION

- A. During transplanting, keep adjacent paving and construction clean and work area in an orderly condition.
- B. Protect trees from damage due to transplanting operations and operations of other contractors and trades. Maintain protection during transplanting and maintenance periods. Treat, repair, or replace damaged plantings.

- C. After planting and before Substantial Completion, remove tags, markings, tie tape, labels, wire, burlap, and other debris from transplanted trees, planting areas, and Project site.

3.13 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Except for materials indicated to be recycled, remove surplus soil, excess excavated material, waste materials, displaced plants, trash, and debris, and legally dispose of them in accordance with Executive Order 115.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

- A. Measurement will be made by the contract unit specified for Tree Transplanting. Measurement shall include the actual number of units of specified material(s) placed and accepted at the locations shown on the Contract Drawings, or as directed by the Project Manager, and in accordance with the Specifications.

4.2 PAYMENT

- A. Payment will be made at the contract unit price, and shall include required materials, transportation, equipment, labor, excavation, stockpiling, storing, maintaining, disposing, hauling off, watering, dust control, erosion and sediment control, fine grading, as required in accordance with the Contract Drawings and Specifications.

END OF SECTION 32 96 43

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Contract Drawings and general provisions of the Contract, including General and Supplementary Conditions and the City and County of Denver Standard Specifications for Construction General Contract Conditions (2011)
- B. City and County of Denver Engineering Division, Wastewater Capital Project Management Standard Construction Specifications, dated March 15, 2016.
- C. Wastewater Capital Projects Management Special Project Provisions for Asbury & Tejon.
- D. Wastewater Capital Projects Management Supplemental Technical Specifications for Asbury & Tejon.
- E. Denver Parks and Recreation Asbury and Tejon Specifications, OCT 2018.

1.2 SUMMARY

- A. This Section includes requirements for furnishing of all supervision, labor, materials, equipment and transportation required to maintain the landscape areas called for under this contract for the time-period specified. The work includes but is not limited to: weed control, re-seeding, re-sodding, mowing, weed control, watering of plant material and pruning, irrigation system repair and maintenance, fence installation and maintenance, maintenance of erosion control measures (BMP's) including storm water features and coordination with City staff.
- B. Related Sections:
 - 1. WCPM Supplemental Technical Specification 31 23 00 "Earthwork".
 - 2. WCPM Supplemental Technical Specification 31 23 19 "Water Control and Dewatering".
 - 3. WCPM Standard Construction Specification 23.0 Section "Storm Water Management".
 - 4. Division 31 32 50 Section "Watering".
 - 5. Division 32 80 00 Section "Irrigation Systems".
 - 6. Division 32 84 33 Section "Automatic Irrigation Controllers".
 - 7. Division 32 93 00 Section "Trees, Plants, and Groundcovers".
 - 8. Division 32 92 23 Section "Sodding"
 - 9. Division 32 92 20 Section "Native Seeding and Wetland Sod"

1.3 SUBMITTALS

- A. Maintenance Reports: Submit detailed maintenance quarterly reports and schedules for the Maintenance and Guarantee Period for review and approval by the Project Manager, the City Forester, and the City Naturalist.
- B. Material List: Submit a detailed list of materials, to be used for seeding, fertilization, pesticides, pesticides that are to be used for seeding, weed control, plant health and mulching.
- C. Equipment List: submit a detailed list of equipment and chemical controls to be used for weed control, seeding and mulching operations. Include brand and model number of all equipment to be used for soil preparation and seeding activities.
- D. Work Examples: submit list of three projects completed in the last two years of similar complexity to this project with name and location of project, the Project Manager's name and telephone number, name of project landscape architect and telephone number. Include certifications held by contractor and subcontractor employees who will oversee the work during the maintenance period.

1.4 CONTRACTUAL REQUIREMENTS

- A. Maintenance and Warranty Period: The maintenance and Warranty period shall commence from the date of Work startup of the Contract Work in accordance with these Specifications and continue for the period of two (2) years from Date of Substantial Completion.
- B. Limits of Work Area: All improvements and maintenance within the project work area are included unless otherwise indicated on the Contract Drawings or directed by the Project Manager. Areas outside defined areas, as illustrated on the Contract Drawings, will be maintained by the City.
- C. Performance of Work: The Contractor's work force and equipment shall be accepted by the Project Manager prior to the commencement of the maintenance period. The Contractor shall submit to the Project Manager an outline of the equipment and crew sizes to be utilized throughout the maintenance period. Maintenance work shall not be divided among several Contractors but shall be done by one entity. In the event that the Project Manager finds any items unacceptable, the Contractor shall make the revisions noted by the Project Manager at no additional cost to the City and County of Denver.
- D. Scheduling / Progress Reports:
 - 1. Scheduling: Prior to the beginning of the Maintenance and Warranty Period, the Contractor shall submit for approval by the Project Manager a detailed schedule identifying all activities which are to be performed. Examples of such

commitments include the regular intervals for weed control, fertilization, pesticide applications and mowings and other operations and the month and week which are scheduled for other major activities such as reseeding and mulching. It is not the Project Manager's intent to require the Contractor to meet each deadline on a specific day, but merely to identify the general time periods for such activities. The Contractor may modify the schedule due to weather conditions, providing that the Project Manager is notified in advance of any changes.

2. Notification: The Contractor shall be required to notify the Project Manager a minimum forty-eight (48) hours in advance of all major work so the Project Manager has the option of being present at the time of the work. Examples of such work are: clean cultivation, mowing, spraying, seeding, mulching or other activities relating to the repair of landscape items. In the event that proper notification is not given by the Contractor, the Project Manager shall have the right to require the Contractor to reschedule any such work until such time that the Project Manager is available. The above provision applies only to work which could be perceived as normal or regularly scheduled maintenance, emergency repairs do not apply.
 3. Progress Reports: The Contractor shall submit quarterly progress reports during the growing season and quarterly progress reports through the winter. The written progress reports shall be sent to the Project Manager outlining work completed, damage incurred, and problems encountered. Progress reports shall contain digital photo documentation of work.
 4. Site Meetings: The Contractor shall meet, on site, with the Project Manager and City staff on a quarterly basis to review the project status.
 5. After Hours Contact: The Contractor shall provide one (1) after hours contact and telephone number.
- E. Maintenance Coordination: The Contractor shall coordinate maintenance operations and activities with the Project Manager.
- F. Failure to Perform: In the event that, in the Project Manager's opinion, action has not been taken on the part of the Contractor to properly maintain the project, the Project Manager may take whatever action that is deemed necessary to affect such repairs and any costs incurred will be deducted from the Contract amount.
- G. Licenses, Taxes, and Insurance:
1. Licenses: The Contractor agrees to obtain and pay for all licenses required by the City, State, and Federal governments that are necessary for legally conducting business. The Contractor shall maintain all licenses and permits required for maintenance activities (e.g. pesticide application).
 2. Taxes: The Contractor shall pay all applicable taxes, including sales taxes on materials supplied.

3. Insurance: The Contractor shall maintain all insurance policies in accordance with the General Contract Conditions of the contract through the entire term of the Maintenance and Guarantee period.

H. Payment Schedule: Payments shall be made as indicated in Measurement and Payment section.

PART 2 - PRODUCTS

2.1 Pesticides:

- A. General: Pesticide, registered and approved by EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by Project Manager and authorities having jurisdiction.
- B. Pre-Emergent Herbicide (Selective and Non-Selective): As approved by the Project Manager.
- C. Post-Emergent Broadleaf Herbicide: As approved by the Project Manager.
- D. For cultivated landscape areas: As approved by the Project Manager.
- E. For Native Grass areas: "Milestone", as manufactured by Dow AgroSciences.

PART 3 - EXECUTION

3.1 IRRIGATED TURF CARE (Bluegrass Sod and Seed)

- A. Watering: All watering shall be done in such a way as to encourage establishment, deep root growth and drought tolerance.
- B. Fertilization: Turf areas shall be fertilized with accepted material (20-5-10) two (2) times per growing season at a rate of one pound (1 lb) of nitrogen per one-thousand square feet (1,000 sf), once between April 15 and June 1 and once again between August 1st and September 15th.
- C. IPM (Integrated Pest Management): Apply approved pesticides as needed to control establishment and growth of annual and perennial weeds. Spot applications shall be required in areas of excessive growth. The Contractor is responsible for ensuring turf establishment and that turf is not adversely affected by pesticide applications. No pesticides will be allowed until seedlings are at least three months old. After establishment, pesticide applications shall be done as required and directed by the Project Manager during the maintenance period.

- D. Insect and Disease Control: Insects and disease treatment shall be by application of necessary insecticides and fungicides as plant condition require.
- E. Topdressing.
1. Soil used as topdressing material is to be consistent with existing soil texture where it is to be applied. Organic materials used are to meet Denver Park's organic material specifications.
 2. Topdressing is to be used in non-athletic fields when soil tests or leveling needs determine the application.
 3. Filling Low Spots: Fill low spots with matching existing soil when filling noticeable depressions or holes. Compact per WCPM Supplemental Technical Specification 31 23 00 "Earthwork".
- F. Repair all bare areas or dead areas of grass greater than 1 square foot (1 sq. ft.). Repairs shall occur within five (5) calendar days of notice to repair the condition. Upon the Project Manager's written approval, the Contractor may repair turf at a later date mutually agreed upon.
1. Seeding: If the original installation was by seed, repairs to such areas are to be reseeded. Replacement products and installation shall comply with specifications for original seeding.
 2. Sodding: If the original installation was sodded, repairs to such areas are to be resodded. Replacement products and installation shall comply with specifications for original sodding.
- G. Mowing, Trimming and Edging:
1. The Contractor shall be responsible for mowing of all areas defined by the contract and Contract Drawings until acceptance.
 2. When turfgrasses reach three and one-half-inch (3-1/2") height, begin weekly mowing and trimming program to maintain turf at 3-inch (3") height. Do not remove more than thirty-three percent (33%) of grass leaf in single mowing. Do not mow when soil is wet. Remove clippings from adjacent paved areas. Mower blades are to be sharp to avoid tearing grass blades.
 3. Areas not accessible to riding mowers shall be string line trimmed each mowing if necessary to match the mowing height. Limit string line trimming as much as possible around trees and objects (i.e., posts, utility boxes), by using Roundup and/or pre-emergent pesticides six- to twelve-inch (6"-12") radius kept clear, and base of shrubs and trees require twenty-four (24)-inch minimum radius clear of turf (bare soil/mulch).
 4. Turf along concrete edges will be removed in cool season turf areas to the edge of the concrete curb or walkway using the appropriate edging equipment. The edge of the concrete surface should be visible after edging.

3.2 NATIVE SEEDING AREAS

- A. Refer to Native Seeding section 32 92 20 for satisfactory establishment criteria

- B. The maintenance period shall begin at Substantial Completion and continue for a period of three (3) years until Acceptance of native seed areas. Acceptance of native seeded areas will not be given until the City Naturalist and the Project Manager are satisfied with the germination and there is a full stand of grass, in a vigorous growing condition, with consistent and complete coverage in accordance with the Specifications. During this time, the contractor shall be responsible for watering, mowing, spraying, weeding, fertilizing and all related work as necessary to ensure that seeded areas are in a vigorous growing condition. Provide all supervision, labor, material and equipment to develop and maintain seeded areas. After Acceptance, maintenance shall become the responsibility of the City.
- C. Maintain and establish native seed areas by weeding, mowing, trimming, replanting, watering and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas and re-mulch to produce a full coverage stand of grass. Provide materials and installation the same as those used in the original installation.
1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and meadow damaged or lost in areas of subsidence.
 2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
 3. Apply treatments as required to keep meadow and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.
- D. Watering: All watering shall be done in such a way as to encourage establishment, deep root growth and drought tolerance.
1. Non-Irrigated Native: Watering in non-irrigated native areas shall consist of watering of all existing trees and shrubs as well as any new trees or shrubs that are to be watered for establishment. Refer to Division 31 Section "Watering" for requirements.
 2. Watering: Utilize irrigation system to water native seeded areas to obtain establishment of an acceptable grass stand, and to supplement natural moisture levels during dry periods.
 - a. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas. Obtain approval of Project Manager of irrigation system and schedule proposed for use.
 - b. Water native grasses with fine spray at a minimum rate of one-half inch (1/2") per week for six (6) weeks after planting unless rainfall precipitation is adequate.
 - c. Do not over-water in a manner which kills drought-tolerant components of the seed mix.

E. Mowing:

1. Year One: Mowing of native grasses in the first year after seeding should be avoided. If a mowing of native grasses is required obtain the approval from the City Naturalist and Project Manager prior to mowing. If mowing in the first year is allowed, then mow only in the early growing season or late in the fall to allow grass seeds to drop. Mowing shall be at a height of six inches (6") to eight inches (8").
2. Year Two: Mow native grasses in the early spring or late fall to allow desirable grass seeds to drop. Mowing shall be at a height of six inches (6") to eight inches (8"). Control undesirable plant species as necessary by mowing, hand-pulling, selective pesticide application, and/or prescribed burning.
3. Year Three: Mow native grasses in the early spring or late fall to allow desirable grass seeds to drop. Mowing shall be at a height of six inches (6") to eight inches (8"). Control undesirable plant species as necessary by mowing, hand-pulling, selective pesticide application, and/or prescribed burning.

F. Weed Control:

1. Weed Control Prior to Initial Installation per Division 32 Section "Soil Preparation".
2. Weed control shall be done for the duration of the Maintenance and Warranty Period and when weed density meets or exceeds twelve (12) plants per square yard. Weed control shall be completed by one of the following methods:
 - a. Clean Cultivation: Clean cultivate using a rod weeder or other approved equipment tilling the ground no more than 2-inches (2") deep. Contractor shall coordinate timing of clean cultivations with the vegetative conditions on the site. Exact timing of cultivations shall be adjusted to control weed germination on the site. It is the responsibility of the Contractor to clean cultivate as necessary to prevent excessive growth of vegetation. Undesirable species shall not be allowed to seed on the site. Bindweed shall not be clean cultivated but removed by pesticide spot applications.
 - b. Mowing: Mowing of undesirable species shall be done per the approval of the City Naturalist and the Project Manager as a weed control method. Undesirable species shall not be allowed to seed on the site. Avoid distribution of weed seeds by catching all clippings, bagging clippings and removing them from the site. Existing grass stands to remain shall not be mowed until late fall or early spring to encourage seed drop.
 - c. Hand Removal: Hand-removal shall include the removal of all above-ground and below-ground stems, roots and flower masses prior to the development of seed.
 - d. Chemical Control: If necessary, apply to perennial and annual weeds by a licensed applicator trained in plant identification at no additional cost to the City. Obtain the Project Manager's approval prior to applying pesticide. Apply per manufacturer's recommendations. Contractor is responsible for ensuring seed establishment and that seed is not adversely

affected by pesticide applications. The Contractor shall use pesticides for specific species as recommended by CSU Agricultural Extension Service or the City Naturalist.

- e. Spot Application Chemical Control: Apply pesticide by hand applicator directly to invasive annual and perennial weeds. Allow a minimum two (2) weeks between application and any seeding activities.

G. Reseeding:

1. Evaluate native grass areas every ninety (90) days during the Maintenance and Warranty Period as to success of germination and coverage. Use the following criteria:
 - a. Reseed all areas that meet the following conditions:
 - 1) Areas of bare or dead grass greater than twenty-four inches (24") by twenty-four inches (24") square.
 - 2) Areas of weed density greater than twelve (12) plants per square foot.
 - 3) Areas with general density of specified grasses less than twelve (12) plants per square foot.
2. Reseed unacceptable areas as defined above. Reseeding, soil preparation and mulching shall comply with Division 32 Sections "Turfgrass Seeding" and "Soil Preparation". Seed mixes may be revised (% of species) to better suit site conditions. If requested by the Project Manager or City Naturalist, mix shall be revised at no additional cost to the Contract. Where drill seeding is not feasible, hand broadcast seed and rake into the soil to achieve 1/4- to 1/2-inch coverage of soil. The seed application rate shall be doubled in all areas where it is mechanically broadcast and quadrupled in areas requiring hand broad casting. Hydroseeding is not allowed.
3. Timing of reseeding shall be as specified herein. Upon the Project Manager's written approval, the Contractor may reseed at a later date mutually agreed upon.

3.3 TREE, SHRUB, AND PLANT CARE

- A. Pruning: Refer to Division 32 93 00 Section "Trees, Plants, and Groundcovers" for maintenance requirements.
- B. Replacement of Plants: Remove and replace dead, diseased, dying or damaged plants (including material damaged by vehicles or vandalism) within fourteen (14) calendar days of notification by the Project Manager or the City Forester. Upon the Project Manager's written approval, the Contractor may replace rejected plants at a later date, mutually agreed upon, provided that the Contractor removes all rejected plants within fourteen (14) calendar days of the notice to replace such plants. If the rejected plants are not removed within fourteen (14) calendar days, the City may remove and replace these plants and any costs associated with the removal and replacement shall be

deducted from the Contract price. All areas damaged by replacement operations are to be fully restored to their original condition as specified. Plant material damaged by vehicles or vandalism shall be replaced by the Contractor at no cost to the City. Guarantee all plantings to be true to name and to meet all conditions of these specifications. Any plant which is not true to name as indicated by leaf, flower form or fruiting characteristics revealed within maintenance period shall be replaced by the Contractor at the Contractor's expense.

- C. Transplanted Material: Refer to Division 32 96 43 Section "Tree Transplanting".
- D. Non-Irrigated Plant Material (trees): all plant material that not served by an automatic underground irrigation system shall be watered by Contractor for the duration of the maintenance and guarantee period. Water all plant material at a rate of ten (10) gallons per inch of tree caliper (e.g. a two-inch (2") tree requires twenty (20) gallons) to maintain optimum growth. Watering frequency shall be adjusted based on rainfall, season and plant performance. Maintain a large enough water basin around plants so that enough water can be applied to establish moisture through the major root zone. When hand watering; use a water wand to break the water force. Winter watering is the responsibility of the Contractor throughout the maintenance period as many times as required to prevent the plant material from desiccation. Watering may be done by water truck, but must not promote or cause erosion or displacement of mulch or erosion control items.

3.4 IRRIGATION SYSTEM AND WATER MANAGEMENT

- A. Contractor shall check all irrigation systems for proper operation after each mowing, and any deficiencies or adjustments shall be repaired prior to the next watering cycle. Any damage to system caused by Contractor's operations shall be repaired without charge to City.
- B. Contractor is responsible for following all Denver Water restrictions and establishment rules for new landscapes per Denver Water, rules and regulations at: <http://www.denverwater.org>.
- C. Contractor shall be responsible for providing an Establishment Watering Schedule, Transition Watering Schedule and a Maintenance Watering Schedule to the Project Manager, the Operation Supervisor and the Toro Field Representative (when applicable).
 - 1. All irrigation schedules and zone controller charts shall ensure that there will be no ponding or runoff of water during any of the scheduled times.
 - 2. Prior to any plant material being installed all schedules shall be provided to the Project Manager and the Operations Supervisor.
 - 3. The water schedule templates are available from Denver Parks Water Conservation and the Project Manager.

4. Contractor shall make any modifications to the programming as requested by the Project Manager.
5. Initial Irrigation (Days 1-21):
Plants shall be adequately watered for the first twenty-one (21) days after installation or until seeds have germinated and emerged or sod has become firmly rooted.
 - a. Exact timing of irrigation cycles will depend on weather conditions, soil conditions, and speed of emergence of grass seed.
 - b. Short, frequent irrigation cycles shall be used.
 - c. Split cycles or the 'cycle and soak' feature must be employed to reduce erosion or run off in seeded areas.
 - d. Do not exceed three inches (3") of total water per week.
 - e. Coordinate with irrigation system schedule and programming with the Project Manager, and City staff. Project Manager may choose to involve other parties from the City or irrigation equipment manufacturer.
 - f. Do not over-water native seeded areas in a manner which adversely impacts germination and growth of any components of the seed mix.
 - g. Contractor shall submit a meter reading before and after establishment to verify water use.
6. Transition Irrigation (Days 21-60):
 - a. Less frequent, but longer watering cycles will provide moisture at depths that will encourage seedlings to continue to develop and sod to develop deeper roots.
 - b. Allow the surface soils to dry slightly between watering to encourage deeper rooting.
 - c. Watering shall be done utilizing historic evapotranspiration rates for the current watering month(s).
 - d. Do not over-water native seeded areas in a manner which adversely impacts germination and growth of any components of the seed mix.
7. Maintenance Irrigation (Days 61 – End of Maintenance Period):
 - a. Irrigate as needed to maintain an optimum stand of turf while minimizing water use.
 - b. Irrigation frequency shall be adjusted at a minimum, based on monthly historical evapotranspiration rates and plant (turf and tree) water requirements.
 - c. It is the responsibility of the Contractor to coordinate with Project Manager, Operations Staff, and local Toro Field Representative the programming of irrigation controllers, to properly irrigate plant materials and turfgrass.
 - d. Do not over-water native seeded areas in a manner which adversely impacts germination and growth of any components of the seed mix.
8. Once sod has been laid, begin watering to build up the sub-soil moisture. This will be the most critical time to apply water.

- a. Water up to one and one-half inches (1-1/2") of water per day for the first two (2)- to three (3)-days.
 - b. Probe the soil to determine if the moisture has penetrated down to a minimum of four inches (4").
 - c. During the next three (3) weeks the amount of water needed will be similar to that of the historical evapotranspiration rates for the season per day.
 - d. Each day may require more than one application depending on wind and temperature in order to keep the root zone and blades moist.

- D. All damage to irrigation system during the landscape and irrigation maintenance period shall be repaired by the Contractor with identical materials.

- E. Time of Irrigation: Watering shall be done during the approved City and Denver Water-allowed water window. Coordinate times with the Project Manager.

- F. Winterization of Irrigation System: Under the maintenance period, the Contractor shall be responsible for winterizing irrigation pumps, if applicable, and draining irrigation system for the full maintenance period.
 - 1. Remove water from system by use of compressed air.
 - 2. Remove water from drip lines by opening flushing plugs.
 - 3. Submit a meter reading after winterization of the system has occurred to Parks Water Conservation.
 - 4. Winterization shall occur no later than October 15th unless a variance has been granted from the Project Manager.

- G. Spring Start-Up: The Contractor shall be responsible for starting up the irrigation system in the spring (April 15).
 - 1. Fully activate the system including controller start-up, in order to demonstrate that it is in full working order.
 - a. Any repairs that are needed as a result of improper winterization shall be corrected by the Contractor at no additional cost to the City.
 - 2. Correct all deficiencies and make any adjustments to ensure proper system function.
 - 3. Submit a meter reading prior to spring start-up to the Project Manager.

- H. It shall be the responsibility of the Contractor to ensure the satisfactory operation of the entire irrigation system and workmanship within the project area. The entire system, including materials, shall be maintained to be complete and remain operable in every detail by the Contractor throughout the maintenance period, and the Contractor agrees to make any adjustments or repair any defects occurring within the maintenance period within 7 calendar days of notification by the Project Manager.
 - 1. Contractor shall replace any materials with manufacturer's defects at no additional cost to City.

2. Replacement of any equipment shall match that installed and designed on the irrigation plans unless a variance is granted from Project Manager.
 3. Problems resulting in leakage or water waste shall be repaired within 12 hours of notification.
 4. Contractor is responsible for emergency repairs and or shut downs.
 - a. If Contractor neglects to perform these duties within the specified time, the City may make such repairs at the Contractor's expense.
 - b. In the case of an emergency, where in the judgment of the City, delay would cause serious loss or damage, repairs or replacement may be made by verbal communication and without notice being sent to the Contractor, and the Contractor shall pay the cost thereof.
- I. Any settling of irrigation trenches/backfill material during the maintenance period shall be repaired by the Contractor's at no additional cost to the City.
 1. Contract documents shall govern irrigation replacement during maintenance period the same as new work.
 2. Replacements are to be made at no additional cost to the City.
 - J. Any vandalism to the irrigation system prior to contract completion shall be repaired and/or replaced at Contractor's expense.

3.5 INSPECTION AND ACCEPTANCE

- A. Formal Inspections: The project will be inspected during the Maintenance and Guarantee Period at the following points:
 1. Quarterly Inspections
 2. Contract Completion Inspection
- B. Quarterly Inspections: Shall occur quarterly from the date of Substantial Completion. The review will consist of a review of all maintenance contract responsibilities. The Contractor shall keep a quarterly report to be turned in at inspections to review work done to date, including any subcontracting, frequency of schedule, notifications made, materials list, equipment list etc.
- C. Contract Completion Inspection and Acceptance: The Contractor must give seven (7) days of notice to the Project Manager requesting a Contract Completion Inspection. During the inspection, the Project Manager shall prepare a list of any defects discovered during the inspection ("Punch List") and submit the punch list to the Contractor. If, in the opinion of the Project Manager, all work has been completed or performed per the contract documents, the Project Manager will provide the Contractor with written notice of Contract Completion and Acceptance.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

- A. Measurement will be based on the percentage complete for the lump sum contract amount for Landscape Maintenance, from the first approved planting, seeding or sodding through and until final acceptance.

4.2 PAYMENT

- A. Payment will be made at the lump sum contract price, and shall include required materials, transportation, equipment, labor, excavation, stockpiling, disposing, hauling off, watering, dust control, erosion and sediment control, installation of pipes, wires, heads, valves, boxes, soil amendments and fertilizers, weed control, plant materials, disking, raking, spreading, fine grading, mowing, furnishing and installation of seeds, mulch installation and maintenance of temporary protection by fencing or other means, unless specified elsewhere within the Contract Drawings and Specifications. All cost for this work shall be included within this bid item and no additional payment will be made. At the option of the Construction Project Manager, payment may be made in percentage installments based upon type, location and scope of work in relation to the milestone schedule included in SC6. The total payment for this bid item shall not exceed seventy-five percent (75%) of the lump sum price during construction. The remaining twenty-five percent (25%) shall be paid after final site cleanup, completion of all punch list items and demobilization from site

END OF SECTION 32 97 00

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Contract Drawings and general provisions of the Contract, including General and Supplementary Conditions and the City and County of Denver Standard Specifications for Construction General Contract Conditions (2011)
- B. City and County of Denver Engineering Division, Wastewater Capital Project Management Standard Construction Specifications, dated March 15, 2016.
- C. Wastewater Capital Projects Management Special Project Provisions for Asbury & Tejon.
- D. Wastewater Capital Projects Management Supplemental Technical Specifications for Asbury & Tejon.
- E. Denver Parks and Recreation Asbury and Tejon Specifications, OCT 2018.

1.2 SUMMARY

- A. This Section includes requirements for furnishing and installation of sub-drainage systems as shown on the Contract Drawings, as specified herein, or as required to complete the work.
- B. Related Work:
 - 1. WCPM Standard Construction Specification 2.0 "Site Preparation".
 - 2. WCPM Standard Construction Specification 4.0 "Utility Trenching and Excavation".
 - 3. WCPM Standard Construction Specification 5.0 "Bedding and Backfilling".
 - 4. WCPM Standard Construction Specification 6.0 "Surface Restoration".
 - 5. WCPM Standard Construction Specification 10.0 "Storm / Sanitary Sewer Pipe and Culverts".
 - 6. WCPM Standard Construction Specification 47.0 "Construction Survey and Monumentation"
 - 7. WCPM Supplemental Technical Specification 31-23-00 Section "Earthwork".
 - 8. DPR Division 01 56 39 Section "Tree Retention and Protection".
 - 9. DPR Division 32 13 13 Section "Concrete Walks, Curbs, and Miscellaneous Flatwork".
 - 10. Division 32 18 16 Section "Playground Protective Surfacing".
 - 11. Division 32 33 50 Section "Playground Equipment".

1.3 SUBMITTALS

- A. See General Contract Conditions Title 3, section 309 "Contractor Submittals and other Written Communications to the City" and Title 4, section 405 "Shop Drawings, Product Data, and Samples"
- B. Prior to construction, the contractor shall create a submittal log for review by the Construction Project Manager. The Construction Project Manager shall review and make recommendations for additional submittal items.
- C. The contractor shall allow a minimum cycle of ten (10) working days for review of each submittal by the City.
- D. All submittals shall be delivered to the Construction Project Manager.
- E. Design of the Subdrainage system based upon record drawings of the Playground Equipment area.
- F. Product Data: For each type of product for approval prior to construction.
 - 1. Piping: Submit twelve inch (12") length of each type of underdrain piping to be used.
 - 2. Geotextile Fabric: Submit twelve inch (12") by twelve inch (12") sample.
 - 3. Bedding material: Submit one (1) quart sample.
 - 4. Filter material: Submit one (1) quart sample.

1.4 CONTRACT RECORD DRAWINGS

- A. Preparation of Contract Record Drawings: Provide record drawings of the Playground Equipment area, including elevations and provide dimensions from two range points or permanent points of reference (building corners, sidewalk, road intersections or permanent structures).
- B. Prior to the installation of the subdrainage system, the Contractor will provide on-site copies of original subdrainage design Drawings for incorporation into the "Contract Record Drawings (see 1.4 A.)". Contractor to revise Contract Record Drawings in red ink as Work progresses of the subdrainage system to show any changes to the plan and include all field dimensions. Contract Record Drawings shall be brought up-to-date prior to any Pay Application Submittals that contain subdrainage installation. Should the Contractor choose to utilize GPS for the purposes of documenting Work in progress, a hard copy print will need to be provided prior to Pay Application Submittal. A print of Contract Record Drawings shall be available at the Project Site for review by Project Manager at any time during the project.
- C. Contract Record Drawings shall encompass entire scope of work.

- D. Preparation of Contract Record Drawings: Provide dimensions from two permanent range points the location and elevation of the following items:
 - 1. Clean-outs
 - 2. Change of Direction
 - 3. Inlets/Outlets
 - 4. Catch Basins

- D. Make dimensions accurately at the same scale used in the original Contract Drawings, or larger. Notes and dimension lettering must be legible.

- E. Final Submittal: Upon completion of Project, prior to final acceptance, secure digital copy of grading design from Project Manager and record installation information that reflects all changes made over the course of the construction project, prepared by a qualified draftsman. Contract Record Drawings shall include details of any revisions as per actual installation. Deliver and submit to the Project Manager for review the following items:
 - 1. Digital Contract Record Drawings in both PDF and AutoCAD release 2010 or newer bound format (include any related X-ref files, plot files and pen settings.) Make any additional changes to the file as directed by the Project Manager prior to final submittal and approval.

- F. Request for final payment will not be certified or processed until all Contract Record Drawing prints and digital files have been received and approved.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Materials: Deliver materials in original containers. Protect materials from damage during delivery and while stored at site. The Project Manager reserves the right to inspect containers before or after installation to verify compliance with Specifications.

- B. Bulk Materials:
 - 1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
 - 2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
 - 3. Accompany each delivery of bulk materials with appropriate certificates.
 - 4. Protect piping and geotextile fabric from damage or contamination with soil or other construction materials from time of delivery to installation.

1.6 PROJECT/SITE CONDITIONS

- A. Field Measurements: Verify actual grade elevations, service and utility locations, irrigation system components, and dimensions of plantings and related construction contiguous with proposed subdrainage installations by field measurements before proceeding with work.

1.7 WARRANTY

- A. Provide a one year warranty for material and installation from date of acceptance.
- B. Expenses due to vandalism before Final Acceptance shall be the Contractor's responsibility.
- C. Any settling of backfilled trenches that occurs during warranty period shall be repaired at no expense to the City, including complete restoration of damaged property.
- D. Once Final Acceptance is granted, the City will maintain turf and planting areas during warranty period. The Contractor is responsible to monitor and coordinate Automatic Irrigation Controller scheduling and maintenance with the Project Manager for any seeding, sodding or planting areas under the Contractor's one year warranty.
- E. Project Manager reserves the right for Parks Operations Staff to make temporary repairs during the warranty period as necessary to keep systems in operating condition without voiding the Contractor's warranty, nor relieving the Contractor of their responsibilities.
- F. During the one year warranty, the Contractor shall make repairs and replacements within three days of notification. If the Contractor fails to make repairs within three days, the City will make repairs and contact the bonding company.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. PVC under drain: ASTM D2729, minimum 4-inch diameter, plain or perforated type as indicated on the Contract Drawings, with required fittings. Perforated pipe shall comply with requirements of ASTM 272a, with 2 rows of evenly spaced three eighths inch (3/8") diameter perforations, one hundred twenty (120)-degrees apart, providing a minimum number of holes of four (4) per foot.
- B. Vertical Drain System: "Multi-flow Drainage Systems" or approved equal.
- C. Geotextile Fabric: Non-woven fabric "140N" by Tencate-Mirafi or acceptable substitution.

- D. Bedding Material: Solid pipe bedding material to be three quarters inch (3/4") crushed stone. Perforated pipe, refer to manufacturers specifications or drawings for required bedding material.
- E. Concrete: Per Specification section DPR Division 32 13 13 Section " Concrete Walks, Curbs, and Miscellaneous Flatwork ".

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Examine areas where the Work of this Section will be performed for compliance with requirements and conditions affecting installation and performance.
 - 1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within the work area.
 - 2. Verify that final grades are completed in accordance with the drawings.
- B. Proceed with installation only after unsatisfactory conditions have been corrected and approved by Project Manager.
- C. PVC under drain: Install pipe under drains as shown on the Contractor's subdrainage design Drawings. Pitch shall be a minimum of one half of one percent (0.5%) or as shown on Contract Drawings. Contractor is responsible to immediately notify the Project Manager of any discrepancies.
- D. Vertical Drain System: Install "Multi-flow Drainage System" or approved equal as shown on the Contract Drawings. The amount of trench excavated at any time shall not exceed the amount of drain that can be set and backfilled completely in one (1) working day. The trench shall be four inches (4") wide and at the depth specified by the manufacturer. The collection system shall be centered in the trench and backfilled with bedding material. Collection system fittings shall be installed per manufacturer's recommendations.
- E. Solid Pipe: Refer to the City and County of Denver Wastewater Management Standard Detail Drawings document available at the following website:

<https://www.denvergov.org/content/denvergov/en/right-of-way-services/engineering-regulatory-analytics/engineering-plan-review/manuals-regulations.html>
- F. Geotextile fabric used for the pipe under drains system shall be placed in the trench once pipe trench is prepared to receive pipe. The fabric shall be placed in full contact

with the trench bottom and sides. The fabric shall be secured to the trench sides or top edge in a manner which does not damage the integrity of the fabric. The fabric shall be protected from damage during the placement of the pipe and granular fill. Install granular fill and pipe in trench to dimensions specified on Contract Drawings. Contractor is responsible to ensure that no debris, sediment or foreign material enters the granular fill that inhibit drainage. Any installation that does not meet these standards shall be replaced at the direction of the Project Manager at no additional cost to the City. Fabric edges shall overlap at least 6-inches for the full width of the trench.

3.2 CLEANING

- A. Clean and flush out lines before covering. Remove and legally dispose of all waste material and debris in accordance with Executive Order 115.
- B. Restore all fences, ditches, yards, lawns, and other structures or surfaces to condition equal to or better than before work began.

3.3 PROTECTION

- A. Restrict access to subdrainage installation. Erect temporary fencing or barricades and install warning signs as required or directed by the Project Manager at no additional cost to the City.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

- A. Measurement will be based on the percentage complete for the lump sum contract amount for Subdrainage Systems.

4.2 PAYMENT

- A. Payment will be made at the lump sum contract price, and shall include required materials, transportation, equipment, labor, excavation, stockpiling, disposing, hauling off, associated fittings, joints, joint materials, trenching, bedding materials, connections to other pipes or structures, compaction watering, dust control, erosion and sediment control, and fine grading, as required in accordance with the Contract Drawings and Specifications.
- B. All cost for this work shall be included within this bid item and no additional payment will be made. At the option of the Construction Project Manager, payment may be made in percentage installments based upon type, location and scope of work in relation to the period of performance. The total payment for this bid item shall not exceed seventy-five percent (75%) of the lump sum price during construction. The remaining twenty-

five percent (25%) shall be paid after final site cleanup, completion of all punch list items and demobilization from site.

END OF SECTION 33 46 00



DENVER

PUBLIC WORKS

Wastewater Capital Projects Management

Geotechnical Report

For Asbury and Tejon Park

October 2018



Kumar & Associates, Inc.
Geotechnical and Materials Engineers
and Environmental Scientists

2390 South Lipan Street
Denver, CO 80223
phone: (303) 742-9700
fax: (303) 742-9666
email: kadenver@kumarusa.com
www.kumarusa.com



Office Locations: Denver (HQ), Colorado Springs, Fort Collins, and Frisco, Colorado

GEOTECHNICAL ENGINEERING STUDY
PROPOSED ASBURY & TEJON PARK IMPROVEMENTS
WEST ASBURY AVENUE
DENVER, COLORADO

Prepared By:

Bruce E. Berends, P.E.

Reviewed By:

Wade Gilbert, P.E.



Prepared For:

Great Ecology
1435 Larimer Street, Suite 200
Denver, Colorado 80202

Attention: Mr. Chris Loftus, RLA

Project No. 17-1-141

March 24, 2017

TABLE OF CONTENTS

SUMMARY.....	1
PURPOSE AND SCOPE OF WORK.....	2
PROPOSED CONSTRUCTION.....	2
SITE CONDITIONS	2
SUBSURFACE CONDITIONS.....	3
INFILTRATION RATES	4
GEOTECHNICAL ENGINEERING CONSIDERATIONS.....	5
FOUNDATION RECOMMENDATIONS.....	6
EARTH RETAINING STRUCTURES.....	7
WATER SOLUBLE SULFATES.....	8
TEMPORARY EXCAVATIONS.....	9
DESIGN AND CONSTRUCTION SUPPORT SERVICES.....	9
LIMITATIONS	10

FIG. 1 – LOCATION OF EXPLORATORY BORINGS AND PERCOLATION TESTING

FIG. 2 – LOGS OF EXPLORATORY BORINGS

FIG. 3 – LEGEND AND NOTES

FIGS. 4 and 5 – SWELL-CONSOLIDATION TEST RESULTS

TABLE I – SUMMARY OF LABORATORY TEST RESULTS

SUMMARY

1. Sandy lean clay to clayey sand fill was encountered below the surficial topsoil in Borings 1, 2, 4 and 7 to depths ranging from about 1.5 to 5 feet. Native sandy lean clay to clayey sand was encountered below the fill at depths ranging from about 4 to 5 feet in Borings 1, 4 and 7, and below the topsoil at a depth of about 0.5 foot. The native lean sandy clay and clayey sand, where encountered, extended to depths ranging from about 7 to 13 feet. Claystone bedrock was encountered below the fill, native soils and/or topsoil at depths ranging from about 0.5 to 13 feet, and extended to the maximum 15-foot depth of the borings. Approximately the upper 2.5 to 4 feet of the claystone in Borings 2 and 3 was weathered. Sampler penetration blow counts suggest the native clayey soils and weathered claystone are generally stiff, the unweathered claystone is medium hard to very hard. The native clayey soils in Boring 7 contained a zone of soft material. The exact lateral and vertical extent, and degree of compaction of the fill material across the site were not determined as part of this study.

The results of swell-consolidation tests performed on relatively undisturbed samples of the clayey fill and native soils, and claystone are presented on Figs. 3 and 4. The tested samples of the clayey sand fill and native clayey sand had a negligible swell-potential and the weathered claystone had a moderate swell potential when wetted under a 1 ksf surcharge.

2. Groundwater was encountered at a depth of about 14 feet in Boring 1 at the time of drilling; groundwater was not observed at the time of drilling in Borings 2 through 8 . Upon completion of drilling, Borings 2, 3, 5, 6 and 7 were left open to allow follow-up groundwater level measurements, and the remaining borings were backfilled. When the follow-up measurements were made two days after drilling, the groundwater level was measured at depths ranging from about 3.5 to 9 feet.
3. Based on the subsurface conditions encountered in the exploratory borings drilled near the structures, it appears the materials at foundation bearing level will likely consist of clayey fill or native clayey soils at the north and south outfall structures, the south outlet structures and the playground, and claystone at the north outlet structure. The native clayey soils are expected to generally be suitable for support of shallow foundations; however, the soft clayey sand encountered in Boring 7 would not be suitable for support of shallow foundations without some form of subgrade improvement. We recommend the existing fill be assumed to be nonengineered and unsuitable for support of shallow foundations. Shallow foundations founded on claystone with a moderate swell potential may be subject to distress caused by uplift if the claystone becomes wetted and expands. Drilled piers bearing in the bedrock are generally the preferred foundation system where expansive claystone is present at or near the foundation bearing level of shallow foundations; however, drilled piers will be relatively costly for the minor drainage structures. If the drainage structures and playground equipment can experience some movement without serious distress and the risk of some distress is acceptable to the owner, we believe shallow foundations bearing on a layer of new structural fill, with limited overexcavation of the fill and claystone, may be used.

PURPOSE AND SCOPE OF WORK

This report presents the results of a geotechnical engineering study performed for the proposed improvements to the Asbury & Tejon Park located north and south of West Asbury Avenue, between South Tejon and South Vallejo Streets, in Denver, Colorado. The study was conducted for the purpose of obtaining subsurface data and developing geotechnical engineering recommendations for the design and construction of the proposed improvements. The study was conducted in general accordance with the scope of work described in our Proposal No. P-16-483 dated November 29, 2016.

A field exploration program consisting of drilling eight exploratory borings was conducted to obtain information on the subsurface conditions. Samples of the soils and bedrock obtained during the field exploration were tested in the laboratory to determine their classification and engineering characteristics. The results of the field exploration and laboratory testing programs were analyzed to develop geotechnical engineering recommendations for design and construction of structure foundations. The results of the field exploration and laboratory testing programs, and recommended design parameters and geotechnical engineering considerations related to construction of the proposed park improvements are included in this report.

PROPOSED CONSTRUCTION

We understand the improvements will include constructing playground structures in a new playground area, and new storm drain outfall and outlet structures. In addition, the area north of Asbury Avenue will be regraded to create a constructed wetland, the existing trickle channel south of Asbury will be realigned to the east, and the culvert below Asbury Street will be realigned. We anticipate the height of headwalls and wingwalls for the new outfall and outlet structures will not exceed about 3 to 4 feet.

If the proposed construction varies significantly from that described above or depicted in this report, we should be notified to reevaluate the recommendations provided herein.

SITE CONDITIONS

Asbury & Tejon Park is bisected by W. Asbury Avenue, which crosses the approximate center of the park. North of Asbury Avenue, the park is bordered by single-family residential properties. The portion of the park south of Asbury Avenue is bordered by Tejon Street to the east, commercial properties to the south and multi-family housing structures to the west. At the time of our site field activities, the park site was occupied by a playground and associated equipment south of Asbury

Avenue, an asphalt-paved basketball court immediately north of Asbury Avenue, and concrete sidewalks. A small concrete-lined drainage channel crosses the park site from north to south, with stormwater discharging from a storm drain pipe at the upper end of the channel near the north end of the park and flowing into a storm water outlet near the south end of the site. An approximately 140-foot-long section of storm drain pipe carries the channel flows under Asbury Avenue. The park generally slopes down toward the drainage channel at grades in the range of about 3% to 30%. There is approximately 20 feet of relief over the area of the park.

SUBSURFACE CONDITIONS

Information on the subsurface conditions at the site was obtained by drilling eight exploratory borings at the approximate locations shown on Fig. 1. The borings were advanced through the overburden soils and into the underlying bedrock with 4-inch diameter continuous flight, and were logged by a representative of Kumar & Associates, Inc. Samples of the soils and bedrock materials were taken with either a 2-inch I.D. California liner sampler. The sampler was driven into the various strata with blows from a 140-pound hammer falling 30 inches in general conformance with the standard penetration test procedure described by ASTM Method D1586. The interpreted penetration resistance values provide an indication of the relative density or consistency of the soils. Depths at which the samples were taken and the penetration resistance values are shown on the logs of the exploratory borings presented on Fig. 2. The legend and notes for the boring logs are presented on Fig. 3.

Samples obtained from the exploratory borings were visually classified in the laboratory by the project engineer and samples were selected for laboratory testing. Laboratory testing included index property tests, such as moisture content (ASTM D2216), dry unit weight, grain size analysis (ASTM D422) and liquid and plastic limits (ASTM D4318). Swell-consolidation tests (ASTM D4546, Method B) were conducted on undisturbed samples of the soil to determine the compressibility or swell characteristics under loading and when submerged in water. The percentage of water soluble sulfates was determined in general accordance with CDOT CP-L2103 for selected samples. The results of the laboratory tests are presented to the right of the logs on Fig. 2 and on Figs. 4 and 5, and are summarized in Table I.

Sandy lean clay to clayey sand fill was encountered below the surficial topsoil in Borings 1, 2, 4 and 7 to depths ranging from about 1.5 to 5 feet. Native sandy lean clay to clayey sand was encountered below the fill at depths ranging from about 4 to 5 feet in Borings 1, 4 and 7, and

below the topsoil at a depth of about 0.5 foot. The native lean sandy clay and clayey sand, where encountered, extended to depths ranging from about 7 to 13 feet. Claystone bedrock was encountered below the fill, native soils and/or topsoil at depths ranging from about 0.5 to 13 feet, and extended to the maximum 15-foot depth of the borings. Approximately the upper 2.5 to 4 feet of the claystone in Borings 2 and 3 was weathered. Sampler penetration blow counts suggest the native clayey soils and weathered claystone are generally stiff, the unweathered claystone is medium hard to very hard. The native clayey soils in Boring 7 contained a zone of soft material. The exact lateral and vertical extent, and degree of compaction of the fill material across the site were not determined as part of this study.

The results of swell-consolidation tests performed on relatively undisturbed samples of the clayey fill and native soils, and claystone are presented on Figs. 3 and 4. The tested samples of the clayey sand fill and native clayey sand had a negligible swell-potential and the weathered claystone had a moderate swell potential when wetted under a 1 ksf surcharge.

Groundwater was encountered at a depth of about 14 feet in Boring 1 at the time of drilling; groundwater was not observed at the time of drilling in Borings 2 through 8 . Upon completion of drilling, Borings 2, 3, 5, 6 and 7 were left open to allow follow-up groundwater level measurements, and the remaining borings were backfilled. When the follow-up measurements were made two days after drilling, the groundwater level was measured at depths ranging from about 3.5 to 9 feet.

A Kumar & Associates certified asbestos building inspector (CABI) observed the drilling of the geotechnical soil borings at the project site. In accordance with Colorado Department of Public Health and Environment (CDPHE) 6 CCR 1007-2, Regulations Pertaining to Solid Waste Sites and Facilities, a CABI is required to conduct a regulated asbestos-contaminated soil (RACS) determination during soil-disturbing activities that could potentially encounter asbestos-containing material (ACM) debris. Fill material was observed in four of the eight borings; however, no suspect ACM was observed in the soil cuttings generated during drilling activities.

INFILTRATION RATES

The soils encountered in the percolation test holes generally consisted of claystone and sandy lean clay fill. These soils are estimated to classify as Hydrologic Soil Group D as defined in "Urban Hydrology for Small Watersheds," TR-55 (Natural Resource Conservation Service, 1986).

The percolation rates measured at the test locations ranged from about 0.06 to 0.10 inches per hour. The corresponding infiltration rates calculated using the Michigan LID Manual procedures range from about 0.01 to 0.06 inches per hour. The following table summarizes the test results by location.

Test Location	Depth of Percolation Test Hole (in.)	Calculated Infiltration Rate (in/hr)
Boring 2	48	0.01
Boring 3	24	0.02
Boring 5	12	0.03
Boring 6	54	0.06
Boring 7	36	0.02

“Urban Hydrology for Small Watersheds” cites typical infiltration rates in the range of 0.02 to 0.10 inches per hour for Group D soils.

GEOTECHNICAL ENGINEERING CONSIDERATIONS

Based on the subsurface conditions encountered in the exploratory borings drilled near the structures, it appears the materials at foundation bearing level will likely consist of clayey fill or native clayey soils at the north and south outfall structures, the south outlet structures and the playground, and claystone at the north outlet structure. The native clayey soils are expected to generally be suitable for support of shallow foundations; however, the soft clayey sand encountered in Boring 7 would not be suitable for support of shallow foundations without some form of subgrade improvement. We recommend the existing fill be assumed to be nonengineered and unsuitable for support of shallow foundations. Shallow foundations founded on claystone with a moderate swell potential may be subject to distress caused by uplift if the claystone becomes wetted and expands. Drilled piers bearing in the bedrock are generally the preferred foundation system where expansive claystone is present at or near the foundation bearing level of shallow foundations; however, drilled piers will be relatively costly for the minor drainage structures. If the drainage structures and playground equipment can experience some movement without serious distress and the risk of some distress is acceptable to the owner, we believe shallow foundations bearing on a layer of new structural fill, with limited overexcavation of the fill and claystone, may be used.

FOUNDATION RECOMMENDATIONS

We recommend headwalls and wingwalls for the drainage outfall and outlet structures, and the playground equipment be supported on shallow spread-footing or mat foundations bearing on undisturbed stiff native soils or new structural fill extending down to native soils or bedrock. The design and construction criteria presented below should be observed for shallow foundations. The construction details should be considered when preparing project documents.

1. We recommend headwalls and wingwalls for the drainage outfall and outlet structures, and the playground equipment be supported on spread-footing or mat foundations bearing on undisturbed stiff native soils or new structural fill extending down to native soils or bedrock.
2. Footings placed on undisturbed natural soils or new structural fill prepared in accordance with the recommendations in this report should be designed for an allowable soil bearing pressure of 2,000 psf.
3. Where partial overexcavation of the existing fill is planned, we recommend the foundations be supported on a minimum 2-foot depth of structural fill. If claystone bedrock is encountered in foundation excavations, it should be overexcavated and replaced with structural fill. Based on the moderate swell potential of the claystone bedrock measured during this study, we recommend the claystone be overexcavated to a minimum depth of 2 feet.
4. Where weak soils similar to those encountered in Boring 7 are encountered in foundation excavations, we recommend the weak soils be overexcavated to a minimum 2 feet below foundation bearing level and replaced with Grading 67 aggregate placed on a layer of punched and drawn Type 2 biaxial geogrid, such as Tensar BX1200.
5. Spread footings should have a minimum width of 16 inches for continuous footings and 24 inches for isolated pads.
6. Foundations should be provided with adequate soil cover above their bearing elevation for frost protection. Placement of foundations at least 36 inches below the exterior grade is typically used in this area. If movement of the drainage structure foundations caused by frost

heave is not of concern, the foundations of these structures may be constructed with less than 36 inches of soil cover.

7. Continuous foundation walls should be reinforced top and bottom to span an unsupported length of at least 10 feet.
8. Structural fill placed for support of spread footings should consist of the on-site clayey fill or native clayey soils, or imported soils having a maximum of 50% passing the No. 200 sieve, and a maximum liquid limit of 35 and maximum plasticity index of 20. The on-site claystone bedrock is not suitable for use as structural fill.
9. Structural fill placed for support of foundations should be placed at a moisture content in the range of optimum to 3 percentage points above optimum for backfill consisting on-site or imported clayey soils, and within 2 percentage points of optimum for predominantly granular soils. The structural fill should be compacted to at least 95% of the standard Proctor (ASTM D698) maximum dry density. Structural fill should extend down from the edges of the footings at a 1 horizontal to 1 vertical projection.
10. The conditions encountered in the exploratory borings indicate excavations for foundations of the south outlet structure foundations may extend 1 to 2 feet below the groundwater level. Therefore, it will likely be necessary to dewater foundation excavations during construction. We believe the excavation can be dewatered during construction using perimeter trenches combined with sumps. The trenches should be sloped to sumps where water can be pumped from the excavation.
11. A representative of the project geotechnical engineer should observe all footing excavations prior to fill and concrete placement.

EARTH RETAINING STRUCTURES

Headwalls and wingwalls for the drainage structures should be designed for the lateral earth pressure generated by the backfill. The lateral earth pressure acting on a wall is a function of the degree of rigidity of the retaining structure and the type of material used as backfill. Rigid earth structures that are restrained from lateral deflection, should be designed for the at-rest earth pressure condition. Cantilevered walls capable of deflecting under lateral loads will allow

mobilization of the shear strength of the backfill and may be designed for the lateral earth pressure represented by the active earth pressure condition. Walls that are partially restrained from deflecting should be designed for an intermediate lateral earth pressure between the at-rest and active earth pressures. Considering the anticipated low heights of the retaining structures, we assume the on-site soils will be the preferred backfill.

The table below provides recommended equivalent fluid unit weights for moist and submerged conditions for the recommended backfill.

Condition	Equivalent Fluid Unit Weight (pcf)	
	Moist	Submerged*
At-rest	70	35
Intermediate	60	30
Active	55	27
* Submerged values do not include hydrostatic pressure.		

All retaining structures should be designed for appropriate surcharge pressures such as traffic, construction materials, and equipment. The pressures recommended above assume a horizontal backfill surface. An upward sloping backfill surface will increase the lateral pressure imposed on a retaining structure.

The lateral resistance shallow foundations placed on undisturbed native soils and/or structural fill material will be a combination of the sliding resistance of the footing on the foundation materials and passive earth pressure against the side of the footing. Resistance to sliding at the bottoms of the footings may be calculated based on a coefficient of friction of 0.30. The passive pressure against the sides of the foundations may be calculated using an equivalent fluid unit weight of 100 pcf, assuming buoyant conditions. The above values are working values.

WATER SOLUBLE SULFATES

The concentrations of water soluble sulfates measured in two samples obtained from the exploratory borings were 0.01% and 0.46%. These concentrations of water soluble sulfates represent a Class 0 to Class 2 severity exposure of sulfate attack on concrete exposed to these materials. The degree of attack is based on a range of Class 0, Class 1, Class 2, and Class 3 severity exposure as presented in ACI 201.2R.

Based on the laboratory data and our experience, we recommend all concrete exposed to the on-site materials meet the cement requirements for Class 2 exposure as presented in ACI 201. Alternatively, the concrete could meet the Colorado Department of Transportation's (CDOT) cement requirements for Class 2 exposure as presented in Section 601.04 of the CDOT Standard Specifications for Road and Bridge Construction (2011).

TEMPORARY EXCAVATIONS

We assume that the temporary excavations will be constructed by excavating the slopes to a stable configuration. All excavations should be constructed in accordance with OSHA requirements, as well as state, local and other applicable requirements. The contractor's on-site "competent person" should confirm that all necessary slope and shoring design are performed. In addition, the slopes should be monitored on a regular basis for signs of movement and safety considerations.

In our opinion, the on-site fills and native soils should classify as OSHA Type C soil and the claystone should classify as OSHA Type B. Excavations below groundwater or where perched water exists and seeps into the excavation are possible could require much flatter side slopes than those allowed by OSHA.

DESIGN AND CONSTRUCTION SUPPORT SERVICES

Kumar & Associates, Inc. should be retained to review the project plans and specifications for conformance with the recommendations provided in our report. We are also available to assist the design team in preparing specifications for geotechnical aspects of the project, and performing additional studies if necessary to accommodate possible changes in the proposed construction.

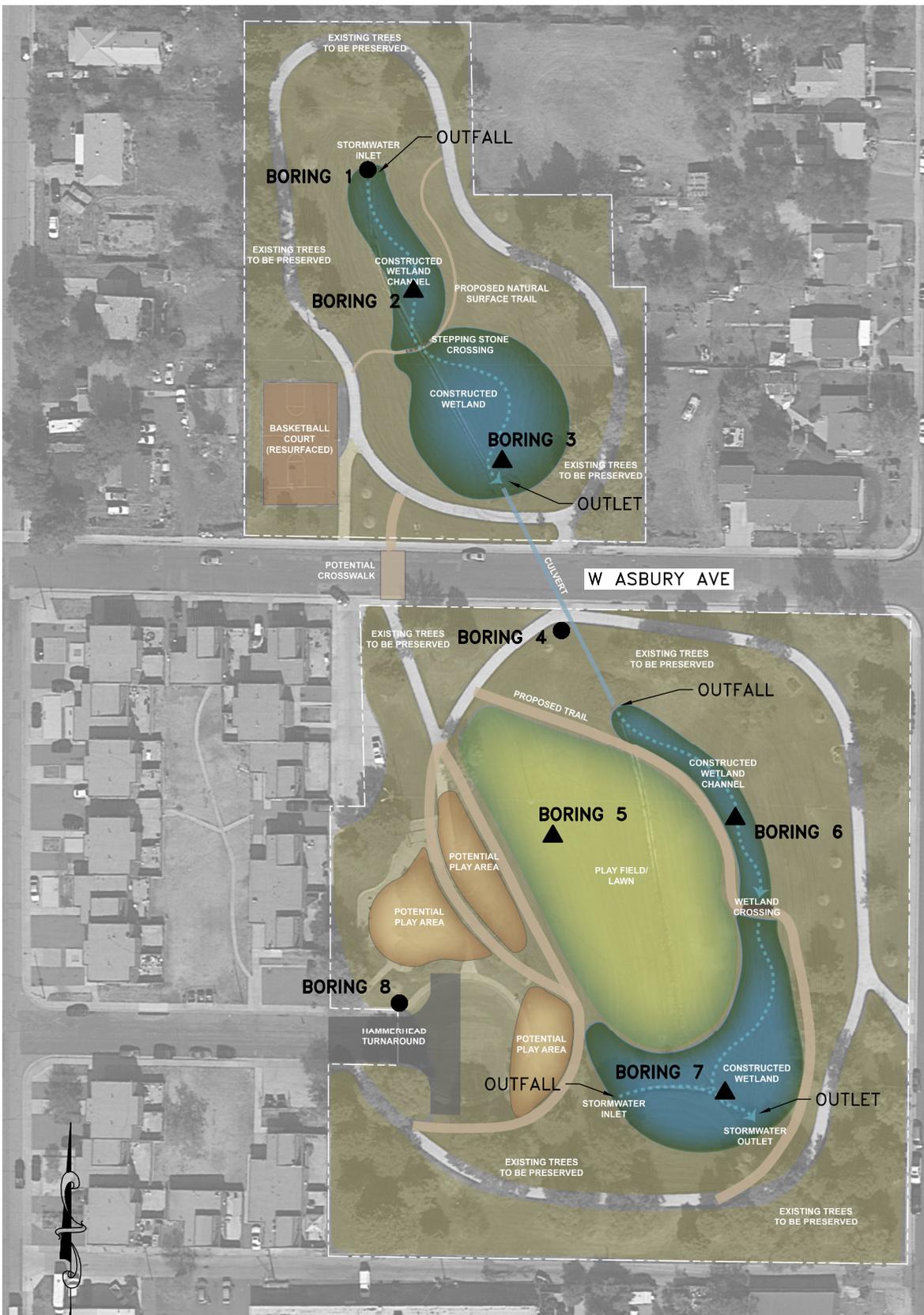
We recommend that Kumar & Associates, Inc. be retained to provide observation and testing services to document that the intent of this report and the requirements of the plans and specifications are being followed during construction, and to identify possible variations in subsurface conditions from those encountered in this study so that we can re-evaluate our recommendations, if needed.

LIMITATIONS

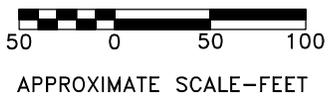
This study has been conducted in accordance with generally accepted geotechnical engineering practices in this area for exclusive use by the client for design purposes. The conclusions and recommendations submitted in this report are based upon the data obtained from the exploratory borings at the locations indicated on Fig. 1, and the proposed type of construction. This report may not reflect subsurface variations that occur between the exploratory borings, and the nature and extent of variations across the site may not become evident until site grading and excavations are performed. If during construction, fill, soil, rock or water conditions appear to be different from those described herein, Kumar & Associates, Inc. should be advised at once so that a re-evaluation of the recommendations presented in this report can be made. Kumar & Associates, Inc. is not responsible for liability associated with interpretation of subsurface data by others.

BEB/jw

cc: book, file



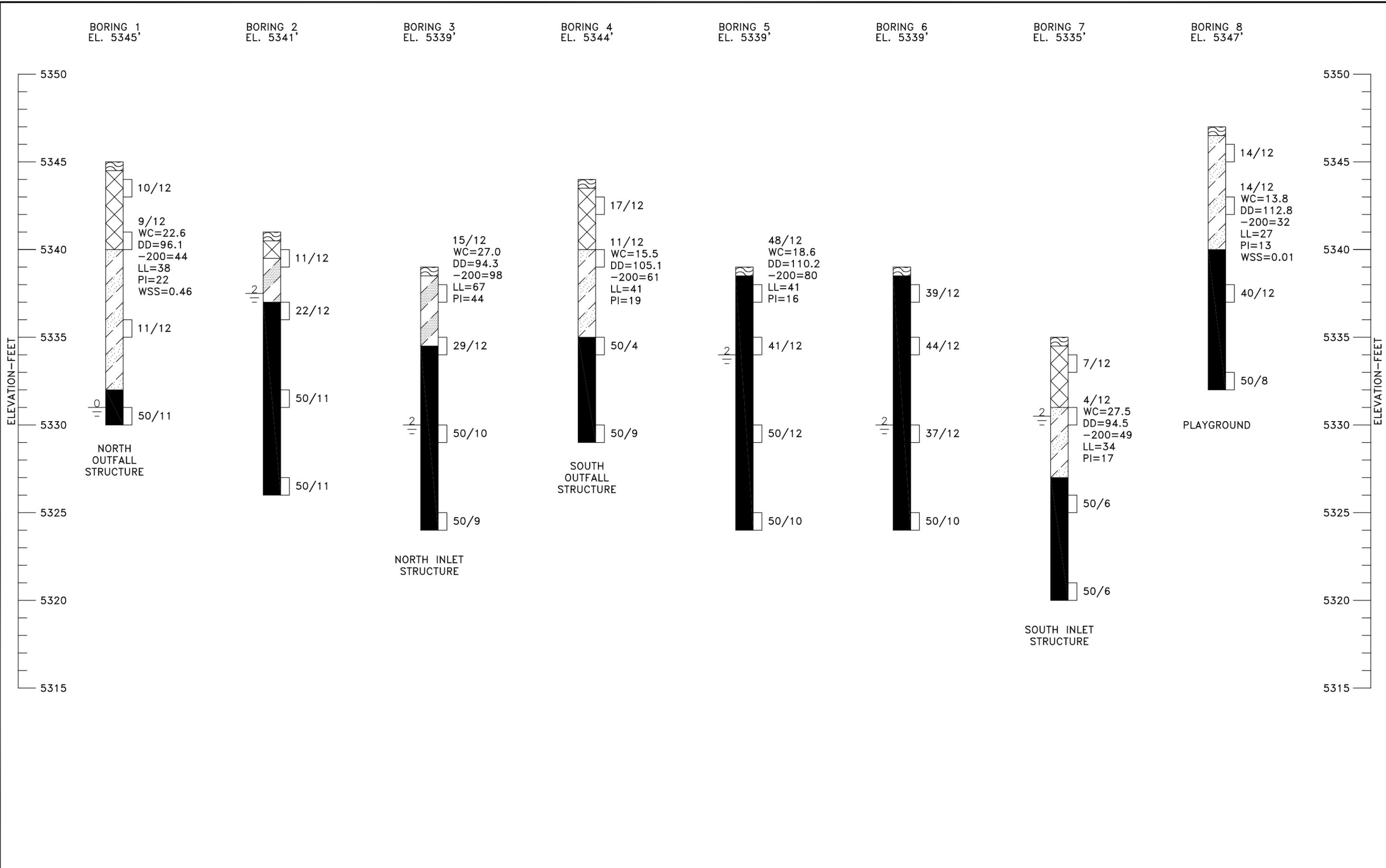
S TEJON ST



- LEGEND:**
- BORING LOCATION
 - ▲ BORING & COMPANION PERCOLATION TEST LOCATION

March 24, 2017 - 04:20pm
 W:\Projects\2017\17-1-141_Asbury and Tejon Park Improvements\Drafting\171141-01.dwg

Mar 25, 17 5:25am V:\Projects\2017\17-1-141 Asbury and Tejon Park Improvements\Drafting\171141-02 to 03.dwg



LEGEND



TOPSOIL.



FILL: SANDY LEAN CLAY TO CLAYEY SAND, MOIST, BROWN.



SANDY LEAN CLAY (CL) TO CLAYEY SAND (SC), STIFF, WITH SOFT ZONE IN BORING 7, MOIST, BROWN.



WEATHERED CLAYSTONE, STIFF, FISSURED, MOIST, BROWN.



CLAYSTONE BEDROCK WITH OCCASIONAL SANDSTONE LENSES, MEDIUM HARD TO VERY HARD, MOIST, BROWN.



DRIVE SAMPLE, 2-INCH I.D. CALIFORNIA LINER SAMPLE.

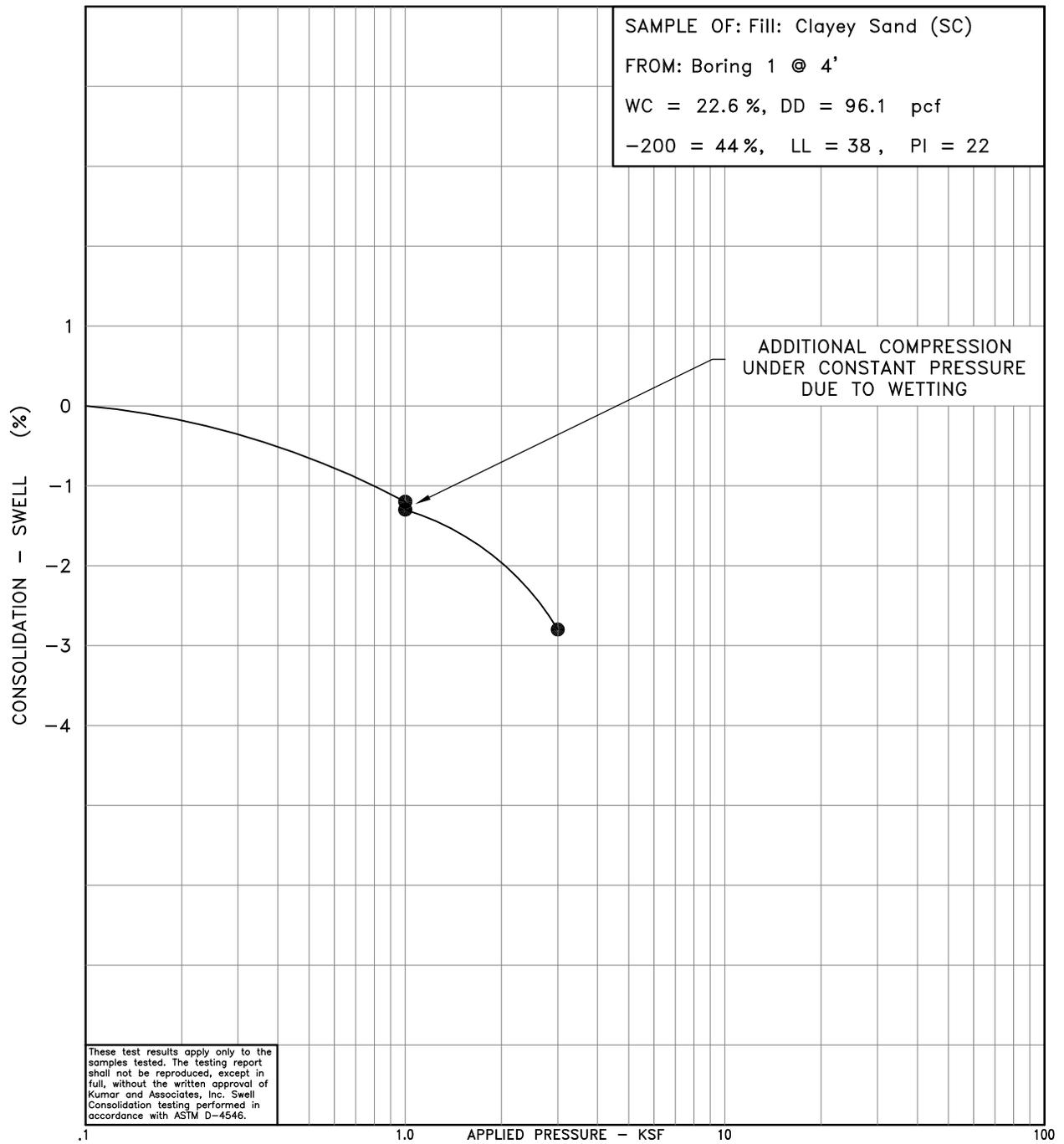
10/12 DRIVE SAMPLE BLOW COUNT. INDICATES THAT 10 BLOWS OF A 140-POUND HAMMER FALLING 30 INCHES WERE REQUIRED TO DRIVE THE SAMPLER 12 INCHES.

$\frac{2}{-}$ DEPTH TO WATER LEVEL AND NUMBER OF DAYS AFTER DRILLING MEASUREMENT WAS MADE.

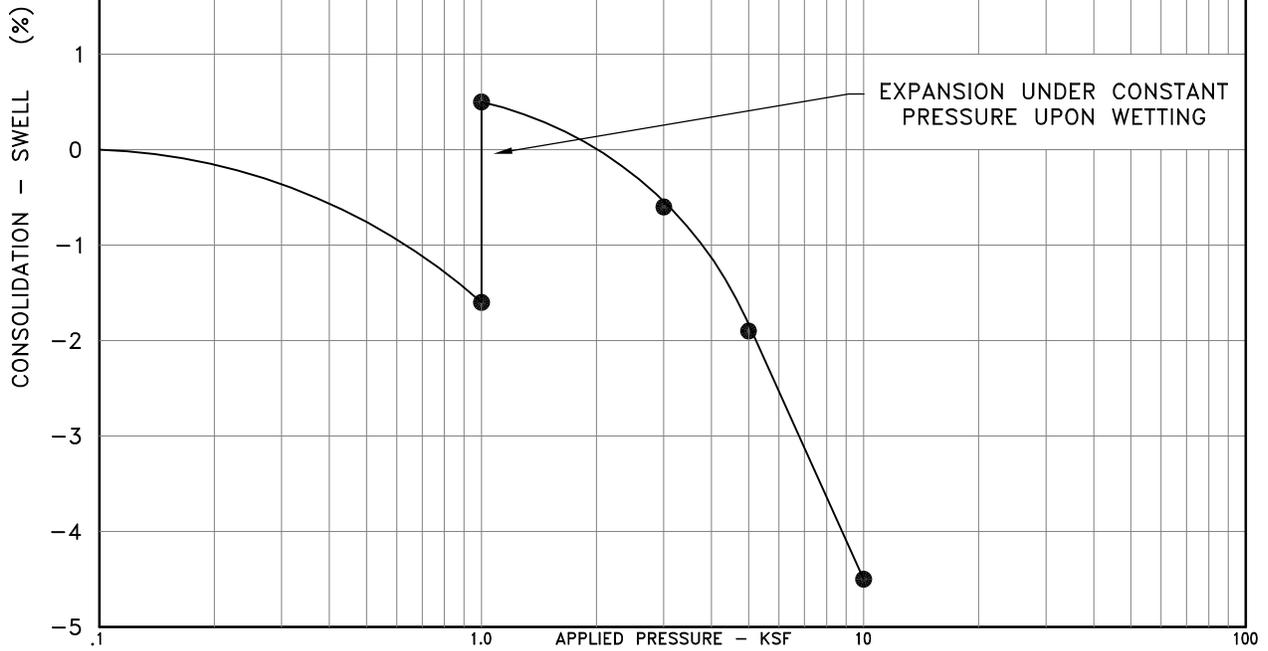
NOTES

1. THE EXPLORATORY BORINGS WERE DRILLED ON JANUARY 31, 2017 WITH A 4-INCH DIAMETER CONTINUOUS FLIGHT POWER AUGER.
2. THE LOCATIONS OF THE EXPLORATORY BORINGS WERE MEASURED APPROXIMATELY WITH HAND-HELD GPS INSTRUMENT.
3. THE ELEVATIONS OF THE EXPLORATORY BORINGS WERE OBTAINED BY INTERPOLATION BETWEEN CONTOURS ON THE SITE PLAN PROVIDED.
4. THE EXPLORATORY BORING LOCATIONS AND ELEVATIONS SHOULD BE CONSIDERED ACCURATE ONLY TO THE DEGREE IMPLIED BY THE METHOD USED.
5. THE LINES BETWEEN MATERIALS SHOWN ON THE EXPLORATORY BORING LOGS REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN MATERIAL TYPES AND THE TRANSITIONS MAY BE GRADUAL.
6. GROUNDWATER LEVELS SHOWN ON THE LOGS WERE MEASURED AT THE TIME AND UNDER CONDITIONS INDICATED. FLUCTUATIONS IN THE WATER LEVEL MAY OCCUR WITH TIME.
7. LABORATORY TEST RESULTS:
WC = WATER CONTENT (%) (ASTM D 2216);
DD = DRY DENSITY (pcf) (ASTM D 2216);
-200 = PERCENTAGE PASSING NO. 200 SIEVE (ASTM D 1140);
LL = LIQUID LIMIT (ASTM D 4318);
PI = PLASTICITY INDEX (ASTM D 4318);
WSS = WATER SOLUBLE SULFATES (%) (CP-L 2103).

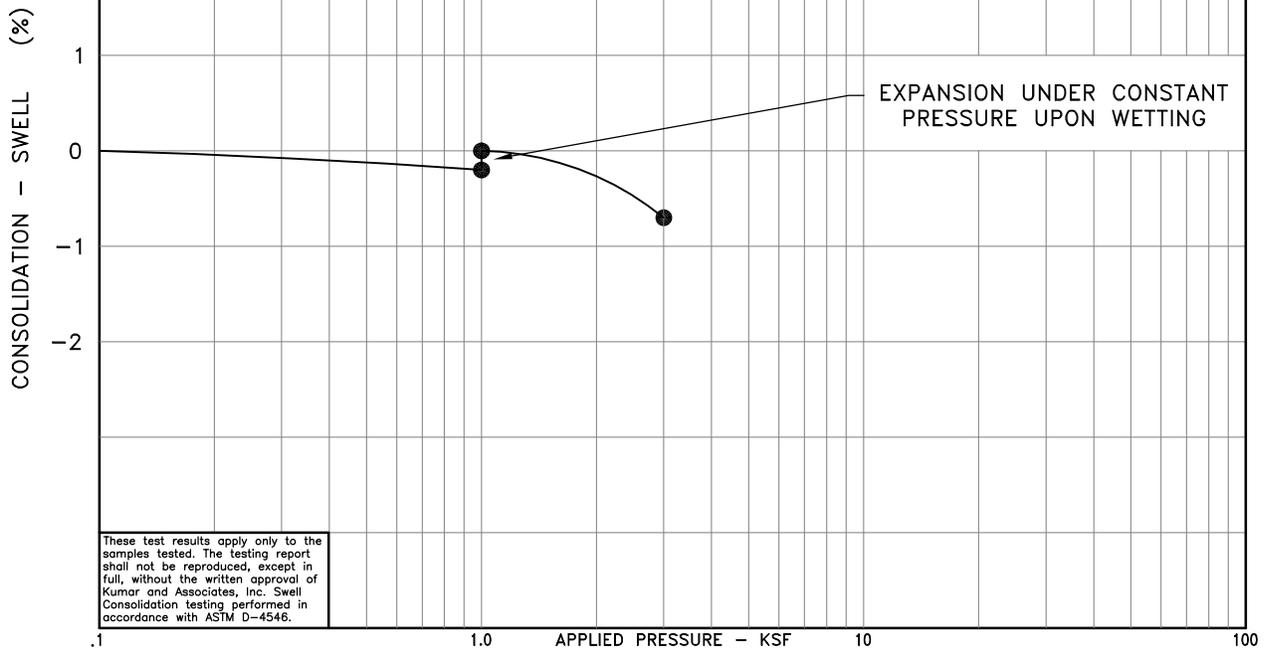
March 24, 2017 - 04:21pm
V:\Projects\2017\17-1-141 Asbury and Tolon Park Improvements\Drafting\171141-04 to 05.dwg



SAMPLE OF: Weathered Claystone
 FROM: Boring 3 @ 1'
 WC = 27.0 %, DD = 94.3 pcf
 -200 = 98 %, LL = 67 , PI = 44



SAMPLE OF: Clayey Sand (SC)
 FROM: Boring 8 @ 4'
 WC = 13.8 %, DD = 112.8 pcf
 -200 = 32 %, LL = 27 , PI = 13



These test results apply only to the samples tested. The testing report shall not be reproduced, except in full, without the written approval of Kumar and Associates, Inc. Swell Consolidation testing performed in accordance with ASTM D-4546.

March 24, 2017 - 04:21pm
 V:\Projects\2017\17-1-141 Asbury and Tolson Park Improvements\Drafting\171141-04 to 05.dwg

TABLE I
SUMMARY OF LABORATORY TEST RESULTS

PROJECT NO.: 17-1-141
 PROJECT NAME: Asbury and Tejon Park
 DATE SAMPLED: 1-31-17
 DATE RECEIVED: 2-2-17

SAMPLE LOCATION		DATE TESTED	NATURAL MOISTURE CONTENT (%)	NATURAL DRY DENSITY (pcf)	GRADATION		PERCENT PASSING NO. 200 SIEVE	ATTERBERG LIMITS		WATER SOLUBLE SULFATES (%)	SOIL OR BEDROCK TYPE
BORING	DEPTH (feet)				GRAVEL (%)	SAND (%)		LIQUID LIMIT (%)	PLASTICITY INDEX (%)		
1	4	2-9-17	22.6	96.1			44	38	22	0.46	Fill: Clayey Sand (SC)
3	1	2-9-17	27.0	94.3			98	67	44		Weathered Claystone
4	4	2-9-17	15.5	105.1			61	41	19		Sandy Lean Clay (CL)
5	1	2-9-17	18.6	110.2			80	41	16		Claystone Bedrock
7	4	2-9-17	27.5	94.5			49	34	17		Clayey Sand (SC)
8	4	2-9-17	13.8	112.8			32	27	13	0.01	Clayey Sand (SC)



DENVER

PUBLIC WORKS

Wastewater Capital Projects Management

Draft Materials Management Plan

For Asbury and Tejon Park

October 2018

December 28, 2017

Draft Materials Management Plan

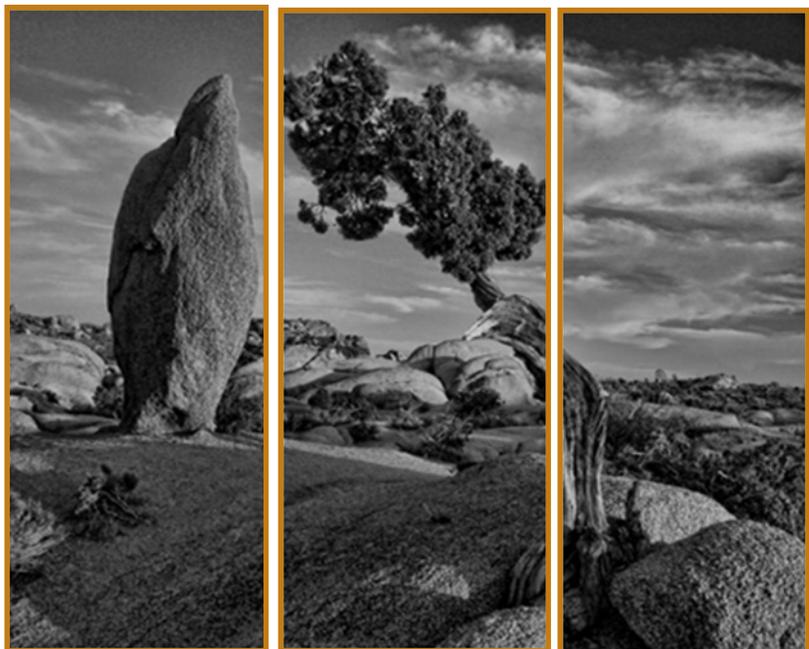
Tejon and Asbury Park Water Quality Project
Denver, Colorado

Prepared For:

City and County of Denver – Department of Public Health and Environment
200 West 14th Avenue, Suite 310
Denver, Colorado 80204

Pinyon Project No.:

I/17-007-02.8002





Corporate Headquarters
9100 West Jewell Avenue, Suite 200 Lakewood, CO 80232
TEL 303 980 5200 FAX 303 980 0089
www.pinyon-env.com

December 28, 2017

Draft Materials Management Plan

Tejon and Asbury Park Water Quality Project
Denver, Colorado

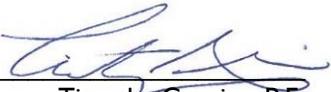
Prepared For:

City and County of Denver – Department of Public Health and Environment
200 West 14th Avenue, Suite 310
Denver, Colorado 80204

Pinyon Project No.:

1/17-007-02.8002

Prepared by:



Timothy Grenier, P.E.
Environmental Engineer

Reviewed by:



Brian Partington
Principal – Project Delivery

Table of Contents

1.	Introduction.....	1
1.1	Proposed Action.....	1
1.2	Key Parties and Responsibilities.....	1
1.3	Site Description.....	2
1.4	Previous Environmental Documentation.....	2
1.5	Known Environmental Conditions.....	2
2.	Health and Safety.....	4
3.	Environmental Responsibilities.....	5
3.1	CCD Responsibilities.....	5
3.2	MMP Supervisor Requirements and Training.....	5
3.3	Certified Asbestos Building Inspector.....	5
3.4	Contractor Responsibilities.....	6
3.4.1	Health and Safety Officer Requirements.....	7
3.4.2	Worker Requirements.....	7
3.4.2.1	Tier 1 – Front-Line Workers.....	7
3.4.2.2	Tier 2 – Excavation Workers.....	8
3.4.2.3	Tier 3 – Other Workers.....	8
4.	Soil Evaluation Criteria.....	9
5.	Soil Handling Procedures.....	11
5.1	Process Flow.....	11
5.2	Field Screening.....	13
5.3	Soil Sampling.....	13
5.4	General Soil Stockpiling Requirements.....	13
5.5	Regulated Asbestos-Contaminated Soils (RACS).....	13
6.	Special Wastes.....	15
6.1	Drums or Waste Containers.....	15
6.2	Slag, Coal, Ash.....	16
6.3	Electrical Equipment (PCBs).....	16
6.4	Biological Waste.....	16
7.	Reuse Criteria.....	17
7.1	Non-Hazardous Disposal.....	17
7.2	Hazardous Waste Disposal.....	17
8.	Construction Water Handling Procedures.....	18
8.1	Stormwater.....	18
8.2	Groundwater.....	18
8.3	Leachate.....	19
9.	Additional Requirements.....	20
9.1	Dust.....	20

Table of Contents (continued)

9.2	Decontamination of Heavy Equipment.....	20
9.3	Site Security	20
9.4	Monitoring Wells.....	20
9.5	Complaints	20
10.	Imported Materials.....	21
10.1	Sample Analysis and Frequency.....	21
10.2	Imported Fill Documentation	22
11.	Reporting.....	23
12.	References.....	24

Appendices

Appendix A	Site Characterization Technical Memorandum	
Appendix B	CDPHE Solid Waste Regulation – Section 5.5 and Management of Regulated Asbestos Contaminated Soil, and Air Quality Control Commission Regulation No. 8 Part B - Asbestos	
Appendix C	Environmental Protection Agency Regional Screening Levels-Residential and Composite Worker, EPA Toxicity Maximum Concentrations of Contaminants, CDPHE-Hazardous Materials and Waste Management Division Groundwater Protection Values Soil Cleanup Table	
Appendix D	City and County of Denver – Guidance for Reuse of Soil on City Projects	
Appendix E	Remediation Activities Discharging to Surface Water Permit Information	

I. Introduction

Pinyon Environmental, Inc. (Pinyon), was retained by the City and County of Denver (CCD), to prepare this Draft Materials Management Plan (MMP) for the Tejon and Asbury Park Water Quality Project (the Site) (Appendix A, Figure 1). This MMP addresses handling and disposal of impacted materials and other suspect materials encountered during construction activities at the Site. This MMP has been developed to assist field construction personnel in preparing for identification and management of soil and/or groundwater that may be impacted by suspect materials.

It is the intent that this MMP will be attached to the project Plans and Specifications and that bidding contractors will have an opportunity to review this document as they prepare bids for construction. This MMP has been prepared to ensure, when properly implemented by the future-selected Contractor (Contractor), that work activities will be completed in such a way as to protect human health and the environment. Further, this MMP has been prepared to minimize potential delays, and to develop approved standard procedures that will be implemented as needed in the event that suspect materials are encountered during construction. It is the responsibility of the Contractor to customize, finalize, and implement the MMP; follow all appropriate regulations, obtain proper permits, transfer existing permits (such as the dewatering permit), and utilize field personnel trained to identify potential contamination. In the event that any discrepancy is noted between this MMP and any applicable regulation, the regulation will take precedence, unless a variance has been previously approved by the regulatory agency.

I.1 Proposed Action

The CCD has proposed water quality improvements for Tejon and Asbury Park. The existing concrete trickle channel which extends north to south through the park will be replaced with constructed wetland channels and basins. Improvements will also include installation of new concrete walks, maintenance trails, a crusher fines trail, stepping stone weir, and expansion and renovation of the playground.

I.2 Key Parties and Responsibilities

The Contractor is responsible for providing this MMP to its staff and subcontractors and for compliance with the MMP. Through implementation of this MMP, the CCD will be immediately notified of potential environmental-related findings pertaining to construction activities at the Site. The key parties, their contact information and project responsibilities, are outlined below:

Organization	Role/Responsibility	Contact Information
City and County of Denver	City Project Manager	Brian Wethington Phone: 720-865-3147 Email: brian.wethington@denvergov.org
City and County of Denver, Department of Public Health and Environment (DDPHE)	Environmental Quality Technical Oversight	Agatha Linger Phone: 720-865-5356 Email: Agatha.Linger@denvergov.org If no immediate response, call 720-460-1706

Organization	Role/Responsibility	Contact Information
Construction Contractor	Health and Safety Officer/ Construction	TBD
TBD	MMP Supervisor/CABI, meeting the requirements in Section 3.2 and 3.3 of the MMP, will conduct Environmental oversight quality assurance to identify potentially contaminated soil and potential asbestos-containing materials	TBD

1.3 Site Description

The Site is located to the northwest and southwest of the West Asbury Avenue and South Tejon Street intersection, and is bisected by West Asbury Avenue (Appendix A, Figure 1). Excavations are primarily proposed to be completed with the majority, if not all, of the proposed work to be completed within the park property.

1.4 Previous Environmental Documentation

Based on the findings of the *Limited Environmental Screen for Tejon and Asbury Park*, Interoffice Memorandum completed by the CCD Department of Public Health and Environment (DDPHE), dated March 24, 2016 (CCD, 2016), facilities with environmental concerns in connection with the Site were not identified. The Denver Radium Superfund Site, CST Metro Corner Store closed leaking-underground storage tank (LUST) site, and the Circle K Store open LUST site were identified within a quarter mile of the Site, with each of the sites being either down-gradient or cross-gradient. There does not appear to be historical chemical impacts to the Site soil and groundwater; however, it was common to encounter unregulated fill material in subsurface soil in Denver. Fill material was historically used to backfill channels and for surface grading purposes.

Based on this information, a soil sample was collected and lab analyzed for landfill waste characterization; test trenches were completed to investigate potential subsurface debris and impacts; and a groundwater sample was collected to support a Remediation Activities Discharging to Surface Water Permit with the Colorado Department of Public Health and Environment (CDPHE) – Water Quality Control Division (WQCD). The constituents analyzed in the soil and groundwater samples were below their applicable regulatory values; however, asbestos was identified during the test trench investigation. Details regarding the subsurface investigation findings can be found in the Site Characterization Technical Memorandum (Appendix A).

1.5 Known Environmental Conditions

Pinyon completed test trench excavations at the Site on November 16, 2017. Debris was encountered in three of the four trenches (TP-01, TP-03, and TP-04) (Appendix A, Figure 2). The debris included brick and mortar, glass, concrete, plastic, wood, and a gray fiber. A total of four suspect asbestos-containing material (ACM) samples were collected and analyzed by polarized light microscopy (PLM) analysis during the investigation. The gray fiber, which is considered friable, was encountered at two feet below ground surface (bgs) in TP-03, was found to be an ACM (Appendix A). The fiber was approximately two-inch by four-inch in size, and the entire piece was removed from the site for lab analysis. No other pieces of the material were encountered, and no

other ACMs were found; however, it is possible that more of the material (or other ACM) will be encountered during site construction.

Based on the presence of debris at the project area, the contractor must understand that regulated asbestos-contaminated soil (RACS) and/or non-RACS may be encountered during construction. RACS means soil, ash, or debris (plus six inches in all directions of surrounding soil or other matrix material) that contains friable ACM, non-friable ACM that have been rendered friable, or non-friable ACM that is likely to be rendered friable during disturbance activities. Non-RACS is soil or debris that has non-damaged, non-friable ACM, or damaged non-friable ACM that does not have a high probability of becoming friable during disturbance.

Management of RACS will be conducted in accordance with CDPHE Solid and Hazardous Waste Commission/Hazardous Materials and Waste Management Division, Part I – Regulations Pertaining to Solid Waste Sites and Facilities – Section 5.5 Regulations, Management of Regulated Asbestos Contaminated Soil (Section 5.5), as well as the CDPHE Air Quality Control Commission – Regulation No. 8 Part B – Asbestos (Reg 8) (Appendix B). The project MMP Supervisor/Certified Asbestos Building Inspector (CABI), as described in Sections 3.2 and 3.3, will evaluate materials encountered during construction, and based on those evaluations will follow the appropriate portions of the regulations

2. Health and Safety

Due to the potential to encounter suspect materials, there is a possibility for increased risk to the health of workers during excavation within the Site. Project personnel must be made aware of the potential hazards and worker safety and awareness is of the highest priority. Therefore, a Health and Safety Plan (HASP) must be developed by the Contractor.

The Contractor will be required to employ the proper personnel, monitoring equipment, and personal protective equipment (PPE) to provide a safe working environment for its employees, consultants and sub-contractors. The Contractor's field personnel must conduct work in Level D PPE until conditions arise that require additional protection. The decision to require additional protection is the responsibility of the Contractor's Health and Safety Officer (HSO) and should be evaluated based on observation of worker conditions. An MMP Supervisor will be designated and it is the responsibility of the MMP Supervisor to provide the HSO with information regarding environmental conditions, as available, to assist in that decision. The provisions of this MMP are summarized below, and will be incorporated into the HASP. However, in no way shall the HASP be limited to these provisions.

- The Contractor must develop a HASP in accordance with 29 Code of Federal Regulations (CFR) 1910 (Occupational Safety and Health Standards) and 29 CFR 1926 (Safety and Health Regulations for Construction) for the Project.
- The HASP must be prepared to address the environmental conditions described in this MMP.
- Workers and managers associated with intrusive Project area activities will be required to undergo a one-time health and safety orientation meeting at the start of the Project, to include a brief on-site description of Project area conditions. This meeting must include two-hour asbestos awareness training conducted by a trained asbestos professional (i.e., CABI). If Project personnel change for any reason during Project work (i.e., additional or replacement personnel), additional asbestos awareness trainings are required.
- The general contractor may share its HASP with its subcontractors or require each subcontractor to prepare its own plan.

3. Environmental Responsibilities

The following sections detail the responsibilities of the applicable parties that will be associated with the Project.

3.1 CCD Responsibilities

The CCD is the project owner. As such, the CCD will be responsible for:

- Overall project management
- Contracting with the Contractor

3.2 MMP Supervisor Requirements and Training

Prior to implementation of the MMP, the Contractor will retain an MMP Supervisor to independently verify that the requirements of this plan are followed. The MMP Supervisor must be a competent individual with at least two years of experience in the field identification of suspect material and potential environmental hazards (e.g. abandoned underground storage tanks, asbestos, lead-based paint, or lead-containing materials), as well as appropriate characterization, management, and disposal methods for impacted materials. The MMP Supervisor will have a minimum training requirement of 40-hour Occupational Safety and Health Administration (OSHA) Hazardous Waste Operations Training and current 8-hour OSHA annual update. It is the responsibility of the MMP Supervisor to:

- Complete daily field notes detailing environmental conditions and responses to suspect materials that are identified.
- Provide regular updates to CCD.
- Ensure adherence to the MMP by identifying suspect materials and applying proper procedures outlined herein.
- Verify or perform field screening of soil in adherence to this plan (see Section 4.0).
- Notify CCD immediately of any unexpected environmental conditions or potentially impacted material.
- If RACS is discovered, the MMP Supervisor will file a notification to the CDPHE and a copy must be submitted to the CCD Project Manager and DDPHE within 24 hours.
- Be on-site to verify Project operations on an as-needed basis when potentially impacted media have been encountered.
- Track and/or sign tickets and manifests for material hauled off-site for either reuse or disposal.
- Complete logs that thoroughly detail Project Quality Assurance (QA) activities.

3.3 Certified Asbestos Building Inspector

The MMP Supervisor designated by the Contractor should also be a CABI. In addition to the requirements and training listed in Section 3.2, the MMP Supervisor/CABI will also complete oversight and documentation of RACS. The CABI must meet the training requirements of Section 5.5.3(D) of the Regulation Pertaining to Solid Waste Work Sites and Facilities. The CABI will also be trained and certified in accordance with Air Quality

Control Commission Regulation No. 8 (5 Colorado Code of Regulations (CCR 1001-10, Part B)), for the identification of asbestos-containing materials and the collection of samples to evaluate asbestos content. All CABIs must have worked on at least three different asbestos-in-soil projects and have a minimum of 40 hours of experience as a CABI. The CABI must have sufficient experience to identify historical urban fill, and associated RACS in the field. Depending on the project schedule, a minimum of one CABI will be overseeing excavation work. It may be necessary to engage multiple CABIs if areas of known historical fill or debris are identified at multiple excavation areas. As a cost saving measure, the individual conducting CABI work should also be qualified to serve as the MMP Supervisor.

For this project, the CABI will complete the following:

- Conduct Two-Hour Asbestos Awareness Training to all Project personnel involved in subsurface disturbance and earth moving activities. For the purpose of this MMP, any workers that could engage in subsurface excavation work, such as equipment operators and laborers. If Project personnel change for any reason during Project work (i.e., additional or replacement personnel), the CABI will conduct additional Two-Hour Asbestos Awareness Training as needed. Two-hour Asbestos Awareness Training should include such topics as:
 - Background information on asbestos
 - Health effects of asbestos
 - Worker protection programs
 - Recognition of suspect materials, including historical urban fill, debris, or other materials where there would be reason to believe that RACS may be present
 - Site-specific concerns related to asbestos and historical urban fill
 - Immediate actions should RACS be suspected
- The CABI will be present on a full-time basis during excavation activities.
- Waste that can clearly be identified as only landscaping-type waste does not require CABI oversight.
- It is the responsibility of the Contractor and CABI to ensure that the subcontractor performing RACS disturbance is capable of meeting the state requirements if RACS is managed during the project.

3.4 Contractor Responsibilities

The Contractor will be responsible for the following:

- Designating an HSO and MMP Supervisor/CABI.
- Providing necessary equipment and personnel to implement the MMP.
- Coordinating review of MMP requirements with the MMP Supervisor, DDPHE, CCD Project Manager, and the Engineer prior to beginning work.
- Initiate appropriate tailgate meetings with its workers and appropriate parties, including the MMP Supervisor/CABI, before subsurface work begins, to educate personnel on the hazards regarding regulated materials on the Project, and the mitigation measures presented herein.

- Ensuring that subcontractors adhere to the MMP during Project work.
- If suspect historical urban fill, debris, household waste, or RACS is encountered, contact the MMP Supervisor/CABI to evaluate the situation.
- It is the responsibility of the Contractor and CABI to ensure that the subcontractor performing RACS disturbance is capable of meeting the state requirements if RACS is managed during project.
- Ensuring that proper procedures for material reuse or disposal are followed. This includes ensuring that suspect material that has been disturbed is not reused on-site unless it meets the designated reuse criteria or is disposed in accordance with applicable regulations and not in storm drains, sanitary sewers, streams, irrigation facilities, or waterways.
- Ensuring that non-salvageable, non-hazardous solid waste materials excavated are removed from the Project area and disposed of at the Denver-Arapahoe Disposal Site (DADS) in accordance with local, state, and federal laws.
- Contacting the CCD Project Manager and Engineer for conditions resulting in schedule or budget impacts to the Project.

3.4.1 Health and Safety Officer Requirements

Prior to the initiation of Project work, the Contractor will designate a HSO. The HSO must:

- Complete health and safety monitoring during subsurface work
- Evaluate the appropriate level of PPE based on health and safety monitoring to be completed during subsurface work
- Ensure that Project activities and personnel adhere to the HASP set in place by the Contractor

3.4.2 Worker Requirements

Tier 1, Tier 2 and Tier 3 workers will be utilized during project activities. Worker responsibilities are as follows.

3.4.2.1 Tier 1 – Front-Line Workers

Tier 1 workers include personnel that would be responsible for mitigating suspect materials and include equipment operators and laborers actually handling materials in accordance with this MMP. These workers must:

- Complete mandatory two-hour asbestos awareness training, and training on identification of suspect materials by the MMP Supervisor/CABI. This training is a prerequisite to commencing work on this project for the applicable workers.
- Complete work as directed by the MMP Supervisor, and in accordance with this MMP and HASP requirements.
- Complete work in accordance with the requirements of the OSHA, Hazardous Waste Operations and Emergency Response (HAZWOPER; 29 CFR 1910.120). The level of training in accordance with HAZWOPER shall be the decision of the HSO.

3.4.2.2 Tier 2 – Excavation Workers

Tier 2 workers include personnel that could encounter potentially impacted materials during the course of work, but will not be responsible for management of these materials. These employees include, but are not limited to front-line equipment operators, foremen, and operators that will complete typical excavation activities during the Project, but will not complete handling of these materials after discovery. These personnel must:

- Complete mandatory two-hour asbestos awareness training, and training on identification of suspect materials by the MMP Supervisor/CABI. This training is a prerequisite to commencing work on this project for the applicable workers.
- Complete work as directed by the MMP Supervisor, and in accordance with this MMP and HASP requirements.
- Immediately stop work in the event that potentially suspect materials are identified, and notify the MMP Supervisor of the discovery.
- Complete work in accordance with the requirements of the OSHA, HAZWOPER. The level or training in accordance with HAZWOPER shall be the decision of the HSO.

3.4.2.3 Tier 3 – Other Workers

- Tier-3 workers include personnel that will not complete sub-surface work activities. As the potential for these workers to encounter impacted materials on this Project is low, MMP training requirements do not apply.

4. Soil Evaluation Criteria

CDPHE Groundwater Protection Values (CDPHE, 2014), Environmental Protection Agency (EPA) Regional Screening Levels, and other state/federal guidance will be used for comparison to soil data (Appendix C). In addition to the CCD's Guidance for Reuse of Soil on City Projects, dated October 5, 2017 (Appendix D), the following guidance is applicable for evaluating soil concentrations for varying exposure scenarios:

CDPHE Groundwater Protection – These are often the most protective values and were developed to protect groundwater; these values are the maximum chemical concentration in soil that will not leach into groundwater. The CDPHE-Hazardous Materials and Waste Management Division Groundwater Protection Values Soil Cleanup Table (Appendix C) values will be used for comparison to soil data.

EPA RRSL Residential Protection – These are the second most protective values and are typically the soil concentrations that would be considered appropriate for reuse in residential areas and parks without restriction (except where values do not meet groundwater protection values as described above). These are the Residential Regional Screening Levels (RRSLs, Appendix C). Soil with concentrations exceeding the RRSL cannot be reused at the Site.

EPA CWRS� Composite Worker Protection – These are the third most protective values, and are the acceptable concentrations that would be protective for City workers on City-owned properties such as right of ways (e.g., roads, sidewalks, bike paths), utilities corridors (e.g., stormwater, wastewater, water), or City-owned facilities (e.g., maintenance garages, office buildings, safety buildings) (Appendix D). Soil with concentrations that exceed the Composite Worker Regional Screening Level (CWRS�) will be removed from the Site, and disposed at DADS.

Arsenic Standards (exception to RSLs) - In Colorado, arsenic occurs naturally, and often at concentrations greater than the RSLs. The CDPHE has state-specific guidance related to evaluating arsenic concentrations in soil, specifically regarding screening data collected from sites where historical use does not indicate the potential for arsenic impacts (CDPHE, 2011a). The guidance is based on the collection of over 2,700 samples from 44 counties in Colorado. The average concentration of arsenic in soils based on this sampling was 11 milligrams per kilogram (mg/kg). The CDPHE has adopted a policy that if arsenic concentrations are lower than 11 mg/kg, and releases of arsenic could not have occurred at the site, the CDPHE will require no further action to address arsenic in soil.

RACS and Non-RACS Standards – If RACS and/or Non-RACS is identified during site construction, disturbance activities must comply with the standards set forth in CDPHE Section 5.5 and Reg 8. The critical requirement is to avoid generating or being in direct contact with airborne dust and work shall stop immediately. Materials with RACS and/or Non-RACS are not suitable for reuse and must be disposed of at DADS. The landfill processes will be followed, specifically regarding notification, profiling, and material handling procedures (e.g., unlined, single, or double-lined trucks).

Hazardous Waste – A material can be defined as hazardous based on definition (i.e., EPA F-Listed wastes) or based on characteristics such as corrosivity, ignitability, reactivity, or toxicity characteristics. A material is defined as hazardous if any of the following criteria are met:

- The material contains a listed hazardous waste (discussed in 6 CCR 1007-3 Part 261 Subpart D)
- The pH is less than or equal to 2.0 or greater than or equal to 12.5; this material would be considered corrosive
- The flashpoint is less than 140 degrees Fahrenheit; this material would be considered ignitable

- The material is reactive
- Toxicity Characteristic Leaching Procedure (TCLP) results exceed the hazardous waste threshold

20 Times Rule - Waste Management (the operator of the DADS) will accept solid material where concentrations as determined by the TCLP method are less than 20 times the EPA Toxicity Maximum Concentrations of Contaminants (included as Appendix C); this is referred to as the “20 Times Rule”. Polychlorinated biphenyls (PCBs) are an exception to this rule, as discussed in Section 6.3. As an example, the regulatory level for lead provided by the EPA Toxicity Maximum Concentrations of Contaminants is 5.0 milligrams per liter (mg/L) when analyzed by TCLP. The Waste Management acceptable limit, when analyzed by totals analysis, would then be less than 100 mg/kg, using the 20 Times Rule. If concentrations of any contaminant exceed the 20 Times Rule by totals analysis, then analysis for TCLP is required. If the TCLP results exceed the toxicity characteristic maximum concentration, then the material would require disposal at a hazardous waste disposal site in accordance with CDPHE requirements.

Note that all soil evaluation and disposition of soils must be confirmed and approved by DDPHE before disposal and/or reuse.

5. Soil Handling Procedures

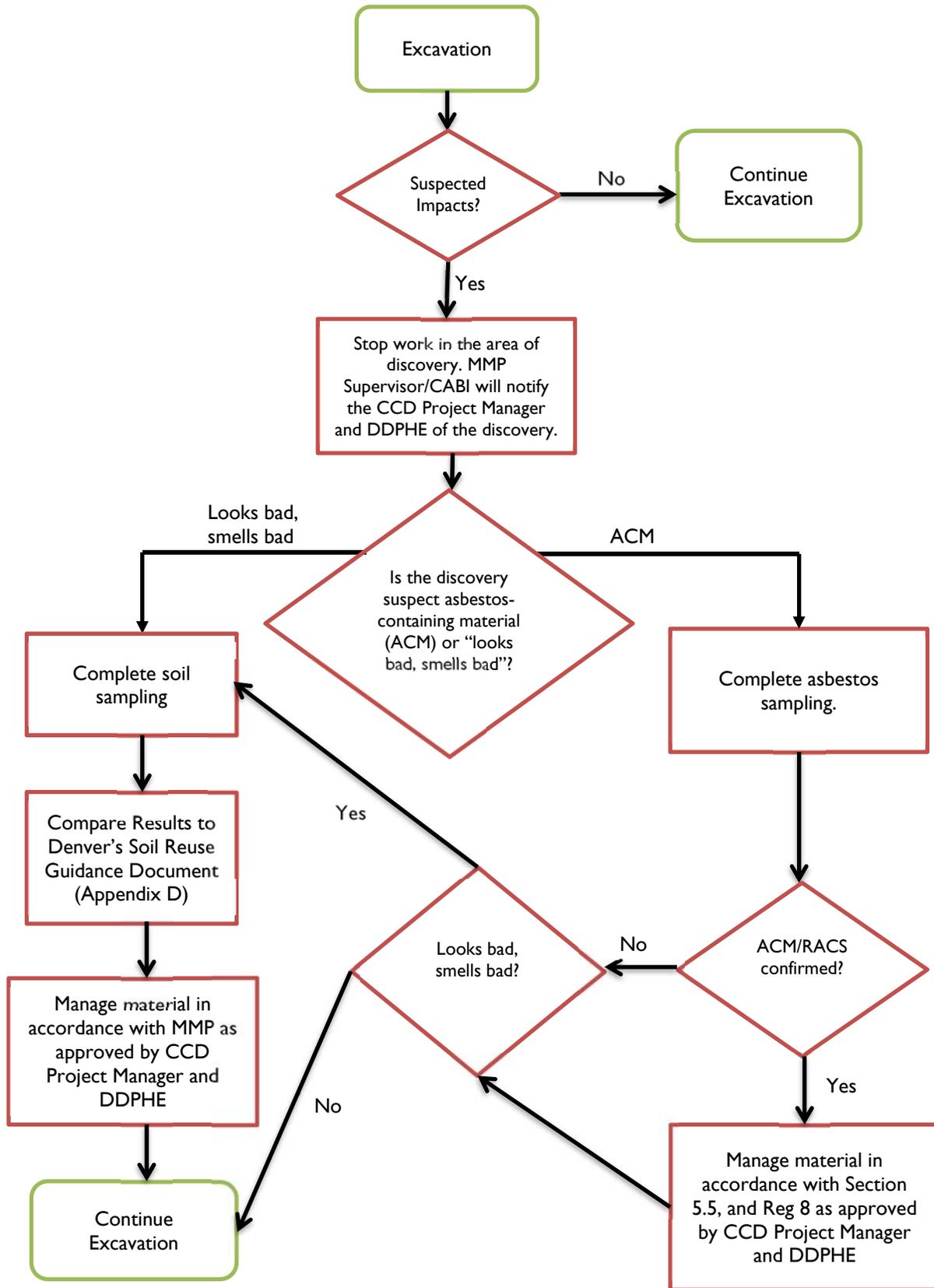
Project activities include excavations up to a maximum depth of approximately seven feet bgs. The seven feet is from the top of the existing grade to the bottom of the proposed grade; much of the excavations will involve scraping/regrading existing slope. Excavation may occur in areas where impacted soil could be encountered. Additionally, because of the heterogeneous nature of the soil, it is important that the Contractor be aware of the possibility of encountering unknown or suspect materials and know how to manage materials. Detailing the proper procedures for handling these materials is a key purpose of this MMP.

If unknown/unanticipated conditions are encountered during the Project, the Contractor must immediately stop work in the area of the discovery until the MMP Supervisor, CCD Project Manager, and DDPHE evaluate how to proceed per the requirements of this MMP. If suspect materials, HUF, or debris is encountered, the CABI must provide field screening and/or visually assess the materials. RACS must be characterized and managed in accordance with CDPHE Section 5.5 and Reg 8 (Appendix B). The Contractor must immediately notify the MMP Supervisor, CCD Project Manager, and DDPHE of the discovery. Following discussions with the MMP Supervisor, CCD Project Manager, and DDPHE, additional characterization, remediation, and/or analyses may be required. Work may continue in other areas of the Project while the discovery is resolved. The following sections provide detail on Project-specific procedures for unexpected or unknown materials that may be encountered.

CCD's Guidance for Reuse of Soil on City Projects, dated October 5, 2017, provides criteria by which CCD employees and/or third parties may, or may not, reuse excess soil from CCD projects at both CCD-owned properties and properties owned by others (Appendix D). DDPHE sign off is required for any reuse options.

5.1 Process Flow

The following process-flow chart presents the general process that will be followed during excavation activities.



5.2 Field Screening

Debris/HUF Materials - Visual monitoring of excavated soils should be completed during Project soil disturbance and earth-moving activities. Debris/HUF material that is encountered will be assessed for the presence of suspect RACS by a CABI.

Landfill Gas – No landfill gases (methane, carbon dioxide, or hydrogen sulfide) are anticipated at the Site; therefore, field monitoring for landfill gasses will only be completed as required by the Site-specific HASP for worker health and safety. If monitoring for landfill gases is required by the HSO, a Landtec GEM (or equivalent) handheld landfill gas monitor or combustible gas indicator (CGI) will be used to evaluate methane and/or the lower explosive limit, respectively.

Staining/Odors – Project personnel will assess excavated soils for visual and olfactory indications of potential impacts. Soils where visual or olfactory impacts are observed must be screened with field instrumentation to allow it to be designated for unrestricted use or stockpiled and managed. If potentially impacted soil is identified, excavation within proximity to the impacted area will then only continue under the observation of the MMP Supervisor. The utmost care should be taken to separate “clean” soils from potentially impacted soils. Once the MMP Supervisor confirms that excavation has transitioned into clean soils and potentially impacted material is no longer being excavated, the stockpiled material will be sampled for characterization and waste disposal purposes. Soil sampling analytical parameters are provided in Section 5.3 and the soil reuse criteria is provided in Section 7.

Field Instruments – Field instruments will be utilized on an as-needed basis, particularly if petroleum- or solvent-impacted soil is suspected and is being disturbed. A photoionization detector (PID) or flame ionization detector (FID) (related to heavy petroleum hydrocarbons such as oil or grease) may be used in the field to screen for non-specific volatile organic compounds (VOCs). If PID/FID concentrations exceed 50 parts per million (ppm), sampling will be required.

5.3 Soil Sampling

Soil sampling will be conducted in accordance to the CCD Guidance for Reuse of Soil on City Projects, dated October 5, 2017 (Appendix D).

5.4 General Soil Stockpiling Requirements

If uncharacterized materials are encountered, the material must be temporarily stockpiled on 6 mil plastic sheeting and covered pending receipt of the results of laboratory analysis in accordance with the soil sampling protocols identified in the CCD Guidance for Reuse of Soil on City Projects document, dated October 5, 2017. Stormwater best-management practices (BMPs) as identified in the Storm Water Management Plan (SWMP), which the Contractor will be responsible for procuring, will be applied to the stockpiles of potentially impacted material to prevent contact with stormwater runoff and erosion. Stockpiles of potentially impacted soil will be limited to a maximum of 500 cubic yards each. All other soils must be handled in accordance with the SWMP. This general stockpiling requirement does not apply if RACS is suspected or confirmed to be present (see Section 5.5 below).

5.5 Regulated Asbestos-Contaminated Soils (RACS)

If suspect HUF, debris, household waste, or RACS is identified by the Contractor or CABI, work in the area must stop immediately, the area must be secured, and the MMP Supervisor/CABI and DDPHE will evaluate the situation.

Oversight and documentation of RACS shall be conducted by a CABI who meets the training requirements as defined in Section 3.2 of this MMP. A CABI must be present during soil moving and earth-moving activities, including excavations, at all times and at each work location where excavations are taking place. All RACS management will be performed by a Contractor capable of meeting the requirements in CDPHE Section 5.5 and Reg 8 (Appendix B) as documented by a CABI. If suspect RACS is discovered, the critical requirement is to avoid generating or being in direct contact with airborne dust, avoid disturbing the material unless the requirements of CDPHE Section 5.5 and Reg 8 have been met, and immediately stop work in the area until proper protocols are put in place. The MMP Supervisor/CABI must notify the CCD Project Manager and DDPHE immediately.

The Contractor is ultimately responsible for ensuring that RACS is characterized and managed in accordance with CDPHE Section 5.5 (Appendix B). Asbestos associated with buried utilities, including asbestos-covered irrigation and pipe lines may be encountered during soil moving and earth-moving activities. If asbestos is excavated and is still part of a former building system component (not broken or spread out), that material is not considered RACS, but must be abated per Reg 8. The Contractor should avoid activities that would break, crumble, powderize, or spread the ACM to avoid converting it into RACS, which is more onerous to abate. Asbestos-wrapped pipe should be carefully dug around until fully exposed. This will allow an abatement contractor to wrap and cut the asbestos-wrapped pipe for easier abatement and disposal. **Confirmation with DDPHE will be required to address how RACS will be mitigated, if encountered.**

6. Special Wastes

Although not anticipated, other special wastes could include items such as drums, underground storage tanks (USTs), chemical or fuel containers, slag, coal, ash, biological waste, potential PCB-containing electrical equipment (e.g. transformers, light ballasts, voltage regulators, capacitors and circuit breakers), batteries, tar, and sludge. These materials may be present in small quantities and can be difficult to characterize. Upon identification of special wastes, excavation at that location will cease until additional assessment by the MMP Supervisor can be completed. The MMP Supervisor will attempt to assess special wastes based on prudent and safe observation of the following:

- Handling of any special wastes will only be conducted under the direction of the MMP Supervisor and will be minimized whenever possible.
- If it is safe to move, special waste will be containerized or be placed on polyethylene plastic sheeting and covered, until additional assessment has been completed by the MMP Supervisor (the time frame will allow for laboratory testing and obtaining a profile and manifest for disposal).
- The special waste will remain covered or containerized until final removal.
- Stockpile requirements as described in Section 5.4 will apply and stockpile areas will be secured to prevent contact with unauthorized personnel and the public.
- The material will be characterized per the MMP and manifests will be obtained before it is disposed of off-site, and the material will be disposed of as soon as possible. If additional assessment of this material indicates that the material does not meet applicable regulatory requirements for disposal as a non-hazardous waste, the MMP Supervisor will arrange for off-site disposal at a licensed hazardous waste facility, or other appropriate disposal site.
- Special wastes that are generated will be managed in accordance with applicable local, state and federal regulations.
- Where potentially impacted material is determined to be non-hazardous by the MMP Supervisor, the material may be disposed of as non-hazardous solid waste at DADS.

6.1 Drums or Waste Containers

When drums or waste containers are identified, the Contractor will make note of any of the following conditions and notify the MMP Supervisor and DDPHE.

- Indications of unsafe conditions, including swelling drums, leaking, fumes, odors, etc.
- Markings and or labels on containers/drums, condition of the containers/drums (e.g., rust, holes, damage, corrosion) and other indications of contents.
- Pressurized/swelling drums, suspected explosives, potentially shock-sensitive materials or other potentially dangerous items will not be handled until a person with appropriate experience with these situations has been consulted.

6.2 Slag, Coal, Ash

Slag, coal, or ash cannot be reused on the project and will be disposed at DADS unless the waste does not meet the DADS waste acceptance criteria (i.e. fails TCLP analysis). These materials should be sampled in accordance with the requirements to dispose of the material at the DADS landfill. If the material cannot be accepted at the DADS landfill, additional sampling may be required by the alternate receiving facility. Ash is frequently associated with RACS and must be managed in accordance with CDPHE Section 5.5 and Reg 8 (Appendix B).

6.3 Electrical Equipment (PCBs)

If any potential electrical equipment (including transformers, light ballasts, voltage regulators, capacitors and circuit breakers) suspected of containing PCBs is identified, it will be segregated, analyzed, and depending on PCB concentrations, transported off-site for disposal at a PCB-permitted disposal facility, if necessary. Until testing is completed, any electrical equipment visually identified during excavation will be assumed to contain PCBs. Equipment where the absence of PCBs has been verified may then be disposed as solid waste, or recycled. Waste Management will accept materials where PCB concentrations are less than 50 parts per million. If this material will be disposed at DADS, the MMP Supervisor will work with DDPHE to complete a WM PCB Certification, which must include copies of analytical reports confirming the PCB concentrations.

6.4 Biological Waste

Biological waste includes the following types of waste specified in Colorado Solid Waste Regulations 6 CCR 1007-2, Section 13:

- Biohazardous waste
- Blood and body fluids
- Infectious waste
- Medical waste
- Pathological waste
- Pharmaceutical waste
- Potentially infectious waste

Biological wastes are regulated as solid waste under Colorado Solid Waste Regulations 6 CCR 1007-2 Section 13. Biological wastes should not be handled and work should be shut down upon discovery of biological waste. The Contractor will contact the MMP Supervisor and DDPHE and wait for the appropriate support personnel and evaluation prior to continuing work.

7. Reuse Criteria

Soil must meet the unrestricted/residential criteria for onsite reuse in accordance with CCD's Guidance for Reuse of Soil on City Projects, dated October 5, 2017.

Any and all off-Site reuse of soil excavated from the Site requires DDPHE approval. The following sections are presented as references for proper soil disposal.

7.1 Non-Hazardous Disposal

If the soil is not suitable for reuse per CCD's Guidance for Reuse of Soil on City Projects, dated October 5, 2017, it must be disposed at the City-owned Denver Arapahoe Disposal Site (DADS) in accordance with the City's Executive Order No. 115. DADS will not accept hazardous or liquid waste; therefore, if encountered, this waste must be handled in accordance with Section 7.2.

The Contractor, MMP Supervisor, and DDPHE must coordinate before the project begins to obtain DADS approval/waste profile, and waste manifests. It is possible, as limited sampling has been conducted, additional sampling may be required before a waste profile is approved and waste manifests are issued.

Solid waste including HUF and debris, and non-hazardous waste including geotechnically unsuitable soils or soils with constituents of concern at concentrations above EPA RRSLs (not characterized as hazardous or liquids, see Section 7.5), must be transported off-Site to DADS. **These materials may not be reused on-Site.**

DADS will accept solid material where concentrations as determined by the TCLP are less than 20 times the toxicity characteristic maximum concentration, this is referred to as the "20 times rule". The EPA TCLP Maximum Concentrations of Contaminants are provided as Appendix C. Soils with constituents of concern exceeding the 20 times rule during the project will also require TCLP evaluation.

Note: Certain waste streams are specifically excluded in the Solid Waste Regulations (CDPHE, 2011b). The MMP Supervisor (and as approved by CCD) will be responsible for ultimate classification for disposal.

7.2 Hazardous Waste Disposal

If sample analysis indicates that the soil is designated as hazardous waste, the soil will be containerized immediately in a lined roll-off box, labeled, and transported to a designated storage area (either on-site or off-site) pending off-site disposal at a hazardous waste disposal facility. Waste manifests must be completed for the material prior to transportation to the disposal facility in accordance with state and federal regulations. Once identified as hazardous waste, this material may not be stored on-site longer than 90 days.

The Deer Trail Landfill operated by Clean Harbors Environmental at 108555 East Highway 36 in Deer Trail, Colorado is the only facility within Colorado licensed to accept hazardous waste. The next closest licensed hazardous waste disposal facilities are located in Nebraska, Utah and Texas. Manifestation and transportation of these waste materials on public highways, streets, or roadways will be in accordance with 49 CFR and any applicable Department of Transportation regulations.

8. Construction Water Handling Procedures

Construction water may consist of stormwater, surface water, groundwater, and leachate and will be addressed using the following procedures. The section of the MMP must be updated by the Contractor upon issuance of a construction dewatering permit from CDPHE.

8.1 Stormwater

The Contractor is required to obtain all applicable permits related to construction stormwater compliance with either or both the CDPHE, or the CCD, and implement best management practices and verify compliance in accordance with those permits. Additional information may be found here:

https://www.denvergov.org/content/dam/denvergov/Portals/705/documents/guidelines/PWES-007.0-Construction_Activities_Stormwater_Manual.pdf.

8.2 Groundwater

Groundwater flow is expected to mimic the topography of the Site; groundwater is expected to flow east towards the South Platte River and was encountered at around 4.75 feet bgs at test trench TP-04, which is located at the southern portion of the Site. Test trenches TP-01 and TP-02 were completed to 7.5 and 8 feet bgs respectively, and groundwater was not encountered (Appendix A).

Groundwater that may be encountered during subsurface construction activities will require sampling and analysis prior to discharge as part of the dewatering permit. Water from dewatering operations shall not be directly discharged into any waters of the State, including wetlands, irrigation ditches, canals, or storm sewers, unless allowed by the permit. Unless prohibited by law or otherwise specified in the Contract, the water from dewatering operations shall be contained in tanks in locations approved by the CCD Project Manager, treated for discharge in accordance with the dewatering permit, or shall be hauled away from the Project for proper disposal in accordance with applicable laws and regulations.

Evaluation of water disposition will be conducted in coordination with the MMP Supervisor and CCD. If results of sampling indicate that groundwater has been impacted at concentrations exceeding the appropriate CDPHE standard, the Contractor must understand that the CDPHE will not allow this water to be discharged without appropriate permitting and/or treatment. Groundwater sampling for benzene, toluene, ethylbenzene, and xylene (BTEX) was completed at the Site on August 25, 2017. BTEX was not detected in the sample above the laboratory detection limit (Appendix A).

In the event that groundwater is encountered, the Contractor will implement the most cost effective method of groundwater handling and disposal that meets state and federal regulations. If the Contractor intends to treat groundwater for discharge into a waters of the State, the Contractor must abide by the standards set forth in the Remediation Activities Discharge to Surface Water permit COG315000 (Appendix E). At the time of completion of this MMP, the dewatering permit had yet to be approved by the CDPHE-WQCD. The Contractor will be responsible for ensuring that an approved permit is in place prior to initiating construction activities. Once the dewatering permit has been transferred to the Contractor, the Contractor must include the permit as Appendix E, and maintain a copy of the permit on-site during construction.

A Remediation Activities Management Plan (RAMP) must be completed prior to discharge activities taking place. In accordance with permit procedures, the Contractor shall fill out and submit monthly Discharge Monitoring Reports (DMRs) to CDPHE-WQCD for the life of the permit, even if discharge activities are not conducted. Copies of monthly submittals shall be provided to the City.

The following are some general provisions; however, any requirements noted on the permit(s) take precedence over this MMP.

- Untested groundwater or groundwater that does not meet the discharge standards will not be discharged onto the ground or into sanitary or storm sewers.
- Groundwater that does meet discharge standards as evaluated by the MMP Supervisor may be discharged in accordance with applicable federal, state, and local regulations, or may be used on-site for moisture treatment of engineered fill material, or for dust suppression (assuming it meets Colorado Ground Water Standards). Use of groundwater for moisture treatment or dust suppression must be confirmed to be in compliance with water rights before implementation.
- Where chemical concentrations in groundwater are above permit limits, the water will either be permitted and treated on-site or transported off-site and disposed at a licensed treatment facility.
- The MMP Supervisor will discuss treatment and/or disposal options with the CCD Project Manager, and the CCD Project Manager will provide direction to the Contractor, who will be responsible for water treatment and/or disposal in accordance with the Contractor's approved permits.

8.3 Leachate

Materials excavated from below the groundwater table have the potential to generate liquids. If saturated materials are encountered, stockpile areas will be constructed to drain material before re-use as engineered fill, or transport for off-site disposal.

Generated liquids will drain to a central sump which must be of sufficient capacity to prevent overflowing. The sump will be excavated into the ground and sloped to a central location. It will also be lined with 10-mil polyethylene sheeting; a layer of gravel will be implemented to hold the sheeting in place and will extend beyond the edge of the sheeting. A berm will be placed around the sump to prevent surface water from commingling with the generated leachate water. Liquids accumulated within the sump will be submitted for analysis by the Contractor and coordinated with the MMP Supervisor. If constituents in the water exceed the surface water standards or CDPHE-WQCD permit limits (if applicable), the water must either be disposed at a licensed disposal facility with appropriate waste profiles and manifests or be treated to meet those standards before discharge (in accordance with the discharge permit). Solid wastes generated during this process must also be evaluated in accordance with sampling procedures prior to disposal; if this material will require disposal off-site, it must pass the paint filter test (U.S. EPA Method 9095A) prior to disposal at a licensed solid waste disposal facility.

9. Additional Requirements

9.1 Dust

In accordance with 5 CCR 1001 – AQCC Regulations, the Contractor will obtain an Air Pollution Emissions Notice (APEN) and Application for Construction Permit, if required. The Contractor will take reasonable measures to prevent particulate matter from becoming airborne and to prevent the visible discharge of fugitive particulate emissions beyond the property boundary on which the emissions originate. The Contractor shall provide sufficient quantities of equipment and personnel for dust control sufficient to prevent dust nuisance on and about the Site. Blowing dust and airborne particulates shall be controlled by wetting or other means, if approved by the MMP Supervisor and Project Manager. Dust control agents shall be applied in accordance with manufacturer’s recommendations. The measures taken must be effective in the control of fugitive emissions at all times on the site, including periods of inactivity such as evenings, weekends, and holidays as well as any other periods of inactivity.

9.2 Decontamination of Heavy Equipment

Equipment that has come into contact with potentially impacted waste as identified by the MMP Supervisor will be decontaminated prior to leaving the project site to prevent impacted material and/or soil with nuisance weed seeds from being spread off-site. Gross removal of material from equipment will be completed using hand tools such as shovels, brooms and brushes. If the MMP Supervisor finds it necessary, more thorough decontamination may be required such as pressure washing. Spent decontamination water will be collected in basins and pumped into water containers. The Contractor will be responsible for analyzing the waste-water and working with the MMP Supervisor and City to evaluate final disposal options in accordance with applicable federal, state and local regulations. A minimum of 10-mil polyethylene liner shall be placed beneath equipment needing decontamination to collect residual materials and prevent unauthorized dispersal of liquids.

9.3 Site Security

The Contractor will be responsible for maintaining effective access control for the project.

9.4 Monitoring Wells

Two groundwater monitoring wells were installed during subsurface investigations and will likely be abandoned prior to starting construction. Other monitoring wells are not anticipated; however, if groundwater monitoring wells are encountered, special care will be taken so as not to disturb their structural integrity. If this is not possible, the well will be properly abandoned and replaced after construction (if needed) as coordinated and conducted by the MMP Supervisor. DDPHE shall be notified and will coordinate abandonment of monitoring wells.

9.5 Complaints

Any complaints received by the Contractor will be immediately reported to the CCD Project Manager. Additionally, any environmental-related complaint, such as noise, odor, or dust, will be immediately reported to DDPHE. Complaints must be addressed within 24 hours.

10. Imported Materials

Any soils, including embankment and/or topsoil, brought to the Site must meet the Unrestricted Reuse Criteria.

For each source of imported embankment or topsoil:

- The Contractor shall assure and certify that unacceptable concentrations of constituents in the analyses described below in Section 10.1, including but not limited to those defined in the 40 CFR Part 261 Subparts C and D, and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Section 101(14) as amended, are not incorporated into the project as a result of importing embankment or topsoil materials.
- The Contractor shall submit such certification to DDPHE and the City Project Manager, signed and stamped (or sealed) by one of the following:
 - A qualified environmental consultant
 - Certified Industrial Hygienist (CIH)
 - Certified Hazardous Materials Manager (CHMM)
 - Registered Professional Engineer (PE)
 - Certified Safety Professional (CSP)
 - Registered Environmental Manager (REM)
- Additionally, the material must be visually evaluated by a CABI, and be determined free of confirmed or suspected RACS, solid waste, debris, and demolition materials.

If Contractor source material for embankment or topsoil, originating outside of the project limits, is placed at the project and was not cleared through the sampling protocols described in Section 10.1, the Contractor shall remove the material from the project, dispose of it in accordance with applicable laws and regulations, and make necessary restoration. This work will be the sole burden of the Contractor.

The cost of complying with these requirements, including sampling, testing, and corrective action by the Contractor, will not be paid for separately, and shall be included in the work.

10.1 Sample Analysis and Frequency

Representative samples of proposed import fill shall be collected at a frequency of one sample for every 500 cubic yards, per the CCD Guidance for Reuse of Soil on City Projects, dated October 5, 2017 (Appendix D). Samples will, at a minimum, be analyzed for the following constituents:

- VOCs
- Semi-Volatile Organic Compounds (SVOCs)
- Total Petroleum Hydrocarbons (TPH)
- Pesticides

- Herbicides
- PCBs
- The eight Resource Conservation and Recovery Act (RCRA) 8 Metals
- Asbestos – if debris is found and if suspect ACM is found in the debris

The DDPHE may adjust the frequency of sample analysis, and analysis requirements, at its discretion.

10.2 Imported Fill Documentation

Certification documentation shall be provided to the City Project Manager and DDPHE for approval prior to being brought to the project site.

II. Reporting

Upon project completion, the MMP Supervisor/CABI will prepare a summary report detailing the work performed at the project specifically related to the implementation of this MMP. The report will include the following:

- Detailed documentation of the on- or off-site soil disposition
- Maps showing the locations of site features related to this MMP, including sample locations, location of wastes discovered, and any other important features identified during the implementation of this MMP
- Field Screening and analytical data
- Summary and copies of analytical results/reports
- Summary of material quantities that were managed and the procedures used
- Location and manner of soil use (ie., embankment fill, surface soil, etc.) including any cover materials (soil, asphalt, etc.)
- Representative site photographs showing soil reuse areas
- A reference to the proximity to groundwater (must meet requirements described in Section 7.1)
- Documentation or approvals for reuse of materials containing debris or soil categorized as Restricted Reuse
- Waste profiles and waste manifests for all solid waste, soil, water or other material transported off-site for disposal
- Any other documentation detailing important features related to this project
- If RACS and/or Non-RACS is encountered during construction, documentation and reporting in accordance with CDPHE Section 5.5 and Reg 8

12. References

CCD, 2016. "Interoffice Memorandum, Limited Environmental Screen for Tejon and Asbury Park," Denver Environmental Health Department, March 24, 2016.

CDPHE, 2011a. "Risk Management Guidance for Evaluating Arsenic Concentrations in Soil." Colorado Department of Public Health and Environment, Hazardous Materials and Waste Management Division, June 2011.

CDPHE, 2011b. "Regulations Pertaining to Solid Waste Disposal Sites and Facilities, 6 CCR 1007-2, Part 1." Prepared by the Colorado Department of Public Health and Environment, Hazardous Waste Unit, August 22, 2011.

Appendix A Site Characterization Technical Memorandum

Site Characterization Technical Memorandum

Date: December 18, 2017

Subject: Tejon and Asbury Park Water Quality Project

Site Characterization Activities

This Memorandum serves as an attachment to the Materials Management Plan (MMP) for the subject project. References noted herein may be found in the references section of the MMP.

Project Background

The City and County of Denver (CCD) has proposed water quality improvements for Tejon and Asbury Park. The project area is located to the northwest and southwest of the West Asbury Avenue and South Tejon Street intersection, and is bisected by West Asbury Avenue (Figure 1).

Excavations are primarily proposed to be completed within the park property. The existing concrete trickle channel which extends north to south through the park will be replaced with constructed wetland channels and basins. Improvements will also include installation of new concrete walks, maintenance trails, a crusher fines trail, stepping stone weir, and expansion and renovation of the playground.

The CCD Department of Environmental Health (DEH), completed a Limited Environmental Screen for Tejon and Asbury Park and the findings were presented in an Interoffice Memorandum dated March 24, 2016. DEH's review of historical site uses did not identify evidence of environmental conditions in connection with the project area. The Denver Radium Superfund Site, CST Metro Corner Store closed leaking-underground storage tank (LUST) site, and the Circle K Store open LUST site, were identified within a quarter mile of the project area, with each of the sites being either down-gradient or cross-gradient. A soil sample was collected for landfill waste characterization purposes, four test trenches were completed to evaluate subsurface soil conditions, and a groundwater sample was collected to support a Remediation Activities Discharging to Surface Water Permit with the Colorado Department of Public Health and Environment (CDPHE) – Water Quality Control Division (WQCD).

Soil Sampling

Based on the findings of the DEH Interoffice Memorandum, Pinyon collected one composite soil sample from the project area on May 22, 2017. The composite sample, SS-01, was made up of four aliquot samples collected from the project area (Figure 2). Each of the four aliquots were collected from a depth of approximately one foot below ground surface (bgs).

No staining, odors, or other evidence of soil impacts were identified in the aliquots. Pinyon collected each aliquot using a hand-auger and a one-cup volume measuring cup. Once the auger reached a depth of around one foot bgs, Pinyon measured one cup worth of soil, from each location, and placed into a zip-lock bag. The four aliquots were thoroughly mixed in the sealed zip-lock bag. Once mixing was completed the soil was placed in laboratory supplied sample containers, labeled, placed on ice, and submitted under chain of custody controls, to Origins Laboratory, Inc. (Origins), of Denver, Colorado (attached). The samples were collected to support

a waste profile at the Denver-Arapahoe Disposal Site (DADS) per CCD and Waste Management requirements. The samples were analyzed for the following:

- Volatile Organic Compounds (VOCs) by Environmental Protection Agency (EPA) Method 8260C
- Polycyclic Aromatic Hydrocarbons (PAHs) by EPA Method 8270D SIM
- The eight Resource Conservation and Recovery Act (RCRA 8) Metals by EPA Method 9010C and 7471A
- Toxicity Characteristic Leaching Procedure (TCLP) for lead by EPA Method 1311/6010C
- Polychlorinated Biphenyls (PCBs) by EPA Method 8082A

Soil analytical results were compared to the EPA Regional Screening Levels for residential and composite worker soil (RRSL and CWRSL), the CDPHE Groundwater Protection Values, and the “20 Times Rule”. Waste Management (the operator of the DADS) will accept solid material where concentrations as determined by the TCLP method are less than 20 times the EPA Toxicity Maximum Concentrations of Contaminants; this is referred to as the “20 Times Rule”. As an example, the regulatory level for lead provided by the EPA Toxicity Maximum Concentrations of Contaminants is 5.0 milligrams per liter (mg/L) when analyzed by TCLP. The Waste Management acceptable limit, when analyzed by totals analysis, would then be less than 100 milligrams per kilogram (mg/kg), using the 20 Times Rule. If concentrations of any contaminant exceed the 20 Times Rule by totals analysis, then analysis for TCLP is required. If the TCLP results exceed the toxicity characteristic maximum concentration, then the material would require disposal at a hazardous waste disposal site in accordance with CDPHE requirements. The 20 Times Rule for lead is 100 mg/kg, which is below the RRSL. This value is commonly exceeded; therefore, lead was automatically analyzed by the TCLP method regardless of the detected concentrations.

Due to high levels of naturally occurring arsenic in Colorado, instead of using the RRSL or the IRSL, the CDPHE has established a risk-based screening level for arsenic of 11 mg/kg (Table 1).

Table I – Soil Analytical Table (Detected Parameters)

						Sample ID	SS-01
						Sample Date	5/22/2017
						Matrix	Soil
Chem Name	Units	40 CFR Part 261 Rule of 20	CDPHE Groundwater Protection Values	USEPA RSLs Composite Worker Soil THQ=1.0	USEPA RSLs Resident Soil THQ=1.0		
TCLP Metals by 1311/6010C							
TCLP Lead	mg/L	5	NV	NV	NV	0.0453 J	
Total Metals by 6010C							
Arsenic*	mg/kg	100	NV	11*	11*	2.84 J	
Barium	mg/kg	2000	NV	230,000	15,000	228	
Cadmium	mg/kg	20	NV	980	71	1.06	
Chromium (III+VI)	mg/kg	100	NV	NV	NV	14.9	
Lead	mg/kg	100	NV	800	400	46.8	
Selenium	mg/kg	20	NV	5,800	390	9.41	
Silver	mg/kg	100	NV	5,800	390	0.340 J	
Total Metals by 7471A							
Mercury	mg/kg	4	NV	46	11	0.0824	
PCB by 8082A							
Arochlor 1260	mg/kg	NV	1000	0.99	0.24	0.016	
PAH by 8270D SIM							
Acenaphthylene	mg/kg	NV	NV	NV	NV	0.00801 J	
Anthracene	mg/kg	NV	1000	230,000	18,000	0.0176	
Benz(a)anthracene	mg/kg	NV	1000	21	1.1	0.131	
Benzo(a) pyrene	mg/kg	NV	1000	2.1	1.1	0.167	
Benzo(b)fluoranthene	mg/kg	NV	1000	21	1.1	0.231	
Benzo(g,h,i)perylene	mg/kg	NV	NV	NV	NV	0.127	
Benzo(k)fluoranthene	mg/kg	NV	1000	210	11	0.0913	
Chrysene	mg/kg	NV	1000	2,100	110	0.183	
Dibenz(a,h)anthracene	mg/kg	NV	1000	2.1	0.11	0.0304	
Fluoranthene	mg/kg	NV	1000	30,000	2,400	0.251	

		Sample ID	SS-01				
		Sample Date	5/22/2017				
		Matrix	Soil				
Chem Name	Units	40 CFR Part 261 Rule of 20	CDPHE Groundwater Protection Values	USEPA RSLs Composite Worker Soil THQ=1.0	USEPA RSLs Resident Soil THQ=1.0		
PAH by 8270D SIM							
Fluorene	mg/kg	NV	1000	30,000	2,400	0.00801 J	
Indeno(1,2,3-c,d)pyrene	mg/kg	NV	1000	21	1.1	0.13	
Phenanthrene	mg/kg	NV	NV	NV	NV	0.109	
Pyrene	mg/kg	NV	1000	23,000	1,800	0.364	

Notes:

THQ=1.0- U.S. EPA Regional Screening Levels with a Total Hazard Quotient of 1.0 for Residential and Composite Worker Soils (EPA, 2017)

40 CFR Part 261 Rule of 20 – 20 times the EPA Toxicity Characteristic – Maximum Concentration of Contaminants

TCLP – toxicity characteristic leaching procedure

PCB – polychlorinated biphenyl

PAH – polycyclic aromatic hydrocarbon

CDPHE – Colorado Department of Public Health and Environment

NV – No regulatory value

mg/kg – milligrams per kilogram

mg/L – milligrams per liter

J – Greater than the detection limit but less than the reporting limit

* - Colorado has a state specific CDPHE screening value for arsenic, 11 mg/kg

Soil Results Discussion

No staining, odors, other evidence of soil impacts, or debris were noted from the four aliquots, which were composited into soil sample SS-01. Several metals, one PCB, and several PAHs were detected above the laboratory detection limit; however, none of the detected parameters exceeded their respective regulatory or screening values.

Test Trench Excavations

On November 16, 2017, Pinyon’s EPA and state accredited Certified Asbestos Building Inspector (CABI) who meets the training requirements described in the CDPHE, Hazardous Materials and Waste Management Division 6 CCR 1007-2, Part 1, Regulation Pertaining to Solid Waste Sites and Facilities, Section 5.5.3 (D), provided oversight during the completion of four test trench excavations. The trenches were completed in areas where the greatest volume of earth-moving activities is planned to occur (Figure 2). The trench depths were based on the proposed construction excavation depths, with the depths ranging from five to eight feet bgs (Table 2).

Table 2 – Summary of Field Observations and laboratory Results

Test Pit ID	GPS Coordinates	Layer Depth (feet)	Layer Status	Non-Suspect Material Observed	Soil Description	Suspect Material Observed	Sample ID	Sample Result
TP-01				Glass	Grass layer followed by medium brown lean sandy clay with calcareous deposits, angular gravel, and oxidized soil.	Mortar at 1.5 feet below ground surface	TP-01(1)	ND
			2-3	None	Copper brown to medium brown lean clay with sand,	None	NA	NA
			3-7	None	Copper brown to medium brown lean clay with sands.	None	NA	NA
			7-7.5	None	Weathered bedrock.	None	NA	NA

- Key**
- No building debris observed
 - Construction debris with no associated suspect materials observed (asphalt, wood, concrete, metal, plastic, glass, red brick)
 - Suspect material observed and tested, but reported as no asbestos detected
 - Confirmed non-friable asbestos by testing
 - Confirmed friable asbestos by testing
 - NA Not Applicable
 - ND No asbestos detected

Test Pit ID	GPS Coordinates	Layer Depth (feet)	Layer Status	Non-Suspect Material Observed	Soil Description	Suspect Material Observed	Sample ID	Sample Result
TP-02	39.680781° -105.012164°	0-1		None	Dark brown lean clay with sands, some calcareous pockets, and organic roots.	None	NA	NA
		1-2		None	Dark brown lean clay with sands, large gravel, some calcareous pockets, and organic roots.	None	NA	NA
		2-8		None	Brown weathered bedrock	None	NA	NA



Key

- No building debris observed
- Construction debris with no associated suspect materials observed (asphalt, wood, concrete, metal, plastic, glass, red brick)
- Suspect material observed and tested, but reported as no asbestos detected
- Confirmed non-friable asbestos by testing
- Confirmed friable asbestos by testing
- NA Not Applicable
- ND No asbestos detected

Test Pit ID	GPS Coordinates	Layer Depth (feet)	Layer Status	Non-Suspect Material Observed	Soil Description	Suspect Material Observed	Sample ID	Sample Result
TP-03	39.680205° -105.011774°		0-4	Confirmed friable asbestos by testing	Glass	Brown silty sands	Gray fibrous material at two feet below ground surface. Brick was sampled at TP-04	TP-03(1) TP-04 ND
			4-7	Construction debris with no associated suspect materials observed (asphalt, wood, concrete, metal, plastic, glass, red brick)	Wood	Gray lean clay	None	NA

- Key
- No building debris observed
 - Construction debris with no associated suspect materials observed (asphalt, wood, concrete, metal, plastic, glass, red brick)
 - Suspect material observed and tested, but reported as no asbestos detected
 - Confirmed non-friable asbestos by testing
 - Confirmed friable asbestos by testing
 - NA Not Applicable
 - ND No asbestos detected

Test Pit ID	GPS Coordinates	Layer Depth (feet)	Layer Status	Non-Suspect Material Observed	Soil Description	Suspect Material Observed	Sample ID	Sample Result
TP-04	39.679630° -105.011600°	0-1		Plastic	Brown silty sands with organic roots	None	NA	NA
		1-3		Concrete with no associated suspect material and glass	Lean clay with sands	Brick and mortar	TP-04(1): Mortar TP-04(2): Red Brick	TP-04(1): ND TP-04(2): ND
		3-5		Concrete with no associated suspect material and glass	Lean clay with sands	Red Brick	NA	NA



- Key
- No building debris observed
 - Construction debris with no associated suspect materials observed (asphalt, wood, concrete, metal, plastic, glass, red brick)
 - Suspect material observed and tested, but reported as no asbestos detected
 - Confirmed non-friable asbestos by testing
 - Confirmed friable asbestos by testing
 - NA Not Applicable
 - ND No asbestos detected

Test Trench Results Discussion

Debris was encountered in three of the four trenches (TP-01, TP-03, and TP-04). The debris included brick and mortar, glass, concrete, plastic, wood, and a gray fibrous material. A total of four suspect asbestos containing material (ACM) samples were collected from the three trenches (Table 2). The samples were submitted to Reservoirs Environmental Laboratory (Reservoirs), a National Voluntary Laboratory Accreditation Program (NVLAP) accredited lab, for analysis of asbestos using polarized-light microscopy (PLM) by EPA Method 600/R-93/116. Based on the PLM analysis, one of the materials, TP-03(1) which is a gray fibrous material encountered at two feet bgs in TP-03, was found to be an ACM (Table 2). An approximately two-inch by four-inch piece of gray fabric was collected. Although it was not clearly identifiable during sampling, the lab analytical report indicated that the material is a gray fibrous plaster, indicating that it may have been part of a pipe wrap. Only one piece of the material was encountered with the entire piece of fabric collected for the sample. This was the only piece of the gray fabric that was encountered during the test trench excavations.

Soil samples were not collected during the test trench excavation because a sample was already collected during the initial soil sample event and because impacted soil was not observed.

Groundwater Sampling

A groundwater sample was collected and submitted for laboratory analysis, on August 25, 2017, from monitoring well MW-01 (Figure 2). Groundwater was observed at 18.2 feet bgs. The Denver Radium Superfund Site is located within a quarter mile of the project area, but the CDPHE has not historically required analysis for the parameters listed on the Remediation Discharge Permit application for this superfund site. The Circle K Store LUST site is located within a quarter mile of the project area. Because of the proximity of the Circle K Store LUST site, the groundwater sample was submitted for benzene, toluene, ethylbenzene, and xylenes (BTEX) analysis by EPA Method 8260C.

Groundwater Results Discussion

No odors or sheen were observed from the groundwater at monitoring well MW-01. BTEX was not detected above the laboratory detection limit.

General Discussion

Recommendations regarding this investigation will be incorporated into the Project MMP, which will include discussions on the depth of construction, permit requirements, and methodology for handling potentially impacted media.

Limitations

This report was prepared by Pinyon Environmental, Inc., at the request of and for the sole benefit of the City and County of Denver (CCD), or any entity controlling, controlled by, or under common control with CCD. The information offered in this report are based on the data obtained from a limited number of samples. Soil and groundwater conditions typically vary even over short distances. Thus, the nature and extent of variations outside the subsurface investigation may not become evident except through further investigation.

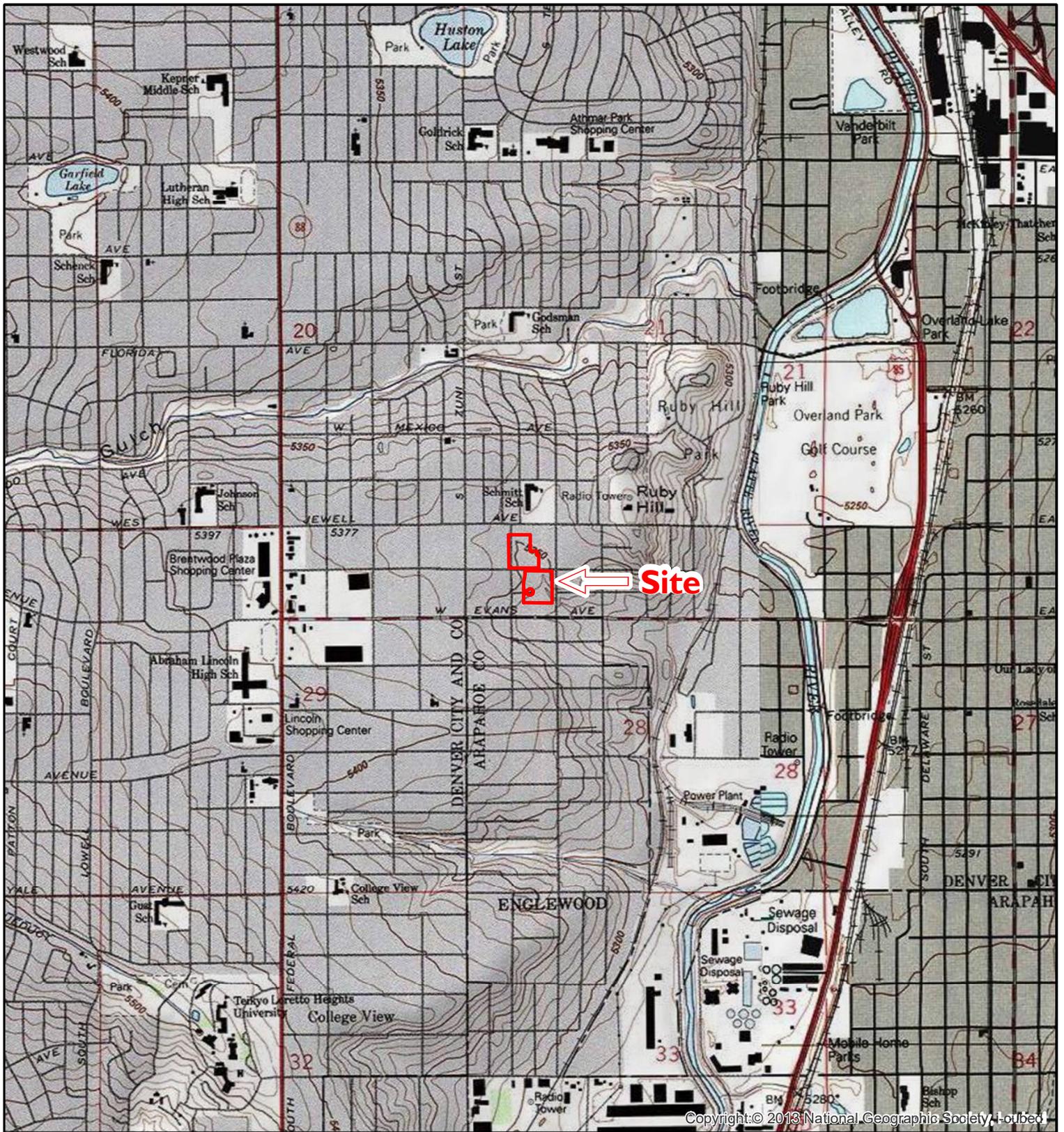
This report is the exclusive and present use for CCD, or any entity controlling, controlled by, or under common control with CCD. Laboratory analysis has been performed for specific constituents during the course of this investigation, as described in the text. This study makes no attempt to assess constituents not searched for in the laboratory analysis.

Attachments:

Figures

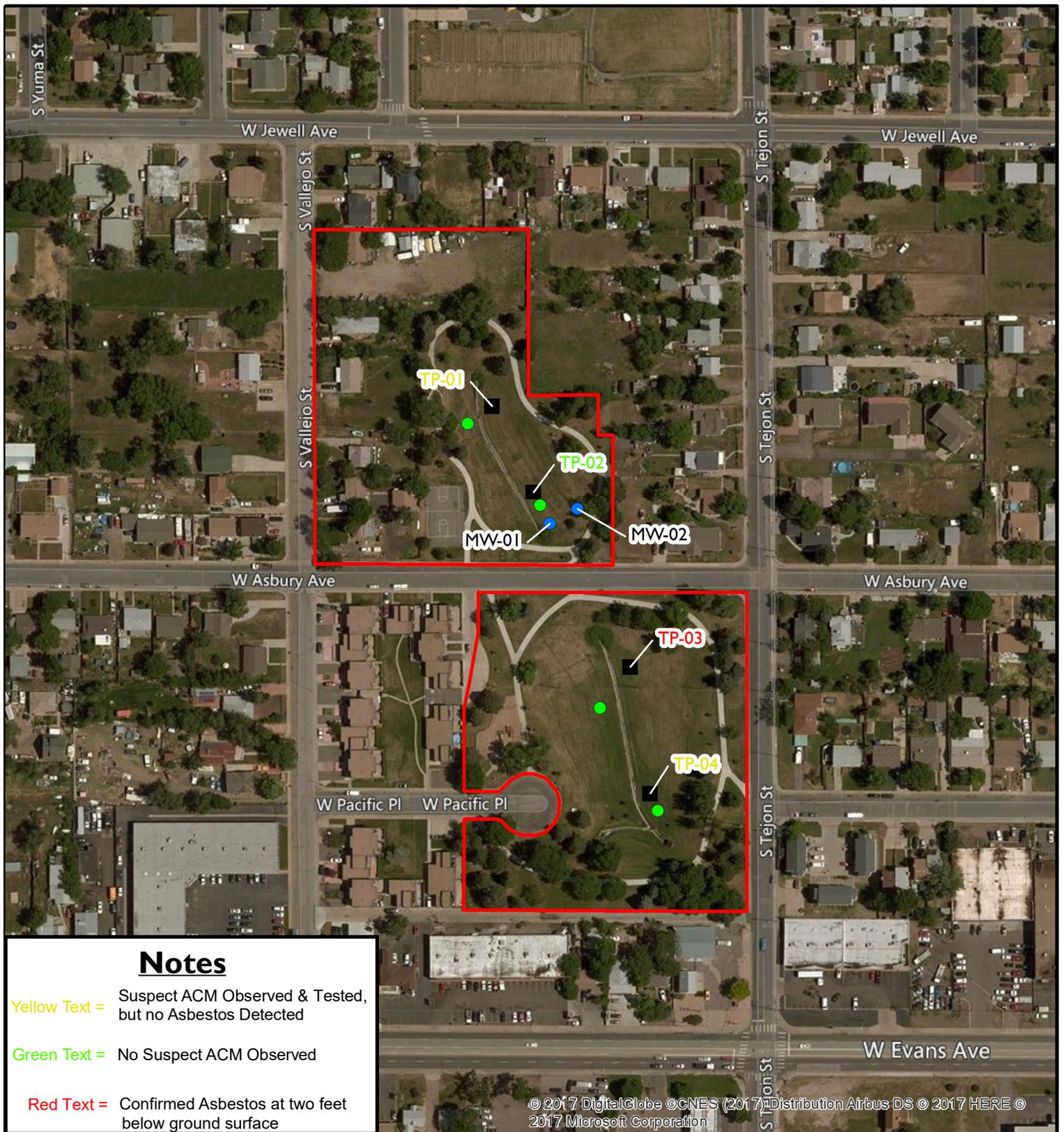
CABI Certification

Analytical Reports for Soil, Asbestos, and Groundwater



Copyright © 2013 National Geographic Society, I-cubed

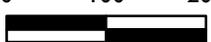
<p>N</p> <p>Legend</p> <p> Site Boundary</p> <p>USGS 7.5' Topographic Map Fort Logan, Colorado 1965 (Revised 1994)</p>	<p>0 1,000 2,000</p> <p> Feet</p>	<p>Pinyon Environmental, Inc.</p>	
		<p>SITE LOCATION Tejon and Asbury Park Water Quality Project Denver, Colorado</p>	
<p>Site Location: Section 28, Township 4S, Range 68W, 6th Principal Meridian</p>		<p>Drawn By: SJA</p>	<p>Figure: I</p>
<p>Pinyon Project Number: I/17-007-02.8002</p>		<p>Reviewed By: TRG</p>	<p>Date: 9/8/2017</p>



Notes

- Yellow Text** = Suspect ACM Observed & Tested, but no Asbestos Detected
- Green Text** = No Suspect ACM Observed
- Red Text** = Confirmed Asbestos at two feet below ground surface

N Legend

-  Site Boundary
 -  Test Trench Locations
 -  Groundwater Monitoring Well Locations
 -  Soil Sample Aliquot Locations for Sample SS-01
- 0 100 200
 Feet



SITE PLAN

Tejon and Asbury Park
 Water Quality Project
 Denver, Colorado

Site Location: Section 28, Township 4S, Range 68W, 6th Principal Meridian

Pinyon Project Number: I/17-007-02.8002

Drawn By: SJA

Reviewed By: TRG

Figure: 2

Date: 12/1/2017



Colorado Department
of Public Health
and Environment

ASBESTOS CERTIFICATION*

This certifies that

Tim Grenier

Certification No.: 18029

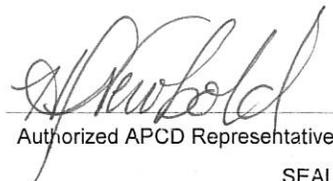
has met the requirements of 25-7-507, C.R.S. and Air Quality Control
Commission Regulation No. 8, Part B, and is hereby certified by the
state of Colorado in the following discipline:

Building Inspector*

Issued: March 27, 2017

Expires: March 27, 2018

** This certificate is valid only with the possession of a
current Division-approved training course certification
in the discipline specified above.*


Authorized APCD Representative
SEAL

May 31, 2017

Pinyon

Tim Grenier

9100 West Jewell Avenue, Suite 200

Lakewood CO 80232

Project Name - Tejon and Asbury Park

Project Number - [none]

Attached are your analytical results for Tejon and Asbury Park received by Origins Laboratory, Inc. May 22, 2017. This project is associated with Origins project number Y705257-01.

The analytical results in the following report were analyzed under the guidelines of EPA Methods. These methods are identified as follows; "SW" are defined in SW-846, "EPA" are defined in 40CFR part 136 and "SM" are defined in the most current revision of Standard Methods For the Examination of Water and Wastewater.

The analytical results apply specifically to the samples and analyses specified per the attached Chain of Custody. As such, this report shall not be reproduced except in full, without the written approval of Origin's laboratory.

Unless otherwise noted, the analytical results for all soil samples are reported on a wet weight basis. All analytical analyses were performed under NELAP guidelines unless noted by a data qualifier.

Any holding time exceedances, deviations from the method specifications or deviations from Origins Laboratory's Standard Operating Procedures are outlined in the case narrative.

Thank you for selecting Origins for your analytical needs. Please contact us with any questions concerning this report, or if we can help with anything at all.

Origins Laboratory, Inc.
303.433.1322
o-squad@oelabinc.com



Pinyon
9100 West Jewell Avenue, Suite 200
Lakewood CO 80232

Tim Grenier
Project Number: [none]
Project: Tejon and Asbury Park

CROSS REFERENCE REPORT

Sample ID	Laboratory ID	Matrix	Date Sampled	Date Received
SS-01	Y705257-01	Soil	May 22, 2017 10:45	05/22/2017 11:09

Origins Laboratory, Inc.



Jen Pellegrini For Noelle Doyle Mathis, President

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Pinyon
 9100 West Jewell Avenue, Suite 200
 Lakewood CO 80232

Tim Grenier
 Project Number: [none]
 Project: Tejon and Asbury Park

Origins Laboratory F-012207-01-R1
Effective Date: 01/09/12

Sample Receipt Checklist

Origins Work Order: 4705257 Client: Pinyon
 Client Project ID: Tejon + Asbury Park
 Checklist Completed by: [Signature] Shipped Via: US
 (UPS, FedEx, Hand Delivered, Pick-up, etc.)
 Date/time completed: 5-22-12 1125 Airbill #: N/A
 Matrix(s) Received: (Check all that apply): Soil/Solid Water Other: _____ (Describe)
 Cooler Number/Temperature: 1 / 20.7 °C / _____ °C / _____ °C / _____ °C
 Thermometer ID: 1003

Requirement Description	Yes	No	N/A	Comments (if any)
If samples require cooling, was the temperature between 0°C to ≤ 6°C ⁽¹⁾ ?		/		samples same day
Is there ice present (document if blue ice is used)		/		
Are custody seals present on cooler? (if so, document in comments if they are signed and dated, broken or intact)		/		
Are custody seals present on each sample container? (if so, document in comments if they are signed and dated, broken or intact)		/		
Were all samples received intact ⁽¹⁾ ?	/			
Was adequate sample volume provided ⁽¹⁾ ?	/			
Are short holding time analytes or samples with HTs due within 48 hours present ⁽¹⁾ ?		/		
Is a chain-of-custody (COC) present and filled out completely ⁽¹⁾ ?	/			
Does the COC agree with the number and type of sample bottles received ⁽¹⁾ ?	/			
Do the sample IDs on the bottle labels match the COC ⁽¹⁾ ?	/			
Is the COC properly relinquished by the client with date and time recorded ⁽¹⁾ ?	/			
For volatiles in water – is there headspace (> ¼ inch bubble) present? If yes, contact client and note in narrative.			/	
Are samples preserved that require preservation and was it checked ⁽¹⁾ ? (note ID of confirmation instrument used in comments) / (preservation is not confirmed for subcontracted analyses in order to insure sample integrity)/(pH <-2 for samples preserved with HNO3, HCL, H2SO4) / (pH >10 for samples preserved with NaAsO2+NaOH, ZnAc+NaOH)		/		
Additional Comments (if any):				

⁽¹⁾If NO, then contact the client before proceeding with analysis and note date/time and person contacted as well as the corrective action to in the additional comments (above) and the case narrative.

 5/23/12
 Reviewed by (Project Manager) Date/Time Reviewed

Origins Laboratory, Inc.



Jen Pellegrini For Noelle Doyle Mathis, President

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Pinyon
 9100 West Jewell Avenue, Suite 200
 Lakewood CO 80232

Tim Grenier
 Project Number: [none]
 Project: Tejon and Asbury Park

SS-01

5/22/2017 10:45:00AM

Analyte	Result	Min Detection Limit	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Notes
---------	--------	---------------------	-----------------	-------	----------	-------	----------	----------	-------

GEL Laboratories, LLC
Y705257-01 (Soil)

PAH by 8270D SIM

2-Methylnaphthalene	ND	0.00801	0.016	mg/kg	4	1668134	05/25/2017	05/26/2017	U
Acenaphthene	0.00801	0.00801	0.016	"	"	"	"	"	J
Acenaphthylene	ND	0.00801	0.016	"	"	"	"	"	U
Anthracene	0.0176	0.00801	0.016	"	"	"	"	"	
Benzo(a)anthracene	0.131	0.00801	0.016	"	"	"	"	"	
Benzo(a)pyrene	0.167	0.00801	0.016	"	"	"	"	"	
Benzo(b)fluoranthene	0.231	0.00801	0.016	"	"	"	"	"	
Benzo(ghi)perylene	0.127	0.00801	0.016	"	"	"	"	"	
Benzo(k)fluoranthene	0.0913	0.00801	0.016	"	"	"	"	"	
Chrysene	0.183	0.00801	0.016	"	"	"	"	"	
Dibenzo(a,h)anthracene	0.0304	0.00801	0.016	"	"	"	"	"	
Fluoranthene	0.251	0.00801	0.016	"	"	"	"	"	
Fluorene	0.00801	0.00801	0.016	"	"	"	"	"	J
Indeno(1,2,3-cd)pyrene	0.130	0.00801	0.016	"	"	"	"	"	
Naphthalene	ND	0.0048	0.016	"	"	"	"	"	U
Phenanthrene	0.109	0.00801	0.016	"	"	"	"	"	
Pyrene	0.364	0.00801	0.016	"	"	"	"	"	

Surrogate: 5-alpha-Androstane 77% 30-118 " " "

PCB by 8082A

Origins Laboratory, Inc.



The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Jen Pellegrini For Noelle Doyle Mathis, President

Pinyon
 9100 West Jewell Avenue, Suite 200
 Lakewood CO 80232

Tim Grenier
 Project Number: [none]
 Project: Tejon and Asbury Park

SS-01

5/22/2017 10:45:00AM

Analyte	Result	Min Detection Limit	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Notes
---------	--------	---------------------	-----------------	-------	----------	-------	----------	----------	-------

GEL Laboratories, LLC
Y705257-01 (Soil)

PCB by 8082A

Aroclor-1016	ND	0.00134	0.00404	mg/kg	1	1669222	05/30/2017	05/31/2017	U
Aroclor-1221	ND	0.00134	0.00404	"	"	"	"	"	U
Aroclor-1232	ND	0.00134	0.00404	"	"	"	"	"	U
Aroclor-1242	ND	0.00134	0.00404	"	"	"	"	"	U
Aroclor-1248	ND	0.00134	0.00404	"	"	"	"	"	U
Aroclor-1254	ND	0.00134	0.00404	"	"	"	"	"	U
Aroclor-1260	0.016	0.00134	0.00404	"	"	"	"	"	
Aroclor-Total	0.016	0.00134	0.00404	"	"	"	"	"	

Surrogate: 4cmx	61 %		30-120			"	"	"	
Surrogate: Decachlorobiphenyl	81 %		32-139			"	"	"	

TCLP Metals by 1311/6010C

Lead	0.0453	0.033	0.100	mg/L	1	1667987	05/24/2017	05/25/2017	J
------	---------------	--------------	-------	------	---	---------	------------	------------	---

Total Metals by 6010C

Arsenic	2.84	0.587	3.52	mg/kg	1	1667760	05/23/2017	05/24/2017	J
Barium	228	0.117	0.587	"	"	"	"	"	
Cadmium	1.06	0.117	0.587	"	"	"	"	"	
Chromium	14.9	0.176	0.587	"	"	"	"	"	

Origins Laboratory, Inc.



Jen Pellegrini For Noelle Doyle Mathis, President

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Pinyon
 9100 West Jewell Avenue, Suite 200
 Lakewood CO 80232

Tim Grenier
 Project Number: [none]
 Project: Tejon and Asbury Park

SS-01

5/22/2017 10:45:00AM

Analyte	Result	Min Detection Limit	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Notes
---------	--------	---------------------	-----------------	-------	----------	-------	----------	----------	-------

GEL Laboratories, LLC
Y705257-01 (Soil)

Total Metals by 6010C

Lead	46.8	0.387	1.17	mg/kg	1	1667760	05/23/2017	05/24/2017	
Selenium	9.41	0.587	3.52	"	"	"	"	"	
Silver	0.340	0.117	0.587	"	"	"	"	"	J

Total Metals by 7471A

Mercury	0.0824	0.0044	0.0131	mg/kg	1	1668000	05/24/2017	05/25/2017	
---------	--------	--------	--------	-------	---	---------	------------	------------	--

VOC by EPA 8260C

1,1,1,2-Tetrachloroethane	ND		0.00200	mg/kg	1	B7E2203	05/22/2017	05/22/2017	Ua
1,1,1-Trichloroethane	ND		0.00200	"	"	"	"	"	Ua
1,1,2,2-Tetrachloroethane	ND		0.00200	"	"	"	"	"	Ua
1,1,2-Trichloroethane	ND		0.00200	"	"	"	"	"	Ua
1,1-Dichloroethane	ND		0.00200	"	"	"	"	"	Ua
1,1-Dichloroethene	ND		0.00200	"	"	"	"	"	Ua
1,1-Dichloropropene	ND		0.00200	"	"	"	"	"	Ua
1,2,3-Trichlorobenzene	ND		0.00500	"	"	"	"	"	Ua
1,2,3-Trichloropropane	ND		0.00500	"	"	"	"	"	Ua
1,2,4-Trichlorobenzene	ND		0.00500	"	"	"	"	"	Ua
1,2,4-Trimethylbenzene	ND		0.00200	"	"	"	"	"	Ua
1,2-Dibromo-3-chloropropane	ND		0.00500	"	"	"	"	"	Ua

Origins Laboratory, Inc.



Jen Pellegrini For Noelle Doyle Mathis, President

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Pinyon
 9100 West Jewell Avenue, Suite 200
 Lakewood CO 80232

Tim Grenier
 Project Number: [none]
 Project: Tejon and Asbury Park

SS-01

5/22/2017 10:45:00AM

Analyte	Result	Min Detection Limit	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Notes
---------	--------	---------------------	-----------------	-------	----------	-------	----------	----------	-------

Origins Laboratory, Inc.
Y705257-01 (Soil)

VOC by EPA 8260C

1,2-Dibromoethane (EDB)	ND		0.00200	mg/kg	1	B7E2203	05/22/2017	05/22/2017	Ua
1,2-Dichlorobenzene	ND		0.00200	"	"	"	"	"	Ua
1,2-Dichloroethane	ND		0.00200	"	"	"	"	"	Ua
1,2-Dichloropropane	ND		0.00200	"	"	"	"	"	Ua
1,3,5-Trimethylbenzene	ND		0.00200	"	"	"	"	"	Ua
1,3-Dichlorobenzene	ND		0.00200	"	"	"	"	"	Ua
1,3-Dichloropropane	ND		0.00200	"	"	"	"	"	Ua
1,4-Dichlorobenzene	ND		0.00200	"	"	"	"	"	Ua
2,2-Dichloropropane	ND		0.00200	"	"	"	"	"	Ua
2-Butanone	ND		0.0100	"	"	"	"	"	Ua
2-Chlorotoluene	ND		0.00200	"	"	"	"	"	Ua
2-Hexanone	ND		0.0100	"	"	"	"	"	Ua
4-Chlorotoluene	ND		0.00200	"	"	"	"	"	Ua
4-Isopropyltoluene	ND		0.00200	"	"	"	"	"	Ua
4-Methyl-2-pentanone	ND		0.0100	"	"	"	"	"	Ua
Acetone	ND		0.0200	"	"	"	"	"	Ua
Benzene	ND		0.00200	"	"	"	"	"	Ua
Bromobenzene	ND		0.00200	"	"	"	"	"	Ua
Bromochloromethane	ND		0.00200	"	"	"	"	"	Ua
Bromodichloromethane	ND		0.00200	"	"	"	"	"	Ua

Origins Laboratory, Inc.



Jen Pellegrini For Noelle Doyle Mathis, President

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Pinyon
 9100 West Jewell Avenue, Suite 200
 Lakewood CO 80232

Tim Grenier
 Project Number: [none]
 Project: Tejon and Asbury Park

SS-01

5/22/2017 10:45:00AM

Analyte	Result	Min Detection Limit	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Notes
---------	--------	---------------------	-----------------	-------	----------	-------	----------	----------	-------

Origins Laboratory, Inc.
Y705257-01 (Soil)

VOC by EPA 8260C

Bromoform	ND	0.00200	mg/kg	1	B7E2203	05/22/2017	05/22/2017	Ua
Bromomethane	ND	0.00200	"	"	"	"	"	Ua
Carbon disulfide	ND	0.00500	"	"	"	"	"	Ua
Carbon tetrachloride	ND	0.00200	"	"	"	"	"	Ua
Chlorobenzene	ND	0.00200	"	"	"	"	"	Ua
Chloroethane	ND	0.00500	"	"	"	"	"	Ua
Chloroform	ND	0.00200	"	"	"	"	"	Ua
Chloromethane	ND	0.00200	"	"	"	"	"	Ua
cis-1,2-Dichloroethene	ND	0.00200	"	"	"	"	"	Ua
cis-1,3-Dichloropropene	ND	0.00200	"	"	"	"	"	Ua
Dibromochloromethane	ND	0.00200	"	"	"	"	"	Ua
Dibromomethane	ND	0.00200	"	"	"	"	"	Ua
Ethylbenzene	ND	0.00200	"	"	"	"	"	Ua
Hexachlorobutadiene	ND	0.00500	"	"	"	"	"	Ua
Iodomethane	ND	0.0150	"	"	"	"	"	Ua
Isopropylbenzene	ND	0.00200	"	"	"	"	"	Ua
m,p-Xylene	ND	0.00400	"	"	"	"	"	Ua
Methyl tert-Butyl Ether	ND	0.00200	"	"	"	"	"	Ua
Methylene Chloride	ND	0.0200	"	"	"	"	"	Ua
Naphthalene	ND	0.0100	"	"	"	"	"	Ua

Origins Laboratory, Inc.



Jen Pellegrini For Noelle Doyle Mathis, President

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Pinyon
 9100 West Jewell Avenue, Suite 200
 Lakewood CO 80232

Tim Grenier
 Project Number: [none]
 Project: Tejon and Asbury Park

SS-01

5/22/2017 10:45:00AM

Analyte	Result	Min Detection Limit	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Notes
---------	--------	---------------------	-----------------	-------	----------	-------	----------	----------	-------

Origins Laboratory, Inc.
Y705257-01 (Soil)

VOC by EPA 8260C

n-Butylbenzene	ND		0.00200	mg/kg	1	B7E2203	05/22/2017	05/22/2017	Ua
n-Propylbenzene	ND		0.00200	"	"	"	"	"	Ua
o-Xylene	ND		0.00200	"	"	"	"	"	Ua
sec-Butylbenzene	ND		0.00200	"	"	"	"	"	Ua
Styrene	ND		0.00200	"	"	"	"	"	Ua
tert-Butylbenzene	ND		0.00200	"	"	"	"	"	Ua
Tetrachloroethene	ND		0.00200	"	"	"	"	"	Ua
Toluene	ND		0.00200	"	"	"	"	"	Ua
trans-1,2-Dichloroethene	ND		0.00200	"	"	"	"	"	Ua
trans-1,3-Dichloropropene	ND		0.00200	"	"	"	"	"	Ua
Trichloroethene	ND		0.00200	"	"	"	"	"	Ua
Trichlorofluoromethane	ND		0.00300	"	"	"	"	"	Ua
Vinyl chloride	ND		0.00200	"	"	"	"	"	Ua

Surrogate: 1,2-Dichloroethane-d4	126 %		70-130			"	"	"	
Surrogate: Toluene-d8	96.3 %		70-130			"	"	"	
Surrogate: 4-Bromofluorobenzene	105 %		70-130			"	"	"	

Origins Laboratory, Inc.



Jen Pellegrini For Noelle Doyle Mathis, President

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Pinyon
 9100 West Jewell Avenue, Suite 200
 Lakewood CO 80232

Tim Grenier
 Project Number: [none]
 Project: Tejon and Asbury Park

Volatile Organic Compounds by GC/MS SW846 8260C - Quality Control
Origins Laboratory, Inc.

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
---------	--------	-----------------	-------	-------------	---------------	------	-------------	-----	-----------	-------

Batch B7E2203 - EPA 5030 (soil)

Blank (B7E2203-BLK1)

Prepared: 05/22/2017 Analyzed: 05/22/2017

1,1,1,2-Tetrachloroethane	ND	0.00200	mg/kg							Ua
1,1,1-Trichloroethane	ND	0.00200	"							Ua
1,1,2,2-Tetrachloroethane	ND	0.00200	"							Ua
1,1,2-Trichloroethane	ND	0.00200	"							Ua
1,1-Dichloroethane	ND	0.00200	"							Ua
1,1-Dichloroethene	ND	0.00200	"							Ua
1,1-Dichloropropene	ND	0.00200	"							Ua
1,2,3-Trichlorobenzene	ND	0.00500	"							Ua
1,2,3-Trichloropropane	ND	0.00500	"							Ua
1,2,4-Trichlorobenzene	ND	0.00500	"							Ua
1,2,4-Trimethylbenzene	ND	0.00200	"							Ua
1,2-Dibromo-3-chloropropane	ND	0.00500	"							Ua
1,2-Dibromoethane (EDB)	ND	0.00200	"							Ua
1,2-Dichlorobenzene	ND	0.00200	"							Ua
1,2-Dichloroethane	ND	0.00200	"							Ua
1,2-Dichloropropane	ND	0.00200	"							Ua
1,3,5-Trimethylbenzene	ND	0.00200	"							Ua
1,3-Dichlorobenzene	ND	0.00200	"							Ua
1,3-Dichloropropane	ND	0.00200	"							Ua
1,4-Dichlorobenzene	ND	0.00200	"							Ua
2,2-Dichloropropane	ND	0.00200	"							Ua
2-Butanone	ND	0.0100	"							Ua
2-Chlorotoluene	ND	0.00200	"							Ua
2-Hexanone	ND	0.0100	"							Ua
4-Chlorotoluene	ND	0.00200	"							Ua
4-Isopropyltoluene	ND	0.00200	"							Ua

Origins Laboratory, Inc.



Jen Pellegrini For Noelle Doyle Mathis, President

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Pinyon
 9100 West Jewell Avenue, Suite 200
 Lakewood CO 80232

Tim Grenier
 Project Number: [none]
 Project: Tejon and Asbury Park

Volatile Organic Compounds by GC/MS SW846 8260C - Quality Control
Origins Laboratory, Inc.

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
---------	--------	-----------------	-------	-------------	---------------	------	-------------	-----	-----------	-------

Batch B7E2203 - EPA 5030 (soil)

Blank (B7E2203-BLK1)

Prepared: 05/22/2017 Analyzed: 05/22/2017

4-Methyl-2-pentanone	ND	0.0100	mg/kg							Ua
Acetone	ND	0.0200	"							Ua
Benzene	ND	0.00200	"							Ua
Bromobenzene	ND	0.00200	"							Ua
Bromochloromethane	ND	0.00200	"							Ua
Bromodichloromethane	ND	0.00200	"							Ua
Bromoform	ND	0.00200	"							Ua
Bromomethane	ND	0.00200	"							Ua
Carbon disulfide	ND	0.00500	"							Ua
Carbon tetrachloride	ND	0.00200	"							Ua
Chlorobenzene	ND	0.00200	"							Ua
Chloroethane	ND	0.00500	"							Ua
Chloroform	ND	0.00200	"							Ua
Chloromethane	ND	0.00200	"							Ua
cis-1,2-Dichloroethene	ND	0.00200	"							Ua
cis-1,3-Dichloropropene	ND	0.00200	"							Ua
Dibromochloromethane	ND	0.00200	"							Ua
Dibromomethane	ND	0.00200	"							Ua
Ethylbenzene	ND	0.00200	"							Ua
Hexachlorobutadiene	ND	0.00500	"							Ua
Iodomethane	ND	0.0150	"							Ua
Isopropylbenzene	ND	0.00200	"							Ua
m,p-Xylene	ND	0.00400	"							Ua
Methyl tert-Butyl Ether	ND	0.00200	"							Ua
Methylene Chloride	ND	0.0200	"							Ua
Naphthalene	ND	0.0100	"							Ua

Origins Laboratory, Inc.



Jen Pellegrini For Noelle Doyle Mathis, President

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Pinyon
 9100 West Jewell Avenue, Suite 200
 Lakewood CO 80232

Tim Grenier
 Project Number: [none]
 Project: Tejon and Asbury Park

Volatile Organic Compounds by GC/MS SW846 8260C - Quality Control
Origins Laboratory, Inc.

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
---------	--------	-----------------	-------	-------------	---------------	------	-------------	-----	-----------	-------

Batch B7E2203 - EPA 5030 (soil)

Blank (B7E2203-BLK1)

Prepared: 05/22/2017 Analyzed: 05/22/2017

n-Butylbenzene	ND	0.00200	mg/kg							Ua
n-Propylbenzene	ND	0.00200	"							Ua
o-Xylene	ND	0.00200	"							Ua
sec-Butylbenzene	ND	0.00200	"							Ua
Styrene	ND	0.00200	"							Ua
tert-Butylbenzene	ND	0.00200	"							Ua
Tetrachloroethene	ND	0.00200	"							Ua
Toluene	ND	0.00200	"							Ua
trans-1,2-Dichloroethene	ND	0.00200	"							Ua
trans-1,3-Dichloropropene	ND	0.00200	"							Ua
Trichloroethene	ND	0.00200	"							Ua
Trichlorofluoromethane	ND	0.00300	"							Ua
Vinyl chloride	ND	0.00200	"							Ua
Surrogate: 1,2-Dichloroethane-d4	67		ug/L	62.5		107	70-130			
Surrogate: Toluene-d8	62		"	62.5		99.2	70-130			
Surrogate: 4-Bromofluorobenzene	64		"	62.5		103	70-130			

Origins Laboratory, Inc.



Jen Pellegrini For Noelle Doyle Mathis, President

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Pinyon
 9100 West Jewell Avenue, Suite 200
 Lakewood CO 80232

Tim Grenier
 Project Number: [none]
 Project: Tejon and Asbury Park

Volatile Organic Compounds by GC/MS SW846 8260C - Quality Control
Origins Laboratory, Inc.

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
---------	--------	-----------------	-------	-------------	---------------	------	-------------	-----	-----------	-------

Batch B7E2203 - EPA 5030 (soil)

LCS (B7E2203-BS1)

Prepared: 05/22/2017 Analyzed: 05/22/2017

1,1,1,2-Tetrachloroethane	0.0943	0.00200	mg/kg	0.100		94.3	70-130			
1,1,1-Trichloroethane	0.0912	0.00200	"	0.100		91.2	70-130			
1,1,2,2-Tetrachloroethane	0.0927	0.00200	"	0.100		92.7	70-130			
1,1,2-Trichloroethane	0.0863	0.00200	"	0.100		86.3	70-130			
1,1-Dichloroethane	0.0888	0.00200	"	0.100		88.8	70-130			
1,1-Dichloroethene	0.102	0.00200	"	0.100		102	70-130			
1,1-Dichloropropene	0.0891	0.00200	"	0.100		89.1	70-130			
1,2,3-Trichlorobenzene	0.0945	0.00500	"	0.100		94.5	70-130			
1,2,3-Trichloropropane	0.0982	0.00500	"	0.100		98.2	70-130			
1,2,4-Trichlorobenzene	0.0925	0.00500	"	0.100		92.5	70-130			
1,2,4-Trimethylbenzene	0.0951	0.00200	"	0.100		95.1	70-130			
1,2-Dibromo-3-chloropropane	0.0923	0.00500	"	0.100		92.3	70-130			
1,2-Dibromoethane (EDB)	0.0892	0.00200	"	0.100		89.2	70-130			
1,2-Dichlorobenzene	0.0933	0.00200	"	0.100		93.3	70-130			
1,2-Dichloroethane	0.0987	0.00200	"	0.100		98.7	70-130			
1,2-Dichloropropane	0.0894	0.00200	"	0.100		89.4	70-130			
1,3,5-Trimethylbenzene	0.0946	0.00200	"	0.100		94.6	70-130			
1,3-Dichlorobenzene	0.0927	0.00200	"	0.100		92.7	70-130			
1,3-Dichloropropane	0.0871	0.00200	"	0.100		87.1	70-130			
1,4-Dichlorobenzene	0.0897	0.00200	"	0.100		89.7	70-130			
2,2-Dichloropropane	0.0922	0.00200	"	0.100		92.2	70-130			
2-Butanone	0.473	0.0100	"	0.500		94.6	70-130			
2-Chlorotoluene	0.0942	0.00200	"	0.100		94.2	70-130			
2-Hexanone	0.458	0.0100	"	0.500		91.7	70-130			
4-Chlorotoluene	0.0865	0.00200	"	0.100		86.5	70-130			
4-Isopropyltoluene	0.0895	0.00200	"	0.100		89.5	70-130			

Origins Laboratory, Inc.



Jen Pellegrini For Noelle Doyle Mathis, President

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Pinyon
 9100 West Jewell Avenue, Suite 200
 Lakewood CO 80232

Tim Grenier
 Project Number: [none]
 Project: Tejon and Asbury Park

Volatile Organic Compounds by GC/MS SW846 8260C - Quality Control
Origins Laboratory, Inc.

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
---------	--------	-----------------	-------	-------------	---------------	------	-------------	-----	-----------	-------

Batch B7E2203 - EPA 5030 (soil)

LCS (B7E2203-BS1)

Prepared: 05/22/2017 Analyzed: 05/22/2017

4-Methyl-2-pentanone	0.441	0.0100	mg/kg	0.500		88.3	70-130			
Acetone	0.498	0.0200	"	0.500		99.6	70-130			
Benzene	0.0877	0.00200	"	0.100		87.7	70-130			
Bromobenzene	0.0891	0.00200	"	0.100		89.1	70-130			
Bromochloromethane	0.101	0.00200	"	0.100		101	70-130			
Bromodichloromethane	0.103	0.00200	"	0.100		103	70-130			
Bromoform	0.114	0.00200	"	0.100		114	70-130			
Bromomethane	0.105	0.00200	"	0.100		105	70-130			
Carbon disulfide	0.0997	0.00500	"	0.100		99.7	70-130			
Carbon tetrachloride	0.0959	0.00200	"	0.100		95.9	70-130			
Chlorobenzene	0.0844	0.00200	"	0.100		84.4	70-130			
Chloroethane	0.109	0.00500	"	0.100		109	70-130			
Chloroform	0.0980	0.00200	"	0.100		98.0	70-130			
Chloromethane	0.0886	0.00200	"	0.100		88.6	70-130			
cis-1,2-Dichloroethene	0.0948	0.00200	"	0.100		94.8	70-130			
cis-1,3-Dichloropropene	0.0932	0.00200	"	0.100		93.2	70-130			
Dibromochloromethane	0.106	0.00200	"	0.100		106	70-130			
Dibromomethane	0.0984	0.00200	"	0.100		98.4	70-130			
Ethylbenzene	0.0902	0.00200	"	0.100		90.2	70-130			
Hexachlorobutadiene	0.0956	0.00500	"	0.100		95.6	70-130			
Iodomethane	0.0896	0.0150	"	0.100		89.6	70-130			
Isopropylbenzene	0.0873	0.00200	"	0.100		87.3	70-130			
m,p-Xylene	0.185	0.00400	"	0.200		92.3	70-130			
Methyl tert-Butyl Ether	0.0906	0.00200	"	0.100		90.6	70-130			
Methylene Chloride	0.0822	0.0200	"	0.100		82.2	70-130			
Naphthalene	0.0937	0.0100	"	0.100		93.7	70-130			

Origins Laboratory, Inc.



Jen Pellegrini For Noelle Doyle Mathis, President

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Pinyon
 9100 West Jewell Avenue, Suite 200
 Lakewood CO 80232

Tim Grenier
 Project Number: [none]
 Project: Tejon and Asbury Park

Volatile Organic Compounds by GC/MS SW846 8260C - Quality Control
Origins Laboratory, Inc.

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
---------	--------	-----------------	-------	-------------	---------------	------	-------------	-----	-----------	-------

Batch B7E2203 - EPA 5030 (soil)

LCS (B7E2203-BS1)

Prepared: 05/22/2017 Analyzed: 05/22/2017

n-Butylbenzene	0.0933	0.00200	mg/kg	0.100		93.3	70-130			
n-Propylbenzene	0.0945	0.00200	"	0.100		94.5	70-130			
o-Xylene	0.0886	0.00200	"	0.100		88.6	70-130			
sec-Butylbenzene	0.0923	0.00200	"	0.100		92.3	70-130			
Styrene	0.0915	0.00200	"	0.100		91.5	70-130			
tert-Butylbenzene	0.0916	0.00200	"	0.100		91.6	70-130			
Tetrachloroethene	0.0837	0.00200	"	0.100		83.7	70-130			
Toluene	0.0818	0.00200	"	0.100		81.8	70-130			
trans-1,2-Dichloroethene	0.0964	0.00200	"	0.100		96.4	70-130			
trans-1,3-Dichloropropene	0.0978	0.00200	"	0.100		97.8	70-130			
Trichloroethene	0.0888	0.00200	"	0.100		88.8	70-130			
Trichlorofluoromethane	0.108	0.00300	"	0.100		108	70-130			
Vinyl chloride	0.0980	0.00200	"	0.100		98.0	70-130			
Surrogate: 1,2-Dichloroethane-d4	63		ug/L	62.5		100	70-130			
Surrogate: Toluene-d8	62		"	62.5		98.4	70-130			
Surrogate: 4-Bromofluorobenzene	63		"	62.5		101	70-130			

Origins Laboratory, Inc.



Jen Pellegrini For Noelle Doyle Mathis, President

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Pinyon
 9100 West Jewell Avenue, Suite 200
 Lakewood CO 80232

Tim Grenier
 Project Number: [none]
 Project: Tejon and Asbury Park

Volatile Organic Compounds by GC/MS SW846 8260C - Quality Control
Origins Laboratory, Inc.

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
---------	--------	-----------------	-------	-------------	---------------	------	-------------	-----	-----------	-------

Batch B7E2203 - EPA 5030 (soil)

Matrix Spike (B7E2203-MS1)	Source: Y705243-01			Prepared: 05/22/2017 Analyzed: 05/22/2017						
1,1,1,2-Tetrachloroethane	0.102	0.00200	mg/kg	0.100	ND	102	70-130			
1,1,1-Trichloroethane	0.108	0.00200	"	0.100	ND	108	70-130			
1,1,2,2-Tetrachloroethane	0.0983	0.00200	"	0.100	ND	98.3	70-130			
1,1,2-Trichloroethane	0.0946	0.00200	"	0.100	ND	94.6	70-130			
1,1-Dichloroethane	0.104	0.00200	"	0.100	ND	104	70-130			
1,1-Dichloroethene	0.119	0.00200	"	0.100	ND	119	70-130			
1,1-Dichloropropene	0.104	0.00200	"	0.100	ND	104	70-130			
1,2,3-Trichlorobenzene	0.102	0.00500	"	0.100	0.00406	98.1	70-130			
1,2,3-Trichloropropane	0.102	0.00500	"	0.100	ND	102	70-130			
1,2,4-Trichlorobenzene	0.102	0.00500	"	0.100	0.00168	100	70-130			
1,2,4-Trimethylbenzene	0.105	0.00200	"	0.100	ND	105	70-130			
1,2-Dibromo-3-chloropropane	0.0938	0.00500	"	0.100	ND	93.8	70-130			
1,2-Dibromoethane (EDB)	0.0975	0.00200	"	0.100	ND	97.5	70-130			
1,2-Dichlorobenzene	0.102	0.00200	"	0.100	ND	102	70-130			
1,2-Dichloroethane	0.106	0.00200	"	0.100	ND	106	70-130			
1,2-Dichloropropane	0.0998	0.00200	"	0.100	ND	99.8	70-130			
1,3,5-Trimethylbenzene	0.106	0.00200	"	0.100	ND	106	70-130			
1,3-Dichlorobenzene	0.102	0.00200	"	0.100	ND	102	70-130			
1,3-Dichloropropane	0.0955	0.00200	"	0.100	ND	95.5	70-130			
1,4-Dichlorobenzene	0.105	0.00200	"	0.100	ND	105	70-130			
2,2-Dichloropropane	0.110	0.00200	"	0.100	ND	110	70-130			
2-Butanone	0.530	0.0100	"	0.500	ND	106	70-130			
2-Chlorotoluene	0.106	0.00200	"	0.100	ND	106	70-130			
2-Hexanone	0.504	0.0100	"	0.500	0.00292	100	70-130			
4-Chlorotoluene	0.0958	0.00200	"	0.100	0.000440	95.3	70-130			
4-Isopropyltoluene	0.0999	0.00200	"	0.100	ND	99.9	70-130			

Origins Laboratory, Inc.



Jen Pellegrini For Noelle Doyle Mathis, President

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Pinyon
 9100 West Jewell Avenue, Suite 200
 Lakewood CO 80232

Tim Grenier
 Project Number: [none]
 Project: Tejon and Asbury Park

Volatile Organic Compounds by GC/MS SW846 8260C - Quality Control
Origins Laboratory, Inc.

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
---------	--------	-----------------	-------	-------------	---------------	------	-------------	-----	-----------	-------

Batch B7E2203 - EPA 5030 (soil)

Matrix Spike (B7E2203-MS1)	Source: Y705243-01			Prepared: 05/22/2017 Analyzed: 05/22/2017						
4-Methyl-2-pentanone	0.461	0.0100	mg/kg	0.500	0.00408	91.4	70-130			
Acetone	0.553	0.0200	"	0.500	ND	111	70-130			
Benzene	0.0998	0.00200	"	0.100	ND	99.8	70-130			
Bromobenzene	0.0963	0.00200	"	0.100	ND	96.3	70-130			
Bromochloromethane	0.112	0.00200	"	0.100	ND	112	70-130			
Bromodichloromethane	0.114	0.00200	"	0.100	ND	114	70-130			
Bromoform	0.119	0.00200	"	0.100	ND	119	70-130			
Bromomethane	0.116	0.00200	"	0.100	ND	116	70-130			
Carbon disulfide	0.118	0.00500	"	0.100	ND	118	70-130			
Carbon tetrachloride	0.108	0.00200	"	0.100	ND	108	70-130			
Chlorobenzene	0.0950	0.00200	"	0.100	ND	95.0	70-130			
Chloroethane	0.116	0.00500	"	0.100	ND	116	70-130			
Chloroform	0.111	0.00200	"	0.100	ND	111	70-130			
Chloromethane	0.0977	0.00200	"	0.100	ND	97.7	70-130			
cis-1,2-Dichloroethene	0.109	0.00200	"	0.100	ND	109	70-130			
cis-1,3-Dichloropropene	0.106	0.00200	"	0.100	ND	106	70-130			
Dibromochloromethane	0.115	0.00200	"	0.100	ND	115	70-130			
Dibromomethane	0.107	0.00200	"	0.100	ND	107	70-130			
Ethylbenzene	0.102	0.00200	"	0.100	ND	102	70-130			
Hexachlorobutadiene	0.104	0.00500	"	0.100	ND	104	70-130			
Iodomethane	0.102	0.0150	"	0.100	ND	102	70-130			
Isopropylbenzene	0.0975	0.00200	"	0.100	ND	97.5	70-130			
m,p-Xylene	0.207	0.00400	"	0.200	ND	104	70-130			
Methyl tert-Butyl Ether	0.102	0.00200	"	0.100	ND	102	70-130			
Methylene Chloride	0.110	0.0200	"	0.100	ND	110	70-130			
Naphthalene	0.0999	0.0100	"	0.100	0.00198	97.9	70-130			

Origins Laboratory, Inc.



Jen Pellegrini For Noelle Doyle Mathis, President

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Pinyon
 9100 West Jewell Avenue, Suite 200
 Lakewood CO 80232

Tim Grenier
 Project Number: [none]
 Project: Tejon and Asbury Park

Volatile Organic Compounds by GC/MS SW846 8260C - Quality Control
Origins Laboratory, Inc.

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
---------	--------	-----------------	-------	-------------	---------------	------	-------------	-----	-----------	-------

Batch B7E2203 - EPA 5030 (soil)

Matrix Spike (B7E2203-MS1)	Source: Y705243-01			Prepared: 05/22/2017 Analyzed: 05/22/2017						
n-Butylbenzene	0.107	0.00200	mg/kg	0.100	ND	107	70-130			
n-Propylbenzene	0.107	0.00200	"	0.100	ND	107	70-130			
o-Xylene	0.0967	0.00200	"	0.100	ND	96.7	70-130			
sec-Butylbenzene	0.104	0.00200	"	0.100	ND	104	70-130			
Styrene	0.108	0.00200	"	0.100	ND	108	70-130			
tert-Butylbenzene	0.103	0.00200	"	0.100	ND	103	70-130			
Tetrachloroethene	0.0974	0.00200	"	0.100	ND	97.4	70-130			
Toluene	0.0940	0.00200	"	0.100	ND	94.0	70-130			
trans-1,2-Dichloroethene	0.113	0.00200	"	0.100	ND	113	70-130			
trans-1,3-Dichloropropene	0.108	0.00200	"	0.100	ND	108	70-130			
Trichloroethene	0.101	0.00200	"	0.100	ND	101	70-130			
Trichlorofluoromethane	0.115	0.00300	"	0.100	ND	115	70-130			
Vinyl chloride	0.107	0.00200	"	0.100	ND	107	70-130			
Surrogate: 1,2-Dichloroethane-d4	65		ug/L	62.5		104	70-130			
Surrogate: Toluene-d8	62		"	62.5		99.3	70-130			
Surrogate: 4-Bromofluorobenzene	64		"	62.5		102	70-130			

Origins Laboratory, Inc.



Jen Pellegrini For Noelle Doyle Mathis, President

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Pinyon
 9100 West Jewell Avenue, Suite 200
 Lakewood CO 80232

Tim Grenier
 Project Number: [none]
 Project: Tejon and Asbury Park

Volatile Organic Compounds by GC/MS SW846 8260C - Quality Control
Origins Laboratory, Inc.

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
---------	--------	-----------------	-------	-------------	---------------	------	-------------	-----	-----------	-------

Batch B7E2203 - EPA 5030 (soil)

Matrix Spike Dup (B7E2203-MSD1)	Source: Y705243-01			Prepared: 05/22/2017 Analyzed: 05/22/2017						
1,1,1,2-Tetrachloroethane	0.0983	0.00200	mg/kg	0.100	ND	98.3	70-130	3.71	20	
1,1,1-Trichloroethane	0.0969	0.00200	"	0.100	ND	96.9	70-130	11.2	20	
1,1,2,2-Tetrachloroethane	0.0947	0.00200	"	0.100	ND	94.7	70-130	3.73	20	
1,1,2-Trichloroethane	0.0916	0.00200	"	0.100	ND	91.6	70-130	3.20	20	
1,1-Dichloroethane	0.0957	0.00200	"	0.100	ND	95.7	70-130	8.03	20	
1,1-Dichloroethene	0.109	0.00200	"	0.100	ND	109	70-130	8.93	20	
1,1-Dichloropropene	0.0939	0.00200	"	0.100	ND	93.9	70-130	10.2	20	
1,2,3-Trichlorobenzene	0.107	0.00500	"	0.100	0.00406	103	70-130	4.46	20	
1,2,3-Trichloropropane	0.101	0.00500	"	0.100	ND	101	70-130	0.354	20	
1,2,4-Trichlorobenzene	0.102	0.00500	"	0.100	0.00168	100	70-130	0.0588	20	
1,2,4-Trimethylbenzene	0.0985	0.00200	"	0.100	ND	98.5	70-130	6.84	20	
1,2-Dibromo-3-chloropropane	0.0970	0.00500	"	0.100	ND	97.0	70-130	3.31	20	
1,2-Dibromoethane (EDB)	0.0944	0.00200	"	0.100	ND	94.4	70-130	3.23	20	
1,2-Dichlorobenzene	0.0980	0.00200	"	0.100	ND	98.0	70-130	3.57	20	
1,2-Dichloroethane	0.103	0.00200	"	0.100	ND	103	70-130	2.80	20	
1,2-Dichloropropane	0.0969	0.00200	"	0.100	ND	96.9	70-130	2.89	20	
1,3,5-Trimethylbenzene	0.100	0.00200	"	0.100	ND	100	70-130	5.61	20	
1,3-Dichlorobenzene	0.0969	0.00200	"	0.100	ND	96.9	70-130	5.32	20	
1,3-Dichloropropane	0.0930	0.00200	"	0.100	ND	93.0	70-130	2.63	20	
1,4-Dichlorobenzene	0.0956	0.00200	"	0.100	ND	95.6	70-130	9.27	20	
2,2-Dichloropropane	0.0984	0.00200	"	0.100	ND	98.4	70-130	10.7	20	
2-Butanone	0.516	0.0100	"	0.500	ND	103	70-130	2.60	20	
2-Chlorotoluene	0.0992	0.00200	"	0.100	ND	99.2	70-130	6.53	20	
2-Hexanone	0.497	0.0100	"	0.500	0.00292	98.8	70-130	1.38	20	
4-Chlorotoluene	0.0905	0.00200	"	0.100	0.000440	90.1	70-130	5.60	20	
4-Isopropyltoluene	0.0933	0.00200	"	0.100	ND	93.3	70-130	6.79	20	

Origins Laboratory, Inc.



Jen Pellegrini For Noelle Doyle Mathis, President

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Pinyon
 9100 West Jewell Avenue, Suite 200
 Lakewood CO 80232

Tim Grenier
 Project Number: [none]
 Project: Tejon and Asbury Park

Volatile Organic Compounds by GC/MS SW846 8260C - Quality Control
Origins Laboratory, Inc.

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
---------	--------	-----------------	-------	-------------	---------------	------	-------------	-----	-----------	-------

Batch B7E2203 - EPA 5030 (soil)

Matrix Spike Dup (B7E2203-MSD1)	Source: Y705243-01			Prepared: 05/22/2017 Analyzed: 05/22/2017						
4-Methyl-2-pentanone	0.452	0.0100	mg/kg	0.500	0.00408	89.6	70-130	1.97	20	
Acetone	0.544	0.0200	"	0.500	ND	109	70-130	1.65	20	
Benzene	0.0935	0.00200	"	0.100	ND	93.5	70-130	6.50	20	
Bromobenzene	0.0927	0.00200	"	0.100	ND	92.7	70-130	3.79	20	
Bromochloromethane	0.106	0.00200	"	0.100	ND	106	70-130	5.07	20	
Bromodichloromethane	0.110	0.00200	"	0.100	ND	110	70-130	3.00	20	
Bromoform	0.116	0.00200	"	0.100	ND	116	70-130	2.71	20	
Bromomethane	0.110	0.00200	"	0.100	ND	110	70-130	5.10	20	
Carbon disulfide	0.104	0.00500	"	0.100	ND	104	70-130	12.3	20	
Carbon tetrachloride	0.0979	0.00200	"	0.100	ND	97.9	70-130	9.51	20	
Chlorobenzene	0.0892	0.00200	"	0.100	ND	89.2	70-130	6.23	20	
Chloroethane	0.110	0.00500	"	0.100	ND	110	70-130	5.27	20	
Chloroform	0.105	0.00200	"	0.100	ND	105	70-130	5.84	20	
Chloromethane	0.0903	0.00200	"	0.100	ND	90.3	70-130	7.89	20	
cis-1,2-Dichloroethene	0.102	0.00200	"	0.100	ND	102	70-130	7.02	20	
cis-1,3-Dichloropropene	0.101	0.00200	"	0.100	ND	101	70-130	4.68	20	
Dibromochloromethane	0.113	0.00200	"	0.100	ND	113	70-130	2.05	20	
Dibromomethane	0.105	0.00200	"	0.100	ND	105	70-130	1.40	20	
Ethylbenzene	0.0937	0.00200	"	0.100	ND	93.7	70-130	8.54	20	
Hexachlorobutadiene	0.0974	0.00500	"	0.100	ND	97.4	70-130	6.05	20	
Iodomethane	0.0952	0.0150	"	0.100	ND	95.2	70-130	7.19	20	
Isopropylbenzene	0.0903	0.00200	"	0.100	ND	90.3	70-130	7.69	20	
m,p-Xylene	0.193	0.00400	"	0.200	ND	96.4	70-130	7.33	20	
Methyl tert-Butyl Ether	0.0989	0.00200	"	0.100	ND	98.9	70-130	2.91	20	
Methylene Chloride	0.104	0.0200	"	0.100	ND	104	70-130	5.82	20	
Naphthalene	0.103	0.0100	"	0.100	0.00198	101	70-130	2.61	20	

Origins Laboratory, Inc.



Jen Pellegrini For Noelle Doyle Mathis, President

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Pinyon
 9100 West Jewell Avenue, Suite 200
 Lakewood CO 80232

Tim Grenier
 Project Number: [none]
 Project: Tejon and Asbury Park

Volatile Organic Compounds by GC/MS SW846 8260C - Quality Control
Origins Laboratory, Inc.

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
---------	--------	-----------------	-------	-------------	---------------	------	-------------	-----	-----------	-------

Batch B7E2203 - EPA 5030 (soil)

Matrix Spike Dup (B7E2203-MSD1)	Source: Y705243-01			Prepared: 05/22/2017 Analyzed: 05/22/2017						
n-Butylbenzene	0.0988	0.00200	mg/kg	0.100	ND	98.8	70-130	7.65	20	
n-Propylbenzene	0.0978	0.00200	"	0.100	ND	97.8	70-130	8.67	20	
o-Xylene	0.0926	0.00200	"	0.100	ND	92.6	70-130	4.29	20	
sec-Butylbenzene	0.0966	0.00200	"	0.100	ND	96.6	70-130	7.59	20	
Styrene	0.102	0.00200	"	0.100	ND	102	70-130	6.09	20	
tert-Butylbenzene	0.0963	0.00200	"	0.100	ND	96.3	70-130	6.80	20	
Tetrachloroethene	0.0885	0.00200	"	0.100	ND	88.5	70-130	9.59	20	
Toluene	0.0877	0.00200	"	0.100	ND	87.7	70-130	6.85	20	
trans-1,2-Dichloroethene	0.103	0.00200	"	0.100	ND	103	70-130	9.61	20	
trans-1,3-Dichloropropene	0.104	0.00200	"	0.100	ND	104	70-130	3.70	20	
Trichloroethene	0.0947	0.00200	"	0.100	ND	94.7	70-130	6.77	20	
Trichlorofluoromethane	0.111	0.00300	"	0.100	ND	111	70-130	3.47	20	
Vinyl chloride	0.103	0.00200	"	0.100	ND	103	70-130	3.89	20	
Surrogate: 1,2-Dichloroethane-d4	66		ug/L	62.5		105	70-130			
Surrogate: Toluene-d8	62		"	62.5		98.4	70-130			
Surrogate: 4-Bromofluorobenzene	63		"	62.5		101	70-130			

Origins Laboratory, Inc.



Jen Pellegrini For Noelle Doyle Mathis, President

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Pinyon
 9100 West Jewell Avenue, Suite 200
 Lakewood CO 80232

Tim Grenier
 Project Number: [none]
 Project: Tejon and Asbury Park

Volatile Organic Compounds by GC/MS SW846 8260C - Quality Control
Origins Laboratory, Inc.

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
---------	--------	-----------------	-------	-------------	---------------	------	-------------	-----	-----------	-------

PAH by 8270D SIM - Quality Control
GEL Laboratories, LLC

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
---------	--------	-----------------	-------	-------------	---------------	------	-------------	-----	-----------	-------

Batch 1668134 - SW846 3541

BLANK (1203796831-BLK)

Prepared: 05/25/2017 Analyzed: 05/25/2017

Benzo(a)anthracene	ND	0.00333	mg/kg				-			U
Chrysene	ND	0.00333	"				-			U
Benzo(k)fluoranthene	ND	0.00333	"				-			U
2-Methylnaphthalene	ND	0.00333	"				-			U
Benzo(ghi)perylene	ND	0.00333	"				-			U
Anthracene	ND	0.00333	"				-			U
Benzo(a)pyrene	ND	0.00333	"				-			U
Acenaphthylene	ND	0.00333	"				-			U
Acenaphthene	ND	0.00333	"				-			U
Benzo(b)fluoranthene	ND	0.00333	"				-			U
Dibenzo(a,h)anthracene	ND	0.00333	"				-			U
Fluoranthene	ND	0.00333	"				-			U
Fluorene	ND	0.00333	"				-			U
Indeno(1,2,3-cd)pyrene	ND	0.00333	"				-			U
Naphthalene	ND	0.00333	"				-			U
Pyrene	ND	0.00333	"				-			U
Phenanthrene	ND	0.00333	"				-			U

Surrogate: 5-alpha-Androstane

0.162

"

0.166

98

30-118

LCS (1203796832-BKS)

Prepared: 05/25/2017 Analyzed: 05/25/2017

Acenaphthylene	0.241	0.00333	mg/kg	0.333		72	48-107			
----------------	-------	---------	-------	-------	--	----	--------	--	--	--

Origins Laboratory, Inc.



The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Jen Pellegrini For Noelle Doyle Mathis, President

Pinyon
 9100 West Jewell Avenue, Suite 200
 Lakewood CO 80232

Tim Grenier
 Project Number: [none]
 Project: Tejon and Asbury Park

PAH by 8270D SIM - Quality Control
GEL Laboratories, LLC

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
---------	--------	-----------------	-------	-------------	---------------	------	-------------	-----	-----------	-------

Batch 1668134 - SW846 3541

LCS (1203796832-BKS)

Prepared: 05/25/2017 Analyzed: 05/25/2017

Acenaphthene	0.249	0.00333	mg/kg	0.333		75	55-99			
Benzo(b)fluoranthene	0.306	0.00333	"	0.333		92	36-120			
Phenanthrene	0.251	0.00333	"	0.333		75	53-97			
Benzo(a)anthracene	0.305	0.00333	"	0.333		92	51-108			
Benzo(a)pyrene	0.288	0.00333	"	0.333		86	35-121			
Anthracene	0.248	0.00333	"	0.333		74	52-102			
Benzo(ghi)perylene	0.280	0.00333	"	0.333		84	39-119			
Benzo(k)fluoranthene	0.304	0.00333	"	0.333		91	26-121			
Chrysene	0.297	0.00333	"	0.333		89	54-103			
Dibenzo(a,h)anthracene	0.291	0.00333	"	0.333		87	35-142			
Fluoranthene	0.258	0.00333	"	0.333		77	39-108			
Fluorene	0.244	0.00333	"	0.333		73	47-106			
Indeno(1,2,3-cd)pyrene	0.304	0.00333	"	0.333		91	41-130			
2-Methylnaphthalene	0.295	0.00333	"	0.333		89	53-102			
Naphthalene	0.300	0.00333	"	0.333		90	57-98			
Pyrene	0.312	0.00333	"	0.333		94	41-114			

Surrogate: 5-alpha-Androstane

0.171

"

0.167

103

30-118

MS (1203796833 S)

Source: Y705257-01

Prepared: 05/25/2017 Analyzed: 05/26/2017

Fluorene	0.316	0.0161	mg/kg	0.403	0.00801	76	33-123			
Benzo(ghi)perylene	0.426	0.0161	"	0.403	0.127	74	17-118			
Pyrene	0.757	0.0161	"	0.403	0.364	97	30-131			
Phenanthrene	0.390	0.0161	"	0.403	0.109	70	35-119			
Naphthalene	0.345	0.0161	"	0.403	<0.00484	86	33-117			
Indeno(1,2,3-cd)pyrene	0.432	0.0161	"	0.403	0.130	75	17-133			
Fluoranthene	0.500	0.0161	"	0.403	0.251	62	28-116			
Dibenzo(a,h)anthracene	0.374	0.0161	"	0.403	0.0304	85	18-146			

Origins Laboratory, Inc.



Jen Pellegrini For Noelle Doyle Mathis, President

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Pinyon
 9100 West Jewell Avenue, Suite 200
 Lakewood CO 80232

Tim Grenier
 Project Number: [none]
 Project: Tejon and Asbury Park

PAH by 8270D SIM - Quality Control
GEL Laboratories, LLC

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
---------	--------	-----------------	-------	-------------	---------------	------	-------------	-----	-----------	-------

Batch 1668134 - SW846 3541

MS (1203796833 S)		Source: Y705257-01			Prepared: 05/25/2017 Analyzed: 05/26/2017					
Benzo(k)fluoranthene	0.447	0.0161	mg/kg	0.403	0.0913	88	24-122			
2-Methylnaphthalene	0.363	0.0161	"	0.403	<0.00807	90	31-119			
Benzo(b)fluoranthene	0.529	0.0161	"	0.403	0.231	74	28-126			
Benzo(a)pyrene	0.469	0.0161	"	0.403	0.167	75	27-126			
Benzo(a)anthracene	0.452	0.0161	"	0.403	0.131	79	41-118			
Anthracene	0.332	0.0161	"	0.403	0.0176	78	36-120			
Acenaphthylene	0.298	0.0161	"	0.403	<0.00807	74	39-116			
Acenaphthene	0.300	0.0161	"	0.403	0.00801	72	38-117			
Chrysene	0.484	0.0161	"	0.403	0.183	75	42-113			
Surrogate: 5-alpha-Androstane	0.161		"	0.202	0.154	80	30-118			

MSD (1203796834 SD)		Source: Y705257-01			Prepared: 05/25/2017 Analyzed: 05/26/2017					
Anthracene	0.298	0.016	mg/kg	0.401	0.0176	70	36-120	11	30	
Indeno(1,2,3-cd)pyrene	0.385	0.016	"	0.401	0.130	64	17-133	12	30	
Acenaphthylene	0.276	0.016	"	0.401	<0.00801	69	39-116	8	30	
2-Methylnaphthalene	0.325	0.016	"	0.401	<0.00801	81	31-119	11	30	
Benzo(a)anthracene	0.404	0.016	"	0.401	0.131	68	41-118	11	30	
Pyrene	0.630	0.016	"	0.401	0.364	66	30-131	18	30	
Acenaphthene	0.277	0.016	"	0.401	0.00801	67	38-117	8	30	
Naphthalene	0.316	0.016	"	0.401	<0.00481	79	33-117	9	30	
Benzo(a)pyrene	0.422	0.016	"	0.401	0.167	64	27-126	11	30	
Fluorene	0.298	0.016	"	0.401	0.00801	72	33-123	6	30	
Fluoranthene	0.442	0.016	"	0.401	0.251	48	28-116	12	30	
Dibenzo(a,h)anthracene	0.333	0.016	"	0.401	0.0304	76	18-146	12	30	
Chrysene	0.433	0.016	"	0.401	0.183	62	42-113	11	30	
Benzo(k)fluoranthene	0.401	0.016	"	0.401	0.0913	77	24-122	11	30	
Benzo(ghi)perylene	0.381	0.016	"	0.401	0.127	64	17-118	11	30	

Origins Laboratory, Inc.



Jen Pellegrini For Noelle Doyle Mathis, President

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Pinyon
 9100 West Jewell Avenue, Suite 200
 Lakewood CO 80232

Tim Grenier
 Project Number: [none]
 Project: Tejon and Asbury Park

PAH by 8270D SIM - Quality Control
GEL Laboratories, LLC

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
---------	--------	-----------------	-------	-------------	---------------	------	-------------	-----	-----------	-------

Batch 1668134 - SW846 3541

MSD (1203796834 SD)	Source: Y705257-01			Prepared: 05/25/2017 Analyzed: 05/26/2017						
Benzo(b)fluoranthene	0.476	0.016	mg/kg	0.401	0.231	61	28-126	11	30	
Phenanthrene	0.345	0.016	"	0.401	0.109	59	35-119	12	30	
Surrogate: 5-alpha-Androstane	0.152		"	0.200	0.154	76	30-118			

Origins Laboratory, Inc.



Jen Pellegrini For Noelle Doyle Mathis, President

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Pinyon
 9100 West Jewell Avenue, Suite 200
 Lakewood CO 80232

Tim Grenier
 Project Number: [none]
 Project: Tejon and Asbury Park

PCB by 8082A - Quality Control
GEL Laboratories, LLC

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
---------	--------	-----------------	-------	-------------	---------------	------	-------------	-----	-----------	-------

Batch 1669222 - SW846 3541

BLANK (1203799431-BLK)

Prepared: 05/30/2017 Analyzed: 05/31/2017

Aroclor-1016	ND	0.00333	mg/kg				-			U
Aroclor-1221	ND	0.00333	"				-			U
Aroclor-1232	ND	0.00333	"				-			U
Aroclor-1242	ND	0.00333	"				-			U
Aroclor-1248	ND	0.00333	"				-			U
Aroclor-1254	ND	0.00333	"				-			U
Aroclor-1260	ND	0.00333	"				-			U
Aroclor-Total	ND	0.00333	"				-			U

Surrogate: Decachlorobiphenyl

0.00572

"

0.00666

86

32-139

Surrogate: 4cmx

0.00423

"

0.00666

64

30-120

LCS (1203799432-BKS)

Prepared: 05/30/2017 Analyzed: 05/31/2017

Aroclor-1016	0.0251	0.00333	mg/kg	0.0333		75	48-93			
Aroclor-1260	0.0284	0.00333	"	0.0333		85	58-117			
Surrogate: 4cmx	0.00424		"	0.00666		64	30-120			
Surrogate: Decachlorobiphenyl	0.0056		"	0.00666		84	32-139			

MS (1203799433 S)

Source: 424042001

Prepared: 05/30/2017 Analyzed: 05/31/2017

Aroclor-1016	0.0265	0.00359	mg/kg	0.0359	<0.0012	74	23-121			
Aroclor-1260	0.0298	0.00359	"	0.0359	<0.0012	83	35-135			
Surrogate: 4cmx	0.00434		"	0.00718	0.00417	60	30-120			
Surrogate: Decachlorobiphenyl	0.00562		"	0.00718	0.0054	78	32-139			

MSD (1203799434 SD)

Source: 424042001

Prepared: 05/30/2017 Analyzed: 05/31/2017

Aroclor-1016	0.0226	0.00359	mg/kg	0.0359	<0.0012	63	23-121	16	29	
Aroclor-1260	0.0256	0.00359	"	0.0359	<0.0012	71	35-135	15	33	
Surrogate: Decachlorobiphenyl	0.00495		"	0.00718	0.0054	69	32-139			
Surrogate: 4cmx	0.00361		"	0.00718	0.00417	50	30-120			

Origins Laboratory, Inc.



Jen Pellegrini For Noelle Doyle Mathis, President

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Pinyon
9100 West Jewell Avenue, Suite 200
Lakewood CO 80232

Tim Grenier
Project Number: [none]
Project: Tejon and Asbury Park

PCB by 8082A - Quality Control
GEL Laboratories, LLC

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
---------	--------	-----------------	-------	-------------	---------------	------	-------------	-----	-----------	-------

Batch 1669222 - SW846 3541

Origins Laboratory, Inc.



Jen Pellegrini For Noelle Doyle Mathis, President

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Pinyon
 9100 West Jewell Avenue, Suite 200
 Lakewood CO 80232

Tim Grenier
 Project Number: [none]
 Project: Tejon and Asbury Park

TCLP Metals by 1311/6010C - Quality Control
GEL Laboratories, LLC

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch 1667987 - SW846 3010A										
MS (1203795714 S)			Source: Y705257-01			Prepared: 05/24/2017 Analyzed: 05/25/2017				
Lead	4.37	0.100	mg/L	5.00	0.0453	86.6	75-125			
TB (1203795715-BLK)						Prepared: 05/24/2017 Analyzed: 05/25/2017				
Lead	ND	0.100	mg/L				-			U
BLANK (1203796441-BLK)						Prepared: 05/24/2017 Analyzed: 05/25/2017				
Lead	ND	0.100	mg/L				-			U
LCS (1203796442-BKS)						Prepared: 05/24/2017 Analyzed: 05/25/2017				
Lead	4.15	0.100	mg/L	5.00		83	80-120			
DUP (1203796443 D)			Source: Y705257-01			Prepared: 05/24/2017 Analyzed: 05/25/2017				
Lead	0.0455	0.100	mg/L		0.0453		0-20	0.418	20	J

Origins Laboratory, Inc.



Jen Pellegrini For Noelle Doyle Mathis, President

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Pinyon
 9100 West Jewell Avenue, Suite 200
 Lakewood CO 80232

Tim Grenier
 Project Number: [none]
 Project: Tejon and Asbury Park

Total Metals by 6010C - Quality Control
GEL Laboratories, LLC

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
---------	--------	-----------------	-------	-------------	---------------	------	-------------	-----	-----------	-------

Batch 1667760 - SW846 3050B

BLANK (1203795820-BLK)

Prepared: 05/23/2017 Analyzed: 05/24/2017

Silver	ND	0.478	mg/kg				-			U
Arsenic	ND	2.87	"				-			U
Barium	ND	0.478	"				-			U
Cadmium	ND	0.478	"				-			U
Chromium	ND	0.478	"				-			U
Lead	0.386	0.956	"				-			J
Selenium	0.508	2.87	"				-			J

LCS (1203795821-BKS)

Prepared: 05/23/2017 Analyzed: 05/24/2017

Silver	47.6	0.484	mg/kg	48.4		98.5	80-120			
Selenium	50.6	2.90	"	48.4		105	80-120			
Lead	49.5	0.967	"	48.4		102	80-120			
Chromium	49.6	0.484	"	48.4		103	80-120			
Cadmium	49.7	0.484	"	48.4		103	80-120			
Arsenic	47.9	2.90	"	48.4		99	80-120			
Barium	49.3	0.484	"	48.4		102	80-120			

DUP (1203795822 D)

Source: Y705257-01

Prepared: 05/23/2017 Analyzed: 05/24/2017

Chromium	14.0	0.607	mg/kg		14.9		0-20	6.23	20	
Arsenic	4.26	3.64	"		2.84		0-20	40.1	20	
Lead	52.1	1.21	"		46.8		0-20	10.8	20	
Selenium	9.62	3.64	"		9.41		0-20	2.21	20	
Silver	0.205	0.607	"		0.340		0-20	49.7	20	J
Cadmium	1.13	0.607	"		1.06		0-20	6.18	20	
Barium	275	0.607	"		228		0-20	18.6	20	

MS (1203795823 S)

Source: Y705257-01

Prepared: 05/23/2017 Analyzed: 05/24/2017

Origins Laboratory, Inc.



Jen Pellegrini For Noelle Doyle Mathis, President

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Pinyon
 9100 West Jewell Avenue, Suite 200
 Lakewood CO 80232

Tim Grenier
 Project Number: [none]
 Project: Tejon and Asbury Park

Total Metals by 6010C - Quality Control
GEL Laboratories, LLC

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
---------	--------	-----------------	-------	-------------	---------------	------	-------------	-----	-----------	-------

Batch 1667760 - SW846 3050B

MS (1203795823 S)		Source: Y705257-01			Prepared: 05/23/2017 Analyzed: 05/24/2017					
Barium	315	0.591	mg/kg	59.1	228	147	75-125			
Silver	54.7	0.591	"	59.1	0.340	91.9	75-125			
Selenium	65.2	3.55	"	59.1	9.41	94.3	75-125			
Lead	97.3	1.18	"	59.1	46.8	85.4	75-125			
Cadmium	54.5	0.591	"	59.1	1.06	90.3	75-125			
Arsenic	56.4	3.55	"	59.1	2.84	90.6	75-125			
Chromium	69.3	0.591	"	59.1	14.9	92	75-125			
PS (1203798529 S)		Source: Y705257-01			Prepared: 05/23/2017 Analyzed: 05/26/2017					
Barium	2.72	0.00607	mg/kg	0.500		59.9	80-120			

Origins Laboratory, Inc.



Jen Pellegrini For Noelle Doyle Mathis, President

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Pinyon
 9100 West Jewell Avenue, Suite 200
 Lakewood CO 80232

Tim Grenier
 Project Number: [none]
 Project: Tejon and Asbury Park

Total Metals by 7471A - Quality Control
GEL Laboratories, LLC

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch 1668000 - SW846 7471A Prep										
BLANK (1203796468-BLK)					Prepared: 05/24/2017 Analyzed: 05/25/2017					
Mercury	ND	0.0116	mg/kg				-			U
LCS (1203796469-BKS)					Prepared: 05/24/2017 Analyzed: 05/25/2017					
Mercury	6.50	0.600	mg/kg	7.10		91.6	80-120			
DUP (1203796473 D)					Source: 423446001 Prepared: 05/24/2017 Analyzed: 05/25/2017					
Mercury	0.0225	0.0123	mg/kg		0.0237		0-20	5.34	20	
MS (1203796474 S)					Source: 423446001 Prepared: 05/24/2017 Analyzed: 05/25/2017					
Mercury	0.148	0.0126	mg/kg	0.126	0.0237	99	80-120			

Origins Laboratory, Inc.



Jen Pellegrini For Noelle Doyle Mathis, President

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Pinyon
9100 West Jewell Avenue, Suite 200
Lakewood CO 80232

Tim Grenier
Project Number: [none]
Project: Tejon and Asbury Park

Notes and Definitions

- Ua Sample is Non-Detect.
- U Result not detected above the detection limit
- J Greater than the detection limit but less than the reporting limit
- ND Analyte NOT DETECTED at or above the reporting limit
- RPD Relative Percent Difference

All soil results are reported on a wet weight basis.

Origins Laboratory, Inc.



Jen Pellegrini For Noelle Doyle Mathis, President

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.



November 28, 2017

Subcontract Number: NA
Laboratory Report: RES 394973-1
Project # / P.O. # 11700702
Project Description: Asbury Park

Pinyon Environmental Engineering
9100 West Jewell Ave. Suite 200
Lakewood CO 80232

Dear Customer,

Reservoirs Environmental, Inc. is an analytical laboratory accredited for the analysis of Industrial Hygiene and Environmental matrices by the National Voluntary Laboratory Accreditation Program (NVLAP), Lab Code 101896-0 for Transmission Electron Microscopy (TEM) and Polarized Light Microscopy (PLM) analysis and the American Industrial Hygiene Association (AIHA), Lab ID 101533 - Accreditation Certificate #480 for Phase Contrast Microscopy (PCM) analysis. This laboratory is currently proficient in both Proficiency Testing and PAT programs respectively.

Reservoirs Environmental, Inc. has analyzed the following samples for asbestos content as per your request. The analysis has been completed in general accordance with the appropriate methodology as stated in the attached analysis table. The results have been submitted to your office.

RES 394973-1 is the job number assigned to this study. This report is considered highly confidential and the sole property of the customer. Reservoirs Environmental, Inc. will not discuss any part of this study with personnel other than those of the client. The results described in this report only apply to the samples analyzed. This report must not be used to claim endorsement of products or analytical results by NVLAP or any agency of the U.S. Government. This report shall not be reproduced except in full, without written approval from Reservoirs Environmental, Inc. Samples will be disposed of after sixty days unless longer storage is requested. If you have any questions about this report, please feel free to call 303-964-1986.

Sincerely,

A handwritten signature in blue ink that reads "Elisa Mari". Below the signature, the text "Elisa Mari for" is printed in a smaller, blue, sans-serif font.

Jeanne Spencer
President

RESERVOIRS ENVIRONMENTAL INC.

NVLAP Lab Code 101896-0

TABLE: PLM BULK ANALYSIS, PERCENTAGE COMPOSITION BY VOLUME

RES Job Number: **RES 394973-1**
 Client: **Pinyon Environmental Engineering**
 Client Project Number / P.O.: **11700702**
 Client Project Description: **Asbury Park**
 Date Samples Received: **November 21, 2017**
 Method: **EPA 600/R-93/116 - Short Report, Bulk**
 Turnaround: **3-5 Day**
 Date Samples Analyzed: **November 28, 2017**

ND=None Detected
 TR=Trace, <1% Visual Estimate
 Trem/Act=Tremolite/Actinolite

Client Sample Number	Lab ID Number	L A Y E R	Physical Description	Sub Part (%)	Asbestos Content		Non Asbestos Fibrous Components (%)	Non-Fibrous Components (%)
					Mineral	Visual Estimate (%)		
TP-01 (1)	EM 1977153	A	Red brick	10		ND	0	100
			B	White/tan plaster	90		ND	0
TP-03 (1)	EM 1977154	A	Gray fibrous plaster	100	Chrysotile	20	15	65
TP-04 (1)	EM 1977155	A	Dark gray granular material	5		ND	0	100
			B	Light gray/white brick	95		ND	0
TP-04 (2)	EM 1977156	A	Red brick	100		ND	0	100

TEM Analysis recommended for organically bound material (i.e. floor tile) if PLM results are <1%.



Liu Wenlong

Analyst / Data QA

Due Date: 11/23/17
 Due Time: _____

REILAB Reservoirs Environmental, Inc.

5801 Logan St. Denver, CO 80216 • Ph: 303-964-1986 • Fax 303-477-4275 • Toll Free 866-RES-ENV

I - L - 4

RES 394973

INVOICE TO: (IF DIFFERENT)

SUBMITTED BY: REILAB ENVIRONMENTAL
 Company: REILAB ENVIRONMENTAL
 Address: 9100 W SEWELL AVE
LAKEWOOD CO 80232

Company: _____
 Address: _____

Project Number and/or P.O. #: 11700702
Project Description/Location: ASBURY PARK

CONTACT INFORMATION:
 Contact: TIM GREYER
 Phone: 303-980-5200
 Fax: _____
 Cell/pager: _____

Final Data Deliverable Email Address: GREYER@REILAB-ENV.COM

ASBESTOS LABORATORY HOURS: Weekdays: 7am - 7pm & Sat. 8am - 5pm <u>PLM</u> / PCM / TEM _____ RUSH (Same Day) _____ PRIORITY (Next Day) <u>X</u> STANDARD (3-5 Day) (Rush PCM = 2hr, TEM = 6hr.)		CHEMISTRY LABORATORY HOURS: Weekdays: 8am - 5pm Metal(s) / Dust** _____ RUSH _____ 24 hr. _____ 3-5 Day RCRA 8 / Metals & Welding _____ RUSH (3 Day) _____ 5 Day _____ 10 Day Fume Scan / TCLP** _____ RUSH _____ 24 hr. _____ 3 day _____ 5 Day		MICROBIOLOGY LABORATORY HOURS: Weekdays: 9am - 6pm E.coli and/or Coliforms* _____ 24-48 Hour Pathogens* _____ 24-48 Hour Microbial Growth* _____ 5-10 Day Legionella _____ 10 Day Mold _____ RUSH _____ 24 Hr _____ 48 Hr _____ 3 Day _____ 5 Day		LAB NOTES:	
PLM - Short report, Point Count, Long report, Qualitative		PCRA 8, TCLP, Welding Fume, Metals Scan, pH		DUST - Total, Respirable		METALS - Analyte(s)	
TEM - AHERA, Level II, 7402, ISO, +/- (Air, Bulk or Dust), Quant, Semi-Quant, Micro-vac, ISO-Indirect Preps		PCM - 7400A, 7400B, OSHA		ORGANICS - METH, TSS		VALID MATRIX CODES	
RCRA 8, TCLP, Welding Fume, Metals Scan, pH		Pathogens: Aerobic Plate Count, Salmonella, E coli, O157:H7, Listeria, S aureus, Campylobacter, +/- or Quantification		E coli and/or Coliforms: +/- or Quantification		Air = A Dust = D Soil = S Swab = SW Drinking Water = DW Waste Water = WW O = Other **ASTM E1792 approved wipe media only**	
State Water (Please Circle One) Yes / No		Microbial Growth: Aerobic Plate Count ID, Y & M or Bacteria, Fungal, +/- or Quantification		Legionella: +/- or Quantification		Bulk = B Paint = P Wipe = W F = Food	
Other: Bioburden, LAL or Environmental		Mold: Spore Trap or Bulk: +/-, Identification, Quantification		Viability or Non-Viability		Time Collected hh:mm a/p	
SAMPLER'S INITIALS OR OTHER NOTES:		Matrix Code		Date Collected mm/dd/yy		EM Number (Laboratory Use Only)	
Sample Volume (L) / Area		# Containers		Date Collected mm/dd/yy		EM Number (Laboratory Use Only)	
X				01	11/16/17	1100	1977153
X				01	11/16/17	1110	1
X				01	11/16/17	1120	5
X				01	11/16/17	1130	6

(Additional samples shall be listed on attached long form.)

Number of samples received: _____
 NOTE: REI will analyze incoming samples based upon information received and will not be responsible for errors or omissions in calculations resulting from the inaccuracy of original data. By signing client/company representative agrees that submission of the following samples for requested analysis as indicated on this Chain of Custody shall constitute an analytical services agreement with payment in full for NET 30 days, failure to comply with payment terms may result in a 1.5% monthly interest surcharge.

Relinquished By: Robert [Signature] Date/Time: 11/21/17 9:30

Laboratory Use Only

Contact Data Entry	Phone Email Fax	Date	Time
Contact QA	Phone Email Fax	Date	Time
Carrier: <u>Hand</u>	FedEx / UPS / USPS / Drop Box / Courier	Date	Time
Sample Condition: On Ice	Sealed Yes / No	Date	Time
Temp. (F°)	Yes / No	Date	Time
Initials	Initials	Date	Time
Initials	Initials	Date	Time

Pinyon

Tim Grenier

9100 West Jewell Avenue, Suite 200

Lakewood CO 80232

Project Name - Asbury Park and Tejon

Project Number - [none]

Attached are your analytical results for Asbury Park and Tejon received by Origins Laboratory, Inc. August 25, 2017. This project is associated with Origins project number Y708338-01.

The analytical results in the following report were analyzed under the guidelines of EPA Methods. These methods are identified as follows; "SW" are defined in SW-846, "EPA" are defined in 40CFR part 136 and "SM" are defined in the most current revision of Standard Methods For the Examination of Water and Wastewater.

The analytical results apply specifically to the samples and analyses specified per the attached Chain of Custody. As such, this report shall not be reproduced except in full, without the written approval of Origin's laboratory.

Unless otherwise noted, the analytical results for all soil samples are reported on a wet weight basis. All analytical analyses were performed under NELAP guidelines unless noted by a data qualifier.

Any holding time exceedances, deviations from the method specifications or deviations from Origins Laboratory's Standard Operating Procedures are outlined in the case narrative.

Thank you for selecting Origins for your analytical needs. Please contact us with any questions concerning this report, or if we can help with anything at all.

Origins Laboratory, Inc.
303.433.1322
o-squad@oelabinc.com



Pinyon
9100 West Jewell Avenue, Suite 200
Lakewood CO 80232

Tim Grenier
Project Number: [none]
Project: Asbury Park and Tejon

CROSS REFERENCE REPORT

Sample ID	Laboratory ID	Matrix	Date Sampled	Date Received
MW-01	Y708338-01	Water	August 25, 2017 11:50	08/25/2017 12:20

Per the email from Rachel on 8/28/17, the sample ID was changed from MW-02 to MW01.

Origins Laboratory, Inc.



The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Pinyon
 9100 West Jewell Avenue, Suite 200
 Lakewood CO 80232

Tim Grenier
 Project Number: [none]
 Project: Asbury Park and Tejon

Origins Laboratory

F-012207-01-R1
 Effective Date: 01/09/12

Sample Receipt Checklist

Origins Work Order: 4708338 Client: Rayon
 Client Project ID: Asbury Park + Tejon
 Checklist Completed by: Jen Pellegrini Shipped Via: HP
 Date/time completed: 8/25/17 (UPS, FedEx, Hand Delivered, Pick-up, etc.)
 Airbill #: N/A
 Matrix(s) Received: (Check all that apply): Soil/Solid Water Other: _____
 Cooler Number/Temperature: 1 / 22.8 °C _____ / _____ °C _____ / _____ °C
 Thermometer ID: TRX5 (Describe)

Requirement Description	Yes	No	N/A	Comments (if any)
If samples require cooling, was the temperature between 0°C to ≤ 6°C ⁽¹⁾ ?		X		Sampled same day
Is there ice present (document if blue ice is used)	X			
Are custody seals present on cooler? (if so, document in comments if they are signed and dated, broken or intact)		X		
Are custody seals present on each sample container? (if so, document in comments if they are signed and dated, broken or intact)		X		
Were all samples received intact ⁽¹⁾ ?	X			
Was adequate sample volume provided ⁽¹⁾ ?	X			
Are short holding time analytes or samples with HTs due within 48 hours present ⁽¹⁾ ?		X		
Is a chain-of-custody (COC) present and filled out completely ⁽¹⁾ ?	X			
Does the COC agree with the number and type of sample bottles received ⁽¹⁾ ?	X			
Do the sample IDs on the bottle labels match the COC ⁽¹⁾ ?	X			
Is the COC properly relinquished by the client with date and time recorded ⁽¹⁾ ?	X			
For volatiles in water – is there headspace (> ¼ inch bubble) present? If yes, contact client and note in narrative.		X		
Are samples preserved that require preservation and was it checked ⁽¹⁾ ? (note ID of confirmation instrument used in comments) / (preservation is not confirmed for subcontracted analyses in order to insure sample integrity)/(pH <2 for samples preserved with HNO3, HCl, H2SO4) / (pH >10 for samples preserved with NaAsO2+NaOH, ZnAc+NaOH)	X			HCl
Additional Comments (if any):				

⁽¹⁾If NO, then contact the client before proceeding with analysis and note date/time and person contacted as well as the corrective action to in the additional comments (above) and the case narrative.

Reviewed by (Project Manager) JAP Date/Time Reviewed 8/25/17

Origins Laboratory, Inc.



The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Pinyon
9100 West Jewell Avenue, Suite 200
Lakewood CO 80232

Tim Grenier
Project Number: [none]
Project: Asbury Park and Tejon

MW-01
8/25/2017 11:50:00AM

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Notes
---------	--------	-----------------	-------	----------	-------	----------	----------	-------

Origins Laboratory, Inc.
Y708338-01 (Water)

BTEX by EPA 8260C

Benzene	ND	1.00	ug/L	1	B7H2901	08/29/2017	08/29/2017	U
Toluene	ND	1.00	"	"	"	"	"	U
Ethylbenzene	ND	1.00	"	"	"	"	"	U
Xylenes, total	ND	1.00	"	"	"	"	"	U
Surrogate: 1,2-Dichloroethane-d4	102 %	84-121			"	"	"	
Surrogate: Toluene-d8	101 %	85-115			"	"	"	
Surrogate: 4-Bromofluorobenzene	98.8 %	84-114			"	"	"	

Origins Laboratory, Inc.



The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Pinyon
 9100 West Jewell Avenue, Suite 200
 Lakewood CO 80232

Tim Grenier
 Project Number: [none]
 Project: Asbury Park and Tejon

Volatile Organic Compounds by GC/MS SW846 8260C - Quality Control
Origins Laboratory, Inc.

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
---------	--------	-----------------	-------	-------------	---------------	------	-------------	-----	-----------	-------

Batch B7H2901 - EPA 5030B (Water)

Blank (B7H2901-BLK1)

Prepared: 08/29/2017 Analyzed: 08/29/2017

Benzene	ND	1.00	ug/L							U
Toluene	ND	1.00	"							U
Ethylbenzene	ND	1.00	"							U
Xylenes, total	ND	1.00	"							U
Surrogate: 1,2-Dichloroethane-d4	67		"	62.5	108		84-121			
Surrogate: Toluene-d8	64		"	62.5	103		85-115			
Surrogate: 4-Bromofluorobenzene	58		"	62.5	92.9		84-114			

Origins Laboratory, Inc.



The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Pinyon
 9100 West Jewell Avenue, Suite 200
 Lakewood CO 80232

Tim Grenier
 Project Number: [none]
 Project: Asbury Park and Tejon

Volatile Organic Compounds by GC/MS SW846 8260C - Quality Control
Origins Laboratory, Inc.

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
---------	--------	-----------------	-------	-------------	---------------	------	-------------	-----	-----------	-------

Batch B7H2901 - EPA 5030B (Water)

LCS (B7H2901-BS1)

Prepared: 08/29/2017 Analyzed: 08/29/2017

Benzene	55.1	1.00	ug/L	50.0		110	73.3-129			
Toluene	55.9	1.00	"	50.0		112	76.2-123			
Ethylbenzene	57.3	1.00	"	50.0		115	73.6-130			
m,p-Xylene	114	2.00	"	100		114	76.1-126			
o-Xylene	58.8	1.00	"	50.0		118	76.6-124			
Surrogate: 1,2-Dichloroethane-d4	64		"	62.5		103	84-121			
Surrogate: Toluene-d8	63		"	62.5		101	85-115			
Surrogate: 4-Bromofluorobenzene	56		"	62.5		90.4	84-114			

Origins Laboratory, Inc.



The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Pinyon
 9100 West Jewell Avenue, Suite 200
 Lakewood CO 80232

Tim Grenier
 Project Number: [none]
 Project: Asbury Park and Tejon

Volatile Organic Compounds by GC/MS SW846 8260C - Quality Control
Origins Laboratory, Inc.

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
---------	--------	-----------------	-------	-------------	---------------	------	-------------	-----	-----------	-------

Batch B7H2901 - EPA 5030B (Water)

Matrix Spike (B7H2901-MS1)	Source: Y708325-01			Prepared: 08/29/2017 Analyzed: 08/30/2017						
Benzene	50.9	1.00	ug/L	50.0	ND	102	74-130			
Toluene	50.3	1.00	"	50.0	ND	101	73-131			
Ethylbenzene	51.2	1.00	"	50.0	ND	102	76-132			
m,p-Xylene	103	2.00	"	100	ND	103	69-139			
o-Xylene	52.9	1.00	"	50.0	ND	106	74-131			
Surrogate: 1,2-Dichloroethane-d4	58		"	62.5		92.5	84-121			
Surrogate: Toluene-d8	63		"	62.5		100	85-115			
Surrogate: 4-Bromofluorobenzene	64		"	62.5		102	84-114			

Origins Laboratory, Inc.



The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Pinyon
 9100 West Jewell Avenue, Suite 200
 Lakewood CO 80232

Tim Grenier
 Project Number: [none]
 Project: Asbury Park and Tejon

Volatile Organic Compounds by GC/MS SW846 8260C - Quality Control
Origins Laboratory, Inc.

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
---------	--------	-----------------	-------	-------------	---------------	------	-------------	-----	-----------	-------

Batch B7H2901 - EPA 5030B (Water)

Matrix Spike Dup (B7H2901-MSD1)	Source: Y708325-01			Prepared: 08/29/2017 Analyzed: 08/30/2017						
Benzene	50.5	1.00	ug/L	50.0	ND	101	74-130	0.828	20	
Toluene	48.8	1.00	"	50.0	ND	97.6	73-131	3.07	20	
Ethylbenzene	49.3	1.00	"	50.0	ND	98.6	76-132	3.80	20	
m,p-Xylene	99.4	2.00	"	100	ND	99.4	69-139	3.56	20	
o-Xylene	51.7	1.00	"	50.0	ND	103	74-131	2.30	20	
Surrogate: 1,2-Dichloroethane-d4	59		"	62.5		94.9	84-121			
Surrogate: Toluene-d8	61		"	62.5		97.8	85-115			
Surrogate: 4-Bromofluorobenzene	62		"	62.5		98.8	84-114			

Origins Laboratory, Inc.



The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Pinyon
9100 West Jewell Avenue, Suite 200
Lakewood CO 80232

Tim Grenier
Project Number: [none]
Project: Asbury Park and Tejon

Notes and Definitions

U Sample is Non-Detect.

ND Analyte NOT DETECTED at or above the reporting limit

RPD Relative Percent Difference

All soil results are reported at a wet weight basis.

Origins Laboratory, Inc.



The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Jen Pellegrini For Noelle Doyle Mathis, President

Appendix B

**CDPHE Solid Waste Regulation – Section 5.5
Management of Regulated Asbestos Contaminated Soil**

**Air Quality Control Commission Regulation No. 8 Part
B - Asbestos**

DEPARTMENT OF PUBLIC HEALTH AND ENVIRONMENT

Solid and Hazardous Waste Commission/Hazardous Materials and Waste Management Division

6 CCR 1007-2

PART 1 - REGULATIONS PERTAINING TO SOLID WASTE SITES AND FACILITIES

Deletion and Replacement of Existing Section 5.5 Regulations (Management of Asbestos-Contaminated Soil) with New Section 5.5 Regulations (Management of Regulated Asbestos Contaminated Soil (RACS)); the Addition of Appendix 5A (Sample Collection Protocols and Analytical Methodologies) and the Associated Additions and Revision to Section 1.2 Definitions

(Adopted by the Solid and Hazardous Waste Commission on August 19, 2014)

1) Amend Section 1.2 by adding the following definitions in alphabetical order to read as follows:

1.2 Definitions

“Adjacent Receptor Zone” means an area of uncontrolled access at a distance of 150’ or less from the nearest Regulated Work Area (RWA) boundary during active Regulated Asbestos Contaminated Soil (RACS) disturbance. For the purpose of this definition, highways, streets, and roads without sidewalks, where only vehicles are permitted, are considered to be areas of controlled access and therefore not adjacent receptor zones. For the purpose of this definition "vehicle" means a device that is capable of moving itself, or of being moved, from place to place upon wheels, including bicycles and electrical assisted bicycles. For the purpose of this definition, an area for which access is not ordinarily controlled that is closed to the public during soil disturbing activities in the adjacent RWA is considered to be an area of controlled access and therefore not an adjacent receptor zone.

“Air Monitoring Specialist” (“AMS”) means a person trained and certified, in accordance with the requirements of Air Quality Control Commission Regulation No. 8 (5 CCR 1001-10, Part B), for the collection of air samples to determine airborne particulate and/or asbestos concentrations.

“Ancillary Worker” means a worker that has not completed the training under Section 5.5.3(A) and (B) of these regulations.

“Area of Contamination” (“AOC”) means a discrete, discernible area of known RACS.

“Certified Asbestos Building Inspector” (“CABI”) means a person trained and certified in accordance with Air Quality Control Commission Regulation No. 8 (5 CCR 1001-10, Part B), for the identification of asbestos-containing materials and the collection of samples to determine asbestos content, including qualified Department personnel.

“Debris” means any discarded material that contains or consists of any of the following: construction, renovation and demolition debris (regardless of how it was generated), building or facility components, components of building systems (HVAC, plumbing, electrical, control, fire protection, roofing), components of pavement or drainage systems, industrial or machinery components, and/or mechanical components from motorized vehicles.

“Friable asbestos-containing material” (“Friable ACM”) means any material that contains asbestos and when dry can be crumbled, pulverized, or reduced to powder by hand pressure and that contains more than one percent asbestos by weight, area, or volume. The term includes non-friable forms of asbestos after such previously non-friable material becomes damaged to the extent that when dry it can be crumbled, pulverized, or reduced to powder by hand pressure as determined in the field by a CABI.

“Geofabric” for the purposes of Section 5.5 means a permeable fabric or synthetic material used for both visual and physical separation.

“Low Emissions Methods” means soil disturbing activities that will not result in visible emissions without the use of wet methods.

“Non-Regulated Asbestos Contaminated Soil” (“Non-RACS”) means soil or debris that contains only:

- 1) Intact non-damaged, non-friable asbestos-containing materials (ACM); or,
- 2) Damaged non-friable ACM(s) that do not have a high probability to release fibers based on the forces expected to act upon the material during disturbance as determined in the field by a CABI(s) through a “RACS Determination”. The following ACM(s) are predetermined to be Non-RACS:
 - a. Resin based materials including but not limited to phenolic-plastic (Bakelite), used in electrical and mechanical parts
 - b. Resilient flooring (vinyl, asphalt, rubber) excluding non-tar impregnated friable felt backing on sheet vinyl flooring (linoleum)
 - c. Tar impregnated or asphaltic materials in good condition that have not become brittle
 - d. Elastic, pliable, or rubberized materials, including but not limited to:
 - i. Pliable duct sealant
 - ii. Pliable fiberglass insulation sealant
 - iii. Pliable fire-stop caulking /sealants
 - iv. Pliable window and door caulking
 - e. Extremely hard materials, coatings and sealants including but not limited to:
 - i. Laboratory countertops and sinks
 - ii. Epoxy type Concrete Masonry Unit (CMU) coatings
 - iii. Epoxy type panel adhesive
 - iv. Duct sealant
 - v. Ceiling tile adhesive
 - f. Other ACM(s) as approved by the Department at the request of the owner or person disturbing debris, to not have a high probability to release fibers.

"Project" means any soil disturbing activity that involves Regulated Asbestos Contaminated Soil (RACS) within a planned geographic area(s) of disturbance, as defined in the Notification of RACS Disturbance form submitted for that specific management or remediation scope, starting from the time of first RACS disturbance and continuing through final RACS removal or stabilization and final demobilization. A project may include one or more Regulated Work Areas (RWAs), and start dates and stabilization dates for individual RWAs within a project may be different.

“Project Specific RACS Management Plan” (“PSRMP”) means a Regulated Asbestos Contaminated Soil (RACS) management plan for a single project submitted in accordance with Section 5.5.5(A).

“Qualified Project Monitor” (“QPM”) means an individual who has the training and/or experience necessary to identify materials suspected of containing asbestos and who has the authority to make prompt decisions relating to the management of such materials, and who meets the training requirements in Section 5.5.3.

“Regulated Asbestos Contaminated Soil” (“RACS”) means soil, ash or debris (plus six (6) inches in all directions of surrounding soil or other matrix material) containing:

- 1) Friable asbestos-containing materials (ACM) as determined in the field by a Certified Asbestos Building Inspector (CABI) through a RACS determination;
- 2) Previously non-friable ACM(s) that have been rendered friable as determined in the field by a CABI(s) through a RACS determination;
- 3) Non-friable ACM(s) that have a high probability of releasing fibers based on the forces expected to act upon the material during soil disturbance as determined in the field by a CABI(s) through a RACS determination;
- 4) Deteriorated non-friable ACM(s) that are in poor condition resulting in a high probability to release fibers due to weathering, historical mechanical impact, fire damage (by evidence of ACM within an ash layer) or other factors as determined in the field by a CABI(s) through a RACS determination;
- 5) The following broken, resized, or damaged ACM(s) are RACS:
 - a. Asbestos cement materials
 - b. Plaster
 - c. Brittle caulking, glazing and sealants
 - d. Powdery Concrete Masonry Unit (CMU) sealant
 - e. Powdery floor leveling compound
 - f. Drywall/wallboard and associated joint compound material
 - g. Firebrick
 - h. Other material as determined by the Department, at the request of the owner or person disturbing debris, to have a high probability to release fibers.

- 6) Soil or ash known to contain non-visible asbestos based on documented evidence.

“RACS Determination” for the purpose of Section 5.5 means a determination, conducted in the field by a Certified Asbestos Building Inspector (CABI), of the friability of Asbestos Containing Material (ACM) and the probability of non-friable ACM to release fibers based on the condition of the material and the forces that are expected to act on it during disturbance. Determinations of friability shall be based on the requirements for such determinations set forth in Air Quality Control Commission Regulation No. 8 (5 CCR 1001-10, Part B). Determinations of the probability for non-friable ACM to release fibers during disturbance shall be based on the following:

- 1) The condition of the material prior to disturbance, based on observations of weathering, the integrity of the material, historical mechanical impact, or fire damage;
- 2) The potential for the material to be broken, resized or damaged during planned disturbance;
- 3) The material shall be considered RACS if the planned disturbance includes any of the following:
 - a. Augers
 - b. Rotary style trenchers
 - c. Driving on ACM lying on the surface (vehicles or equipment)
 - d. Blasting or other detonation
 - e. Intentional burning
 - f. Other types of direct mechanical impact which are:
 - i. In direct contact with ACM or result in observation of ACM after disturbance, and
 - ii. Causing damage to the ACM

“Regulated work area” (“RWA”) as used in Section 5.5 of these regulations means the portion(s) of a site at which soil disturbing activities involving RACS occur.

“Risk-Based Air Threshold” for the purpose of Section 5.5 means one of the following thresholds based on project duration and receptor population, or as approved by the Department, as determined based on the sampling, analytical, and data evaluation procedures provided in Appendix 5A:

- a. an average of 0.003 fibers per cubic centimeter (f/cc) for projects with durations of thirty (30) working days or less with child receptors;
- b. an average of 0.0003 f/cc for projects with durations between thirty (30) working days and one calendar year with child receptors;
- c. an average of 0.006 f/cc for projects with durations of thirty (30) working days or less with only adult receptors, including commercial workers and non-OSHA workers;
- d. an average of 0.0006 f/cc for projects with durations between thirty (30) working days and one calendar year with only adult receptors excluding commercial workers and non-OSHA workers;
- e. an average of 0.0009 f/cc for projects with durations of between thirty (30) working days and one calendar year with only commercial worker receptors;
- f. an average of 0.001 f/cc for projects with durations between 30 days and one year with only non-OSHA worker receptors;
- g. if the total duration of the project exceeds, or is anticipated to exceed, one year, the owner/operator shall contact the Department for a project specific risk-based threshold.

“Staging” for the purposes of Section 5.5, means the accumulation of RACS in the RWA for twelve (12) hours or less.

“Standard Operating Procedure” (“SOP”) means a RACS management plan for multiple projects submitted in accordance with Section 5.5.5(B).

“Stockpiling” for the purposes of Section 5.5, means the accumulation of RACS that will exist for more than twelve (12) hours, up to and including ten (10) calendar days.

“Storage” for the purposes of Section 5.5, means the accumulation of RACS greater than ten (10) days, but not exceeding six (6) months unless a longer timeframe is approved by the Department and complies with local governing authority requirements.

“Visible” means capable of being seen with the unaided eye.

“Visual Inspection” for the purposes of Section 5.5 means observation with sufficient proximity to identify discrete visible materials, while maintaining the safety of the inspector.

2) Amend Section 1.2 by revising the following definitions to read as follows:

1.2 Definitions

“Adequately wet” means sufficiently wet to minimize visible emissions of dust and/or debris within the regulated work area (RWA) and either:

- a. Prevent the release of visible emissions from leaving the RWA in accordance with Section 5.5 of these regulations; or
- b. Demonstrate that asbestos fibers are not leaving the RWA above risk-based air thresholds.

The observance of visible emissions, outside of the RWA, of dust and/or debris may be an indication that soils are not adequately wet.

“Asbestos” means the asbestiform varieties of serpentinite (chrysotile), riebeckite (crocidolite), amosite (cummingtonite-grunerite), anthophyllite, actinolite and tremolite.

“Asbestos-containing material” (“ACM”) means any material that contains more than one percent (1%) asbestos.

“Friable asbestos waste” means any asbestos waste that has been or can be pulverized or reduced to powder by hand pressure when dry.

“Mechanical” means operated or produced by mechanism, tool or machine.

“Soil-disturbing activities” means digging, excavating, staging, loading, stockpiling, backfilling, compacting, grading, tilling, drilling, intrusive sampling, and equipment or vehicle movement or any other mechanical activity, that when used, disturbs the surface and/or subsurface soil. For the purposes of Section 5.5 disturbance or removal of

debris and/or RACS is considered a soil disturbing activity. For the purposes of Section 5.5 hand disturbance or removal of RACS is subject to this regulation, but is not considered to be a mechanical disturbance.

“Visible emissions” means any airborne or liquid emissions, coming from, or having come into contact with RACS, which are visually detectable without the aid of instruments. Proper disposal of appropriately filtered decontamination water does not constitute a visible emission.

3) Amend Section 1.2 by deleting the definition of “Asbestos-contaminated soil” as follows:

1.2 Definitions

~~**“Asbestos-contaminated soil” means soil containing any amount of asbestos.**~~

4) Add a Table of Contents for Section 5 (Asbestos Waste Management) to read as follows:

SECTION 5

ASBESTOS WASTE MANAGEMENT

- 5.1 General Provisions
- 5.2 Non-Friable Asbestos Waste Disposal Areas
- 5.3 Friable Asbestos Waste Disposal Areas
- 5.4 Storage of Asbestos Waste
- 5.5 Management of Regulated Asbestos-Contaminated Soil (RACS)
 - 5.5.1 Scope and Applicability
 - 5.5.2 Exemptions
 - 5.5.3 Training
 - 5.5.4 Response to Unplanned RACS Discovery
 - (A) Immediate Actions

- (B) 24-Hour Notification Requirements
- (C) Interim Actions
- 5.5.5 Response to Planned RACS Management
 - (A) Project Specific RACS Management Plan (PSRMP)
 - (B) Standard Operating Procedures (SOPs)
 - (C) Standard Requirements of Section 5.5.7
 - (D) Risk Based Approach
- 5.5.6 Remediation of Asbestos in Soil
- 5.5.7 Standard Requirements for the Disturbance of RACS
 - (A) Establishment and Control of a Regulated Work Area (RWA)
 - (B) Personal Protective Equipment (PPE) for the Purposes of Preventing Cross-Contamination
 - (C) Wetting
 - (D) Wind Speed Monitoring
 - (E) Air Monitoring
 - (F) Work Practices to be Followed During RACS Disturbance
 - (G) Loading and Placement of RACS
 - (H) Onsite Staging, Stockpiling, and Storage of RACS
 - (I) Decontamination
 - (J) RACS Spill Response
 - (K) Requirements for Exposed RACS Remaining in Place
 - (L) Documentation
- 5.5.8 Packaging and Disposition of Regulated Asbestos-Contaminated Soil (RACS)
 - (A) Disposal of RACS
 - (B) Onsite Reuse of RACS
 - (C) Demonstration of Non-RACS
- 5.5.9 Fees

Appendix 5A: Sample Collection Protocols and Analytical Methodologies

5) Delete the existing Section 5.5 Regulations (Management of Asbestos-Contaminated Soil) in their entirety and replace with a new Section 5.5 Regulations (Management of Regulated Asbestos-Contaminated Soil (RACS)) to read as follows:

SECTION 5

ASBESTOS WASTE MANAGEMENT

5.5 MANAGEMENT OF REGULATED ASBESTOS-CONTAMINATED SOIL (RACS):

5.5.1 SCOPE AND APPLICABILITY

The requirements of Section 5.5 apply to the owner or operator of any property with regulated asbestos contaminated soil (RACS) at which soil-disturbing activities are occurring or planned. The owner/operator may choose to follow the procedures set forth in Sections 5.5.1(A) and 5.5.1(B) below when debris is exposed or disturbed to determine if the debris is RACS. The requirements of Sections 5.5.1(C) and 5.5.1(D) apply when RACS is exposed or disturbed.

(A) Any person who disturbs debris or exposes debris during a soil disturbing activity shall characterize debris to determine the applicability of Section 5.5, and have appropriate personnel to characterize debris. Any person who disturbs debris or exposes debris during a soil disturbing activity shall:

(1) Conduct visual inspection of disturbed material;

(2) If debris is exposed during soil disturbing activities, and/or the soil or ash is known to contain asbestos fibers, through documented evidence, then Section 5.5 is applicable. If there is no visible RACS or documented evidence of RACS at a site, an owner/operator does not have a duty under these regulations to sample or otherwise investigate for RACS prior to commencing soil disturbing activities;

(3) If debris is exposed that only contains green waste, and/or natural stone with no associated material suspected of containing asbestos fibers, then Section 5.5 is not applicable.

(4) In the event of an emergency in which a soil disturbing activity in an area of debris must continue or commence at once, a RACS determination in accordance with Section 5.5.1(B) may be postponed during the initial response to the immediate emergency. However, the RACS determination must be made within 48 hours of the initial emergency response.

(5) Any person who exposes but does not disturb debris during a soil disturbing activity shall have protocols to characterize debris as required by this section 5.5.1(A) and stabilize any debris determined to be RACS as required by Section 5.5.7(K), unless the debris is exempted by subsection 5.5.2(A) through (F).

(B) Any person who disturbs debris during soil disturbing activities, when the subject debris is not excluded within Section 5.5.1(A)(3), must inspect the debris, through continuous visual inspection during soil disturbing activities, to determine if the debris is, or contains, suspect asbestos-containing material (ACM). If debris is exposed that only contains metal, glass, plastic, wood, and/or bare concrete with no associated material suspected of being ACM (such as sealants, adhesives, mastics, coatings, adhered materials, or resins), then Section 5.5 is not applicable. The

person(s) conducting the visual inspection must be a Qualified Project Monitor (QPM) or a Certified Asbestos Building Inspector (CABI).

All suspect ACM(s) must be:

- (1) Assumed to be ACM; or
- (2) Sampled by a CABI. The samples shall be analyzed by a National Voluntary Laboratory Accreditation Program (NVLAP) participating laboratory utilizing Polarized Light Microscopy (PLM) (EPA Method 600/R-93/116 or equivalent) to determine if it is ACM; or
- (3) Determined to be ACM, or non-ACM, through the use of documentation specific to the material observed in the field establishing the asbestos content of the material (e.g. laboratory analysis results from previous encounters with the same material).
- (4) The ACM determination shall be made within seven (7) calendar days of discovery of the debris.
 - (a) Within 24 hours of discovery of debris, and until the ACM determination is made, the debris shall be stabilized in accordance with Section 5.5.4(A)(3) of these regulations.
 - (b) No additional disturbance, other than necessary to perform the required stabilization in Section 5.5.4(A)(3), of the debris shall occur prior to the asbestos determination.
- (5) A person who disturbs debris, determined or assumed to be or contain ACM per this 5.5.1(B), shall determine if the ACM is exempted in accordance with Section 5.5.2 of these regulations.
- (6) A person who disturbs debris, determined or assumed to be or contain ACM per this 5.5.1(B), shall make a RACS determination by:
 - (a) Assuming the debris containing ACM is RACS and managing the RACS in accordance with Section 5.5 of these regulations; or
 - (b) Applying site and material specific knowledge of the presence or absence of RACS based on observation and/or documented evidence about the nature of ACM(s).
- (7) The owner/operator shall retain, or make available for inspection, records of all RACS determinations onsite for the duration of the debris disturbance, which shall be retained by the owner/operator for a period of six (6) months after the completion of debris disturbing activities.

(C) Soil or ash known to contain non-visible asbestos, based on documented evidence, is RACS and if exposed or disturbed shall be managed in accordance with these regulations.

(D) If soil, ash, or debris is, or contains, RACS then:

- (1) RACS that is exposed or disturbed shall be managed, disposed of, or reused in accordance with these regulations.
- (2) Removal of ACM that is on, or comprises, a facility component, that is located on or in soil that will be disturbed, shall be conducted under this Section 5.5, in accordance with work practices in Air Quality Control Commission Regulation No. 8 (5 CCR 1001-10, Part B), Section III.V, and is not subject to the permit requirements of 5 CCR 1001-10, Part B, if the total quantity of ACM is below the following trigger levels:
 - (a) 260 linear feet on pipes; or
 - (b) 160 square feet on other surfaces; or
 - (c) The volume of a 55-gallon drum.
- (3) RACS that is generated and not disposed of or reused in compliance with Section 5.5.8 of these regulations is solid waste and shall be managed in accordance with the landfill requirements of the Colorado Solid Wastes Disposal Sites and Facilities Act (C.R.S. 30-20, Part 1) and Sections 5.1 through 5.4 of these regulations.
- (4) Except as provided in Section 5.5.1(D)(5), a person who disturbs or exposes RACS shall make the decision upon the initial discovery of RACS to either manage the RACS in accordance with Section 5.5, or cease soil disturbing activities and permanently stabilize the disturbed or exposed RACS to control the release of asbestos fibers in accordance with one of the following:
 - (a) Cover RACS with geofabric, or equivalent visible and physical barrier, and restore the site to pre-disturbance conditions using fill suitable for unrestricted use; or
 - (b) Cover RACS with geofabric, or other visible and physical barrier, followed by eighteen (18) inches of fill suitable for unrestricted use, and vegetation; or
 - (c) Cover RACS with geofabric, or other visible and physical barrier, followed by six (6) inches of fill suitable for unrestricted use, and concrete or asphalt; or
 - (d) Cover RACS with geofabric, or other visible and physical barrier, followed by fill suitable for unrestricted use to grade for vertical excavation faces or trenches; or
 - (e) Alternate cover designs as approved by the Department.
- (5) RACS that is driven upon is an RWA and shall be kept adequately wet in order to prevent visible emissions from leaving the RWA, or demonstrate that asbestos is

not leaving the RWA above risk based thresholds. All equipment surfaces that have come into contact with RACS shall be decontaminated per Section 5.5.7(l) before leaving the RWA.

5.5.2 EXEMPTIONS

- (A) Removal of ACM on a facility component with asbestos quantities above the trigger levels, as defined in 5.5.1(D)(2), is subject to the permit and abatement requirements of Air Quality Control Commission Regulation No. 8 (5 CCR 1001-10, Part B), and is therefore not subject to this Section 5.5., but shall still comply with Sections 5.1 through 5.4 of these regulations.
- (B) Spill response activities that are subject to the requirements of Air Quality Control Commission Regulation No. 8 (5 CCR 1001-10, Part B) are not subject to the requirements of Section 5.5, but shall still comply with Sections 5.1 through 5.4 of these regulations.
- (C) Ambient occurrences of asbestos fibers in soil that are demonstrated to be the result of background conditions and not the result of site specific activities are not subject to the requirements of this Section 5.5. This background demonstration shall be submitted to, and approved by, the Department prior to the exemption being exercised.
- (D) During active solid waste disposal operations, asbestos waste disposal areas that have a certificate of designation are not subject to Section 5.5, but shall comply with the facility's Engineering Design and Operations Plan.
- (E) De minimis projects involving a total RACS disturbance of less than one (1) cubic yard, utilizing low-emission methods, are exempt from this Section 5.5, except for the decontamination procedures in Section 5.5.7(l) and the disposal requirements in Section 5.5.8.
- (F) Projects conducted directly by a homeowner on their residence not used for the purpose of generating of income, including residential landscaping projects and other private residential soil-disturbing projects conducted after the primary dwelling is built, such as planting trees, digging holes for fence posts, installing sign posts, gardening, other such projects conducted by homeowners on their residence, as described above, are not subject to this Section 5.5, but shall still comply with Sections 5.1 through 5.4 of these regulations.
- (G) Soil disturbing activities involving Non-RACS, where no RACS is present or generated, are not subject to the requirements of Section 5.5, but Non-RACS must be disposed as non-friable asbestos waste in accordance with the disposal requirements set forth in Section 5.2 of these regulations.

- (H) Soil disturbing activities involving debris that only contains metal, glass, plastic, wood, and/or bare concrete with no associated material suspected of being ACM (such as sealants, adhesives, mastics, coatings, adhered materials, or resins), as determined by a CABI, QMP, or generator knowledge, are not subject to the requirements of Section 5.5.
- (I) Soil disturbing activities involving debris that only contains green waste or natural stone are not subject to the requirements of Section 5.5.

5.5.3 TRAINING

- (A) All personnel inside the regulated work area (RWA) during the disturbance of RACS shall have annual awareness training. Except as provided in Section 5.5.3(F), this training requirement also applies to equipment operators and drivers of trucks carrying contaminated material for offsite disposal or reuse. This training shall cover information necessary to comply with Section 5.5 requirements and the approved project specific RACS management plan (PSMRP) or standard operating procedure (SOP) (if any) including:
 - 1) General asbestos awareness; including health effects; and
 - 2) Overview of the requirements of Section 5.5 and its implementation; and
 - 3) Overview of suspect ACM that requires further evaluation by a CABI; and
 - 4) Overview of RACS and Non-RACS; and
 - 5) Worker protection, including respiratory protection. An overview of the levels of personal protective equipment (PPE) required for various activities and conditions; and
 - 6) Decontamination requirements for equipment and personnel including the establishment of decontamination station(s); and
 - 7) Engineering controls in order to prevent visible emissions from leaving the RWA or demonstrate that asbestos is not leaving the RWA above risk-based air thresholds; and
 - 8) Overview of RACS handling procedures.

This training shall be conducted by a CABI who is familiar with the site specific plan and/or the Standard Requirements in Section 5.5.7. Records of this training shall be retained, by the owner/operator, and be available for inspection, for a minimum of one year from the date of the training.

(B) In addition to the annual asbestos awareness training required in 5.5.3(A), all personnel inside the RWA during the disturbance of RACS shall have per-project site-specific awareness training. Except as provided in Section 5.5.3(F), this training requirement also applies to equipment operators and drivers of trucks carrying contaminated material for offsite disposal or reuse. This training shall cover site-specific information necessary to comply with Section 5.5 and the selected management approach for the project (PSRMP, SOPs, or the standard requirements of Section 5.5.7), including:

- 1) An overview of the items from 5.5.3(A) as they pertain to site specific provisions and/or conditions that will affect work practices; and
- 2) Project chain-of-command and identification of authorized personnel with stop work authority, and identification of QPM(s); and
- 3) Hands on training specific to the soil disturbing activities the individual will be performing subject to this Regulation.

This training shall be provided by a CABI who meets the training requirements of 5.5.3(D). Records of this training shall be retained by the owner/operator, and be available for inspection, for the duration of the project for which the training was conducted.

(C) Qualified Project Monitors shall have, at a minimum:

- 1) Annual asbestos awareness training and site specific awareness training under Section 5.5.3(A) and (B); and
- 2) Training from a CABI on identifying debris, exempted materials under Section 5.5.1(A)(3), and the assumption of debris to be RACS as outlined in Section 5.5.1; and
- 3) Training from a CABI on how to implement the standard requirements under Section 5.5.7 and how to perform the duties that a QPM may perform in lieu of a CABI; and
- 4) Training from a CABI on how to implement the provisions of the chosen RACS management approach (PSRMP, SOPs, or standard requirements of Section 5.5.7) and how to perform the duties that a QPM may perform in lieu of a CABI; and
- 5) Forty (40) verifiable hours of direct experience implementing Section 5.5.

Records of this training shall be retained by the owner/operator, and be available for inspection for the duration of the project for which the training was conducted.

- (D) Visual Inspection and identification of RACS shall be conducted by a CABI, with forty (40) verifiable hours of on the job asbestos in soils experience on a minimum of three (3) different asbestos in soils projects, conducted under either AQCC Regulation No. 8 or Section 5.5. The CABI shall be independent of the general contractor (GC) and/or abatement contractor unless the CABI and the GC or abatement contractor are both direct employees of the property owner. However, the GC or abatement contractor may hire a subcontractor CABI, but the CABI shall not be a direct employee of the GC or abatement contractor.
- (E) Air monitoring conducted in accordance with this Section 5.5 shall be performed by an Air Monitoring Specialist (AMS).
- (F) Truck drivers who do not complete the training in 5.5.3(A) and (B) are ancillary workers. Soil disturbing activities must cease if the truck driver is present within the RWA unless the driver remains in the cab of the truck, the truck's windows and doors remain closed, and the air handling system remains off while the truck is inside the RWA.

5.5.4 RESPONSE TO UNPLANNED RACS DISCOVERY

Soil disturbing activities that expose RACS without previously approved plans are subject to the following requirements:

- (A) IMMEDIATE ACTIONS: Immediate actions shall be taken by the person conducting the soil disturbing activity, or representative of the owner or operator, to manage RACS in accordance with Section 5.5 and Section 1.2 definitions of these Regulations. These actions shall include, at a minimum, the following:
 - (1) Stopping all soil disturbing activities related to RACS, until the 24-hour notification requirements in Section 5.5.4(B), and the interim action requirements in Section 5.5.4(C), are met. In the event of an emergency in which a soil disturbing activity must continue or commence at once, notification shall be made as soon as possible, but within 24 hours of identifying or assuming the presence of RACS within the soil disturbing area. During the initial response to the immediate emergency, the standard requirements of Section 5.5.7 shall be implemented to the extent possible. Within 48 hours, any disturbed and/or exposed RACS shall be managed in accordance with the standard requirements of Section 5.5.7, an approved PSRMP, or an approved SOP.
 - (2) Establishing and taking measures in order to prevent access to the RWA by unauthorized persons. Instances of unauthorized access not under the control of the owner/operator shall be evaluated to determine if additional access controls are warranted. The unauthorized access, and the response actions taken, shall be documented and provided to the Department within 48 hours of the incident.

(3) Conducting interim surface soil stabilization to reduce emissions including:

- a. Polyethylene sheeting or geofabric with daily inspection, and inspection after storm events, and repair/replacement of sheeting as necessary to maintain stabilization; or
- b. Chemical stabilizer demonstrated to be effective in the stabilization of RACS (e.g. magnesium chloride) with weekly inspection, and inspection after storm events, and re-application of chemical stabilizer as necessary to maintain stabilization; or
- c. Minimum of three (3) inches of soil appropriate for unrestricted use; or
- d. Other means of stabilization as approved by the Department.
- e. Stabilization is not required if RACS is kept adequately wet. Verification of adequately wet conditions shall be conducted at least every two (2) hours, or RACS shall be stabilized by one of the methods described in (3)(a-d) above.

(B) 24-HOUR NOTIFICATION REQUIREMENTS: The owner/operator, or owner/operator representative shall submit a completed Notification of RACS Disturbance form to the Department's Hazardous Materials and Waste Management Division within 24 hours of identifying RACS during a soil disturbing activity.

(C) INTERIM ACTIONS: In accordance with Section 5.5.5, the owner/operator, or owner/operator representative, shall submit to the Department's Hazardous Materials and Waste Management Division, for review and approval, within five (5) working days of the discovery, a PSRMP, SOPs, or indicate the standard requirements of Section 5.5.7 will be followed on the Notification of RACS Disturbance form submitted to the Department.

(D) Once the requirements of Sections 5.5.4(A), (B), and (C) are completed, any soil disturbing activities shall proceed in accordance with applicable requirements.

5.5.5 RESPONSE TO PLANNED RACS MANAGEMENT

Planned soil disturbing activities involving RACS shall be conducted in accordance with the standard requirements identified in Section 5.5.7, and with one of the following management strategies and the associated notification requirement:

(A) PROJECT SPECIFIC RACS MANAGEMENT PLAN (PSRMP);

- (1) The owner/operator, or owner/operator representative, shall submit a completed Notification of RACS Disturbance form to the Department's Hazardous Materials and Waste Management Division at least ten (10) working days prior to any planned soil disturbing activity. This notification shall include submittal of a PSRMP conforming to the requirements of Section 5.5.5(A)(2). The Department will acknowledge receipt of a notification of the intent to utilize a PSRMP by mail or electronic correspondence. The PSRMP shall be approved by the Department prior to implementation.

(2) If the owner/operator choose(s) management in accordance with this Section 5.5.5(A), a PSRMP shall be developed and submitted to the Department's Hazardous Materials and Waste Management Division for review and approval prior to implementation. The Department will use its best efforts to review and respond to the plan within ten (10) working days of receipt. The PSRMP shall include the following:

- (a) Property representative's name and phone number; and
- (b) Property location; and
- (c) General site description, including a description of RACS and the types of known or assumed ACM(s), and the location(s) of these material on the site; and
- (d) Description of planned soil disturbing activities; and
- (e) Description of site management, emission control activities, and work practices to control the release of, and/or exposure to, asbestos outside of the RWA including:
 - (i) Measures to assure that the soil is adequately wet (as that term is defined in Section 1.2 of these regulations), stabilized, or covered during soil disturbing activities; and
 - (ii) Wind speed monitoring during RACS disturbance, including frequency of monitoring, and shutdown and start up criteria; and
 - (iii) An air monitoring plan designed to detect asbestos at the perimeter of the RWA as an indication that the measures to control the release of asbestos outside of the RWA are effective. The plan may include a tiered air monitoring approach providing less frequent air monitoring given demonstrated effectiveness of work practices; and
 - (iv) Work practices specific to mechanical and/or hand disturbance of RACS including measures in order to prevent the release of visible emissions outside of the RWA, or demonstrate that asbestos is not leaving the RWA above risk-based air thresholds; and
 - (v) Work practices for the loading and placement of RACS including spill prevention procedures.
 - (vi) The owner /operator has the option to erect a structure maintained at a negative pressure differential sufficient to contain all dust, with off-gas from the evacuation system treated with HEPA filtration. If this option is chosen, the requirement to submit an air monitoring plan, under Section 5.5.5(A)(2)(e)(iii) is not applicable.

and

- (f) Description and location of any planned sampling. All sampling shall be performed in accordance with the procedures set forth in Appendix 5A. All investigation derived waste shall be managed in accordance with Section 5.5.8.

- (3) A copy of the PSRMP shall be maintained on the site during RACS disturbing activities.
- (4) At the option of the owner/operator and upon notice to the Department, a Soil Characterization and Management Plan approved prior to the effective date of this amended Section 5.5, and that complies with the substantive requirements of the regulation prior to amendment, shall remain in effect until the completion of the subject project or until it is replaced by a PSRMP.

(B) STANDARD OPERATING PROCEDURES (SOPs)

- (1) The owner/operator, or owner/operator representative, shall notify the Department's Hazardous Materials and Waste Management Division, by submitting a completed Notification of RACS Disturbance form, prior to implementation of the previously approved SOPs at a RWA. SOPs that conform to Section 5.5.5(B)(2) shall be approved by the Department prior to implementation. The Department will acknowledge receipt of a notification of the intent to utilize an SOP by mail or electronic correspondence.
- (2) If the owner/operator chooses management in accordance with this Section 5.5.5(B), the owner/operator shall develop and submit to the Department's Hazardous Materials and Waste Management Division, for review and approval, thirty (30) calendar days in advance of any RACS disturbing activities, SOPs that conform with Section 5.5.5(A)(2)(a) – (f) that will be implemented, upon notice to the Department per Section 5.5.5(B)(1), at future RWA(s). A copy of the SOPs shall be maintained on site during RACS disturbing activities for the duration of the Project.
- (3) At the option of the owner/operator and upon notice to the Department, a SOP approved prior to the effective date of this amended Section 5.5, and that complies with the substantive requirements of the regulation prior to amendment, shall remain in effect and may be used to comply with the amended regulation.

(C) STANDARD REQUIREMENTS OF SECTION 5.5.7

The owner/operator, or owner/operator representative, shall submit to the Department's Hazardous Materials and Waste Management Division a completed Notification of RACS Disturbance form indicating the intent to utilize the standard requirements of Section 5.5.7, as a default RACS management plan, prior to any planned soil disturbing activity. This notification shall include property location, general site description, and contact information for the owner/operator responsible for the RWA activities. The Department will acknowledge receipt of a notification of the intent to utilize the standard requirements of Section 5.5.7 by mail or electronic correspondence.

(D) RISK BASED APPROACH

The owner/operator may choose to submit, for Department review and approval, a site-specific risk assessment work plan to evaluate the risks of the proposed work practices associated with planned disturbance activities in an area or areas of RACS.

5.5.6 REMEDIATION OF ASBESTOS IN SOIL

- (A) Remediation is not required of properties at which ACM, RACS, or asbestos waste is located. If the owner of a property chooses to remediate (rather than just manage) all or a portion of the property containing ACM, RACS, or asbestos waste a Remediation Plan shall be submitted to the Department's Hazardous Materials and Waste Management Division for review and approval prior to commencement of activities associated with the remediation. The Remediation Plan shall comply with this Section 5.5, and include the following:
- (1) The standard requirements in accordance with Section 5.5.7, and the plan requirements outlined in Section 5.5.5(A). Alternatively, a risk based approach pursuant to Section 5.5.5(D) may be proposed, for Department review and approval, for disturbance of RACS; and
 - (2) A detailed description of planned remediation activities, including proposed depth and areal extent of remediation, and work practices to be implemented; and
 - (3) The proposed use of the property and area of remediation; and
 - (4) Any planned engineering or institutional controls in order to prevent exposure to any asbestos left in place, or minimize exposure below a risk-based concentration approved by the Department, within the area covered by the Remediation Plan, and
 - (5) A schedule for submittal of a Remediation Completion Report that incorporates the information from Section 5.5.7(L) and any additional information necessary to demonstrate that the remediation goals have been achieved.
- (B) The Department shall use its best efforts to provide written notification that a Remediation Plan has been approved or disapproved within no more than forty-five (45) calendar days after a request by a property owner, unless the property owner and the Department agree to an extension of the review to a date certain.
- (C) If a remedial decision is made by the Department, the area subject to the remedial decision may be subject to C.R.S. Section 25-15-320(2), and an environmental covenant may be required for waste left in place.

5.5.7 STANDARD REQUIREMENTS FOR THE DISTURBANCE OF RACS

The requirements of this section, if followed in their entirety, constitute a default RACS management plan, eliminating the need to submit a PSRMP or SOP.

(A) ESTABLISHMENT AND CONTROL OF A REGULATED WORK AREA (RWA)

(1) Requirements for establishment and control of a RWA applicable to all projects subject to this Regulation:

- (a) Establish a RWA which is identifiable to all persons. Haul roads between RWAs, where RACS is not present, are considered to be outside the RWA(s); however, equipment decontamination [Section 5.5.7(I)] and spill response procedures [Section 5.5.7(J)] shall be followed; and
- (b) Stop all soil disturbing activities in the RWA if ancillary workers or members of the public are present within the RWA. Truck drivers who do not complete the training under Sections 5.5.3(A) and (B) are ancillary workers. Soil disturbing activities must cease if the truck driver is present within the RWA unless the driver remains in the cab of the truck, the truck's windows remain closed, and the air handling system remains off while the truck is inside the RWA; and
- (c) Post labeling and signage to demarcate RWA(s). The RWA shall be demarcated by visible means that fully defines the extent of the RWA. Labeling and signage shall indicate the presence of asbestos, and that the area is off limits to unauthorized personnel.

(2) **Additional Requirement for Projects Disturbing RACS Containing Friable ACM.** Establish a secured work site (e.g., fencing with locks/zip-ties/chains). Personnel, or staff assigned to this duty, may be used to secure the RWA in lieu of fencing. If the RWA is located within a larger secure facility, fencing of the RWA is not necessary as long as the RWA is secured.

(B) PERSONAL PROTECTIVE EQUIPMENT (PPE) FOR THE PURPOSES OF PREVENTING CROSS-CONTAMINATION

(1) Requirements applicable to all RWAs subject to this Regulation:

- (a) Use of disposable booties or impermeable footwear that will be decontaminated per Section 5.5.7(I); and
- (b) Use of disposable gloves or impermeable gloves that will be decontaminated per Section 5.5.7(I); and
- (c) Replace or decontaminate (per Section 5.5.7(I)) all PPE in all instances where the integrity of the PPE is compromised, and when workers exit the RWA; and
- (d) Decontaminate (per Section 5.5.7(I)) or dispose of all used PPE as asbestos contaminated waste.

- (2) **Additional Requirement Applicable to Projects at RWAs Containing Friable ACM.** Use of disposable impermeable suits or equivalent coveralls, remove suits or coveralls upon exiting the RWA, and dispose of used suits or coveralls as asbestos contaminated waste.

(C) WETTING

- (1) Wetting requirements applicable to all RACS disturbance:

- (a) Adequately wet all RACS and soils, or other materials containing RACS, on the surface and in the sub-surface prior to and during RACS disturbance, except as provided in Section 5.5.7(F)(1)(b)(ii). Pre-wetting is not necessary if soils are already adequately wet. Apply water or amended water (as required in Section 5.5.7(C)(2)) at low pressure in order to minimize dust generation and splattering to prevent visible emissions from leaving the RWA, or demonstrate that asbestos is not leaving the RWA above risk-based thresholds.
- (b) Mist RACS and soils, or other materials, containing RACS during placement as needed to maintain the material in an adequately wet condition using equipment mounted spray bars, or additional hose operator(s).
- (c) Except as provided in (d) below, incidental occurrences of visible emissions leaving the RWA shall be managed by evaluating site conditions and engineering controls for each occurrence of visible emissions, and immediately implementing any identified engineering control revisions necessary in order to prevent future occurrences of visible emissions. All instances of visible emissions leaving the RWA shall be documented as required in Section 5.5.7(L) of this regulation.
- (d) When utilizing the risk-based air monitoring threshold approach to evaluate the effectiveness of adequately wetting, visible emissions are allowed to leave the RWA as long as the risk-based air threshold is not exceeded.

- (2) **Additional requirement for RACS that contains friable ACM.** Use amended water containing a wetting agent, such as a 50:50 mixture of polyoxyethylene ester and polyoxyethylene ether, or the equivalent, in a 0.16 percent solution (1 ounce to 5 gallons) of water, or as per manufacturer recommendations for the wetting of asbestos. This requirement may be waived by the Department for emergency situations where the work must occur immediately and wetting agents are not available.

(D) WIND SPEED MONITORING

- (1) Requirements applicable to all projects involving mechanical disturbance of RACS, and hand disturbance of RACS containing friable ACM:

- (a) Take wind measurements from within the RWA using a hand held anemometer. Alternatively, or in conjunction with hand held measurements, an onsite weather station may be used within a quarter mile of the RWA as long as the conditions measured by the weather station are representative of conditions in the RWA.
 - i. Collect wind speed measurements at a minimum of thirty (30) minute intervals and during wind gust(s). Average wind speed measurements shall be obtained manually by taking ten readings at one minute intervals and averaging the ten readings, or through the use of instrumentation that provides a ten minute average wind speed reading.
 - ii. If wind break barriers are used, wind speed measurements may be taken from within barriers; however, wind speed measurements shall also be taken outside the wind break barriers if any RACS disturbing activities, such as loading, are taking place outside or above the barriers. Wind speed shut-down criteria shall be based on measurements taken that are representative of the area of active RACS disturbance.
- (b) Immediate stoppage of all RACS disturbance shall occur based on results of wind speed monitoring conducted in accordance with subsection (a) and exceedance of the following criteria:
 - i. Wind gust(s) in excess of 20 mph, or
 - ii. Sustained winds in excess of 12 mph, averaged over ten (10) minutes, or
 - iii. Winds are interfering with the ability of engineering controls to work as intended, or
 - iv. Winds are creating visible emissions that leave the RWA.
- (c) RACS disturbance may resume when all of the following criteria are met:
 - i. No gust(s) in excess of 20 mph occur for twenty (20) minutes, and
 - ii. No sustained winds in excess of 12 mph occur for twenty (20) minutes, based on a ten (10) minute average wind speed measurement, and
 - iii. Winds are not interfering with the ability of engineering controls to function as intended, and
 - iv. Winds are not creating visible emissions that leave the RWA.

(E) AIR MONITORING

- (1) If using the risk-based air threshold approach to monitor the effectiveness of adequately wetting:
 - (a) Air monitoring to determine asbestos content of visible emissions allowed to leave the RWA, for comparison to the risk-based air thresholds shall not be utilized for projects that are less than ten (10) days in duration.

- (b) Air monitoring to determine asbestos content of visible emissions allowed to leave the RWA, for comparison to the risk-based air thresholds, shall begin on the first day of the project.
 - (c) A minimum of four (4) air samples per day shall be collected for TEM analysis.
 - (d) Sample collection, analysis, and data evaluation shall be conducted in accordance with Appendix 5A.
- (2) If preventing visible emissions leaving the RWA as an indication of the effectiveness of work practices, not for risk evaluation, air monitoring is required during mechanical disturbance of RACS in RWAs with an adjacent receptor zone:
- (a) No air monitoring is required for RACS disturbance that will not exceed a duration of two (2) days. However, the requirements for adequate wetting (Section 5.5.7(C)) and no visible emissions leaving the RWA (Section 5.5.7(F)) shall be adhered to on all RACS disturbance projects. Dividing projects into multiple two (2) day or shorter components shall not be used as a mechanism to avoid air monitoring requirements.
 - (b) Area monitoring shall consist of a minimum of four (4) samples collected on the perimeter of the RWA at appropriate intervals to provide representative information regarding potential releases of asbestos fibers to the adjacent receptor zone(s). Additional samples shall be collected for large perimeter RWAs (greater than one (1) acre). RWAs greater than one (1) acre shall require additional perimeter monitoring points be added at a rate of one (1) sample for every 200 linear feet (or approximately each additional ¼ acre). If representative information about potential releases to the adjacent receptor zone(s) can be collected using less than the minimum number of samples, the remaining sample locations shall be at the discretion of the AMS.
 - (c) Phase Contrast Microscopy (PCM) analysis is required on all samples collected (unless all samples will be analyzed by Transmission Electron Microscope (TEM) by default). The laboratory shall be requested to provide verbal results to the AMS or the QPM by the start of the next working day, or as soon as possible after the start of the next working day, with written results within 24 hours of the receipt of verbal results. A consultation with the Department is required If this timeframe cannot be met by the laboratory.
 - (d) Upon receipt of a laboratory report indicating a “cannot be read (CBR)”, or a “not analyzed (NA) or rejected” due to loose debris or uneven loading, analysis result:
 - i. The AMS shall evaluate the lab report and any field documentation to determine a possible cause for the CBR or “not analyzed (NA) or rejected” result; and

- ii. If the CBR or “not analyzed (NA) or rejected” cannot be correlated to a specific field event that compromised the sample (e.g. the sample was blown over, the filter of the sample was sprayed with water) then the sample shall be prepared for indirect TEM presence/absence analysis to determine potential asbestos content in accordance with Appendix 5A; and
 - iii. If the CBR or “not analyzed (NA) or rejected”, analysis result can be correlated to a compromised sample, then preparation for indirect TEM presence/absence analysis is not required as long as adequate air monitoring data is available to evaluate the effectiveness of engineering controls. However, overloading of a sample with particulate matter does not constitute a compromised sample, and will require indirect preparation for TEM presence/absence analysis; and
 - iv. Field personnel shall evaluate why the sample was compromised and modify field procedures as necessary to avoid future samples from being compromised; and
 - v. The Department project manager shall be notified by phone or email of instances of CBR or “not analyzed (NA) or rejected” analysis results within 24 hours of receipt of verbal results.
- (e) TEM presence/absence analysis is required (analysis providing fiber counts/concentrations is always optional) as described in paragraphs (i) through (iv) below. The laboratory shall be requested to provide verbal results by the start of the next working day, or as soon as possible after the start of the next working day, with written results within 24 hours of the receipt of verbal results.
- i. All samples, required by this Section 5.5, with PCM results having fiber concentrations greater than 0.01f/cc shall be submitted for TEM analysis.
 - ii. During the first five (5) days of RACS disturbance – A minimum of 25% of the samples collected from each RWA, inclusive of the downwind floating samples as described in 5.5.7(E)(2), shall be submitted for TEM analysis. The sample(s) selected for TEM analysis shall have the highest PCM result(s) based on fiber concentration. If all PCM results are Below Detectable Limit (BDL) for fiber concentration, then the sample(s) selected for TEM analysis shall be determined by highest fiber count. If all samples have no fiber counts (i.e. zero (0) fibers counted, not a “below detection limit” fiber concentration) then no TEM analysis is required.
 - iii. After five (5) days of RACS disturbance with no asbestos detections by TEM analysis, the frequency of analysis by TEM, on the highest 25% of PCM results(s), may be reduced to once every five (5) days of RACS disturbance, or portions thereof, using the same selection criteria as in paragraphs (i) and (ii) above. The samples submitted for TEM analysis during the period of reduced frequency TEM analysis shall be either the first occurrence of: 1) high winds exceeding wind shut down criteria, or 2) visible emissions. In the absence of high wind events or visible emissions

the selected day for TEM analysis may be random, as determined by the AMS.

- iv. If there are any asbestos detections during the random once every five (5) days of RACS disturbance analysis by TEM, then TEM analysis shall be conducted for the next three (3) consecutive days of RACS disturbance, or portions thereof, using the same procedures as in paragraph (i) and (ii) above. If there are no additional asbestos detections during the next three (3) consecutive days of RACS disturbance with samples submitted for TEM analysis, then the frequency of TEM analysis may return to random once every five (5) days of RACS disturbance.
 - v. If site conditions, friability of the materials being managed, or work practices change, then the initial five (5) days of TEM analysis shall restart using the provisions set forth in this Section 5.5.7(E)(1)(e).
- (f) Detection or presence responses - For each detection of asbestos by TEM analysis, the following shall be conducted:
- i. Notify the Department project manager by phone or email, on the same calendar day as receipt of verbal or written results (whichever comes first) from the laboratory.
 - ii. Evaluate site conditions and engineering controls for each detection, and immediately implement any identified engineering control revisions necessary with the goal of preventing future detections of asbestos fibers.
 - iii. Submit an Emission Control Plan (ECP) to the Department project manager for each detection (days with multiple detections can be addressed by a single ECP). The ECP shall be submitted within 48 hours from the asbestos detection event and shall contain:
 - 1. The date of the detection.
 - 2. A written description of sample details (sample ID, number of structures detected, type of asbestos detected, PCM analytical result) and any potential cause of the release. Include a description of site activity (engineering controls being employed, equipment being used, size of excavation/soil disturbing activity, types of materials identified, etc.) and CABI observations at the work area before and during the presumed time of release.
 - 3. A diagram or write up of all air sample positions clearly indicating which sample received the TEM detection. Indicate, through illustration or description, prevailing wind direction and average wind speeds for the detection event; include any wind speed shutdowns for the date of detection. If applicable, indicate downwind floater air sample relocation times and new positions through illustration or description.
 - 4. Laboratory reports confirming the type and amount of fibers detected by TEM analysis.

5. Other pertinent information that will additionally describe the release and/or will assist in the prevention of future releases from the RWA.
6. A written description of actions taken and any other proposed actions with the goal of preventing future releases from the RWA.
7. If the owner/operator believes fibers are coming from offsite and are not under the control of the owner/operator, then, in addition to the information provided in the ECP, documentation shall be provided demonstrating additional sources of asbestos fibers.

(g) If there are three (3) TEM detections on consecutive analysis events or ten (10) detections for a single project, consultation with the Department is required to determine if the standard requirements of Section 5.5.7 are being implemented appropriately and whether:

- i. Changes in the standard requirements of Section 5.5.7 are likely to prevent future releases; or
- ii. Changes in the standard requirements of Section 5.5.7 are not likely to prevent future releases and a PSRMP is necessary per Section 5.5.5(A)(2); or
- iii. If the owner/operator believes fibers are coming from offsite and are not under the control of the owner/operator, then, in addition to the information provided in the ECP, documentation shall be provided demonstrating additional sources of asbestos fibers. Air samples shall be collected and analyzed following the analytical procedures of Appendix 5A for the type of project being conducted; and
- iv. Additional consultation with the Department is required to determine whether additional engineering controls for structures within the adjacent receptor zone are appropriate.

(3) **Additional requirement for projects disturbing RACS containing friable ACM.** Collect two (2) additional downwind floating samples for mechanical disturbance of RACS containing friable ACM. The samplers shall be moved based on prevailing wind direction and adjacent receptors. For example, if adjacent receptors are present on only one side of the RWA, one sample location should be maintained between the RWA and the adjacent receptor.

(F) WORK PRACTICES TO BE FOLLOWED DURING RACS DISTURBANCE

(1) Work practice requirements applicable to all management of RACS:

(a) Prevent visible emissions from leaving the RWA, or demonstrate that asbestos is not leaving the RWA above risk based thresholds by:

- i. Excavating in lifts not to exceed the extent of wetting; or

- ii. Conducting continuous wetting while mixing dry materials at the point of RACS disturbance to ensure all materials are adequately wet prior to removal from the excavation.
 - iii. Instances of visible emissions leaving the RWA shall be documented and addressed by changing or increasing controls (e.g. more effective wetting, reduced speed of excavation).
- (b) RACS on exposed excavation faces that will be disturbed and/or managed during the project shall either be kept adequately wet (in accordance with Section 5.5.7(C)), or be stabilized using any of the following in order to prevent visible emissions from leaving the RWA, or demonstrate that asbestos is not leaving the RWA above risk based thresholds:
- i. Polyethylene sheeting or geofabric with daily inspection, and inspection no later than twelve (12) hours following a storm event, and repair/replace sheeting as necessary to maintain stabilization; or
 - ii. Chemical stabilizer demonstrated to be effective in the stabilization of RACS (e.g. magnesium chloride) with weekly inspection, and inspection no later than one (1) calendar day following a storm event, and re-application of chemical stabilizer as necessary to maintain stabilization; or
 - iii. Minimum of three (3) inches of soil appropriate for unrestricted use.
- (c) Stormwater shall be managed in accordance with the Water Quality Control Commission's stormwater regulations (5 CCR 1002-61), which include specific stormwater permitting and management requirements for construction sites. The Water Quality Control Division should be contacted to determine the specific requirements for each project. Stormwater shall be managed in a manner that minimizes run on and runoff from RACS. Stormwater that comes into contact with RACS shall be treated as asbestos contaminated water in accordance with Section 5.5.7(J)(4), and other material(s) impacted by asbestos contaminated stormwater shall be managed as RACS in accordance with Section 5.5.7(J)(3).
- (2) Work Practice requirements applicable to the management of RACS using hand methods on surfaces or in the subsurface:
- a. Wet and remove the RACS and six (6) inches, in all directions, of surrounding soil or other material from the last occurrence of visible ACM; and
 - b. A CABI shall confirm that the visible extent of ACM and surrounding soil, or other material, has been removed (or extent of excavation has been reached). If RACS remains, it shall be managed for stabilization or future removal. If there is no documented evidence of non-visible RACS at the site, then a visual inspection and clearance shall be sufficient to determine the removal of RACS. If there is documented evidence of non-visible

RACS at the site, sampling is required to confirm the removal of RACS. After the removal of the additional six (6) inches, and in the absence of any debris, a QPM may make the determination that RACS has been removed; and

- c. If RACS remains in the RWA, it shall be managed for stabilization, per Section 5.5.7(K), or future removal.
- d. In lieu of stabilization or full removal, sampling may be performed per Section 2.2 of Appendix 5A to demonstrate that the material is not RACS.
- e. Dispose of RACS in accordance with Section 5.5.8.

(3) Work practice requirements applicable to management of RACS using mechanical methods:

- a. For surface occurrence of RACS - Wet and remove all RACS and a minimum of six (6) inches of soil, and/or other matrix material, in all directions from the last occurrence of visible ACM, with CABI confirmation that the visible extent of RACS has been removed.
- b. For subsurface occurrence of RACS - Wet and remove all RACS and a minimum of three (3) linear feet of soil or other matrix material, in the direction(s) of planned excavation, with CABI confirmation that the visible extent of RACS has been removed. If there is no documented evidence of non-visible RACS at the site, then a visual inspection and clearance shall be sufficient to determine the removal of RACS. If there is documented evidence of non-visible RACS at the site, sampling is required to confirm the removal of RACS. After the removal of the additional three (3) linear feet, and in the absence of any debris, a QPM may make the determination that RACS has been removed.
- c. If RACS remains in the RWA, it shall be managed for stabilization, per 5.5.7(K), or future removal.
- d. In lieu of stabilization or full removal, sampling may be performed per Appendix 5A to demonstrate that the material is not RACS.
- e. Package and dispose of RACS in accordance with Section 5.5.8.

(4) Soil or other matrix material that remains after removal of RACS in accordance with Section 5.5.7(F), Section 5.5.7(H)(1)(c)(i), or an approved plan, is not considered RACS, is not subject to Section 5.5, and may be appropriate for unrestricted use, onsite or offsite, as long as it does not contain any other regulated material.

(G) LOADING AND PLACEMENT OF RACS

(1) Requirements for the loading of RACS:

- (a) Protect clean surfaces (including loading surface and truck or disposal container surfaces that may come in contact with RACS) by covering or decontamination of surfaces prior to transport or removal of the truck or disposal container from the RWA and/or loading zone.
- (b) Spill prevention shall consist of:
 - i. Minimization of spillage by not overfilling the excavator or loader bucket and returning the bucket to a closed position prior to moving from the loading point; and
 - ii. Replacement of protective coverings when worn or damaged in order to prevent breaches; and
 - iii. Control of runoff in order to prevent cross contamination from water containing asbestos; and
 - iv. Mitigation of spills of RACS in accordance with Section 5.5.7(J).
- (c) During the process of loading the container, the equipment operator shall lower the bucket as close as possible to the interior of the container before dumping, and dump the load slowly to allow adequate misting and in order to prevent visible emissions from leaving the RWA, or demonstrate that asbestos is not leaving the RWA above risk based thresholds.

(2) Requirements for the transportation of RACS:

- (a) Onsite transportation of RACS between the RWA and an onsite area of staging, stockpiling, storage, disposal or reuse shall comply with the following:
 - i. The packaging requirements for RACS set forth in Section 5.5.8(A) of these regulations are not applicable; however, the decontamination requirements of Section 5.5.7(I) shall be followed at the end of disposal operations, or before disposal equipment is removed from the site; and
 - ii. Driving speeds shall not exceed 12 miles per hour or RACS shall be covered during transport; and
 - iii. For transportation between the RWA and a non-contiguous onsite staging, stockpiling, storage, disposal, or reuse area:
 - 1. Transportation equipment tires shall not contact RACS; or
 - 2. RACS that is driven upon is a RWA and shall be kept adequately wet in order to prevent visible emissions from leaving the RWA, or demonstrate that asbestos is not leaving the RWA above risk based thresholds, and all equipment surfaces that have come into contact

with RACS shall be decontaminated per Section 5.5.7(I) before leaving the RWA; or

3. The haul road shall be managed as RACS for stabilization, per Section 5.5.7(F)(1), and future removal of a minimum of three (3) inches of soil, or other matrix material. If the road is constructed of a durable surface such as concrete or asphalt, the surface shall be decontaminated in accordance with Section 5.5.7(I)(1)(b) using wet methods, followed by CABI inspection verifying that all soil and debris has been removed from the surface. Rinsate/runoff shall be collected and filtrated to less than 5 microns (or applicable local requirements) and discharged to a sanitary sewer or other Department-approved disposal facility or re-applied to RACS that will be managed under these regulations.

(H) ONSITE STAGING, STOCKPILING, AND STORAGE OF RACS

- (1) Staging, as defined in Section 1.2 of these regulations, is the accumulation and temporary storage of RACS in the RWA for 12 hours or less. The following requirements shall apply to the staging of RACS:
 - (a) Staged RACS shall be kept adequately wet.
 - (b) Staging of RACS shall be on 6 mil, or greater, polyethylene sheeting or shall include removal, and management as RACS, of a minimum of three (3) inches of material, from below the staging pile/area prior to demobilization; with visual or measured confirmation of removal. If polyethylene sheeting is placed on top of a durable surface such as concrete or asphalt, the surface must be decontaminated using wet methods, followed by CABI inspection verifying that all soil and debris has been removed from the surface. Rinsate/runoff shall be collected and filtrated to less than 5 microns (or applicable local requirements) and discharged to a sanitary sewer or other Department-approved disposal facility or re-applied to RACS that will be managed under these regulations.
 - (c) Material determined to be clean during generation shall be inspected during placement for staging. Staging of clean material with incidental discovery of RACS shall be managed as follows:
 - i. If a CABI was continually inspecting the material during generation, remove the piece of ACM and one (1) foot of material in all directions, with CABI confirmation that the visible extent of RACS has been removed. If more than one (1) piece of ACM, or a pocket of ACM is discovered, remove the pocket of ACM plus one (1) foot of material in all directions, with CABI confirmation that the visible extent of RACS has been removed. Material that remains after removal of RACS, and CABI visible confirmation, is not considered RACS, is not subject to Section 5.5, and

may be appropriate for unrestricted reuse, onsite or offsite, as long as it does not contain any other regulated material.

- ii. If a CABI was not continually inspecting the material during generation, an intrusive inspection of the pile shall be conducted to determine the extent of RACS contamination, followed by the removal of the visible extent of contamination plus removal of one (1) foot of material in all directions. Alternatively, the entire pile, plus three (3) inches of material below the pile, shall be removed and managed as RACS. If the pile was placed on top of a durable surface such as concrete or asphalt, the surface shall be decontaminated using wet methods, followed by CABI inspection verifying that all soil and debris has been removed from the surface. Rinsate/runoff shall be collected and filtrated to less than 5 microns (or applicable local requirements) and discharged to a sanitary sewer or other Department-approved disposal facility or re-applied to RACS that will be managed under these regulations.
- (2) Stockpiling, as defined in Section 1.2 of these regulations, is the accumulation and storage of RACS that will exist for more than twelve (12) hours, up to and including ten (10) calendar days. The following requirements shall apply to stockpiled RACS:
- (a) Stockpiled RACS shall be placed on a minimum of 6 mil polyethylene sheeting or shall include removal, and management as RACS, of a minimum of three (3) inches of soil, or other matrix material, from under the entire area of RACS stockpiling after stockpile removal. If the stockpile was placed on top of a durable surface such as concrete or asphalt, the surface must be decontaminated using wet methods, followed by CABI inspection verifying that all soil and debris has been removed from the surface. Rinsate/runoff shall be collected and filtrated to less than 5 microns (or applicable local requirements) and discharged to a sanitary sewer or other Department-approved disposal facility or re-applied to RACS that will be managed under these regulations.
 - (b) RACS shall be adequately wet during disturbance.
 - (c) Stockpiled RACS shall be controlled per Section 5.5.7(A).
 - (d) Stockpiled RACS shall be stabilized by:
 - i. Polyethylene sheeting or geotechnical fabric with daily inspection, and inspection no later than twelve (12) hours following storm events, and repair/replace sheeting as necessary to maintain stabilization; or
 - ii. Chemical stabilizer demonstrated to be effective in the stabilization of RACS (e.g. magnesium chloride) with weekly inspection, and inspection no later than one (1) calendar day after storm events, and re-application of chemical stabilizer as necessary to maintain stabilization; or

- iii. Minimum of three (3) inches of soil appropriate for unrestricted use.
- (e) For stockpile areas that are non-contiguous with the RWA, transportation of RACS shall be conducted in accordance with the following:
- i. Transportation equipment tires shall not contact RACS; or
 - ii. The tires shall be decontaminated per Section 5.5.7(I) before leaving the RWA; or
 - iii. The haul road shall be managed as RACS for stabilization, per Section 5.5.7(H)(2)(d), and future removal of a minimum of three (3) inches of soil, or other matrix material. If the road is constructed of a durable surface such as concrete or asphalt, the surface shall be decontaminated using wet methods, followed by CABI inspection verifying that all soil and debris has been removed from the surface. Rinsate/runoff shall be collected and filtrated to less than 5 microns (or applicable local requirements) and discharged to a sanitary sewer or other Department-approved disposal facility or re-applied to RACS that will be managed under these regulations.
- (f) For a stockpile that was previously thought to be free of RACS, but where RACS is subsequently identified, the procedure outlined in Section 5.5.7 (H)(1)(c) shall be followed.
- (3) Storage of RACS exceeding ten calendar days shall require the submission of a RACS Storage Plan. Storage of RACS shall not commence prior to approval of the RACS Storage Plan by the Department's Hazardous Materials and Waste Management Division. The RACS Storage Plan shall include:
- (a) Approval of storage with signature from the property owner; and
 - (b) Volume of RACS intended for storage; and
 - (c) Liner design or provisions for removal of a minimum of three (3) inches of underlying material; and
 - (d) Storm water design including protections for run-on and run-off; and
 - (e) Cover design or use of an equivalent durable stabilizer; and
 - (f) Access control and signage; and
 - (g) Storage timeframe (shall not exceed six (6) months unless an extended storage timeframe is approved by the Department and complies with local governing authority requirements); and
 - (h) Inspection and maintenance schedule; and

- (i) Closure and removal requirements; and
 - (j) Documentation and reporting; and
 - (k) Certification of any designed elements by a Colorado registered Professional Engineer.
- (4) Temporary sub-surface storage of RACS in areas of future planned RACS removal shall not exceed six (6) months and shall comply with the following:
- (a) RACS may only be placed within the Area of Contamination (AOC) that it was originally removed from.
 - (b) Placement of RACS utilizing standard RACS management requirements in accordance with the standard requirements of Section 5.5.7, an approved PSRMP, or an approved SOP.
 - (c) Cover RACS in accordance with the requirements of Section 5.5.7(K).
 - (d) RACS not removed within six (6) months (unless an extended storage timeframe is approved by the Department), shall be considered disposal in accordance with Section 5.5.8(A), or reuse within an AOC and will require an environmental covenant in accordance with Section 5.5.8(B)(1).
- (5) Offsite staging, stockpiling, and storage of RACS are allowed as long as they comply with the disposition requirements of Section 5.5.8.

(I) DECONTAMINATION

(1) Requirements applicable to all projects subject to Section 5.5:

(a) Personnel Decontamination:

- i. Remove booties and/or gloves before exiting RWA and dispose as asbestos contaminated waste; or
- ii. If not using disposable PPE, decontaminate boots in a boot wash station, remove gloves after exiting the boot wash station, and dispose of gloves as asbestos contaminated waste. Rinsate from the boot wash station shall be collected, filtrated to less than 5 microns (or applicable local requirements) and discharged to a sanitary sewer or other Department-approved disposal facility, or re-applied to RACS that will be managed under these regulations.

(b) Decontamination of Equipment or Surfaces that have come into Contact with RACS

i. For equipment that comes into contact with RACS:

1. Wet decontamination on a decontamination pad (minimum 10 mil poly or other durable non-permeable barrier) followed by CABI inspection and verification of equipment decontamination before it leaves the decontamination area. All decontamination liquids and solids shall be contained, and run-on and run-off shall be prevented. Rinsate/runoff shall be collected, filtrated to less than 5 microns (or applicable local requirements) and discharged to a sanitary sewer or other Department-approved disposal facility or re-applied to RACS that will be managed under these regulations. For breaches in the decontamination pad where RACS or water contaminated with asbestos may have impacted the material below the decontamination pad, implement the provisions of Section 5.5.7(J);

and/or

2. Decontamination using HEPA vacuums followed by CABI inspection and verification of equipment decontamination before it leaves the decontamination area.

(c) Protection of Clean Equipment and Surfaces:

- i. Keep all equipment off of RACS; or
- ii. Protect clean surfaces from coming in contact with RACS by covering equipment surfaces or RACS surfaces with polyethylene sheeting or equivalent durable impermeable covering. For onsite movement of excavation equipment between RWAs, where only the excavator bucket has come in contact with RACS, the bucket shall be wrapped in polyethylene sheeting (minimum 6 mil) prior to movement. Protective coverings shall be cleaned, repaired, or replaced as necessary. If protective coverings are breached and RACS or asbestos contaminated water comes into contact with underlying material, the provisions of Section 5.5.7(J) shall be followed. Coverings that have come in contact with RACS shall be disposed as asbestos contaminated waste.

(2) Additional Requirements for Projects Disturbing RACS Containing Friable ACM:

- (a) Remove disposable impermeable suits or equivalent coveralls before exiting RWA and dispose as asbestos contaminated waste, or
- (b) After removal of suits or coveralls, conduct full wet decontamination prior to exiting RWA with collection of rinsate and filtration to less than 5 microns and

discharge to a sanitary sewer or other Department-approved disposal facility.
Re-application of decontamination shower water is prohibited.

(J) RACS SPILL RESPONSE

- (1) Areas where RACS is spilled are RWAs until clean up is completed.
- (2) Spilled material shall be cleaned up immediately and not allowed to dry out or accumulate on any surface. The Department's Hazardous Materials and Waste Management Division shall be notified, through the spill reporting hotline, in the event that spills of RACS cannot be cleaned up within 24 hours of spill identification.
- (3) Where there are breaches in ground coverings that have the potential to allow RACS or water contaminated with asbestos to impact the material below the covering, a minimum of three (3) inches of soil, or other matrix material, shall be removed from beneath the breached ground coverings. Visual or measured (e.g. survey) confirmation that three (3) inches of soil and/or other matrix material from beneath the breached covering has been removed shall be conducted. If ground coverings are placed on top of a durable surface such as concrete or asphalt, the surface shall be decontaminated using wet methods, followed by CABI inspection that all soil and debris has been removed from the surface.
- (4) Rinsate, runoff, or any other water that has come into contact with RACS shall be considered to be asbestos contaminated water and shall be collected and filtrated to less than 5 microns and discharged to a sanitary sewer or other Department-approved disposal facility or re-applied to RACS that will be managed under these regulations.
- (5) Surfaces that are contacted by asbestos contaminated water shall be managed as RACS as per Section 5.5.7(J)(3) or permanently stabilized as per Section 5.5.7(K).
- (6) If work practices in an RWA are causing an ongoing spill outside the RWA, the work practices shall cease or be modified to prevent additional releases.

(K) REQUIREMENTS FOR EXPOSED RACS REMAINING IN PLACE

- (1) Any remaining RACS that has been exposed by the soil disturbing activity, but is not disturbed, such as an excavation side-wall or bottom shall be covered or stabilized using one of the following:
 - (a) Cover RACS with geofabric, followed by eighteen (18) inches of fill suitable for unrestricted use, and vegetation; or

- (b) Cover RACS with geofabric, followed by six (6) inches of fill suitable for unrestricted use, and concrete or asphalt; or
- (c) Cover RACS with geofabric, followed by fill suitable for unrestricted use to grade or six (6) inches, whichever is greater, for vertical excavation faces or trenches; or
- (d) Alternate cover designs as approved by the Department.

(L) DOCUMENTATION

(1) The documents listed below shall be maintained during a project and available for Department review upon request. However, this documentation need not be submitted to the Department unless requested. CABI and AMS notes may be collected by one individual if they possess both certifications; however, if no AMS is onsite the CABI shall provide items listed in the AMS notes section (e.g. wind monitoring and shutdown events). CABI and AMS notes may be taken by another individual, but shall be reviewed, approved, and signed by the CABI or AMS for whom the notes are being taken. Other appropriate personnel may also provide the following documentation.

(a) CABI/QPM Notes shall include documentation of:

- i. Site description including location; and
- ii. Descriptions of site activities; and
- iii. Descriptions of equipment in use; and
- iv. Descriptions of hand removals (including locations); and
- v. Descriptions of types of debris identified; and
- vi. Descriptions of suspect material identified; and
- vii. Friability of ACM identified (as determined by a CABI); and
- viii. Sampling, if conducted (all sampling shall be conducted by a CABI); and
- ix. Decontamination visual inspection and clearances; and
- x. Excavation visual inspection and clearances; and
- xi. Spill response activities; and
- xii. Observations of visible emissions and responses; and
- xiii. Observations of non-earthen material or the appearance of fill; and
- xiv. Observations of other indicators of impact to soils.

(b) AMS notes shall include documentation of:

- i. Wind speed measurements; and
- ii. Prevailing wind direction(s); and
- iii. Wind shut down event(s); and
- iv. Initial air sample locations; and
- v. Air sample relocation notes; and
- vi. Observations of visible emissions and responses; and

- vii. Notes pertaining to sample malfunctions (pump faults, overloading, etc.); and
- viii. Instances of samples being compromised (samples knocked over, sample filters being sprayed with water, samples physically impacted by equipment, etc.); and
- ix. Air sample data (flow rates, time of sampling, volumes, calibration method, etc.).

(c) General documentation shall include:

- i. Disposal records; and
- ii. Analytical reports including chain of custody forms; and
- iii. Evaluations of any samples with a “cannot be read” analysis result and the notifications of these events to the Department; and
- iv. Location of known remaining RACS; and
- v. Creation and removal dates for, and locations of, staged, stockpiled, and/or stored RACS; and
- vi. Stockpile and staging pile inspection logs and documentation of weather events requiring inspection; and
- vii. Logs of all site personnel with access to the RWA; and
- viii. Certification records for all CABIs and AMSs utilized on the project, and
- ix. Records for training conducted in accordance Sections 5.5.3(A) and 5.5.3(B); and
- x. Records demonstrating the QPM(s) meet the training and experience requirements set forth in Section 5.5.3(C); and
- xi. ECP(s) generated during the project.

5.5.8 PACKAGING AND DISPOSITION OF REGULATED ASBESTOS CONTAMINATED SOIL (RACS)

(A) Disposal of RACS

- (1) RACS containing one percent (1%) or greater of friable ACM (as determined in the field by a CABI) by volume per load or container, based on visual estimation through continuous visual inspection or other Department-approved quantifiable means of measurement, shall be packaged in a leak tight container and disposed as friable asbestos waste, in accordance with Section 5.3 of these regulations. Alternatively, a friable ACM determination by a CABI is not required if the disposal load is assumed to be RACS containing 1% or greater of friable ACM and is packaged and disposed of in accordance with Section 5.3 of these regulations. Documentation shall accompany each load of RACS removed from the site stating that soil originating from this site shall not be used as daily cover or reused offsite.

(2) For RACS containing:

- (a) Less than one percent (1%) of friable ACM (as determined in the field by a CABI) by volume, per load or container, based on visual estimation through continuous visual inspection, or other Department-approved quantifiable means of measurement, shall be packaged in a leak tight container and disposed in a manner similar to non-friable asbestos waste, as described in Section 5.2 of these regulations. Documentation must accompany each load of RACS removed from the site stating that soil originating from this site shall not be used as daily cover or reused offsite.
- (b) Except as provided by Section 5.5.8(A)(3), only visible non-friable ACM (as determined in the field by a CABI) that has not been rendered friable, or RACS that contains no visible ACM, shall be packaged in a leak tight container and disposed of as non-friable asbestos waste in accordance with Section 5.2 of this Part 5. Documentation shall accompany each load of RACS removed from the site stating that soil originating from this site shall not be used as daily cover or reused offsite.
- (c) A total volume of debris that is less than 1% of the disposal load, based on visual estimation through continuous visual inspection, and the debris is all assumed to be RACS, then a CABI is not required to make a friable ACM determination.

(3) Owners/operators may utilize alternative packaging for RACS, that contains only non-friable ACM and/or asbestos fibers in soil, that ensures that there are no visible emissions during transport to or from the landfill. The alternative packaging must also be acceptable to the disposal facility accepting the waste. A written notice shall be submitted to the Department at least forty-eight (48) hours prior to the alternative packaging being used. If alternative packaging will be used for material that contains any amount of friable asbestos waste, the alternative packaging shall be in accordance with Section 5.3.5 of the Regulation.

(4) A Design and Operations (D&O) plan shall be submitted to, and approved by, the Department for onsite disposal of RACS outside of the AOC, in accordance with the Colorado Solid Wastes Disposal Sites and Facilities Act (C.R.S. 30-20, Part 1) and these regulations. The packaging requirements set forth above in Section 5.5.8(A)(1-2) are not required for onsite disposal, but the requirements of Section 5.5.5(A)(2)(e) are applicable. An environmental covenant, in accordance with 25-15-320, C.R.S., is required for onsite RACS disposal, and a Certificate of Designation shall be required, in accordance with Section 1.6 of these regulations, unless exempt under Section 1.4.

(B) Onsite reuse of RACS:

- (1) A plan for reuse of RACS within the footprint of the AOC shall be submitted to the Department for review and approval prior to implementation and shall comply with Section 5.5.5(A)(2)(e), and the following cover requirements:
 - (a) Cover RACS with geofabric, followed by eighteen (18) inches of fill suitable for unrestricted use, and vegetation; or
 - (b) Cover RACS with geofabric, followed by six (6) inches of fill suitable for unrestricted use, and concrete or asphalt; or
 - (c) Cover RACS with geofabric, followed by fill suitable for unrestricted use to grade or six (6) inches, whichever is greater, for vertical excavation faces or trenches; and
 - (d) The final grades shall promote surface water run-off and minimize erosion, and shall have slopes no less than 5% (20:1) and no greater than 25% (4:1); or
 - (e) Alternate cover designs as approved by the Department; and
 - (f) An environmental covenant, in accordance with 25-15-320, C.R.S., may be required for onsite reuse of RACS.
- (2) A plan for beneficial reuse of RACS outside the footprint of the AOC, in accordance with Section 8.6, shall be submitted to the Department for review and approval prior to its implementation. The plan shall include provisions for covering RACS and shall comply with the management requirements of Section 5.5.5(A)(2)(e). Additionally, the cover requirements outlined in Section 5.5.7(K) shall be adhered to. An environmental covenant, in accordance with 25-15-320 C.R.S. may be required for beneficial reuse of RACS.

(C) Demonstration of Non-RACS

- (1) Soil or other matrix material initially determined to be RACS may be demonstrated not to be RACS based on visual inspection, removal of all ACM, and sampling and analysis of the remaining material showing no detectable asbestos. Sampling and analysis shall be conducted in accordance with Appendix 5A. If there is no detectable asbestos, this material is no longer subject to Section 5.5 and may be appropriate for unrestricted use, onsite or offsite, as long as it does not contain any other regulated material.

5.5.9 FEES

The Department shall collect fees, from the owner, operator, or person conducting the soil disturbing activity, based on total documented costs, in accordance with Section 1.7

APPENDIX 5A

SAMPLE COLLECTION PROTOCOLS AND ANALYTICAL METHODOLOGIES

1.0 Purpose

- (A) The purpose of this appendix is to establish standard sample collection requirements and analytical methods and procedures for use in identifying and quantifying asbestos fibers in air, bulk material, and environmental media such as soil or ash.

2.0 Sample Collection Requirements

- (A) The following sample collection requirements shall be followed when collecting samples for the purpose of determining the applicability of Section 5.5, and when collecting samples necessary to comply with the requirements of Section 5.5. Remediation plans submitted in accordance with Section 5.5.6 shall include a site specific sampling and analysis plan that incorporates the sample collection methodologies and analytical procedures in this Appendix, or proposes alternatives, and include site specific clearance criteria.

2.1 Bulk Samples

- (A) Bulk samples shall be collected, in a manner sufficient to determine whether the material is asbestos-containing material (ACM) or not ACM, from each type of suspect ACM. Bulk samples shall be collected by a State of Colorado certified Asbestos Building Inspector (CABI). In the absence of bulk sample collection, any suspect ACMs must be assumed to be ACMs.
- (B) Bulk samples shall be collected by homogenous type based on color, pattern, texture, thickness, associated materials, or by other identifying characteristics. Additionally, the quantity and location of a suspect material shall be used to determine the number of bulk samples required to characterize the asbestos content of each homogeneous suspect material. For the purpose of determining that a homogeneous suspect material does not contain asbestos, a minimum of three (3) bulk samples shall be collected from the homogeneous material unless there is insufficient material to constitute three (3) samples. If one of the collected samples of a homogeneous bulk material is determined to be ACM, then the homogeneous material shall be considered ACM.

2.2 Soil Samples

- (A) Samples collected to determine asbestos content in soil shall be ten (10) point aliquot composite samples collected from a maximum area of 1,250 square feet (representing 0-6 inches beyond the exposed surface) or a maximum volume of forty (40) cubic yards. Individual aliquots shall be approximately 1/10 of the entire sample volume. At each aliquot location approximately one (1) tablespoon of soil shall be collected. The total volume of the ten (10) aliquots should equal roughly a half cup. The total collected sample volume should be greater than one quarter ($\frac{1}{4}$) cup, but should not exceed one cup. Aliquot locations shall be randomly selected but shall be representative of the entire sample area or volume (to be inclusive of the interior of soil piles in addition to the surface). However, aliquots shall be co-located with any areas where friable ACM was formerly present. All samples collected to determine asbestos content shall be collected by a CABI.
- (B) Sampling for clearance purposes of any exposed horizontal or vertical surface shall have the following additional requirements:
- 1) The aliquots of a clearance sample shall not be collected until after the RACS, and the required amount of associated material, has been removed.
 - 2) A visual inspection shall be performed and passed (i.e., no visible ACM present) by a CABI prior to the collection of soil samples. Visual inspections shall include the following:
 - a) The area to be cleared shall be designated before the visual inspection; and
 - b) Former locations of friable materials shall be designated; and
 - c) The surface being inspected shall be dry enough to allow identification of suspect ACM; and
 - d) The visual inspection shall be conducted in adequate lighting; and
 - e) The area to be cleared shall be free of visual impediments (e.g. snow cover, plastic sheeting, standing water, etc.); and
 - f) At a minimum, the area to be cleared shall be inspected in at least two (2) perpendicular directions; and
 - g) Single or multiple inspectors may be used to perform a visual inspection and clearance. However, a single inspector shall not

visually inspect more than a five (5) foot width with each pass [i.e. for a clearance area that is 25' x 50' a single inspector would be required to make at least five (5) passes in one direction (25' length) and at least ten (10) passes in the other direction (50' length)]; and

- h) Detailed close examination of the area being cleared is required. The inspector(s) should use limited invasive inspection techniques, such as periodically sifting the surface being cleared and closely inspecting the disturbed area.
- 3) If sidewalls with six (6) inches or greater of vertical height are present, independent ten (10) point aliquot composite samples shall be collected from each of the sidewalls and the floor of the excavation.

2.3 Ash Samples

- (A) Ash that contains, or is comingled with, suspect ACM and/or construction and demolition debris shall be considered to be RACS unless the ash is sampled, and analysis demonstrates that the ash is not RACS. Representative samples of each type of ash materials shall be sampled and analyzed in the same manner as soil (including area/volumetric limitations of sampling). Ash samples shall be collected by homogenous strata, location, content of other surrounding material, or other observations indicating heterogeneity of the ash present. All samples collected to determine asbestos content shall be collected by a CABI. In the absence of suspect ACM or construction and demolition debris, and in the absence of documented evidence of non-visible asbestos, ash material may be treated as non-RACS.

2.4 Cross Contamination Prevention

- (A) All sample collection equipment shall be decontaminated in a manner sufficient to prevent cross contamination between individual samples or individual composite samples. Decontamination is not required between the collection of aliquots comprising a single composite sample.

2.5 Air Samples for Standard RACS Management

- (A) Air samples shall be collected by drawing air through 0.8-micron (μm), 25-millimeter (mm), mixed cellulose ester (MCE) filters, using an open-faced cowl extension oriented face down at an angle of 45°. Sample flow rate shall be between 0.5-10 liters per minute depending on the anticipated duration of sampling and the specified detection sensitivity. The air sampling equipment

shall be run until the minimum volume required is collected for each sample. However, if the minimum air volume required by the method, and/or to reach the required analytical sensitivity, being utilized cannot be met, the State of Colorado trained and certified Air Monitoring Specialist (AMS) shall request that the laboratory prepare the sample using an indirect preparation method, for TEM presence/absence analysis. Air samples shall be collected at a height that is representative of the disturbance activity taking place. However, air samples shall be located at a height between three (3) feet above the ground surface but not to exceed twenty (20) feet above the ground surface. Air samples shall be collected by an AMS.

2.6 Air Samples for Risk-Based Air Threshold Monitoring

- (A) Air samples shall be collected by an AMS. Air monitoring shall be conducted during each partial or full day of soil management activities using fixed and mobile monitors as follows:
- 1) A minimum of four (4) samples shall be collected for each regulated work area (RWA).
 - 2) For the purpose of determining the number of samples necessary, each RWA shall be divided into four (4) equal quadrants. A minimum of one (1) sample shall be collected for each quadrant with an adjacent receptor zone.
 - 3) If an RWA is greater than one (1) acre, one (1) additional sample for each quadrant with an adjacent receptor zone shall be collected and analyzed for each additional one quarter ($\frac{1}{4}$) acre in RWA surface area.
 - 4) Samples shall be located along the RWA perimeter, between the RWA and each adjacent receptor zone. Samples shall be placed between the RWA and any fixed adjacent receptor(s). In the absence of fixed adjacent receptors, sample placement shall be at the AMS's discretion.
 - 5) The sample volume shall be the minimum necessary to meet analytical sensitivity.
 - 6) Samples shall be collected by drawing air through 0.8-micron (μm), 0.25-millimeter (mm), mixed cellulose ester (MCE) filters, using an open-faced cowl extension oriented face down at an angle of 45° .

3.0 Analytical Requirements

- (A) The following analytical methods shall be used to evaluate the presence of asbestos and/or to determine asbestos content when analyzing samples for the purpose of determining the applicability of Section 5.5, and when analyzing samples collected in accordance with Section 5.5:

3.1 Bulk Samples

- (A) Samples of suspect ACM shall be analyzed by polarized light microscopy (PLM), according to United States Environmental Protection Agency (USEPA) Method EPA/600/R-93/116 or equivalent method, to determine if any asbestos fibers are present. If the asbestos content of a sample is estimated to be 1% asbestos or less, but greater than 0%, by a method other than point counting (such as visual estimation), the determination shall be repeated using the point counting technique with PLM. Alternatively, the material may be assumed to be ACM. Analysis shall be conducted by a National Voluntary Laboratory Accreditation Program (NVLAP) accredited laboratory.

3.2 Soil Samples and Ash Samples

- (A) Prior to preparation of a soil or ash sample, bulk materials shall be separated from the soil or ash sample for independent analysis. Any bulk materials identified in a soil or ash sample that contain any amount of asbestos shall be reported as independent layers of the whole sample. The samples shall be adequately prepared (crushed and dried) to facilitate stereomicroscopic analysis by the laboratory. The goal of the preparation process should be to produce dried conglomerates of approximately one eighth inch (1/8") to one quarter inch (1/4") size. Rock and/or stone material does not need to be crushed (this process is not intended to be homogenization). Soil and ash samples shall be analyzed by PLM according to USEPA Method EPA/600/R-93/116 to determine if any asbestos fibers are present. Analysis shall be conducted by a National Voluntary Laboratory Accreditation Program (NVLAP) accredited laboratory. During the stereomicroscopic analysis (10X – 50X) of the soil/ash sample the analyst shall sift through the sample at a rate of approximately one (1) tablespoon per minute. At the end of the stereomicroscopic analysis the sample shall be agitated or shaken as a final check for asbestos prior to the preparation of PLM grab mounts. At no time during the stereomicroscopic analysis shall a sub sample be collected. The entire sample shall be analyzed and the results reported. If no asbestos was identified by PLM after the initial stereomicroscopic examination, then three (3) random grab mount preparations shall be analyzed by PLM to determine if the sample is none detected for asbestos content. If any asbestos is found by the laboratory it shall be reported even in the absence of a second detection (i.e. there does not need to be a second detection to qualify a trace level of asbestos in the sample). Quantification of asbestos content shall be based on the entire sample volume, and be reported as such.

3.3 Air Samples for Standard RACS Management

- (A) Air samples submitted for Phase Contrast Microscopy (PCM) shall be analyzed according to NIOSH Method 7400 by a laboratory showing successful participation in the American Industrial Hygiene Association (AIHA) Proficiency Analytical Testing (PAT) Program or individual(s) certified through the AIHA Asbestos Analysts Registry (AAR) Program.

- (B) Air samples submitted for Transmission Electron Microscopy (TEM), for which quantification of asbestos is desired, shall be prepared and analyzed according to the standard Asbestos Hazard Emergency Response Act (AHERA) method (AHERA; 40 CFR Part 763, Subpart E, Appendix A). All TEM analysis shall be performed by a NVLAP accredited laboratory. If a presence/absence analysis is desired, the analysis shall be performed using the AHERA method modified in the following manner:
 - 1) A minimum of two (2) preparations shall be prepared and utilized for each sample.
 - 2) Analysis shall be conducted on a minimum of four (4) grid openings or until three (3) or more structures are identified, whichever comes first.
 - 3) Any structure (adhering to the AHERA counting rules) identified during analysis shall be reported.
 - a) Identification of less than three (3) structures shall be reported as present.
 - b) Identification of three (3) or greater structures shall be reported as detected.

- (C) Any air sample analysis that results in a “cannot be read (CBR)” determination from the analyst, or a “not analyzed (NA) or rejected” due to loose debris or uneven loading, shall be evaluated by the AMS to determine if a cause of the CBR or NA can be ascertained. If it is determined that the CBR is a result of overloading from airborne emissions, then the AMS shall request that the laboratory prepare the sample, using an indirect preparation method, for TEM presence/absence analysis.

3.4 Risk-Based Air Threshold Samples

(A) Air samples collected for TEM analysis shall be submitted to a NVLAP accredited laboratory. Samples shall be analyzed by TEM according to ISO Method 10312 with the following modifications for PCM equivalent (PCMe) structures:

- 1) An aspect ratio of 3:1 shall be used when counting structures greater than 5 µm in length, rather than the 5:1 ratio specified in the method.
- 2) A width range of 0.25 to 3 µm will be used when counting PCMe structures, rather than the 0.2 to 3 µm specified in the method.
- 3) A minimum of ten grid openings will be counted, rather than the minimum of four (4) grid openings specified in the method.
- 4) Calculations shall be made based on total fibers rather than primary fibers.

(B) The maximum number of grid openings (GOs) to be counted to achieve the specified analytical sensitivity shall be estimated as follows:

$$\text{Number of GOs} = \text{EFA} \div (\text{A}_{\text{GO}} \times \text{V} \times \text{S} \times \text{CF})$$

where:

EFA = effective filter area (385 for a 25-mm filter)

A_{GO} = area of a grid opening (approximately 0.01 mm²; actual value to be provided by the analytical laboratory)

V = volume of air sampled (in liters [L])

S = analytical sensitivity (structures per cubic centimeter [s/cc])

CF = conversion factor (1000 cc/L)

(C) Any air sample analysis that results in a “cannot be read (CBR)” determination from the analyst, or a “not analyzed (NA) or rejected” due to loose debris or uneven loading, shall be prepared by the laboratory, using an indirect preparation method, for TEM presence/absence analysis.

3.5 Data Evaluation for Risk-Based Air Threshold Samples

(A) General requirements:

- 1) Samples collected for comparison to risk-based air thresholds shall be evaluated based on the average (mean) concentration over the exposure duration.

- 2) All valid data shall be used to calculate daily and ten (10) day rolling averages.
- 3) For all projects a minimum of three (3) samples per day must have quantifiable data (not CBR or rejected). If less than three (3) quantifiable analytical results are available then the daily average is invalid.

(B) Project days 1-9:

- 1) The results of the daily samples must be averaged to calculate a daily average for use in comparing to the risk based air threshold for days 1-9 of monitoring.
- 2) A ten (10) day average shall be calculated for days 1-9. The ten (10) day average shall be comprised of at least eight (8) valid daily average results. However, all valid data shall be used to calculate the ten (10) day average.
- 3) If the ten (10) day average exceeds the risk-based air threshold, engineering controls shall be adjusted to reduce the daily average.
- 4) The Department shall be notified within 24 hours if the calculations in paragraphs 1 and 2 above cannot be completed due to invalid data.

(C) Project days 10 and greater:

- 1) Starting on day 10, a ten (10) day rolling average shall be calculated and compared to the risk-based threshold.
- 2) If average concentration trends indicate the risk-based air threshold will be exceeded before project completion, engineering controls shall be adjusted to reduce the daily asbestos emissions.
- 3) If subsequent evaluation of average concentration trends indicates that the risk-based air threshold will still be exceeded before project completion, additional adjustments to engineering controls shall be made.
- 4) If changes in engineering controls are not effective in reducing airborne concentration trends such that the risk-based air thresholds can be met, consultation with the Department is required.
- 5) The Department shall be notified within five (5) working days if the averaged airborne asbestos concentration for the entire project exceeds the risk-based air threshold.

4.0 Documentation

(A) All of the following sampling and analytical documentation shall be maintained during a project and available for Department review upon request. This documentation need not be submitted to CDPHE unless requested or as required in a project specific plan.

1) Documentation of bulk, soil, and ash samples shall include:

- a. A description of the material being sampled including friability.
 - i. For samples collected for characterization purposes also include an estimate of the quantity of visible suspected RACS present.
 - ii. For samples of ash, also include a brief description of the ash layer, and any associated identifiable debris.
- b. Name of person collecting the sample(s).
- c. Date and time of sample collection.
- d. Location of sample collection (a map, drawing, or diagram showing sample locations in relation to the work area and surrounding area).
- e. The boundary/limits that are represented by the collected sample.
- f. Chain of custody documentation.
- g. Laboratory analysis reports.
- h. Log of characterized homogeneous bulk materials including material descriptions, photographic documentation, and asbestos content.

2) Documentation of air samples shall include:

- a. Name of person collecting the sample(s).
- b. Date and time(s) of sample collection.
- c. Locations of air sample collection.
- d. Any relocation of air samples.
- e. A map, drawing, or diagram showing air sample locations (initial and relocations) in relation to the work area and the surrounding area.
- f. Chain of custody documentation.
- g. Laboratory analysis reports.
- h. Explanation of any air sample malfunctions and any voided air samples.
- i. Risk based air threshold concentration calculations.

- j. Air sample data (flow rates, time of sampling, volumes, calibration method, etc.).
- k. Wind speed measurements.
- l. Prevailing wind directions.
- m. Wind shut down events.
- n. Observations of visible emissions and responses.

5.0 Deviations from Sampling and Analysis Procedures

(A) Deviation from this sampling and analysis appendix shall only be allowed upon consultation with, review by, and approval from, the Department.

Regulation No. 8

Part B – Asbestos

Air Quality Control Commission



**Colorado Department
of Public Health
and Environment**

EMISSION STANDARDS FOR ASBESTOS

EXCERPTED FROM
REGULATION NO. 8

"The Control of Hazardous Air Pollutants"
Part B - Emission Standards for Asbestos

COLORADO AIR QUALITY CONTROL
COMMISSION

Effective: January 30, 2008

REGULATION NO. 8
The Control of Hazardous Air Pollutants
PART B
THE CONTROL OF ASBESTOS
5 CCR 1001-10, Part B

	Page
I. INCORPORATED MATERIAL STATEMENT; DEFINITIONS	1
I.A. INCORPORATED MATERIALS.....	1
I.B. DEFINITIONS.....	2
I.C. ACRONYMS.....	13
II. CERTIFICATION REQUIREMENTS	16
II.A. GENERAL REQUIREMENTS.....	16
II.B. GENERAL ABATEMENT CONTRACTOR CERTIFICATES.....	17
II.C. WORKER, SUPERVISOR, BUILDING INSPECTOR, MANAGEMENT PLANNER, PROJECT DESIGNER CERTIFICATES.....	17
II.D. AIR MONITORING SPECIALIST CERTIFICATES.....	19
II.E. TRAINING PROVIDER APPLICATION PROCEDURES.....	24
II.F. INSTRUCTOR QUALIFICATIONS.....	25
II.G. TRAINING COURSE NOTIFICATIONS.....	25
II.H. TRAINING COURSE AUDITS.....	26
II.I. RECIPROCITY.....	26
II.J. PROJECT MANAGER QUALIFICATIONS.....	27
II.K. DENIAL, SUSPENSION, REVOCATION, OR REFUSAL TO RENEW CERTIFICATION.....	27
II.L. EXEMPTIONS.....	27
III. ABATEMENT, RENOVATION AND DEMOLITION PROJECTS	29
III.A. INSPECTION.....	29
III.B. USE OF CERTIFIED AND REQUIRED PERSONNEL.....	30
III.C. PROJECT DESIGN.....	31
III.D. PROJECT MANAGEMENT.....	32
III.E. NOTIFICATIONS.....	32
III.F. ALTERNATIVE PROCEDURES AND VARIANCES.....	34
III.G. PERMITS.....	35
III.H. ABATEMENT SEQUENCE.....	37
III.I. CRITICAL BARRIER INSTALLATION.....	38
III.J. AIR CLEANING AND NEGATIVE PRESSURE REQUIREMENTS.....	39
III.K. DECONTAMINATION UNIT.....	40
III.L. PRE-CLEANING OF SURFACES.....	41
III.M. COVERING FIXED OBJECTS.....	42
III.N. CONTAINMENT COMPONENTS.....	42
III.O. ABATEMENT METHODS.....	44
III.P. CLEARING ABATEMENT PROJECTS.....	46
III.Q. TEAR-DOWN.....	49
III.R. WASTE HANDLING.....	49
III.S. ABATEMENT OF SPECIAL MATERIALS.....	50

III.T. ASBESTOS SPILL RESPONSE.....	52
III.U. MAXIMUM ALLOWABLE ASBESTOS LEVEL	54
III.V. SPECIAL REMOVAL METHODS	56
III.W. STRUCTURALLY UNSOUND BUILDINGS.....	58
III.X. EXEMPTIONS	58
IV. SCHOOL REQUIREMENTS.....	59
IV.A. SCOPE AND PURPOSE.....	59
IV.B. GENERAL LEA RESPONSIBILITIES	59
IV.C. INSPECTION AND REINSPECTION	61
IV.D. SAMPLING	63
IV.E. ANALYSIS.....	64
IV.F. ASSESSMENT.....	65
IV.G. RESPONSE ACTIONS	66
IV.H. OPERATIONS AND MAINTENANCE.....	70
IV.I. TRAINING AND PERIODIC SURVEILLANCE.....	72
IV.J. SCHOOL MANAGEMENT PLANS.....	74
IV.K. RECORDKEEPING	78
IV.L. WARNING LABELS	79
IV.M. EXCLUSIONS.....	79
V. STATE BUILDING REQUIREMENTS	82
V.A. SCOPE AND PURPOSE.....	82
V.B. GENERAL STATE AGENCY RESPONSIBILITIES.....	82
V.C. INSPECTIONS	83
V.D. SAMPLING	83
V.E. ANALYSIS.....	85
V.F. ASSESSMENT	85
V.G. RECORDKEEPING	87
V.H. EXCLUSIONS.....	87
VI. USE OF ASBESTOS IN THE MANUFACTURING, COMMERCE AND CONSTRUCTION INDUSTRIES	89
VI.A. STANDARD FOR ASBESTOS MILLS	89
VI.B. STANDARD FOR ROADWAYS.....	89
VI.C. STANDARD FOR MANUFACTURING.....	89
VI.D. STANDARD FOR SPRAYING.....	90
VI.E. STANDARD FOR FABRICATING	90
VI.F. STANDARD FOR INSULATING MATERIALS.....	91
VII. STATEMENT OF BASIS AND PURPOSE.....	92
VII.A. AMENDMENT TO SECTION II – INCORPORATION OF THE EPA MODEL ACCREDITATION PLAN BY REFERENCE (March 21, 1996).....	92
VII.B. REVISIONS RESULTING FROM HB 95-1016 (September 19, 1996)	92
VII.C. REVISIONS RESULTING FROM SB-01-121, THE DORA ASBESTOS CONTROL PROGRAM 2000 SUNSET REVIEW, AND THE REORGANIZATION OF REGULATION NO. 8, PART B (January 16, 2003)	94
VII.D. REVISIONS TO ADDRESS INCORRECT LANGUAGE IN THE SINGLE-FAMILY RESIDENTIAL DWELLING OPT-OUT PROVISION, ROOFING MATERIALS AND TYPOGRAPHICAL ERRORS (December 18, 2003)	98

VII.E. REVISIONS TO ADDRESS LANGUAGE IN THE SINGLE-FAMILY
RESIDENTIAL DWELLING OPT-OUT PROVISION (December 16, 2004) 99

Appendices
 APPENDIX A – SMALL SCALE PROJECTS104
 APPENDIX B – RECOMMENDED WORK PRACTICES
 FOR THE REMOVAL OF RESILIENT FLOOR COVERINGS107
 APPENDIX C – TRAINING COURSE OUTLINE, REMOVAL OF RESILIENT
 FLOOR COVERINGS IN ACCORDANCE WITH APPENDIX B129

Adopted: December 14, 1978
 Effective: January 30, 1979

Adopted: October 16, 1986
 Effective: November 30, 1986

Adopted: March 16, 1989
 Effective: April 30, 1989

Adopted: February 21, 1991
 Effective: April 30, 1991

Adopted: May 20, 1993
 Effective: June 30, 1993

Adopted: March 21, 1996
 Effective: May 30, 1996

Adopted: September 19, 1996
 Effective: November 30, 1996

Adopted: January 16, 2003
 Effective: March 30, 2003

Adopted: December 18, 2003
 Effective: March 1, 2004

Adopted: December 16, 2004
 Effective: March 2, 2005

Adopted: June 21, 2007
 Effective: August 30, 2007

Adopted: December 21, 2007
Effective: January 30, 2008

REGULATION NO. 8
PART B
ASBESTOS CONTROL

All [underlined text](#) in this regulation indicates defined terms.

I. INCORPORATED MATERIAL STATEMENT; DEFINITIONS

I.A. INCORPORATED MATERIALS

Some documents are noted in this regulation as being incorporated by reference. Materials incorporated by reference are those in existence as of the dates indicated and do not include later amendments. The material incorporated by reference is available for public inspection during regular business hours at the Office of the Commission, located at 4300 Cherry Creek Drive South, Denver, Colorado 80246-1530, or may be examined at any state publications depository library. Parties wishing to inspect these materials should contact the Technical Secretary of the [Commission](#), located at the Office of the Commission. The following materials are herein incorporated by reference:

- I.A.1. United States Environmental Protection Agency's Asbestos Hazard Emergency Response Act (AHERA), (1995) Subpart E, 40 C.F.R. Part 763, section 1, and Appendix E to Subpart E.
- I.A.2. United States Environmental Protection Agency's Asbestos Hazard Emergency Response Act (AHERA) Model Accreditation Plan (MAP), 40 C.F.R. Part 763 (1994), Subpart E, Appendix C.
- I.A.3. United States Environmental Protection Agency's National Emission Standard for Asbestos, Standard For Waste Disposal For Manufacturing, Fabricating, Demolition, Renovation, And Spraying Operations, 40 C.F.R. part 61 section 150 (1995).
- I.A.4. United States Environmental Protection Agency's August 1994 Method [EPA/600/R-93/116](#), "Method for the Determination of [Asbestos](#) in Bulk Building Materials".
- I.A.5. United States Environmental Protection Agency's "Green Book", Managing [Asbestos](#) in Place, (TS-799) 20T-2003, Appendix G (1990).
- I.A.6. United States Environmental Protection Agency's "Pink Book", Simplified Sampling Scheme for Friable Surfacing Materials, ([EPA 560/5-85-030a](#)) (1985).
- I.A.7. National Institute for Occupational Safety and Health ([NIOSH](#)) Method 7400 entitled "Fibers" published in the NIOSH Manual of Analytical Methods, 3rd Edition, second supplement, August 1987.

I.A.8. Occupational Safety and Health Administration ([OSHA](#)) Regulation “Asbestos”, 29 C.F.R. Part 1910.1001, Appendix A (OSHA 1987).

I.B. DEFINITIONS

All terms used in this Regulation No. 8, Part B, and that are not defined below are given the same meaning as in the definitions in Regulation No. 8, Part A (section I.D.), and the common provisions regulation:

- I.B.1. [Accessible](#) when referring to [ACM](#) means that the material is subject to disturbance by [school](#) or building occupants or custodial or maintenance personnel in the course of their normal activities.
- I.B.2. [Act](#) means [C.R.S.](#) sections 25-7-101 et seq., concerning the control of asbestos.
- I.B.3. [Adequately wet](#) means sufficiently mix or penetrate with liquid to prevent the release of particulates. If [visible emissions](#) are observed coming from [asbestos-containing material](#), then that material has not been adequately wetted. However, the absence of visible emissions is not sufficient evidence of being adequately wet.
- I.B.4. [Air erosion](#) means the passage of air over [friable ACBM](#) which may result in the release of [asbestos](#) fibers.
- I.B.5. [Airlock](#) means a system for permitting ingress and egress with minimum air movement between a contaminated area and an uncontaminated area.
- I.B.6. [Air monitoring](#) means measuring the fiber content of a known volume of air collected over a known period of time.
- I.B.7. [Air Monitoring Specialist](#) means a person who performs final visual clearance inspections or any [air monitoring](#) referred to in this regulation.
- I.B.8. [Amended water](#) means water to which a [surfactant](#) has been added.
- I.B.9. [Area of Public Access](#)
- I.B.9.a. Area of Public Access means any building, [facility](#), or property, or only that portion thereof, that any member of the general public can enter without limitation or restriction by the owner or lessee under normal business conditions; except that “Area of Public Access” includes a [single-family residential dwelling](#) and any facility that charges the general public a fee for admission such as any theater or arena. "General Public" does not include employees of the entity that owns, leases, or operates such building, facility, or property, or such portion thereof, or any service personnel or vendors connected therewith.
- I.B.9.b. Notwithstanding the provisions of section I.B.9.a., a [single-family residential dwelling](#) shall not be considered an area of public access for purposes of this

Regulation No. 8, Part B, if the homeowner who resides in the single-family residential dwelling that is the homeowner's primary residence requests, pursuant to section III.E.2., that the single-family residential dwelling not be considered an area of public access.

- I.B.10. [Asbestos](#) means asbestiform varieties of chrysotile, amosite (cummintonite-grunerite), crocidolite, anthophyllite, tremolite, and actinolite.
- I.B.11. [Asbestos Abatement](#) means any of the following:
- I.B.11.a. The wrecking or [removal](#) of [structural members](#) that contain [friable asbestos-containing material](#);
 - I.B.11.b. The following practices intended to prevent the escape of [asbestos](#) fibers into the atmosphere:
 - I.B.11.b.(i). Coating, binding, or resurfacing of walls, ceilings, pipes, or other structures for the purpose of minimizing [friable asbestos-containing material](#) from becoming airborne;
 - I.B.11.b.(ii). Enclosing [friable asbestos-containing material](#) to make it inaccessible;
 - I.B.11.b.(iii). Removing [friable asbestos-containing material](#) from any pipe, duct, boiler, tank, reactor, furnace, or other [structural member](#).
 - I.B.11.b.(iv). Removing [facility components](#) that are asbestos covered or asbestos containing.
- I.B.12. [Asbestos Abatement Contractor](#) means any person hired to conduct [asbestos abatement](#).
- I.B.13. [Asbestos Consulting Firm](#) means any person hired for a fee to conduct any of the following activities, as required by Regulation No. 8, Part B, in the State of Colorado: asbestos building inspection and bulk sampling; development of asbestos management plans; air monitoring for asbestos fibers; development of asbestos project designs; and, project management, as specified in Section II.J.
- I.B.14. [Asbestos Laboratory](#) means any person hired for a fee to conduct asbestos analysis of bulk or air samples, as required by Regulation No. 8, Part B, in the State of Colorado.
- I.B.15. [Asbestos Training Provider](#) means any person who puts on training courses in any of the following asbestos disciplines in the State of Colorado: Worker, Supervisor, Project Designer, Building Inspector, Management Planner or Air Monitoring Specialist.
- I.B.16. [Asbestos-containing building material](#) means [surfacing ACM](#), [thermal system insulation ACM](#), or [miscellaneous ACM](#) that is found in or on interior [structural members](#) or other parts of a [school building](#) or [state building](#).

- I.B.17. [Asbestos-containing material](#) means material containing more than 1% [asbestos](#).
- I.B.18. [Asbestos-containing waste material](#) means mill tailings or any waste that contains [commercial asbestos](#) and is generated by a source subject to the provisions of this Regulation. This term includes, but is not limited to, asbestos waste from control devices, [friable asbestos-containing waste material](#), disposable equipment and clothing, and bags or other similar packaging contaminated with commercial asbestos.
- I.B.19. [Asbestos debris](#) means pieces of [ACM](#) that can be identified by color, texture, or composition, or means dust, if the dust is determined by a [certified](#) Inspector to be ACM.
- I.B.20. [Asbestos mill](#) means any [facility](#) engaged in converting, or in any intermediate step in converting, [asbestos](#) ore into [commercial asbestos](#). Outside storage of [asbestos-containing material](#) is not considered a part of the asbestos mill.
- I.B.21. [Asbestos spill](#) means any release of [asbestos](#) fibers due to a breach of the containment barrier on an abatement project, or due to any cause other than [asbestos abatement](#).
- I.B.22. [Asbestos tailings](#) mean any solid waste that contains asbestos and is a product of asbestos mining or milling operation.
- I.B.23. [Assessment](#), when used in reference to [ACM](#) in a state building, means any evaluation of ACM, or suspected ACM, which determines the need for a [response action](#).
- I.B.24. [Category I nonfriable asbestos-containing material](#) means asbestos-containing packings, gaskets, resilient floor covering, and asphalt roofing products containing more than 1 percent [asbestos](#) as determined using the method specified in Appendix E, Subpart E, 40 C.F.R. Part 763, section 1, [polarized light microscopy](#) (EPA 1995).
- I.B.25. [Category II nonfriable ACM](#) means any material, excluding [category I nonfriable ACM](#), containing more than 1 percent [asbestos](#) as determined using the methods specified in Appendix E, Subpart E, 40 C.F.R. Part 763, section 1, [polarized light microscopy](#), (EPA 1995) that, when dry, cannot be crumbled, pulverized, or reduced to powder by hand pressure.
- I.B.26. [Certified](#) means holding a certificate issued pursuant to this regulation.
- I.B.27. [Certified Industrial Hygienist](#) means an individual who has been certified by the [American Board of Industrial Hygiene](#) to practice as a [CIH](#).
- I.B.28. [Clean Room](#) means an uncontaminated area or room, which is a part of the Worker [decontamination enclosure system](#) with provisions for storage of Workers' street clothes and clean protective equipment.

- I.B.29. [Commercial asbestos](#) means any material containing [asbestos](#) that is extracted from ore and has value because of its asbestos content.
- I.B.30. [Commission](#) means the Colorado Air Quality Control Commission.
- I.B.31. [Critical Barrier](#) means a single layer of 6-mil or greater polyethylene sheeting or an equivalent airtight barrier installed initially over all doors, windows, ventilation openings, drains, wall penetrations, etc., as an additional measure to prevent contaminated air from escaping the [work area](#).
- I.B.32. [Curtained Doorway](#) means a device to allow ingress or egress from one room to another while permitting minimal air movement between the rooms.
- I.B.33. [Cutting](#) means to penetrate with a sharp-edged instrument and includes sawing, but does not include shearing, slicing, or punching.
- I.B.34. [Damaged friable miscellaneous ACM](#) means [friable miscellaneous ACM](#) which has deteriorated or sustained physical injury such that the internal structure (cohesion) of the material is inadequate or, if applicable, which has delaminated such that its bond to the substrate (adhesion) is inadequate or which for any other reason, lacks fiber cohesion or adhesion qualities. Such damage or deterioration may be illustrated by the separation of ACM into layers; separation of ACM from the substrate; flaking, blistering, or crumbling of the ACM surface; water damage; significant or repeated water stains, scrapes, gouges, mars or other signs of physical injury on the ACM. [Asbestos debris](#) originating from the [ACBM](#) in question may also indicate damage.
- I.B.35. [Damaged friable surfacing ACM](#) means [friable surfacing ACM](#), which has deteriorated or sustained physical injury such that the internal structure (cohesion) of the material is inadequate or which has delaminated such that its bond to the substrate (adhesion) is inadequate, or which, for any other reason lacks fiber cohesion or adhesion qualities. Such damage or deterioration may be illustrated by the separation of ACM into layers; separation of ACM from the substrate; flaking, blistering, or crumbling of the ACM surface; water damage; significant or repeated water stains, scrapes, gouges, mars or other signs of physical injury on the ACM. [Asbestos debris](#) originating from the [ACBM](#) in question may also indicate damage.
- I.B.36. [Damaged or significantly damaged thermal system insulation ACM](#) means [thermal system insulation ACM](#) on pipes, boilers, tanks, ducts, and other thermal system insulation equipment where the insulation has lost its structural integrity, or its covering, in whole or in part, is crushed, water-stained, gouged, punctured, missing, or not intact such that it is not able to contain fibers. Damage may be further illustrated by occasional punctures, gouges or other signs of physical injury to ACM; occasional water damage on the protective coverings/jackets; or exposed ACM ends or joints. [Asbestos debris](#) originating from the [ACBM](#) in question may also indicate damage.

- I.B.37. [Decontamination enclosure system](#) means a series of three (minimum) connected rooms, separated from the [work area](#) and from each other by air locks or [curtained doorways](#), for the decontamination of Workers and equipment.
- I.B.38. [Demolition](#) means the wrecking or taking out of any load-supporting [structural member](#) of a [facility](#) together with any related handling operations or the intentional burning of any facility.
- I.B.39. [Division](#) means the Colorado Air Pollution Control Division.
- I.B.40. [Emergency](#) means an unexpected situation or sudden occurrence of a serious and urgent nature that demands immediate action and that constitutes a threat to life, health or that may cause major damage to property. Delay of a contract does not constitute an emergency, nor are [demolition](#) projects emergencies.
- I.B.41. [Encapsulation](#) means application of a liquid material to asbestos-containing material which controls the possible release of [asbestos](#) fibers from the material either by creating a membrane over the surface (bridging encapsulant) or by penetrating into the material and binding its components together (penetrating encapsulant).
- I.B.42. [Enclosure](#) means an airtight, impermeable, permanent barrier around [ACM](#) to minimize the release of [asbestos](#) fibers into the air.
- I.B.43. [Equipment room](#) means a contaminated area or room, which is part of the Worker [decontamination enclosure system](#) with provisions for storage of contaminated clothing and equipment.
- I.B.44. [Fabricating](#) means any processing (e.g., [cutting](#), sawing, drilling) of a manufactured product that contains [commercial asbestos](#), with the exception of processing at temporary sites (field fabricating) for the construction or restoration of facilities. In the case of friction products, fabricating includes bonding, rebonding, [grinding](#), sawing, drilling, or other similar operations performed as part of fabricating.
- I.B.45. [Facility](#) means any institutional, commercial, public, industrial, or residential structure, installation, or building (including any structure, installation, or building containing condominiums or individual dwelling units operated as a residential cooperative, but excluding residential buildings having four or fewer dwelling units); any ship; and any active or inactive waste disposal site. For purposes of the definition, any building, structure, or installation that contains a loft used as a dwelling is not considered a residential structure, installation, or building. Any structure, installation or building that was previously subject to this subpart is not excluded, regardless of its current use or function.
- I.B.46. [Facility component](#) means any part of a [facility](#) including equipment.
- I.B.47. [Fiber release episode](#) means any uncontrolled or unintentional disturbance of [ACM](#) resulting in [visible emissions](#).

- I.B.48. [Final cleaning](#) means the cleaning of all dust and debris from the [work area](#) near the end of the active abatement phase, immediately prior to the final visual inspection.
- I.B.49. [Fixed object](#) means a piece of equipment or furniture in the [work area](#), which cannot be readily removed from the work area.
- I.B.50. [Friable](#) means that the material, when dry, may be crumbled, pulverized, or reduced to powder by hand pressure, and includes previously [nonfriable](#) material after such previously [nonfriable](#) material becomes damaged to the extent that when dry it may be crumbled, pulverized, or reduced to powder by hand pressure.
- I.B.51. [Friable asbestos containing material](#) means any material that contains [asbestos](#) and when dry can be crumbled, pulverized, or reduced to powder by hand pressure and that contains more than one percent asbestos by weight, area or volume. The term includes nonfriable forms of asbestos after such previously nonfriable material becomes damaged to the extent that when dry it can be crumbled, pulverized, or reduced to powder by hand pressure.
- I.B.52. [Functional space](#) means a room, group of rooms, or [homogeneous area](#) (including crawl spaces or the space between a dropped ceiling and the floor or roof deck above), such as a classroom(s), a cafeteria, gymnasium, hallways, designated by a person [certified](#) to prepare management plans, design abatement projects, or conduct [response actions](#).
- I.B.53. [Glovebag](#) means a manufactured or fabricated device, typically constructed of six mil transparent polyethylene or polyvinylchloride plastic, consisting of two inward projecting long sleeves with attached gloves, an internal tool pouch, and an attached, labeled receptacle for asbestos waste.
- I.B.54. [Grinding](#) means to reduce to powder or small fragments and includes mechanical chipping or drilling.
- I.B.55. [HEPA filtration](#) means a filtering system capable of trapping and retaining at least 99.97 percent of all monodispersed particles 0.3 microns in diameter or larger.
- I.B.56. [HEPA vacuum](#) means a vacuum system approved by the manufacturer for use in asbestos applications equipped with [HEPA filtration](#).
- I.B.57. [Homogeneous area](#) means an area of [surfacing material](#), [thermal system insulation](#) material, or [miscellaneous material](#) that is uniform in color and texture.
- I.B.58. [Independent](#) means that a [person](#) is not an employee, agent, representative, partner, joint venture, shareholder, parent or subsidiary company of another person.
- I.B.59. [Large contiguous facility complex](#) means a complex that has a single owner and have 3 or more buildings on a single property or adjoining properties.
- I.B.60. [Local education agency](#) (LEA) means:

- I.B.60.a. Any local educational agency as defined in section 198 of the Elementary and Secondary Education Act of 1965 (20 U.S.C. 3381).
- I.B.60.b. The owner or operator of any nonpublic, nonprofit, elementary, or secondary [school building](#).
- I.B.60.c. The governing authority of any [school building](#) operated under the Defense Department's education system provided for under the Defense Department's Education Act of 1978 (20 U.S.C. 921, et seq.).
- I.B.61. [Manufacturing](#) means the combining of [commercial asbestos](#) – or, in the case of woven friction products, the combining of textiles containing commercial asbestos – with any other material(s), including commercial asbestos, and the processing of this combination into a product. Chlorine production is considered a part of manufacturing.
- I.B.62. [Mini-enclosure](#) means any containment barrier small enough to restrict entry to the [asbestos work area](#) to no more than two Workers, constructed around an area where small-scale, short-duration [asbestos abatement](#) is to be performed.
- I.B.63. [Miscellaneous ACM](#) means [miscellaneous material](#) that is [ACM](#).
- I.B.64. [Miscellaneous material](#) means interior building material on structural components, [structural members](#) or fixtures, such as floor and ceiling tiles, and does not include [surfacing material](#) or [thermal system insulation](#).
- I.B.65. [Movable objects](#) means pieces of equipment or furniture in the [work area](#), which can be readily removed from the work area.
- I.B.66. [Negative pressure ventilation system](#) means portable exhaust systems equipped with [HEPA filtration](#) and capable of maintaining a constant high velocity air flow out of the contaminated area, resulting in a constant low velocity air flow into contaminated areas from adjacent uncontaminated areas.
- I.B.67. [Nonfriable](#) means material which, when dry, may not be crumbled, pulverized, or reduced to powder by hand pressure.
- I.B.68. [Operations and maintenance program](#) means a program of work practices to maintain [friable ACBM](#) in good condition, ensure clean up of [asbestos](#) fibers previously released, and prevent further release by minimizing and controlling friable ACBM disturbance or damage.
- I.B.69. [Particulate asbestos material](#) means finely divided particles of [asbestos](#) or material containing asbestos.
- I.B.70. [Person](#) means any individual, any public or private corporation, partnership, association, firm, trust, or estate, the state or any department, institution, or agency thereof, any municipal corporation, county, city and county, or other political

subdivision of the state, or any other legal entity, which is recognized by law as the subject of rights and duties.

- I.B.71. [Phase Contrast Microscopy](#) is an analytical technique used for the counting of fibers on a filter of an air sample. This technique is not specific for [asbestos](#).
- I.B.72. [Polarized Light Microscopy](#) is an analytical technique used for identifying types of [asbestos](#) fibers in bulk material samples.
- I.B.73. [Porous](#) means capable of trapping, retaining or holding [asbestos](#) fibers even during aggressive cleaning methods such as wet washing, wiping and [HEPA vacuuming](#).
- I.B.74. [Potential damage](#) means circumstances in which:
- I.B.74.a. [Friable ACBM](#) is in an area regularly used by building occupants including maintenance personnel, in the course of their normal activities.
 - I.B.74.b. There are indications that there is a reasonable likelihood that the material or its covering will become damaged, deteriorated, or delaminated due to factors such as changes in building use, changes in operations and maintenance practices, changes in occupancy, or recurrent damage.
- I.B.75. [Potential significant damage](#) means circumstances in which:
- I.B.75.a. [Friable ACBM](#) is in an area regularly used by building occupants, including maintenance personnel, in the course of their normal activities.
 - I.B.75.b. There are indications that there is a reasonable likelihood that the material or its covering will become significantly damaged, deteriorated, or delaminated due to factors such as changes in building use, changes in operations and maintenance practices, changes in occupancy, or recurrent damage.
 - I.B.75.c. The material is subject to major or continuing disturbance, due to factors including, but not limited to, accessibility or, under certain circumstances, [vibration](#) or [air erosion](#).
- I.B.76. [Pre-cleaning](#) means the cleaning of the [work area](#) of visible dust and debris prior to active abatement.
- I.B.77. [Preventive measures](#) means actions taken to reduce disturbance of [ACBM](#) or otherwise eliminate the reasonable likelihood of the materials becoming damaged or significantly damaged.
- I.B.78. [Project Design](#) means plans, specifications, project procedures, containment design/placement, descriptions of engineering controls, and shop drawings for an [asbestos abatement](#) project or [response action](#).
- I.B.79. [Public and Commercial Building](#) means any building, which is not a [school building](#), except that the term does not include any residential apartment building of ten or

fewer units. [Single-family residential dwellings](#) are excluded from this definition. This definition includes all industrial buildings.

- I.B.80. [Regulated asbestos-containing material](#) means (a) [friable asbestos-containing material](#), (b) [Category I nonfriable ACM](#) that has become [friable](#), (c) [Category I nonfriable ACM](#) that will be or has been subjected to sanding, [grinding](#), [cutting](#), or abrading or (d) [Category II nonfriable ACM](#) that has a high probability of becoming or has become crumbled, pulverized, or reduced to powder by the forces expected to act on the material in the course of [demolition](#) or [renovation](#) operations regulated by this regulation.
- I.B.81. [Removal](#) means the taking out or the [stripping](#) of [ACBM](#) from a damaged area, a [functional space](#), or a [homogeneous area](#) in a building.
- I.B.82. [Renovation](#) means altering in any way one or more [facility](#) components. Operations in which load-supporting [structural members](#) are wrecked or taken out are excluded. Examples of [renovation](#) work include replacement or [repair](#) of mechanical ventilation systems, pipes, ceilings, walls, flooring (including floor tiles) and insulating materials.
- I.B.83. [Repair](#) means returning damaged [ACBM](#) to an undamaged condition or to an intact state so as to prevent fiber release.
- I.B.84. [Resilient Floor Tile](#) means tile, which may include vinyl [asbestos](#) tile ([VAT](#)), asphalt tile, and rubber tile. Tile often appears as 9" x 9" or 12" x 12" floor tile squares. This material may be found in [schools](#), offices and residential applications. Not all resilient floor tile contains [asbestos](#).
- I.B.85. [Response action](#) means a method, including [removal](#), [encapsulation](#), [enclosure](#), [repair](#), [operations and maintenance](#), that protects human health and the environment from [friable ACM](#).
- I.B.86. [Roadways](#) mean surfaces on which vehicles travel. This term includes public and private highways, roads, streets, parking areas, and driveways.
- I.B.87. [Routine maintenance area](#) means an area, such as a boiler room or mechanical room, that is not normally frequented by students and in which maintenance employees or contract Workers regularly conduct maintenance activities.
- I.B.88. [Sampling Area](#) means any area, whether contiguous or not, within a building which contains [friable](#) material that is homogeneous.
- I.B.89. [School](#) means any institution that provides elementary or secondary education.
- I.B.90. [School building](#) means:

- I.B.90.a. Any structure suitable for use as a classroom, including a [school facility](#) such as a laboratory, library, school eating facility, or facility used for the preparation of food.
- I.B.90.b. Any gymnasium or other facility, which is specially designed for athletic or recreational activities for an academic course in physical education.
- I.B.90.c. Any other facility used for the instruction or housing of students or for the administration of educational or research programs.
- I.B.90.d. Any maintenance, storage, or utility facility, including any hallway, essential to the operation of any facility described in this definition of “[school building](#)” under subparagraphs I.B.87.a, b, or c.
- I.B.90.e. Any portico or covered exterior hallway or walkway of any facility described in this definition of “[school building](#)” in subparagraphs I.B.87.a, b, c, or d.
- I.B.90.f. Any exterior portion of a mechanical system used to condition interior space of any facility described in this definition of “[school building](#)” in subparagraphs I.B.87.a, b, c, or d.
- I.B.91. [Secondary Containment](#) means a system of airtight barriers to isolate the [work area](#) to prevent the migration of air from the work area.
- I.B.92. [Sheet Vinyl Flooring](#) means material that is usually found in 6 ft., 9 ft., and 12 ft., width sheets. It often consists of three or more laminated layers. The upper layers are comprised of a wear layer and design feature. The bottom layer may be an [asbestos-containing](#) backing, which may be grayish-white in color. Sheet vinyl flooring may be installed in an adhered or loose-laid manner. Other possible applications for this material include countertops and wall coverings. Not all sheet vinyl flooring has an asbestos-containing backing.
- I.B.93. [Shower room](#) means a room between the [clean room](#) and the [equipment room](#) in the Worker [decontamination enclosure](#) suitably arranged for complete showering during decontamination.
- I.B.94. [Significantly damaged friable miscellaneous ACM](#) means damaged [friable](#) miscellaneous [ACM](#) where the damage is extensive and severe.
- I.B.95. [Significantly damaged friable surfacing ACM](#) means damaged [friable surfacing ACM](#) in a [functional space](#) where the damage is extensive and severe.
- I.B.96. [Single-family residential dwelling](#) or unit means any structure or portion of a structure whose primary use is for housing of one family. Residential portions of multi-unit dwellings such as apartment buildings, condominiums, duplexes and triplexes are also considered to be, for the purposes of this Regulation No. 8, single-family residential dwellings; common areas such as hallways, entryways, and boiler rooms are not single-family residential dwellings.

- I.B.97. [Staging area](#) means either the holding area or an area near the waste transfer [airlock](#) where containerized asbestos waste has been placed prior to removal from the [work area](#).
- I.B.98. [State-owned or state-leased buildings](#) means structures occupied by any [person](#) which are either owned by the state or utilized by the state through leases of one year's duration or longer.
- I.B.99. [Strip](#) means to take off [RACM](#) from any part of a [facility](#) or [facility components](#).
- I.B.100. [Structural member](#) means any load-supporting member of a facility, such as beams and load supporting walls; or any non load-supporting member, such as ceilings and non load-supporting walls.
- I.B.101. [Surfacing ACM](#) means [surfacing material](#) that is [ACM](#).
- I.B.102. [Surfacing material](#) means material that is sprayed on, troweled on, or otherwise applied to surfaces, such as acoustical plaster on ceilings and fireproofing materials on [structural members](#), or other materials on surfaces for acoustical, fireproofing, or other purposes.
- I.B.103. [Surfactant](#) means a chemical wetting agent added to water to improve penetration.
- I.B.104. [Thermal system insulation](#) means material applied to pipes, fittings, boilers, breeching, tanks, ducts, or other interior structural components to prevent heat loss or gain, or water condensation, or for other purposes.
- I.B.105. [Thermal system insulation ACM](#) means [thermal system insulation](#) that is [ACM](#).
- I.B.106. [Transmission Electron Microscopy](#) is an analytical technique used for the definitive identification of [asbestos](#). This technique can be used for both air and bulks sample analyses.
- I.B.107. [Trigger levels](#) means amounts of material as follows:
- I.B.107.a. With regard to [single-family residential dwellings](#), the trigger levels are 50 linear feet on pipes, 32 square feet on other surfaces, or the volume equivalent of a 55-gallon drum.
- I.B.107.b. With regard to all areas other than single-family residential dwellings, the trigger levels are 260 linear feet on pipes, 160 square feet on other surfaces, or the volume equivalent of a 55-gallon drum.
- I.B.108. [Vibration](#) means the periodic motion of [friable ACM](#), which may result in the release of [asbestos](#) fibers.
- I.B.109. [Visible emissions](#) means any emissions, which are visually detectable without the aid of instruments, coming from asbestos containing material or [asbestos-containing waste material](#).

- I.B.110. [Waste load-out area](#) means a specially constructed [airlock](#) system utilized as a short-term storage area for bagged or barreled waste and as a port for transferring waste to the transport vehicle. This area is separate from the [decontamination unit](#).
- I.B.111. [Wet cleaning](#) means eliminating [asbestos](#) contamination from building surfaces and objects by using cloths, mops, or other cleaning utensils, which have been dampened with [amended water](#).
- I.B.112. [Work area](#) means a room, group of rooms, or contiguous area sealed or contained by polyethylene barriers and/or walls for the purpose of eliminating air exchange between another room, group of rooms, or contiguous areas.
- I.B.113. [Working day](#) means Monday through Friday and including holidays that fall on any of the days Monday through Friday.

I.C. ACRONYMS

- I.C.1. [ABIH](#) American Board of Industrial Hygiene
6015 West St. Joseph, Suite 102, Lansing, MI 48917-3980
- I.C.2. [ACBM](#) [asbestos-containing building material](#)
- I.C.3. [ACGIH](#) American Conference of Governmental Industrial Hygienists
1300 Kemper Meadow Drive, Cincinnati, OH 45240
- I.C.4. [ACM](#) [asbestos-containing material](#)
- I.C.5. [ACWM](#) [asbestos-containing waste material](#)
- I.C.6. [AHERA](#) Asbestos Hazard Emergency Response Act
- I.C.7. [AIHA](#) American Industrial Hygiene Association
2700 Prosperity Avenue, Suite 250, Fairfax, VA 22031
- I.C.8. [AMS](#) Air Monitoring Specialist
- I.C.9. [ANSI](#) American National Standards Institute
1819 L Street, NW, Suite 600, Washington, DC 20036
- I.C.10. [APCD](#) Air Pollution Control Division
- I.C.11. [ASHARA](#) Asbestos School Hazard Abatement Reauthorization Act
- I.C.12. [ASTM](#) American Society for Testing and Materials
100 Barr Harbor Drive, West Conshohocken, PA 19428-2959
- I.C.13. [AQCC](#) Air Quality Control Commission
- I.C.14. [CCR](#) Code of Colorado Regulations

I.C.15.	CDPHE	Colorado Department of Public Health and Environment
I.C.16.	CFM	cubic feet per minute
I.C.17.	CFR	Code of Federal Regulations
I.C.18.	CIH	Certified Industrial Hygienist
I.C.19.	C.R.S.	Colorado Revised Statutes
I.C.20.	EPA	Environmental Protection Agency Ariel Rios Building, 1200 Pennsylvania Avenue, N.W., Washington, DC 20460
I.C.21.	f/cc	fibers per cubic centimeter
I.C.22.	f/cm³	fibers per cubic centimeter
I.C.23.	f/m³	fibers per cubic meter
I.C.24.	GAC	General Abatement Contractor
I.C.25.	G.E.D.	General Equivalency Diploma
I.C.26.	HEPA	high efficiency particulate air
I.C.27.	HVAC	heating, ventilation and air conditioning
I.C.28.	LCF	large contiguous facility [complex]
I.C.29.	LEA	local education agency
I.C.30.	LPM	liters per minute
I.C.31.	MAAL	Maximum Allowable Asbestos Level in air
I.C.32.	MAP	Model Accreditation Plan (EPA)
I.C.33.	NAM	negative air machine
I.C.34.	NBS	National Bureau of Standards
I.C.35.	NESHAP	National Emissions Standards for Hazardous Air Pollutants (40 C.F.R. Part 61) (EPA), Subparts A (General Provisions), and M (National Emission Standard for Asbestos)
I.C.36.	NIOSH	National Institute for Occupational Safety and Health Hubert H. Humphrey Bldg., 200 Independence Ave., SW, Room 715H, Washington, DC 20201

I.C.37.	<u>NIST</u>	National Institute of Standards and Technology 100 Bureau Drive, Stop 3460, Gaithersburg, MD 20899-3460
I.C.38.	<u>NVLAP</u>	National Voluntary Laboratory Accreditation Program National Institute of Standards and Technology 100 Bureau Drive, MS 2140 Gaithersburg, Maryland 20899-2140
I.C.39.	<u>O&M</u>	Operations and Maintenance
I.C.40.	<u>OSHA</u>	Occupational Safety and Health Administration 200 Constitution Avenue, Washington, D.C. 20210
I.C.41.	<u>PAT</u>	Proficiency Analytical Testing
I.C.42.	<u>PCM</u>	<u>Phase Contrast Microscopy</u>
I.C.43.	<u>PLM</u>	<u>Polarized Light Microscopy</u>
I.C.44.	<u>PPE</u>	personal protective equipment
I.C.45.	<u>PSI</u>	pounds per square inch
I.C.46.	<u>RACM</u>	<u>regulated asbestos-containing material</u>
I.C.47.	<u>RFCI</u>	Resilient Floor Covering Institute 401 E. Jefferson Street, Suite 102, Rockville, MD. 20850
I.C.48.	<u>s/mm²</u>	structures per square millimeter
I.C.49.	<u>SFRD</u>	<u>single-family residential dwelling</u>
I.C.50.	<u>TEM</u>	<u>Transmission Election Microscopy</u>
I.C.51.	<u>TSCA</u>	Toxic Substances Control Act 15 U.S.C. section 2601 <i>et seq.</i> TSCA TITLE II means the 1986 amendments to TSCA found at 15 U.S.C. section 2641 <i>et seq.</i>
I.C.52.	<u>TSI</u>	thermal system insulation
I.C.53.	<u>TWA</u>	time weighted average
I.C.54.	<u>VAT</u>	vinyl asbestos [floor] tile
I.C.55.	<u>VCT</u>	vinyl composition tile

All underlined text in this regulation indicates defined terms; clicking on underlined text will take you to its definition in Section I.

II. CERTIFICATION REQUIREMENTS

II.A. GENERAL REQUIREMENTS

II.A.1. Persons required to be certified as a General Abatement Contractor, Building Inspector, Management Planner, Project Designer, Abatement Worker, Abatement Supervisor or Air Monitoring Specialist shall obtain the appropriate certification from the Division in accordance with this Section II.

II.A.2. Photo IDs and Certificates

Each individual certified under this regulation must have their state certification photo identification (ID) card or state certificate available at each work site so that Division representatives may check their credentials.

Each individual trained under this regulation must have copies of their training and refresher certificates available at each work site so that Division representatives may check their credentials.

II.A.3. Non-Public Access Areas

Any person certified under this regulation to work solely on asbestos abatement projects in non-public access areas shall not be required to pay the application fee. Certificates issued under this paragraph are not valid for abatement in areas of public access, and are not transferable.

II.A.4. Ownership of Training Certificates

Training certificates are considered to be the property of the accredited individual. Training providers must give duplicate original training certificates to the accredited individual upon request. Training providers may charge a reasonable fee for replacement of training certificates.

II.A.5. Falsification of Training Certificates

Falsification of training certificates or licenses used to obtain state certification is considered to be a violation of these regulations, and shall be sufficient reason for the denial of an application for certification, and may result in disciplinary action being taken against an applicant submitting such falsified training certificates or licenses.

II.A.6. An individual may hold more than one certification.

II.B. GENERAL ABATEMENT CONTRACTOR CERTIFICATES

II.B.1. Certificate Duration

General Abatement Contractor ([GAC](#)) certificates are valid for a period of one, two or three years.

II.B.2. Application Procedures

A [person](#) applying for a General Abatement Contractor ([GAC](#)) certificate, renewal of existing certification or reinstatement of expired certification shall submit an application on a form specified by the [Division](#) and, except as provided in paragraph II.A.3 (Non-Public Access Areas) above, pay the applicable fee as specified in the table below:

Certification	Amount		
	1 year	2 years	3 years
GAC	\$2,000.00	N/A	N/A
GAC (renewal)	\$1,000.00	\$2,000.00	\$3,000.00
Out of State (initial)	\$3,000.00	N/A	N/A
Out of State (renewal)	\$2,000.00	\$4,000.00	\$6,000.00

II.B.3. Training Requirements

No training is required for [GACs](#).

II.B.4. GAC Responsibilities

[GACs](#) shall ensure that all Workers and Supervisors are appropriately [certified](#) in accordance with this Section II (Certification Requirements). The GAC must ensure that it employs at least one Colorado state-certified Supervisor who must be on-site at all times when abatement work is proceeding.

II.C. WORKER, SUPERVISOR, BUILDING INSPECTOR, MANAGEMENT PLANNER, PROJECT DESIGNER CERTIFICATES

II.C.1. Certificate Duration

Worker, Supervisor, Building Inspector, Management Planner, and Project Designer certificates will be issued for a period of one, three, or five years and will be valid only while the provisions of sections II.C.3 (Training Requirements), II.C.4 (Examinations) and II.C.5 (Refresher Training Requirements) are met.

II.C.2. Application Procedures

Anyone applying for a Worker, Supervisor, Building Inspector, Management Planner, or Project Designer certificate, renewal of an existing certificate or reinstatement of

an expired certificate shall submit an application on a form specified by the [Division](#) and, except as provided in paragraph II.A.3 (Non-Public Access Areas) above, pay the applicable fee as specified in the table below:

Certification	Amount		
	1 year	3 years	5 years
Worker	\$125.00	\$375.00	\$625.00
Supervisor	\$250.00	\$750.00	\$1250.00
Building Inspector	\$175.00	\$525.00	\$875.00
Management Planner	\$175.00	\$525.00	\$875.00
Project Designer	\$250.00	\$750.00	\$1250.00

II.C.3. Training Requirements

Each individual seeking certification as a Worker, Supervisor, Building Inspector, Management Planner or Project Designer shall complete [Division](#)-approved training.

II.C.4. Examinations

An individual seeking certification, renewal of an existing certificate or reinstatement of an expired certificate in a specific discipline shall pass, on an annual basis, a [Division](#)-administered closed book examination for that discipline. Each examination shall cover the topics included in the training course for that discipline. The testing schedule and procedures shall be determined by the Division.

If an applicant fails to achieve a passing score on a certification exam, he or she may retake the exam after submitting the following items to the Division:

- a new application including payment of a retesting fee of \$125.00; and
- proof of attendance at a remedial training course, if required by the Division.

II.C.5. Refresher Training Requirements

II.C.5.a. Workers, Supervisors, Building Inspectors, Management Planners or Project Designers who are [certified](#) according to this regulation must take an annual refresher training course from a [Division](#)-approved training provider. Prior to the commencement of refresher training, the course provider is required to verify the authenticity of the initial training course certificate and all refresher training certificates. Individuals not in possession of a valid training certificate shall not be given refresher training.

Applicants are ineligible for refresher training if their most recent training certificate has lapsed for a year or longer, in which case the applicant must re-take the initial training. During the period in which the individual's training certificate has expired, the state certificate is not valid. State certification becomes valid once the required training has been completed and state certification requirements have been met.

II.C.5.b. The length of annual refresher courses shall be as follows:

Certification	Length
Worker	One full day (Eight (8) hours)
Supervisor	One full day (Eight (8) hours)
Project Designer	One full day (Eight (8) hours)
Building Inspector	One half day (Four (4) hours)
Management Planner	One half day Building Inspector and one half day Management Planner

II.C.5.c. All courses, at a minimum, must cover the following topics:

- Changes in Federal and State laws, regulations and requirements;
- Developments and/or changes in state-of-the-art procedures;
- Review of the key aspects of the course; and
- Pertinent developments in the particular discipline or the industry as a whole.

Testing of applicants to determine knowledge gained in the refresher course may be done at the option of the course provider.

II.C.6. Combined Certificates

At the request of the applicant, the [Division](#) may issue a combined Supervisor/Project Designer or combined Inspector/Management Planner certificate. The applicant shall submit an application on a form specified by the Division and, except as provided in paragraph II.A.3 (Non-Public Access Areas) above, pay the applicable fee as specified in the table below:

Certification	Amount		
	1 year	3 years	5 years
Supervisor/ Project Designer	\$275.00	\$825.00	\$1375.00
Building Inspector/ Management Planner	\$275.00	\$825.00	\$1375.00

II.D. AIR MONITORING SPECIALIST CERTIFICATES

Effective March 30, 2004, any Individual who performs a final visual inspection or performs any [air monitoring](#) referred to in this regulation must be [certified](#) as an [Air Monitoring Specialist \(AMS\)](#).

Until this provision for certification becomes effective, all activities required to be performed by a [certified Air Monitoring Specialist](#) as stated in this regulation may only be performed by an individual who qualified as an Air Monitoring Specialist under the previous regulation prior to March 30, 2003.

II.D.1. Certificate Duration

[Air Monitoring Specialist \(AMS\)](#) certificates will be issued for a period of one, three, or five years and will be valid only while the Training (II.D.3.a.i and II.D.3.b.i) and Examination (II.D.3.a.iv. and II.D.3.b.iv) requirements are met.

II.D.2. Application Procedures

Anyone applying for an [Air Monitoring Specialist](#) certificate, renewal of existing certification or reinstatement of an expired certificate shall submit an application on a form specified by the [Division](#) and, except as specified in paragraph II.A.3 (Non-Public Access Areas) above, pay the applicable fee as specified in the table below:

Certification	Amount		
	1 year	3 years	5 years
Air Monitoring Specialist	\$250.00	\$750.00	\$1250.00

II.D.3. Initial Certification Requirements

II.D.3.a. New AMS Applicants

Each Individual seeking certification as an [Air Monitoring Specialist](#) shall satisfy the training, experience and education requirements set forth below, unless granted certification based on prior training, experience and education pursuant to section II.D.3.b.:

II.D.3.a.(i). Training

Each individual seeking certification as an [Air Monitoring Specialist](#) shall successfully complete a [Division](#)-approved Air Monitoring Specialist course. An individual [certified](#) by the American Board of Industrial Hygiene as a Certified Industrial Hygienist ([CIH](#)) is not required to attend those portions of the Air Monitoring Specialist course that instruct students exclusively on [air monitoring](#) techniques (e.g., pump calibration, cassette placement, cassette handling, etc.).

II.D.3.a.(i).(A). All initial courses required under this Section II.D.3.a. (New [AMS](#) Applicants), shall, at a minimum, cover the following topics:

- Roles and responsibilities of an AMS
- Characteristics of asbestos and asbestos-containing materials
- Federal and state laws, regulations and requirements
- Understanding building construction and building systems
- Asbestos abatement contracts, specification and drawings
- Response Actions and abatement practices
- Asbestos abatement equipment
- Personal protective equipment

- Air monitoring strategies
- Safety and Health issues other than asbestos-containing material
- Conducting visual inspections
- Legal responsibilities and liabilities of an AMS
- Record keeping and report writing
- Hands-on activities

the course provider shall test the applicants to determine knowledge gained in the course.

II.D.3.a.(ii). Experience

Each individual seeking certification as an [Air Monitoring Specialist](#) shall perform the following on-the-job training activities prior to becoming [certified](#):

- II.D.3.a.(ii).(A). Under the observation of a certified Air Monitoring Specialist, participate in a minimum of 2 final visual inspections and 2 final air clearances.
- II.D.3.a.(ii).(B). Under the supervision of a certified Air Monitoring Specialist, successfully perform a minimum of 80 hours of ambient [air monitoring](#).
- II.D.3.a.(ii).(C). The Air Monitoring Specialist applicant shall provide documentation of this experience on a form specified by the [Division](#). The form shall not be complete until signed by the certified Air Monitoring Specialist(s) who supervised and observed the training. This form shall be submitted to the Division at the time of application for certification.

II.D.3.a.(iii). Education

Anyone seeking certification as an [Air Monitoring Specialist](#) shall possess a high school diploma or General Equivalency Diploma ([G.E.D.](#)).

II.D.3.a.(iv). Examination

Each individual seeking certification as an Air Monitoring Specialist shall pass, on an annual basis, a Division-administered closed book written examination. The examination shall cover the topics included in the training course. The testing schedule and procedures shall be determined by the Division. If an applicant fails to achieve a passing score on a certification test, he or she may retake the test after submitting the following items to the Division:

- 1) a new application including payment of a retesting fee of \$125.00; and
- 2) proof of attendance at a remedial training course, if required by the Division.

The Air Monitoring Specialist applicant must pass the written examination in order to become certified as an AMS.

II.D.3.a.(v). Permissible Activities for AMS Applicants

Any individual seeking certification as an [Air Monitoring Specialist](#), who does not yet meet all the requirements for certification, may perform the following activities prior to becoming [certified](#):

II.D.3.a.(v).(A). Air Monitoring

Under the supervision of a [certified Air Monitoring Specialist](#), an individual attempting to obtain the necessary experience to fulfill the Air Monitoring Specialist requirements may collect ambient [air monitoring](#) samples on behalf of a certified Air Monitoring Specialist to determine compliance with section III.U.1. (Maximum Allowable Asbestos Level). The certified Air Monitoring Specialist overseeing the sampling is, however, responsible for compliance with section III.U.1. (Maximum Allowable Asbestos Level).

II.D.3.a.(v).(B). Final Visual Inspection and Final Air Clearance

Under the observation of a [certified Air Monitoring Specialist](#), anyone attempting to obtain the necessary experience to fulfill the Air Monitoring Specialist requirements may participate in final visual inspections and Final Clearance Air Monitoring along with the certified Air Monitoring Specialist. The certified Air Monitoring Specialist is still responsible for performing all of the required clearance activities specified in section III.P. (Clearing Abatement Projects).

II.D.3.b. Existing AMS Applicants

Any individual who was qualified as an [Air Monitoring Specialist](#) prior to March 30, 2003 shall be deemed to have met the training, experience and education requirements for an Air Monitoring Specialist and shall be eligible for certification as an Air Monitoring Specialist upon completion of the following procedures. Each individual seeking certification as an Air Monitoring Specialist under this paragraph must complete the following items:

II.D.3.b.(i). Training

The applicant must complete a [Division](#)-approved 4-hour [Air Monitoring Specialist](#) refresher course.

II.D.3.b.(ii). Experience

No additional experience is required, but the individual must submit an application for certification as provided for in paragraph II.D.2. no later than June 30, 2003.

II.D.3.b.(iii). Education

There are no education requirements for individuals qualified prior to March 30, 2003.

II.D.3.b.(iv). Examination

Each individual seeking certification as an Air Monitoring Specialist shall pass, on an annual basis, a Division-administered closed book written examination. The examination shall cover the topics included in the training course. The testing schedule and procedures shall be determined by the Division. If an applicant fails to achieve a passing score on a certification test, he or she may retake the test after submitting the following items to the Division:

- 1) a new application including payment of a retesting fee of \$125.00; and
- 2) proof of attendance at a remedial training course, if required by the Division.

II.D.4. Recertification Requirements

II.D.4.a. [Air Monitoring Specialists](#) who are [certified](#) according to this regulation must take an annual refresher training course from a [Division](#)-approved training provider. Prior to the commencement of refresher training, the course provider is required to verify the authenticity of the initial training course certificate and all refresher training certificates. Individuals not in possession of a valid training certificate shall not be given refresher training. The length of the Air Monitoring Specialist refresher course shall be one-half day (four (4) hours).

Applicants are ineligible for refresher training if their most recent training certificate has lapsed for a year or longer, in which case the applicant must re-take the initial training. During the period in which the individual's training certificate has expired, the state certificate is not valid. State certification becomes valid once the required training has been completed and state certification requirements have been met.

II.D.4.b. All refresher courses required under this Section II.D.4. (Recertification Requirements), at a minimum, must cover the following topics:

- Changes in Federal and State laws, regulations and requirements;
- Developments and/or changes in state-of-the-art procedures;
- Review of the key aspects of the course; and
- Pertinent developments in the particular discipline or the industry as a whole.

Testing of applicants to determine knowledge gained in the refresher course may be done at the option of the course provider.

II.E. TRAINING PROVIDER APPLICATION PROCEDURES

- II.E.1. Any [person](#) wishing to offer courses in disciplines for which training or certification is required must be registered as an Asbestos Training Provider. Applicants shall apply to the [Division](#) for approval, except for the training referenced in Appendix C. Applicants seeking approval for initial training or refresher training courses shall submit their request to the Division on a form supplied by the Division along with the written course materials and a fee of \$250.00 per discipline in which they wish to offer courses.
- II.E.1.a. After the initial course approval, applicants shall submit their renewal request to the Division on a form supplied by the Division along with a fee of \$100.00 per discipline in which they wish to offer courses.
- II.E.2. In order for a course to be approved it must adequately address the topics and format contained in the United States Environmental Protection Agency's Asbestos Model Accreditation Plan (MAP), 40 C.F.R. Part 763 (1994), Subpart E, Appendix C. The [Commission](#) recommends the use of audiovisual materials to complement lectures in these courses, where appropriate.
- II.E.3. After reviewing the application for course approval, the [Division](#) shall inform the applicant in writing whether the course is approved for use in Colorado or if changes must be made in the application before approval may be granted.
- II.E.4. Once the applicant has been informed that the course is approved, the course is considered to have contingent approval, and the applicant may begin offering courses in the State. Final approval of the course will not be granted until the [Division](#) has audited the course and determined that the course meets the requirements of this regulation.
- II.E.5. After contingent approval has been granted by the [Division](#), the applicant must make application, if necessary, with the Department of Higher Education, Division of Private Occupation Schools (DHE/DPOS), for approval as an occupational education course. Failure to follow the DHE/DPOS regulations or failure to obtain or retain DHE/DPOS approval may result in the de-certification of the course by the Air Pollution Control Division ([APCD](#)).

II.E.6. Applicants who wish to offer courses already approved by the Environmental Protection Agency or by a state whose training requirements are at least as stringent as the [Commission](#)'s and whose asbestos certification program has been approved by [EPA](#) shall be granted reciprocity to teach classes in Colorado. The approval granted to such course provider shall be at the same level as that already approved by EPA or another state. The applicant shall be subject to all requirements outlined in this regulation.

II.E.7. In the curriculum and course agenda, the applicant must show what portions of the course will be taught by each instructor.

II.F. INSTRUCTOR QUALIFICATIONS

All courses must be taught by qualified instructors. The minimum qualifications for instructors shall be:

II.F.1. A high school diploma or GED;

II.F.2. Current [AHERA](#) training credentials and current Colorado certification for the discipline being taught by the instructor (variances for out-of-state instructors will be considered on a case-by-case basis);

II.F.3. Three (3) years of field experience in the discipline being taught. This may be obtained by a combination of any of the following items:

II.F.3.a. Actual field experience in the field being taught, such as; performing abatement activities as a Worker or Supervisor; or performing inspection and/or management planning activities; or performing [project design](#) activities; or performing [Air Monitoring Specialist](#) activities.

II.F.3.b. Teaching in the discipline, under the supervision of a qualified instructor, with one (1) month of teaching equal to one (1) month of experience.

II.F.3.c. Collegiate or seminar-type classes (e.g., [NIOSH](#) 582, 7400 courses, etc.) with one (1) week of training equal to one (1) month of experience.

II.F.4. Documentation of experience claimed or instruction received must be provided by the applicant. This must include submission of a résumé with telephone numbers, and references, that are provided to allow for verification by the [Division](#).

II.F.5. All instructors must meet the above requirements both at the time of course submission for approval and at the time the course is being taught. The [Division](#) may grant assistant instructor status to those individuals who do not currently meet all requirements at the time of the course submittal. The individuals may re-apply for approval as full instructors once they have met the requirements.

II.G. TRAINING COURSE NOTIFICATIONS

II.G.1. Training course providers must notify the [Division](#) in writing of scheduled courses at least two weeks (10 [working days](#)) prior to the offering of the course. Notification of course cancellations must be provided to the Division by 5:00 p.m. the day prior to the course offering.

II.G.2. For any course in which training or certification is required, the Training Provider must submit a list of students who took the course and a fee of \$10.00 per student to the Division no later than 30 calendar days after the conclusion of the course.

II.H. TRAINING COURSE AUDITS

The [Division](#) may audit any training course given for the purpose of preparing individuals for State certification. Any significant omissions or deficiencies may result in de-certification of the course. There will be no charge to the Division for auditing a training course.

II.I. RECIPROcity

II.I.1. An individual who has a valid certificate, license or other registration from another state, District of Columbia or other territory of the United States, or other [Division](#)-approved national entity (specifically, the National Asbestos Examinations and Registration System) which has a certification and testing program that has been approved by the [EPA](#) and which is at least as stringent as the [Commission's](#), may apply for certification by submitting an application on the form specified by the Division, along with the applicable fee.

II.I.2. Those individuals applying under this subsection II.I. (Reciprocity) for Colorado certification as a Supervisor or project designer must also successfully complete a [Division](#)-administered examination on state laws and regulations related to [asbestos abatement](#) before Colorado certification will be issued.

II.I.3. Those individuals applying under this subsection II.I. (Reciprocity) for Colorado certification as an [Air Monitoring Specialist](#) must also:

II.I.3.a. provide documentation to the [Division](#) showing that they have been [certified](#) to conduct [Air Monitoring Specialist](#) activities for at least 1 year.

II.I.3.b. pass the written examination as described in subparagraph II.D.3.a.(iv). Examination.

II.I.4. After receiving Colorado certification, the applicant shall be subject to all requirements outlined in this regulation regarding training and application for renewal of Colorado certification, including testing requirements.

II.I.5. The applicant shall provide documentation to the [Division](#) as may be necessary to allow the Division to determine if a reciprocal certificate should be issued.

II.J. PROJECT MANAGER QUALIFICATIONS

II.J.1. There is no Project Manager certification requirement. Where a Project Manager is required pursuant to the Regulation No. 8, Part B, the Project Manager shall satisfy the certification, academic training, experience, and educational requirements as set forth below:

II.J.1.a. Certification as a Project Designer in accordance with this Section II. Project Managers must have proof of this certification with them on the project site.

II.J.1.b. Successful completion of a [Division](#)-approved [Air Monitoring Specialist](#) course. A 4-year college degree in industrial hygiene, a degree in environmental health with a major concentration in industrial hygiene, or the possession of a certified industrial hygienist ([CIH](#)) certificate given by the American Board of Industrial Hygiene (ABIH), may be substituted for the above Air Monitoring Specialist course. Project Managers must have proof of the required training with them on the project site.

II.J.1.c. A minimum of one (1) year of experience supervising, overseeing or monitoring [asbestos abatement](#) projects.

II.J.1.d. Possession of a high school diploma or G.E.D.

II.K. DENIAL, SUSPENSION, REVOCATION, OR REFUSAL TO RENEW CERTIFICATION

The [Division](#) may deny, suspend, revoke, or refuse to renew certifications in accordance with the provisions of § 25-7-508, C.R.S.

II.L. Any person performing asbestos consulting firm activities as defined in this regulation must be registered as an Asbestos Consulting Firm. Applicants seeking to be registered shall submit their request to the Division on a form supplied by the Division along with an annual fee of \$500.00.

II.M. Any person performing asbestos laboratory activities as defined in this regulation must be registered as an Asbestos Laboratory. Applicants seeking to be registered shall submit their request to the Division on a form supplied by the Division along with an annual fee of \$250.00.

II.N. EXEMPTIONS

The following sections of the regulation contain exemptions from certain requirements. Please refer to the indicated section for the specific details of the exemption.

- Anyone working in a Non-Public Access Areas is exempted from certain requirements. See paragraph II.A.3.

- Certified Industrial Hygienists are exempted from certain training requirements. See subparagraphs II.D.3.a., II.D.3.b., and subsection II.J.

All underlined text in this regulation indicates defined terms.

III. ABATEMENT, RENOVATION AND DEMOLITION PROJECTS

III.A. INSPECTION

- III.A.1. Prior to any renovation or demolition which may disturb greater than the trigger levels of material identified as a suspect asbestos-containing material pursuant to the EPA "Green Book", Managing Asbestos in Place, Appendix G (1990), the facility component(s) to be affected by the renovation or demolition shall be inspected to determine if abatement is required.
- III.A.1.a. Individuals performing these inspections shall be Building Inspectors certified in accordance with this regulation.
- III.A.1.b. The inspection, sampling and assessments of the suspect materials must be performed as required in paragraph IV.C.1. (Inspection), subsections IV.D. (Sampling) and IV.F. (Assessment) of this regulation.
- III.A.1.c. The analysis of samples collected during these inspections must be performed as required in subsection IV.E. (Analysis) of this regulation with one exception: if the asbestos content of a sample of friable asbestos is estimated to be 1% asbestos or less, but greater than 0%, by a method other than point counting (such as visual estimation), the determination shall be repeated using the point counting technique with polarized light microscopy. If a result obtained by point count is different from a result obtained by visual estimation, the point count result must be used. Tar impregnated samples do not have to be point counted.
- III.A.1.d. Buildings, or those portions thereof, that were constructed after October 12, 1988 shall be exempt from this inspection requirement if an architect or project engineer responsible for the construction of the building, or a state certified Inspector, signs a statement that no ACM was specified as a building material in any construction document for the building or no ACM was used as a building material in the building. NOTE: The Division recommends that all buildings be inspected prior to any renovation or demolition activities, regardless of the date of construction.
- III.A.1.e. To prevent any real or potential conflicts of interest, Building Inspectors identifying ACM must be independent of the GAC that will subsequently abate the ACM identified. Inspectors need not be independent of the GAC if both the Inspector and the licensed GAC are employees of the building owner.
- III.A.2. Abatement, in accordance with Regulation No. 8, is required if the amount of ACM that will be disturbed in connection with the renovation exceeds the trigger levels.
- III.A.3. Any asbestos-containing material that is friable or will be made friable during demolition activities in any area of public access or non-public access area must be removed prior to demolition. Removal, in accordance with Regulation No. 8, is

required if the amount of asbestos-containing material that is friable or will become friable during demolition exceeds the [trigger levels](#).

III.B. USE OF CERTIFIED AND REQUIRED PERSONNEL

III.B.1. Any [person](#) who conducts [asbestos abatement](#) other than abatement performed in a [school building](#) shall obtain a [GAC](#) if the amount of [asbestos](#) to be abated exceeds the [trigger levels](#) on any occasion.

III.B.1.a. A [person](#) required to be [certified](#) in accordance with paragraph III.B.1., above, shall employ at least one state-certified Supervisor who shall be on-site at all times when [asbestos abatement](#) work is proceeding. [Asbestos](#) Workers must have access to a certified Supervisor throughout the duration of the abatement project.

III.B.1.b. For abatement projects where a [GAC](#) is required, all abatement Workers and Supervisors shall be [certified](#) in accordance with the provisions of Section II (Certification Requirements). GACs shall ensure that all [asbestos abatement](#) Workers and Supervisors are properly certified.

III.B.1.c. The requirements of this Paragraph III.B.1. shall not apply to any individual who performs [asbestos abatement](#) on a [single-family residential dwelling](#), that is the individual's primary residence.

III.B.2. With respect to [school buildings](#), [public or commercial buildings](#) and [single-family residential dwellings](#), any individual who inspects any building for the presence of [asbestos](#) shall be [certified](#) as a Building Inspector in accordance with this regulation.

III.B.3. With respect to [school buildings](#), any individual who develops an [asbestos](#) management plan, supervises [asbestos abatement](#) activities, performs asbestos abatement, or designs asbestos abatement projects shall be [certified](#) for the specific activity he is engaged in if the amount of [asbestos-containing material](#) exceeds, on any occasion, 3 linear feet on pipes, or 3 square feet on other surfaces.

III.B.3.a. The [LEA](#) or its contractor shall ensure that at least one state-[certified](#) Supervisor be on-site at all times when [asbestos abatement](#) work is proceeding. [Asbestos](#) Workers must have access to certified Supervisors throughout the duration of the abatement project.

III.B.4. With respect to [public and commercial buildings](#) and [single-family residential dwellings](#), any individual who develops an [asbestos](#) management plan, supervises [asbestos abatement](#) activities, performs asbestos abatement, or designs asbestos abatement projects shall be [certified](#) for the specific activity in which he is engaged if the amount of [asbestos-containing material](#) exceeds, on any occasion, the [trigger levels](#).

III.B.5. Effective March 30, 2004, any individual who performs a final visual inspection or performs any [air monitoring](#) referred to in this regulation must be [certified](#) as an [Air Monitoring Specialist](#).

III.B.6. Project Manager

A project manager shall be used on all [asbestos abatement](#) projects in which the amount of [friable asbestos-containing material](#) to be abated exceeds 1,000 linear feet on pipes, or 3,000 square feet on other surfaces.

III.B.6.a. Waiver of the Project Management Requirements

Building owners who seek to have the project manager requirement waived must submit the request, on a form supplied by the [Division](#) as part of the notification required in III.E.1. (Notices).

III.B.6.a.(i). Waiver requests shall be approved by the Division if the project is performed by a [GAC](#) with a non-compliance history of fewer than two (2) Division-issued compliance determinations with a finding of guilty during the past two (2) years prior to the start of the project.

III.B.6.a.(ii). If the project is conducted by a GAC with a non-compliance history of two (2) or more Division-issued compliance determinations with a finding of guilty during the past two (2) years, the building owner must, on a form supplied by the Division, demonstrate to the satisfaction of the Division that compliance with the project manager requirements is overly burdensome or not feasible.

III.B.6.b. The GAC shall notify the building owner during bid proposals as to whether or not a project manager would be required.

III.C. PROJECT DESIGN

III.C.1. Prior to the start of any [asbestos abatement](#) in an [area of public access](#) of a non-school building, in which the amount of [asbestos-containing material](#) to be abated exceeds 1,000 linear feet on pipes, or 3,000 square feet on other surfaces, a written [project design](#) shall be developed by a Project Designer [certified](#) under these regulations.

III.C.2. Prior to the start of any [asbestos abatement](#) in a [school building](#) in which the amount of [friable asbestos-containing material](#) to be abated exceeds 3 linear feet on pipes, or 3 square feet on other surfaces, a written [project design](#) shall be developed by a Project Designer [certified](#) under these regulations, in accordance with paragraph IV.G.7 of this regulation.

III.C.3. A [project design](#) shall include:

- an accurate and detailed scope of work
- quantities of material to be removed
- a discussion of the removal methods
- air exchange calculations
- signature of the project designer
- [project design](#) completion date and dates of any amendments
- drawings that include:
 - locations of [ACM](#) to be abated
 - the [decontamination unit](#)
 - the waste load-out
 - negative air machines
 - air intake and exhaust
 - emergency exits, when applicable

III.C.4. A signed copy of the [project design](#) shall be available on-site at all times during the abatement activities for review by Inspectors, the Project Manager and the [certified Air Monitoring Specialist](#).

III.D. PROJECT MANAGEMENT

III.D.1. The project manager shall be responsible for:

- assessing that the project is conducted in accordance with this regulation.
- assessing that the [project design](#) is followed.
- assessing that the abatement project is cleared in accordance with this regulation.
- assessing that the asbestos waste generated by the project is properly manifested and disposed of in accordance with this regulation.
- communicating these [assessments](#) to the building owner or [GAC](#).

III.D.2. Project managers shall be [independent](#) of the [asbestos abatement contractor](#) and work strictly on behalf of the building owner to the extent feasible, unless the abatement is being performed in-house.

III.D.3. Project managers must sign the original copy of the permit for the permit to be valid.

III.E. NOTIFICATIONS

III.E.1. Notices

Any [person](#) intending to either abate [asbestos-containing materials](#) in any amount greater than the [trigger levels](#), or demolish a [facility](#) shall, on a form supplied by the [Division](#), provide a written notice of the intent to conduct [asbestos abatement](#) or [demolition](#). When a permit is required under paragraph III.G.1 (Permits), this notice shall serve as the permit application referred to in paragraph III.G.1. False, inaccurate or misleading information contained in the notice is cause for the Division

to revoke a permit issued pursuant to paragraph III.G.1. (Permits) and/or to initiate an enforcement action pursuant to §25-7-508, [C.R.S.](#) Any modification of information contained in the notification must be made in writing to the Division on the first regular business day preceding the change. Notices required under this paragraph are subject to the following conditions:

- III.E.1.a. The notice shall be postmarked or delivered to the [Division](#) at least 10 [working days](#) before commencing an abatement project or [demolition](#) project, except as provided in subparagraphs b., c., and d. of this section. Any fees required under this paragraph III.E.1. (Notices) or III.G.1. (Permits) must accompany the notice for the notice to be accepted by the Division.
- III.E.1.b. If the project is not one for which permit is required pursuant to paragraph III.G.1. (Permits), a processing fee of \$80.00 shall be submitted to the [Division](#) for each notice. For abatement projects that occur in non-public access areas, the Division may charge the [person](#) submitting this notice a fee for site inspections and any necessary monitoring for compliance with applicable sections of this regulation. The fee shall be assessed at a rate of \$80.00 per hour.
- III.E.1.c. For [large contiguous facility complexes](#), if the project is not one for which permit is required pursuant to III.G.1. (Permits), an annual fee in the amount of \$80.00 per abatement project that will be undertaken that year shall be submitted to the [Division](#). If over the course of the year should more than the anticipated number of projects occur, an additional \$80.00 per notice shall be submitted to the Division. At the end of one year the Division will refund fees for projects that have not been performed, less a \$80.00 processing fee.
- III.E.1.d. For demolition projects, a base fee of \$50.00 is required plus an additional \$5.00 per one thousand square feet, or any portion thereof, of structure footprint.
- III.E.1.e. Waiver of the 10-Working Day Notification Period

There are two situations where the [Division](#) will consider a waiver of the 10-[working day](#) notifications. They are:

III.E.1.e.(i). Emergencies

In the event of an [emergency](#) in which [asbestos abatement](#) work must commence at once, the [Division](#) and the appropriate county health department shall be notified immediately by fax or telephone. The [GAC](#) or building owner must submit a written notification on a form supplied by the Division at the start of the next regular State business day after commencing the emergency abatement. The application shall be accompanied by a written explanation of the events surrounding the emergency and signed by both the building owner and the GAC. If the

emergency occurs during non-business hours, the Division and the appropriate county health department shall be notified by telephone on the morning of the next regular State business day

III.E.1.e.(ii). Unexpected Discovery

In the event of an unexpected discovery of [asbestos-containing materials](#) behind a wall, above a ceiling, beneath a floor or otherwise hidden in such a way as to preclude access to it without damaging part of the structure, should the building owner wish to seek a waiver of the normal 10-[working day](#) notification, the [GAC](#) or building owner shall notify the [Division](#) by the end of the next regular State business day following the unexpected discovery.

III.E.1.f. For structures that are declared structurally unsound and in danger of imminent collapse by an authorized State or local governmental representative, as described in paragraph III.W. (Structurally Unsound Buildings), the GAC, [demolition](#) contractor, or building owner shall notify the [Division](#) as early as possible before demolition begins if the operation is as described in subsection III.W. (Structurally Unsound Buildings). The notification shall contain the name, title, and authority of the State or local governmental representative who has ordered the demolition.

III.E.2. Single-Family Residential Dwelling Opt-Out Notice

An owner of a [single-family residential dwelling](#) may opt-out of the [area of public access](#) requirements of this regulation for the abatement of [asbestos-containing material](#) in excess of the [trigger levels](#) in that owner's primary residence by completing the opt-out form. If the homeowner chooses to opt-out, the [GAC](#) contracting with the homeowner shall provide the completed, signed "Single-Family Residential Dwelling Area of Public Access Opt-Out Form" to the Division. For a project in which the homeowner has chosen to opt-out, then the single-family residential dwelling will revert to being subject to the area of public access requirements: 1) at the time of the homeowner's choosing; 2) when the homeowner no longer owns the single-family residential dwelling; or, 3) if the dwelling ceases being the homeowner's primary residence, whichever is first.

III.F. ALTERNATIVE PROCEDURES AND VARIANCES

The [Division](#) may, at its discretion, grant a variance from this Regulation allowing use of an alternative procedure for the clearance of abatement projects or the control of emissions from an [asbestos abatement](#) project provided that the [person](#) conducting the asbestos abatement submits the alternative procedure in writing to the Division along with a \$50.00 review fee, and demonstrates to the satisfaction of the Division that compliance with the regulation is neither practical nor feasible, or that the proposed alternative procedures provide equivalent control of [asbestos](#).

Within sixty (60) days of the receipt of the request the [Division](#) shall notify the applicant in writing of its decision to either grant or deny the variance, except that if the request is to utilize an alternative procedure previously evaluated by the Division the variance shall be granted or denied within (10) ten days. No [person](#) shall begin abatement using such a procedure until a variance has been requested, and approved in writing. Any violation of the conditions of the variance will be considered a violation of this Regulation.

III.G. PERMITS

III.G.1. Permit Applications

III.G.1.a. No [person](#) shall commence an abatement project in which the amount of [friable asbestos-containing material](#) exceeds the [trigger levels](#) in an [area of public access](#) without first obtaining a permit from the [Division](#). Only the [GAC](#) in whose name the permit is issued may conduct the abatement project.

III.G.1.b. Permit fees for [large contiguous facility complexes](#) shall be paid annually to the [Division](#) in the amount of \$1,200.00 plus \$80.00 for each anticipated project. This fee must accompany the permit application for the application to be accepted. At the end of the permit year, the Division will refund fees for projects that have not been conducted, less a \$80.00 processing fee.

III.G.1.c. For any project other than those on [large contiguous facility complexes](#), the permittee shall be assessed a fee for the permit. The fee must accompany each permit application. The fee schedule is as follows:

Project Length	Permit Fee for Projects	
	Applies to ALL facilities including single-family residential dwellings	Applies ONLY to single-family residential dwellings
	Greater than 260 liner feet/ 160 square feet/ 55 gallon drum	Greater than 50 liner feet/ 32 square feet/ 55 gallon drum. but less than or equal to 260 linear feet/ 160 square feet/ 55 gallon drum
1 – 30 days	\$400.00	\$180.00
31 – 90 days	\$800.00	\$300.00
91 - 365 days	\$1,200.00	\$420.00

Any inspections in excess of one for a 30-day permit, two for a 90-day permit, or three for an one-year permit will be assessed at a rate of \$80.00 per hour.

Permits are valid for a maximum of one year. A new permit must be obtained for projects lasting longer than one year.

III.G.2. Permit/Project Modification

Whenever there is a modification in the project, the permittee must notify the [Division](#) and the local county health department (as designated by the Division) in writing. A project modification occurs when there is a change in the scope of work, the scheduled work dates or times, or the project manager. The permittee shall notify the Division by the end of the next regular State business day following the modification.

III.G.3. Multiple-Phase Projects

Buildings owned by the same [person](#), which are at different locations, must be permitted separately. Buildings owned by the same person, which are at the same location, can be covered by one multiple-phase permit. When applying for a permit for abatement to be performed in more than one building or in more than one area within a single building, the applicant shall provide, on a form supplied by the [Division](#), additional information regarding the multiple-phase project. Whenever there is a change in any of the information provided on the form, a new form shall be submitted to the Division that:

III.G.3.a. Indicates clearly which phases of the project have changed,

III.G.3.b. Is postmarked or delivered to the [Division](#) at least 10 [working days](#) before the start of any phase having a change in its starting date

III.G.3.c. Indicates additional phases that are to be added after the start of a multi-phase project by the submission of a new application covering the additional phase or phases 10 [working days](#) prior to the start of the first additional phase. There is a \$80.00 fee for each additional phase after the initial permit approval.

III.G.4. The original of the [Division](#)-issued permit shall be posted in a visible location at the work site at all times.

III.G.5. [Asbestos abatement](#) permits are required for asbestos abatement projects in [single-family residential dwellings](#) for which the amount of [asbestos-containing materials](#) to be abated exceeds the [trigger levels](#), unless either of the following conditions apply:

III.G.5.a. The homeowner has requested that the single-family residential dwelling not be considered an [area of public access](#) pursuant to section III.E.2.; or

III.G.5.b. The individual is performing the abatement project himself/herself in a single-family residential dwelling that is the individual's primary residence.

III.G.6. Transferring a Permit

Should a GAC wish to transfer a permit to another GAC, the GAC who will perform the abatement project must submit a new permit application and pay the [Division](#) a \$55.00 processing fee.

III.G.7. No permit to conduct [asbestos abatement](#) shall be issued to a [person](#) who has failed to pay a [Division](#)-assessed penalty for violating any provision of this Regulation No. 8 or to any person who has otherwise failed to comply with any order of the Division, unless the penalty or order is under appeal before the Air Quality Control [Commission](#).

III.G.8. Permits issued on projects requiring project managers shall not be valid until the original copy of the permit is signed by the project manager.

III.H. ABATEMENT SEQUENCE

This subsection III.H. applies to [asbestos abatement](#) projects in [areas of public access](#) where the amount of [asbestos-containing material](#) that will be abated exceeds the [trigger levels](#).

III.H.1. Pre-Abatement

Pre-abatement is the time period covering the commencement of construction of the containment and all other preparations (including any necessary [pre-cleaning](#)) taking place prior to the actual abatement of [ACM](#). This abatement phase does not include the transport of materials and equipment to the job site. The transport of materials and equipment to the job site is the only activity that is allowed prior to the permit start date.

Below are the steps for the pre-abatement phase of the project. Please note that steps 1 through 6, where applicable, are mandatory, and the exact sequence shown below is mandatory.

- 1) Install [critical barriers](#)
(pursuant to subsection III.I, Critical Barrier Installation)
- 2) Establish negative pressure
(pursuant to subsection III.J, Air Cleaning and Negative Pressure Requirements)
- 3) Construct the [decontamination area](#)
(pursuant to subsection III.K, Decontamination Area)
- 4) Pre-clean surfaces
(pursuant to subsection III.L, Pre-cleaning of Surfaces)
- 5) Cover [fixed objects](#)
(pursuant to subsection III.M, Covering Fixed Objects)
- 6) Construct the containment
(pursuant to subsection III.N, Containment Components)

III.H.2. Active Abatement

Active abatement means the time period beginning with the completion of the pre-abatement phase and ending when the area has passed final clearance air monitoring and the [critical barriers](#) have been completely removed.

The active abatement phase includes the actual "gross" [removal](#) of [ACM](#) and all aspects of "[final cleaning](#)" that are conducted prior to the areas being pronounced ready for a final visual inspection. The final visual inspection, final clearance [air monitoring](#) , and the removal of [critical barriers](#) are the last activities included in the active abatement phase.

Below are the steps for the active abatement phase of the project. Please note that steps 7, 8, 9, and 10, are mandatory, and the exact sequence shown below is mandatory.

- 7) Conduct abatement
(pursuant to subsection III.O, Abatement Methods)
- 8) Conduct final visual inspection
(pursuant to paragraph III.P.1., Final Visual Inspection)
- 9) Conduct final clearance [air monitoring](#)
(pursuant to paragraph III.P.3., Final Clearance Air Monitoring)
- 10) Conduct the tear-down
(pursuant to subsection III.Q., Tear-down)

III.H.3. Post-Abatement

Post abatement means any point in time following the termination of the active abatement phase. Below is the step for the post-abatement phase of the project. Please note that step 11 is mandatory.

- 11) Handle waste. Handling of waste is permissible during the active abatement phase.
(pursuant to subsection III.R., Waste Handling).

III.I. CRITICAL BARRIER INSTALLATION

This subsection III.I. applies to [asbestos abatement](#) projects in [areas of public access](#) where the amount of [asbestos-containing material](#) that will be abated exceeds the [trigger levels](#).

All openings between the [work area](#) and clean areas including, but not limited to, windows, doorways, elevator openings, corridor entrances, drains, ducts, grills, grates, diffusers and skylights shall be sealed with a minimum of one layer of 6-mil polyethylene sheeting.

III.J. AIR CLEANING AND NEGATIVE PRESSURE REQUIREMENTS

This subsection III.J. applies to [asbestos abatement](#) projects in [areas of public access](#) where the amount of [asbestos-containing material](#) that will be abated exceeds the [trigger levels](#).

III.J.1. Negative Air Machines and HEPA Filters

- III.J.1.a. [Negative pressure air filtration units](#) shall be operated continuously from the time of barrier construction through the time that acceptable Final Clearance Air Monitoring results are obtained in accordance with subsection III.P. (Clearing Abatement Projects).
- III.J.1.b. The [GAC](#) who is required to use air cleaning shall properly install, use, operate, and maintain all air-cleaning equipment authorized by this subparagraph III.J. (Air Cleaning and Negative Pressure Requirements).
- III.J.1.c. The [GAC](#) who is required to use air cleaning shall use a [HEPA filter](#) to clean the air, except as noted below:
- III.J.1.c.(i). Bypass devices may be used only during upset or [emergency](#) conditions and then only for so long as it takes to shut down the operation generating the [particulate asbestos material](#).
 - III.J.1.c.(ii). If the use of a filter creates a fire or explosion hazard, the [Division](#) may authorize as a substitute the use of wet collectors designed to operate with a unit contacting energy of at least 9.95 kilopascals (40 inches of water gauge pressure).
 - III.J.1.c.(iii). The [Division](#) may authorize the use of filtering equipment other than [HEPA filters](#) if it has been previously approved by [EPA](#) and if it can be demonstrated to the Division's satisfaction that it is equivalent to the described equipment in filtering [particulate asbestos material](#).
- III.J.1.d. These units shall exhaust filtered air to the outside of the building when the length of exhaust duct required to do so does not overburden the negative air units. If air must be exhausted to the interior of the building, it must be done in accordance with subparagraph III.U.1.b. (During Abatement).

III.J.2. Air Exchange Rates

The [GAC](#) who is required to use air cleaning shall maintain sufficient air cleaning equipment in operation at all times to ensure that the air within the [work area](#) is exchanged a minimum of four (4) times per hour.

III.J.3. Pressure Differential

At all times the differential of the [work area](#) to the clean area shall be, at a minimum, -0.02 inches of water. A manometer or pressure gauge shall be set up on the outside of the containment area so that the pressure differential between the work area and the clean area may be determined. At all times the differential of the work area to the clean area shall be recorded using a strip chart recorder or its equivalent.

III.J.4. Air Flow Direction

At all times air flow direction shall be from the exterior of the containment barriers into the interior of the containment barriers. In addition, smoke tubes shall be readily available on the outside of the containment barriers at all times so that air flow direction may be determined.

III.K. DECONTAMINATION UNIT

This subsection III.K. applies to [asbestos abatement](#) projects in [areas of public access](#) where the amount of [asbestos-containing material](#) that will be abated exceeds the [trigger levels](#).

III.K.1. Construction

A [decontamination unit](#) shall be constructed to provide employees with a facility to be used to decontaminate [asbestos](#)-exposed Workers and equipment before such Workers and equipment leave the [work area](#). The decontamination unit shall consist of the following three stages, which shall be separated by staggered flaps or an equivalent system of barriers that will self-close should negative air pressure fail:

III.K.1.a. Clean Room

The [clean room](#) shall be sized to accommodate the clothes and equipment of the work crew. Clean work clothes, clean disposable clothing, replacement filters for respirators, towels and other necessary items shall be provided in the clean room. No asbestos-contaminated items may enter this room. Workers shall use this area to suit up, store street clothes, and don respiratory protection on their way to the [work area](#), and to dress in clean clothes after showering.

III.K.1.b. Shower

Except for small-scale abatement projects where [glovebag](#) methods or [mini-enclosure](#) methods are used, a portable shower shall be used to permit the employees to clean themselves after exposure to [asbestos](#). Each showerhead shall be supplied with hot and cold water adjustable at the tap, and a drain equipped with a filtration system to filter asbestos from the shower wastewater to a fiber size of five (5) microns prior to discharging the wastewater into a sanitary sewer. The [shower room](#) shall contain one or more

showers to accommodate Workers. The shower enclosure shall be constructed to ensure against leakage of any kind and shall be kept clean of all debris and [ACWM](#) at all times.

III.K.1.c. Equipment (Dirty) Room

The [equipment room](#) shall be used for storage of equipment and tools at the end of a shift after decontamination using a [HEPA filtered](#) vacuum or [wet cleaning](#) techniques. A labeled six (6) mil polyethylene bag for collection of disposable clothing shall be located in this room. Contaminated footwear shall be stored in this area for reuse.

III.K.2. Entry and Exit

The following procedures shall be used for [work area](#) entry and exit unless there is an [emergency](#) situation immediately dangerous to life or health:

III.K.2.a. All personnel and authorized visitors shall enter and exit the [work area](#) through the Worker [decontamination unit](#) and not the waste load-out.

III.K.2.b. All personnel shall don disposable coveralls, head covering and foot covering prior to entering the [work area](#). To prevent contamination from leaving the work area, disposable coveralls in sizes adequate to accommodate movement without tearing shall be worn by all personnel entering the work area. The coveralls (Tyvek® or other material equally effective in preventing gross [ACM](#) from contacting the individual's body) shall include head and foot covers (unless head and foot covers are provided separately).

III.K.2.c. Before leaving the [work area](#), all personnel shall remove gross contamination from the outside of respirators and dispose of protective clothing in containers labeled for disposal in accordance with subparagraph III.R.2.b. (Labeling). Personnel shall proceed to the shower area and then shower and shampoo to remove residual [asbestos](#) contamination. After showering, personnel shall proceed to the [clean room](#).

III.L. PRE-CLEANING OF SURFACES

This subsection III.L. applies to [asbestos abatement](#) projects in [areas of public access](#) where the amount of [asbestos-containing material](#) that will be abated exceeds the [trigger levels](#).

[Pre-cleaning](#) of surfaces contaminated with visible dust or debris shall be conducted prior to the commencement of any abatement project. The following procedures shall be conducted in the order in which they appear:

III.L.1. [HEPA vacuum](#) or wet wipe all surfaces contaminated with visible dust or debris. All [movable objects](#) shall be cleaned of dust and debris by HEPA vacuum or wet wiped before removal from the [work area](#);

III.L.2. Dispose of all dust and debris, filters, mop heads and other contaminated waste as [ACWM](#) pursuant to subsection III.R. (Waste Handling).

III.L.3. [Pre-cleaning](#) of dirt floors shall be conducted in accordance with paragraph III.S.5. (Asbestos-Contaminated Soil).

III.M. COVERING FIXED OBJECTS

This subsection III.M. applies to [asbestos abatement](#) projects in [areas of public access](#) where the amount of [asbestos-containing material](#) that will be abated exceeds the [trigger levels](#).

At a minimum, all [fixed objects](#) in the [work area](#) shall be covered with one (1) layer of six (6) mil polyethylene sheeting, secured in place.

III.N. CONTAINMENT COMPONENTS

This subsection III.N. applies to [asbestos abatement](#) projects in [areas of public access](#) where the amount of [asbestos-containing material](#) that will be abated exceeds the [trigger levels](#).

Construction of the containment components may commence only after adequate negative pressure is established.

Polyethylene sheeting shall be used in the construction of containment barriers in order to isolate the [work area](#) during abatement projects. Spray poly may be substituted for polyethylene sheeting.

III.N.1. Wall, Floor and Ceiling Polyethylene

Polyethylene sheeting shall be used in thicknesses and number of layers as specified in subparagraphs III.N.1.a., b., and c., below, and shall be used to seal all windows, doors, ventilation systems, and wall penetrations, and to cover ceilings, walls, and floors in the [work area](#). Duct tape or spray adhesive shall be used to seal the edges of the plastic and to seal any holes in the containment. Polyethylene sheeting shall be attached using any combination of duct tape or other waterproof tape, furring strips, spray glue, staples, nails, screws or other effective materials capable of sealing adjacent sheets of polyethylene and capable of sealing polyethylene to dissimilar finished or unfinished surfaces under both wet and dry conditions.

III.N.1.a. Laying Polyethylene on Floors

At a minimum, floors shall be covered with sheeting consisting of two (2) layers of six (6) mil polyethylene sheeting, unless spray poly is used. Floor sheeting shall extend up sidewalls at least twelve (12) inches and be sized to minimize seams. No seams shall be located along wall/floor joints.

III.N.1.b. Hanging Polyethylene on Walls

At a minimum, walls shall be covered with sheeting that shall consist of two (2) layers of four (4) mil or thicker polyethylene, unless spray poly is used. It shall be installed to minimize seams and shall extend beyond wall/floor joints at least twelve (12) inches. No seams shall be located along wall/wall joints.

III.N.1.c. Hanging Polyethylene Sheeting on Ceilings

If a [work area](#) has a ceiling that will not be abated as part of the abatement work, at a minimum, the ceiling shall be covered with sheeting that shall consist of one (1) layer of four (4) mil or thicker polyethylene, unless spray poly is used. It shall be installed to minimize seams and shall extend beyond wall/ceiling joints at least twelve (12) inches. No seams shall be located along wall/ceiling joints.

III.N.2. View Port

A clear view port with a minimum size of 12" x 12" shall be installed to allow a view of the interior of the [work area](#). If a view port cannot be installed, an explanation shall be made on the notification form stating that it will not be installed and the reason why.

III.N.3. Waste Load-out Area

All containments shall be constructed to include a [waste load-out area](#). This area shall be separate from the [decontamination unit](#) and shall be used as a temporary storage area for bagged waste and as a port for transferring waste to the transport vehicle. All waste load-out areas must have a minimum of two separate chambers separated by air locks.

III.N.4. Secondary Containment

III.N.4.a. For [glovebag removals](#) (see III.V.1) the [GAC](#) in lieu of full containment shall erect [secondary containment](#) barriers where the amount of [ACM](#) to be removed in a [functional space](#) exceeds three (3) linear or three (3) square feet.

III.N.4.b. For facility component removals (see III.V.2) in lieu of full containment the use of a secondary containment to facilitate the required air clearance monitoring is recommended, but not required.

III.O. ABATEMENT METHODS

This subsection III.O. applies to [asbestos abatement](#) projects in [areas of public access](#) where the amount of [asbestos-containing material](#) that will be abated exceeds the [trigger levels](#).

The three methods of [asbestos abatement](#) are listed below. Any additional requirements using these methods, other than those already specified in this regulation, are detailed in paragraphs II.O.1., 2., and 3., below.

III.O.1. Removal

III.O.1.a. Controlling Airborne Fiber Release/Emissions

III.O.1.a.(i). Wetting

III.O.1.a.(i).(A). Amended Water

[Amended water](#) shall be used to adequately wet [asbestos-containing materials](#) before [removal](#) is attempted. All waste shall be kept adequately wet with amended water until bagged for disposal. [Surfactants](#) must be a commercially available product specifically designed to be mixed with water for use in wetting of asbestos-containing materials.

III.O.1.a.(i).(B). Airless Sprayers

Airless sprayers shall be used when applying [amended water](#) or encapsulant to [asbestos-containing materials](#).

III.O.1.a.(i).(C). Cold Temperature Wetting

When the temperature at the point of wetting is below freezing (0°C / 32°F):

III.O.1.a.i(C)(1) The [GAC](#) shall apply for a variance from the [Division](#) in accordance with the requirements of subsection III.F. (Alternative Procedures and Variances); or

III.O.1.a.i(C)(2) Remove [facility components](#) coated or covered with [friable asbestos-containing materials](#) as units or in sections in accordance with subparagraph III.V.2. (Removing of Facility Components).

III.O.1.a.i(C)(3) Comply with the requirements of section III. (Abatement, Renovation and Demolition Projects).

III.O.1.a.(ii). HEPA Vacuuming

All vacuuming of contaminated surfaces shall be done with a [HEPA filter](#)-equipped vacuum.

III.O.1.a.(iii). Wet Wiping

Wet wiping of contaminated surfaces prior to disassembly of containment barriers shall be done using rags and a bucket of clean or [amended water](#).

III.O.1.b. Removal of Asbestos from Elevated Heights

For [friable asbestos-containing materials](#) that will be [removed](#) or [stripped](#):

III.O.1.b.(i). [Adequately wet](#) the materials to ensure that they remain wet until they are collected for disposal in accordance with subsection III.R. (Waste Handling),

III.O.1.b.(ii). Carefully lower the packaged [ACM](#) to the ground or a lower floor, not dropping, throwing, sliding, or otherwise damaging or disturbing the ACM;

III.O.1.b.(iii). Transport the materials to the ground via dust-tight chutes or containers if they have been [removed](#) or [stripped](#) more than 50 feet above ground level and were not removed as units or in sections; and

III.O.1.b.(iv). Comply with the requirements of section III. (Abatement, Renovation and Demolition Projects).

III.O.2. Encapsulation

III.O.2.a. When spray-applying encapsulants they shall be applied using only airless spray equipment with nozzle pressure adjustable between four hundred (400) and fifteen hundred (1500) [PSI](#) and in accordance with the manufacturer's recommendations for the particular encapsulant.

III.O.3. Enclosure

III.O.3.a. If [enclosure](#) is chosen as the abatement technique, a solid structure (airtight walls and ceilings) shall be built around the [facility component](#) to prevent the release of [ACM](#) into the area beyond the enclosure and to prevent disturbance of ACM by casual contact during future maintenance operations. A containment barrier need not be erected when constructing an enclosure provided that the ACM will not be disturbed during the building of the enclosure. Such a permanent (i.e., for the life of the building) enclosure shall be built of new construction materials and shall be impact resistant and airtight. Before constructing the enclosure, the [person](#) conducting the [asbestos abatement](#) shall move all active electrical conduits, telephone lines, recessed

lights, and pipes out of the area to be enclosed in order to ensure that the enclosure will not have to be reopened later for routine or [emergency](#) maintenance.

- III.O.3.b. The master floor plans shall indicate the exact location and condition of the enclosed [asbestos](#) and this plan shall be kept in a separate asbestos file with the building superintendent or engineer.

III.P. CLEARING ABATEMENT PROJECTS

This subsection III.P. applies to [asbestos abatement](#) projects in [areas of public access](#), other than [school buildings](#), where the amount of [asbestos-containing material](#) that will be abated exceeds the [trigger levels](#). For clearance requirements in school buildings, see paragraph IV.G.9. (Completion of Response Actions).

The [GAC](#), [certified Air Monitoring Specialist](#), and the building owner shall ensure that all abatement projects are completed as described below.

All [air monitoring](#) and final visual inspections required under this regulation shall be performed by certified Air Monitoring Specialists [independent](#) of the GAC to avoid possible conflict of interest.

III.P.1. Final Visual Inspection

At the conclusion of any abatement action and with only [critical barriers](#) still in place, a [certified Air Monitoring Specialist](#), who is [independent](#) of the [GAC](#), shall visually inspect each [work area](#) where such action was conducted, and behind the critical barriers, to determine whether all dust and debris has been removed. If any such dust or debris is found, the area shall be re-cleaned until no dust or debris is found. If a critical barrier is removed for cleaning purposes, the area behind the critical barrier shall be cleaned and the critical barrier immediately replaced.

III.P.2. [Reserved]

III.P.3. Final Clearance Air Monitoring and Sample Analyses

III.P.3.a. Sample Collection

- III.P.3.a.(i). Once the area has passed a final visual inspection and no dust or debris has been found, the [certified Air Monitoring Specialist](#) shall collect air samples using aggressive sampling as described in 40 C.F.R. Part 763, Appendix A to Subpart E ([EPA](#) 1995), to monitor air for clearance after each abatement project; except that fans and leaf blowers shall not be directed toward any known [friable ACM](#) remaining in the [work area](#).

III.P.3.a.(ii). The total number of clearance air samples required to determine compliance with subsection III.P. (Clearing Abatement Projects) for a state-permitted abatement project involving greater than the [trigger levels](#) of [ACM](#) is indicated in the following table:

For each work area within the project where the amount of ACM is:	State-Permitted Project in Non-School Building		Response Action in School Building	
	Minimum # of samples to clear each of the following:		Minimum # of samples to clear each of the following:	
	Work area	Project	Work Area	Project
Less than 3 square feet/3 linear feet	1	5	5	5
From 3 square feet/3 linear feet up to 32 square feet/50 linear feet/volume equivalent of a 55-gallon drum	2	5	5 PCM or 13 TEM	5 PCM or 13 TEM
Greater than 32 square feet/50 linear feet/volume equivalent of a 55-gallon drum up to 160 square feet/260 linear feet/volume equivalent of a 55-gallon drum	5	5	5 PCM or 13 TEM	5 PCM or 13 TEM
Greater than 160 square feet/260 linear feet/volume equivalent of a 55-gallon drum	5	5	13 TEM	13 TEM

III.P.3.b. Clearance Criteria

III.P.3.b.(i). Except as provided in paragraph III.P.3.b.iii., an abatement action shall be considered complete when the average concentration of [asbestos](#) of five air samples collected within the abatement [work area](#) and analyzed by the [TEM](#) method in 40 C.F.R. Part 763, Appendix A to Subpart E ([EPA](#) 1995), is not statistically significantly different, as determined by the Z-test calculation as found in that Appendix A, from the average asbestos concentration of five air samples collected at the same time outside the abatement work area and analyzed in the same manner, and the average asbestos concentration of the three field blanks described in that Appendix A, is below the filter background level of 70 structures per square millimeter (70 s/mm²).

III.P.3.b.(ii). An action shall also be considered complete if the volume of air drawn for each of the five samples collected within the abatement [work area](#) is equal to or greater than 1,199 L of air for a 25-mm filter, or equal to or greater than 2,799 L of air for a 37-mm filter, and the average concentration of [asbestos](#) as analyzed by the [TEM](#) method in 40 C.F.R. Part 763 Appendix A to Subpart E ([EPA](#) 1995), for the five air samples does not exceed the

filter background level of 70 s/mm², as defined in that Appendix A. If the average concentration of asbestos of the five air samples within the abatement work area exceeds 70 s/mm², or if the volume of air in each of the samples is less than 1,199 liters of air for a 25-mm filter, or less than 2,799 L of air for a 37-mm filter, the action shall be considered complete only when the requirements of subparagraph III.P.3.b.i. or III.P.3.b.iii. of this subsection III.P (Clearing Abatement Projects) are met.

III.P.3.b.(iii). The laboratory may analyze [air monitoring](#) samples collected for clearance purposes by [PCM](#) to confirm completion of [removal](#), [encapsulation](#), or [enclosure](#) of [ACM](#). The action shall be considered complete when the results of samples collected in the abatement [work area](#) and analyzed by PCM using the [NIOSH](#) Method 7400 entitled "Fibers" published in the NIOSH Manual of Analytical Methods, 3rd Edition, Second Supplement, August 1987, show that the concentration of fibers for each of the five samples is less than or equal to a limit of quantification for PCM (0.01 fibers per cubic centimeter, 0.01 [f/cm³](#), 10,000 [f/m³](#)). The analyst doing said analysis shall be NIOSH 582 or 582E trained.

III.P.3.c. Laboratory Accreditation

III.P.3.c.(i). The air samples collected under this subsection III.P. shall be analyzed for [asbestos](#) using laboratories accredited by the National Institute of Standards and Technology to conduct such analysis using [transmission electron microscopy](#) or, under circumstances permitted in this subsection III.P. (Clearing Abatement Projects), laboratories showing successful participation in the American Industrial Hygiene Association Proficiency Analytical Testing (PAT) Program for [phase contrast microscopy](#).

III.P.3.c.(ii). Whenever on-site satellite labs are used for [PCM](#) analysis for final clearance purposes, all [persons](#) conducting said analysis shall be properly trained as an analyst pursuant to the [AIHA](#) Laboratory Quality Assurance Program and shall follow all quality control and quality assurance guidelines as set forth in the [NIOSH](#) Method 7400 entitled "Fibers" published in the NIOSH Manual of Analytical Methods, 3rd Edition, second supplement, August 1987. Satellite labs must be directly under the control of properly accredited laboratories pursuant to the requirements set forth in subparagraph III.P.3.b. (Clearance Criteria) above.

III.Q. TEAR-DOWN

This subsection III.Q. applies to [asbestos abatement](#) projects in [areas of public access](#) where the amount of [asbestos-containing material](#) that will be abated exceeds the [trigger levels](#).

The following tasks shall be performed during the tear-down portion of the abatement project:

- Removal of the [critical barriers](#)
- Removal of [negative air machines](#) (NAMs)
- Disassembly of the [decontamination unit](#)
- Disassembly of the [waste load-out area](#)

III.R. WASTE HANDLING

This subsection III.R. applies to [asbestos abatement](#) projects in [areas of public access](#) and non-public access areas where any amount of [asbestos-containing material](#) has been removed.

III.R.1. Disposal Containers

Disposal containers shall be leak-tight and waterproof when sealed. Disposable bags shall be at least six (6) mils polyethylene.

III.R.2. Handling Waste Material

Each [person](#) handling [asbestos-containing waste material](#) (ACWM) shall:

- III.R.2.a. Seal all [asbestos-containing waste material](#) in leak-tight containers while wet and label the containers in accordance with subsection III.R.2.b. (Labeling), below.

Appropriate containers and procedures shall be used to prevent all breakage, rupture or leakage during loading, shipping, transportation and storage of [asbestos-containing waste material](#).

III.R.2.b. Affix warning labels to all [ACWM](#) or to their containers, with either of the following warnings:

Danger
Contains Asbestos Fibers
Avoid Creating Dust
Cancer and Lung Disease Hazard

Or

Caution
Contains Asbestos
Avoid Opening or Breaking Container
Breathing Asbestos is Hazardous
To Your Health

III.R.2.c. Following an abatement project, temporary storage of [ACWM](#) shall be limited to 500 (five hundred), 55-gallon barrels, or the volumetric equivalent thereof, prior to disposal. Storage is permitted only on property owned or operated by the GAC or building owner. Temporary storage shall not exceed a time period of more than 6 months following the completion of the abatement action.

III.R.2.d. Discharge no [visible emissions](#) during the collection, processing (including incineration), packaging, transportation, or deposition of any [ACWM](#) generated by the source.

III.R.2.e. Dispose of [ACWM](#) in accordance with Colorado Department of Health, Hazardous Materials and Waste Management Division regulations.

III.r.2.f. All [asbestos-containing](#) wastewater shall be filtered to five (5) micrometers prior to discharge and shall be discharged to a sanitary sewer.

III.R.3. Follow the waste shipment procedures in accordance with the provisions of 40 C.F.R. part 61 section 150 ([EPA](#) 1995).

III.S. ABATEMENT OF SPECIAL MATERIALS

This subsection III.S. applies to [asbestos abatement](#) projects in [areas of public access](#) where the amount of [asbestos-containing material](#) that will be abated exceeds the [trigger levels](#).

III.S.1. Resilient Floor Tile and Sheet Vinyl Flooring

III.S.1.a. Pursuant to paragraph III.E. (Notification), the [person](#) conducting the project must notify the [Division](#) of the intent to demolish, renovate, or perform [asbestos abatement](#) in any building, structure, [facility](#) or installation, or any portion thereof, which contains [asbestos](#) in any amount that exceeds the [trigger levels](#) whether [friable](#) or not.

III.S.1.b. [Resilient floor tile](#), [sheet vinyl flooring](#), and associated flooring adhesive which contain [asbestos](#), are [nonfriable](#) unless the material is damaged to the extent that when dry it can be crumbled, pulverized or reduced to powder by hand pressure.

III.S.1.c. Provided that the requirements of Appendix B are followed as required, the requirements of following sections do not apply: section II (Certification Requirements), section III, subsections III.G. (Permits), III.H. (Abatement Sequence), III.I. (Critical Barrier Construction), III.J. (Additional Engineering Controls), III.K. (Decontamination Area), III.L. (Pre-cleaning of Surfaces), III.M. (Covering Fixed Objects), III.N. (Containment Components), III.O. (Abatement Methods), III.P. (Clearing Abatement Projects), and III.Q. (Tear-Down).

If a [person](#) grinds, mechanically chips, drills, sands, beadblasts, sandblasts, mechanically powders the material or otherwise damages such material to render it [friable](#), and the amount of the material exceeds the [trigger levels](#), then the following sections do apply: sections I (Definitions), II (Certification Requirements) and III (Abatement, Renovation and Demolition Projects).

III.S.1.d. Sheet Vinyl Flooring

If utilizing the work practices set forth in Appendix B for the [removal](#) of [sheet vinyl flooring](#), any Workers removing the flooring must have successfully completed an 8-hour employee training course which meets the training requirements for flooring Workers set forth in Appendix C to this regulation; furthermore, individuals supervising the removal of sheet vinyl flooring materials must have successfully completed the 8-hour employee training course and an additional training course for Supervisors which meets the training requirements for flooring Supervisors set forth in Appendix C to this regulation.

III.S.2. Asbestos Cement Products

Transite roofing shingles, transite siding and other [asbestos](#) cement products that remain [nonfriable](#) during [removal](#) are subject to the requirements of subsection III.E. (Notifications). The transite roofing shingles, transite siding, or other asbestos cement products must be removed in accordance with paragraph III.S.4. (Other Nonfriable Asbestos-Containing Materials), below. If the transite roofing shingles, siding, other asbestos cement products become [friable](#) during removal, then sections

I. (Definitions), II. (Certification Requirements), and III. (Abatement, Renovation and Demolition Projects) apply.

III.S.3. Asphaltic Materials

Tar impregnated roofing felts, asphalt roofing tiles, roofing asphalts, roofing mastics, and asphaltic pipeline coatings that are [nonfriable](#) and will remain nonfriable during abatement are exempt from this regulation.

III.S.4. Other Nonfriable Asbestos-Containing Materials

- III.S.4.a. Adequately wet the surface areas of the [nonfriable ACM](#) to prevent dust emissions throughout the removal process.
- III.S.4.b. Remove the materials using hand removal methods or power tools that do not subject the material to [cutting](#), [grinding](#), sanding, beadblasting, sandblasting, or otherwise damage the material in such a way as to render it [friable](#).
- III.S.4.c. Remove the material carefully with minimal breakage and disturbance.
- III.S.4.d. If the [nonfriable](#) material is to be disposed of, then it must be transported to the landfill that will accept nonfriable [ACM](#). The landfill must be contacted prior to disposal to ensure that the nonfriable ACM is transported and packaged in accordance with the landfill's specific policy or regulation. If the materials have been rendered [friable](#), they must be disposed of as friable [asbestos-containing waste materials](#) pursuant to subsection III.R. (Waste Handling).

III.S.5. Asbestos-Contaminated Soil

Any soil containing visible [friable asbestos-containing material](#) or any soil with greater than 1% [friable asbestos](#) content in the top 1" of soil is, for the purposes of this subsection, asbestos-contaminated soil. Where the surface area of the asbestos-contaminated soil exceeds the [trigger levels](#), or the volume of contaminated soil to be removed exceeds the volume equivalent of a 55-gallon drum, the [GAC](#) and the building owner shall comply with all of the requirements in subsection III.T. (Asbestos Spill Response), and shall remove gross, visible surface debris, and either remove the top 2" of soil, or seal the area with concrete or other impenetrable material.

III.T. ASBESTOS SPILL RESPONSE

The following procedures apply to all [areas of public access](#), except [school buildings](#), in which there has been a release of [asbestos](#) fibers due to a breach of the containment barrier on an abatement project, or due to any cause other than abatement of asbestos. For fiber releases in [schools](#), see section IV. (School Requirements).

III.T.1. Major Asbestos Spills

In the event of an [asbestos spill](#) involving greater than the [trigger levels](#), the building owner or contractor shall:

- III.T.1.a. Restrict access to the area and post warning signs to prevent entry to the area by [persons](#) other than those necessary to respond to the incident.
- III.T.1.b. Shut off or temporarily modify the air handling system to prevent the distribution of [asbestos](#) fibers to other areas.
- III.T.1.c. Immediately contact the [Division](#) by telephone, submit a notification in compliance with subsection III.E. (Notifications) and, if in an [area of public access](#), apply for a permit in accordance with subsection III.G. (Permits).
- III.T.1.d. Be exempted from the requirements to have a [certified](#) Supervisor on-site at all times, until such time as the immediate danger has passed. Any cleanup or [asbestos abatement](#) that must occur after the immediate danger has passed shall be supervised by a [person](#) certified by the [Division](#).
- III.T.1.e. Using [certified](#) Supervisors and certified Workers in accordance with section II. (Certification Requirements) of this Regulation, seal all openings between the contaminated and uncontaminated areas and establish negative air pressure within the contaminated area in accordance with paragraph III.J. (Air Cleaning and Negative Pressure Requirements). This is to be accomplished using polyethylene sheeting to cover areas such as doorways, windows, elevator openings, corridor entrances, grills, drains, grates, diffusers and skylights.
- III.T.1.f. [HEPA vacuum](#) or steam clean all carpets, drapes, upholstery, and other non-clothing fabrics in the contaminated area, or discard these materials.
- III.T.1.g. Launder or discard contaminated clothing in accordance with subsection III.R. (Waste Handling).
- III.T.1.h. [HEPA vacuum](#) or wet clean all surfaces in the contaminated area.
- III.T.1.i. Discard all materials in accordance with subsection III.R. (Waste Handling).
- III.T.1.j. Following completion of subparagraph III.T.1.a. through III.T.1.i. above, comply with [air monitoring](#) requirements as described in subsection III.P. (Clearing Abatement Projects); air samples shall be collected aggressively as described in 40 C.F.R. Part 763, Appendix A to Subpart E ([EPA 1995](#)), except that the air stream of the leaf blower shall not be directed at any [friable ACM](#) that remains in the area.
- III.T.1.k. Comply with any other measures deemed necessary by the [Division](#) to protect public health.

III.T.2. Minor Asbestos Spills

In the event of an [asbestos spill](#) involving less than or equal to the [trigger levels](#), the building owner or contractor should take the following non-mandatory steps:

- III.T.2.a. Restrict entry to the area and post warning signs to prevent entry to the area by [persons](#) other than those necessary to respond to the incident.
- III.T.2.b. Shut off or temporarily modify the air handling system to prevent the distribution of fibers to other areas in the building.
- III.T.2.c. Seal all openings between the contaminated and uncontaminated areas. This is to be accomplished by using polyethylene sheeting to cover all areas such as windows, doorways, elevator openings, corridor entrances, drains, grills, grates, diffusers and skylights.
- III.T.2.d. [HEPA vacuum](#) or steam clean all carpets, draperies, upholstery and other non-clothing fabrics in the contaminated area, or discard all contaminated materials in accordance with subsection III.R. (Waste Handling).
- III.T.2.e. Launder or discard contaminated clothing in accordance with subsection III.R. (Waste Handling).
- III.T.2.f. [HEPA vacuum](#) or wet clean all non-fabric surfaces in the contaminated area.
- III.T.2.g. Following completion of subparagraphs III.T.2.a. through III.T.2.f. above, conduct [air monitoring](#) as described in paragraph III.P.3. (Final Clearance Air Monitoring and Sample Analyses); air samples shall be collected aggressively as described in 40 C.F.R. Part 763, Appendix A to Subpart E ([EPA](#) 1995), except that the air stream of the leaf blower shall not be directed at any [friable ACM](#) that remains in the [work area](#).

III.U. MAXIMUM ALLOWABLE ASBESTOS LEVEL

At any time, the maximum allowable asbestos level (MAAL) shall not be exceeded in any [area of public access](#).

All [air monitoring](#) required under this regulation shall be performed by [certified Air Monitoring Specialists independent](#) of the [GAC](#) to avoid possible conflict of interest.

III.U.1. Monitoring for the MAAL

III.U.1.a. During Normal Occupancy

For purposes of this paragraph III.U.1, [air monitoring](#) shall be conducted during normal occupancy and samples shall not be collected in an aggressive manner.

III.U.1.b. During Abatement

III.U.1.b.(i). Exhausting NAMs in a Building

If air from [negative air machines \(NAMs\)](#) must be exhausted to the interior of the building, air samples must be taken and analyzed by [PCM](#) or any equivalent method approved by the [Division](#) at least every day and meet the requirements of subsection III.U. (Maximum Allowable Asbestos Level) to ensure that there is no breach in the filtering system. In the event that the maximum allowable [asbestos](#) level is exceeded, all of the requirements of subsection III.T. (Asbestos Spill Response) must be met.

III.U.1.b.(ii). Outside Containment (Non-mandatory)

In the event that airborne fiber levels outside a containment in an [area of public access](#) exceed the [MAAL](#) when analyzed by [PCM](#), the [GAC](#) shall either treat the affected area as an [asbestos spill](#) and comply with all the requirements in subsection III.T. (Asbestos Spill Response) or, reanalyze the samples by [transmission electron microscopy](#) analysis in accordance with 40 C.F.R. Part 763, Appendix A to Subpart E ([EPA](#) 1995), within 24 hours. If the MAAL is exceeded by [TEM](#), comply with section III.T. (Asbestos Spill Response).

III.U.2. The Maximum Allowable Asbestos Level (MAAL)

III.U.2.a. PCM

If [PCM](#) is used as the method of analysis the standard is 0.01 fibers per cubic centimeter of air (f/cc), which is equivalent to 10,000 fibers per cubic meter of air (f/m³). The [NIOSH](#) 7400 Method entitled "Fibers" published in the NIOSH Manual of Analytical Methods, 3rd Edition, Second Supplement, August 1987, shall be used to analyze samples. The number of samples to be taken shall be determined by the [certified Air Monitoring Specialist](#).

III.U.2.b. TEM

Where [TEM](#) is used as the method of analysis, the standard is 70 structures/millimeter² (s/mm²). TEM analysis shall be conducted pursuant to the protocol in 40 C.F.R. Part 763, Appendix A to Subpart E ([EPA](#) 1995).

III.U.2.c. Elevated Ambient Levels

Notwithstanding the provisions of clauses III.U.1.b.i. and III.U.1.b.ii. above, if the [asbestos](#) level in the outside ambient air which is adjacent to an asbestos project site or [area of public access](#) exceeds 70 s/mm² using [TEM](#) analysis or 0.01 fibers per cubic centimeter of air (10,000 f/m³) using [PCM](#) analysis, whichever is applicable, the existing asbestos level in such air shall be the maximum allowable asbestos level.

III.U.3. What to do if the MAAL is Exceeded

III.U.3.a. Second Set by TEM

In the event that airborne [asbestos](#) fiber levels exceed the [MAAL](#) when analyzed by [PCM](#), a second set of samples may be collected during normal occupancy, analyzed by [transmission electron microscopy](#) analysis, and calculated as an eight-hour time-weighted average ([TWA](#)) in accord with 29 C.F.R. Part 1910.1000(d)(1)(i), before any order of abatement is issued. The [TEM](#) sample(s) shall be collected in the same location(s) as the original PCM sample(s) and analyzed within 24 hours of the PCM sample(s).

III.U.3.b. Outside Containment

In the event that airborne fiber levels outside a containment in an [area of public access](#) exceed the [MAAL](#) when analyzed by [PCM](#), the GAC shall either treat the affected area as an [asbestos spill](#) and comply with all the requirements in subparagraph III.T. (Asbestos Spill Response) or, reanalyze the samples by [transmission electron microscopy](#) analysis in accordance with 40 C.F.R. Part 763, Appendix A to Subpart E ([EPA 1995](#)), within 24 hours. If the MAAL is exceeded by [TEM](#), comply with subparagraph III.T. (Asbestos Spill Response).

III.V. SPECIAL REMOVAL METHODS

This subsection III.V. applies to [asbestos abatement](#) projects in [areas of public access](#) where the amount of [asbestos-containing material](#) that will be abated exceeds the [trigger levels](#).

III.V.1. Glovebag Removal

[Glovebag](#) removal methods shall only be allowed where the glovebag can be installed such that it completely surrounds the [ACM](#) to be removed without causing a fiber release.

III.V.1.a. Glovebags shall be at least 6 mil polyethylene in thickness and shall be seamless at the bottom.

III.V.1.b. Glovebags shall not be used in situations where the glovebag could come into contact with surfaces that exceed 150° Fahrenheit.

III.V.1.c. Glovebags may be used only once and may not be moved.

III.V.1.d. For glovebag removals the GAC shall:

III.V.1.d.(i). erect [secondary containment](#) barriers where the amount of [ACM](#) to be removed in a [functional space](#) exceeds three (3) linear or three (3) square feet. In the event of a spill or a breach of the glovebag, the entire area

enclosed by the secondary containment shall be cleaned utilizing [HEPA vacuuming](#) and wet wiping with all debris, filters, mop heads, and cloths disposed of as [ACWM](#) in leak tight containers.

- III.V.1.d.(ii). tape or otherwise seal the glovebag to the area from which [asbestos](#) is to be removed. Glovebags shall be smoke tested for leaks and any leaks sealed prior to use.
- III.V.1.d.(iii). adequately wet, then remove, the [asbestos-containing material](#) from the surface.
- III.V.1.d.(iv). adequately wet any [asbestos-containing material](#) that has fallen from the surface into the enclosed bag using an airless sprayer and [amended water](#), or other materials or equipment equally effective in wetting.
- III.V.1.d.(v). thoroughly clean and wet wipe the surface until no traces of [asbestos-containing material](#) can be seen.
- III.V.1.d.(vi). encapsulate the rough edges of any [asbestos-containing material](#) that will remain on the surface after the glovebag has been removed. This shall be done prior to the removal of the glovebag.
- III.V.1.d.(vii). evacuate the air from the glovebag using a [HEPA filter](#)-equipped vacuum prior to removing the glovebag.
- III.V.1.d.(viii). ensure that the final visual inspection and clearance [air monitoring](#) requirements of subsection III.P. (Clearing Abatement Projects) are met.
- III.V.1.d.(ix). handle and dispose of all waste materials as required in subsection III.R. (Waste Handling).

III.V.2. Facility Component Removal

Only those [facility components](#) in which the [ACM](#) is well adhered to the component may be taken out of the [facility](#) as units or in sections and be exempt from the containment requirements in subsection III.N. (Containment Components) provided that the [GAC](#):

- III.V.2.a. [Adequately wet](#) the [facility component](#) pursuant to subparagraph III.O.1.a.(i). (Wetting) then wrap the facility component in six (6) mil polyethylene prior to removing the facility component; and
- III.V.2.b. Ensure that the abatement project is cleared as required in subsection III.P. (Clearing Abatement Projects) and that the [ACWM](#) is disposed of as required in subsection III.R. (Waste Handling). NOTE: The use of a [secondary containment](#) to facilitate the required air clearance monitoring is recommended, but not required.

- III.V.2.c. Once the components are taken out of the [facility](#), if the components are to be [stripped](#), comply with sections I. (Definitions), II. (Certification Requirements) and III. (Abatement, Renovation and Demolition Projects).

III.W. STRUCTURALLY UNSOUND BUILDINGS

For facilities described in subparagraph III.E.1.e., the [Division](#) may suspend any abatement work practice requirements, the implementation of which may endanger personnel who will be removing [asbestos](#) from the [facility](#). The GAC shall apply for a variance from the Division in accordance with the requirements of subsection III.F. (Alternative Procedures and Variances). During wrecking operations, that portion of the facility that contains [friable asbestos-containing material](#) must be kept adequately wet commencing from prior to the [demolition](#) through delivery of the [demolition](#) debris to a landfill that will accept [friable ACM](#).

III.X. EXEMPTIONS

The following sections of the regulation contain exemptions from certain requirements. Please refer to the indicated section for the specific details of the exemption.

- If the [asbestos-containing material](#) to be abated is less than the [trigger levels](#), then only subsection III.R. (Waste Handling) applies in section III.
- Inspection requirements may be exempt if an architect or Building Inspector certifies a building constructed after October 12, 1988 to be asbestos-free. See subparagraph III.A.1.d.
- If you own a [SFRD](#) that is your primary residence and you choose to do the abatement yourself, certification is not required. See subparagraph III.B.1.c.
- A Project Manager doesn't need to be [independent](#) of the [GAC](#) if the project manager is working in-house. See paragraph III.D.2.
- If you own [SFRD](#), which is your primary residence, you may opt out of having your SFRD deemed an [area of public access](#). See paragraph III.E.2.
- There are three situations in which a [NAM](#) does not have to be fitted with a [HEPA](#) filter. See subparagraph III.J.1.c.
- Certain materials are exempted from many of the abatement requirements. See subsection III.S (Abatement of Special Materials).
- During an emergency, the requirement for a certified Supervisor to be on-site may be temporarily suspended. See subparagraph III.T.1.d.
- While performing facility component removal, full containment is not required. See paragraph III.V.2 (Facility Component Removal).

All underlined text in this regulation indicates defined terms.

IV. SCHOOL REQUIREMENTS

IV.A. SCOPE AND PURPOSE

The requirements in this section of the regulation mirrors the Asbestos Hazard Emergency Response Act of 1986 (AHERA) (15 U.S.C. 2646) that was enacted to identify, manage and reduce exposure to asbestos in schools.

This section of the regulation requires local education agencies to identify friable and nonfriable asbestos-containing material (ACM) in public and private elementary and secondary schools by visually inspecting school buildings for such materials, sampling such materials if they are not assumed to be ACM, and having samples analyzed by appropriate techniques referred to in this rule. The rule requires local education agencies to submit management plans to the Colorado Department of Public Health and Environment, Air Pollution Control Division by October 12, 1988, or if a deferral is applied for and received from the Division, May 9, 1989. The LEA must begin to implement the plans by July 9, 1989, and complete implementation of the plans in a timely fashion. In addition, local education agencies are required to use persons who have been certified to conduct inspections, reinspections, develop management plans, or perform response actions. The rule also includes recordkeeping requirements. LEAs may contractually delegate their duties under this rule, but they remain responsible for the proper performance of those duties. Local education agencies are encouraged to consult with the EPA Regional Asbestos Coordinator or the Division for assistance in complying with this rule.

- IV.A.1. Local education agencies must provide for the transportation of asbestos in accordance with section III of this regulation. Disposal of asbestos-containing waste is governed by rules promulgated by the Colorado Board of Health, and implemented by the Department's Hazardous Materials and Waste Management Division.

IV.B. GENERAL LEA RESPONSIBILITIES

Each LEA shall:

- IV.B.1. Ensure that the activities of any persons who perform inspections, reinspections, and periodic surveillance, develop and update management plans, and develop and implement response actions, including operations and maintenance, are carried out in accordance with section IV of this Regulation No. 8.
- IV.B.2. Ensure that all custodial and maintenance employees are properly trained as required by this section IV and other applicable Federal and/or State regulations (e.g., the Occupational Safety and Health Administration asbestos standard for construction, and the EPA Worker protection rule.)
- IV.B.3. Ensure that workers and building occupants, or their legal guardians, are informed at least once each school year about inspections, response actions, and post-response

- [action](#) activities, including periodic reinspection and surveillance activities that are planned or in progress.
- IV.B.4. Ensure that short-term workers (e.g., telephone repair workers, utility workers, or exterminators) who may come in contact with [asbestos](#) in a [school](#) are provided information regarding the locations of [ACBM](#) and suspected ACBM assumed to be [ACM](#). Documentation of these notifications shall become part of the management plan.
- IV.B.5. Ensure that warning labels are posted in accordance with subsection IV.L.(Warning Labels).
- IV.B.6. Ensure that management plans are available for inspection and notification of such availability has been provided as specified in the management plan under subsection IV.J. (School Management Plans)
- IV.B.7. Designated Person
- IV.B.7.a. Designate a [person](#) to ensure that requirements under this section are properly implemented.
- IV.B.7.b. Ensure that the designated [person](#) receives adequate training to perform duties assigned under section IV.B. Such training shall provide, as necessary, basic knowledge of:
- IV.B.7.c. Health effects of [asbestos](#).
- IV.B.7.c.(i). Detection, identification, and [assessment](#) of [ACM](#).
- IV.B.7.c.(ii). Options for controlling [ACM](#).
- IV.B.7.c.(iii). [Asbestos](#) management programs.
- IV.B.7.c.(iv). Relevant Federal and State regulations concerning [asbestos](#), including those in this [Commission](#) Regulation No. 8 and those of the Occupational Safety and Health Administration, U.S. Department of Labor, the U.S. Department of Transportation and the U.S. Environmental Protection Agency.
- IV.B.8. Consider whether any conflict of interest may arise from the interrelationship among [certified](#) personnel and whether that should influence the selection of certified personnel to perform activities under this section.

IV.C. INSPECTION AND REINSPECTION

IV.C.1. Inspection

- IV.C.1.a. Except as provided in subparagraph b below, before October 12, 1988 or by May 9, 1989, if a deferral has been applied for and received from the [Division](#), local education agencies shall inspect each [school building](#) that they lease, own, or otherwise use as a school building to identify all locations of [friable](#) and [nonfriable ACM](#).
- IV.C.1.b. Any building leased or acquired on or after October 12, 1988, that is to be used as a [school building](#) shall be inspected as described under paragraphs c and d below prior to use as a school building. In the event that [emergency](#) use of an uninspected building as a school building is necessitated, such buildings shall be inspected within 30 days after commencement of such use.
- IV.C.1.c. Each inspection shall be made by a [certified](#) Inspector.
- IV.C.1.d. For each area of a [school building](#), except as excluded under subsection IV.M. (Exclusions), each [person](#) performing an inspection shall:
- IV.C.1.d.(i). Visually inspect the area to identify the locations of all suspected [ACM](#).
 - IV.C.1.d.(ii). Touch all suspected [ACM](#) to determine whether they are [friable](#).
 - IV.C.1.d.(iii). Identify all [homogeneous areas](#) of [friable](#) suspected [ACBM](#) and all homogeneous areas of [nonfriable](#) suspected [ACM](#).
 - IV.C.1.d.(iv). Assume that some or all of the [homogeneous areas](#) are [ACM](#), and, for each homogeneous area that is not assumed to be ACM, collect and submit for analysis bulk samples under subsections IV.D. (Sampling) and IV.E. (Analysis).
 - IV.C.1.d.(v). Assess, under subsection IV.F. (Assessment), [friable](#) material in areas where samples are collected, friable material in areas that are assumed to be [ACM](#), and [friable ACM](#) identified during a previous inspection.
 - IV.C.1.d.(vi). Record the following and submit to the [person](#) designated under subsection IV.B. (General LEA Responsibilities) a copy of such record for inclusion in the management plan within 30 days of the inspection:
 - IV.C.1.d.(vi).(A). An inspection report with the date of the inspection signed by each [certified person](#) making the inspection, and his or her certification number.
 - IV.C.1.d.(vi).(B). An inventory of the locations of the [homogeneous areas](#) where samples are collected, exact location where each bulk sample is collected, dates that samples are collected, homogeneous areas

where [friable](#) suspected [ACBM](#) is assumed to be [ACM](#), and homogeneous areas where [nonfriable](#) suspected [ACBM](#) is assumed to be [ACM](#).

IV.C.1.d.(vi).(C). A description of the manner used to determine sampling locations, the name and signature of each [certified](#) Inspector who collected the samples, and his or her certification number.

IV.C.1.d.(vi).(D). A list of whether the [homogeneous areas](#) identified under subclause IV.C.1.d.(vi)(B) above are [surfacing material](#), [thermal system insulation](#), or [miscellaneous material](#).

IV.C.1.d.(vi).(E). [Assessments](#) made of [friable](#) material, the name and signature of each [certified](#) Inspector making the assessment, and his or her certification number.

IV.C.2. Reinspection

IV.C.2.a. At least once every three years after a management plan is in effect, each [LEA](#) shall conduct a reinspection of all [friable](#) and [nonfriable](#) known or assumed [ACBM](#) in each [school building](#) that they lease, own, or otherwise use as a school building.

IV.C.2.b. Each inspection shall be made by a [certified](#) Inspector.

IV.C.2.c. For each area of a [school building](#), each [person](#) performing a reinspection shall:

IV.C.2.c.(i). Visually reinspect, and reassess, under subsection IV.F. (Assessment) the condition of all [friable](#) known or assumed [ACBM](#).

IV.C.2.c.(ii). Visually inspect material that was previously considered [nonfriable](#) [ACBM](#) and touch the material to determine whether it has become [friable](#) since the last inspection or reinspection.

IV.C.2.c.(iii). Identify any [homogeneous areas](#) with material that has become [friable](#) since the last inspection or reinspection.

IV.C.2.c.(iv). For each [homogeneous area](#) of newly [friable](#) material that is already assumed to be [ACBM](#), bulk samples may be collected and submitted for analysis in accordance with subsections IV.D. (Sampling) and IV.E. (Analysis).

IV.C.2.c.(v). Assess, under subsection IV.F. (Assessment), the condition of the newly [friable](#) material in areas where samples are collected, and newly friable materials in areas that are assumed to be [ACBM](#).

- IV.C.2.c.(vi). Reassess, under subsection IV.F. (Assessment), the condition of [friable](#) known or assumed [ACBM](#) previously identified.
- IV.C.2.c.(vii). Record the following and submit to the [person](#) designated under subsection IV.B. (General LEA Responsibilities), a copy of such record for inclusion in the management plan within 30 days of the reinspection:
- IV.C.2.c.(vii).(A). The date of the reinspection, the name and signature of the [person](#) making the reinspection, his or her certification number, and any changes in the condition of known or assumed [ACBM](#).
- IV.C.2.c.(vii).(B). The exact locations where samples are collected during the reinspection, a description of the manner used to determine sampling locations, the name and signature of each [certified](#) Inspector who collected the samples, and his or her certification number.
- IV.C.2.c.(vii).(C). Any [assessments](#) or [reassessments](#) made of [friable](#) material, the name and signature of the [certified](#) Inspector making the assessments, and his or her certification number.

IV.C.3. General

[Thermal system insulation](#) that has retained its structural integrity and that has an undamaged protective jacket or wrap that prevents fiber release shall be treated as [nonfriable](#) and therefore is subject only to periodic surveillance and [preventive measures](#) as necessary.

IV.D. SAMPLING

IV.D.1. Surfacing Material

A [certified](#) Inspector shall collect, in a statistically random manner that is representative of the [homogeneous area](#), bulk samples from each homogeneous area of [friable surfacing material](#) that is not assumed to be [ACM](#), and shall collect the samples as follows:

- IV.D.1.a. At least three bulk samples shall be collected from each [homogeneous area](#) that is 1,000 ft², or less, except as provided in subparagraph IV.E.3.b.
- IV.D.1.b. At least five bulk samples shall be collected from each [homogeneous area](#) that is greater than 1,000 ft² but less than or equal to 5,000 ft², except as provided in subparagraph IV.E.3.b.
- IV.D.1.c. At least seven bulk samples shall be collected from each [homogeneous area](#) that is greater than 5,000 ft², except as provided in subparagraph IV.E.3.b.

IV.D.1.d. Sampling of [friable surfacing materials](#) should follow the guidance provided in the [EPA](#) publication "Simplified Sampling Scheme for Friable Surfacing Materials" (EPA 560/5-85-030a) (1985).

IV.D.2. Thermal System Insulation

IV.D.2.a. Except as provided in paragraphs IV.D.2.b. through IV.D.2.d. below, a [certified](#) Inspector shall collect, in a randomly distributed manner, at least three bulk samples from each [homogeneous area](#) of [thermal system insulation](#) that is not assumed to be [ACM](#).

IV.D.2.b. Collect at least one bulk sample from each [homogeneous area](#) of patched [thermal system insulation](#) that is not assumed to be [ACM](#) if the patched section is less than 6 linear or square feet.

IV.D.2.c. In a manner sufficient to determine whether the material is [ACM](#) or not ACM, collect bulk samples from each insulated mechanical system that is not assumed to be ACM where cement or plaster is used on fittings such as tees, elbows, or valves, except as provided under subparagraph IV.E.3.b., analysis.

IV.D.2.d. Bulk samples are not required to be collected from any [homogeneous area](#) where the [certified](#) Inspector has determined that the [thermal system insulation](#) is fiberglass, foam glass, rubber, or other non-[ACBM](#).

IV.D.3. Miscellaneous Material

In a manner sufficient to determine whether material is [ACM](#) or not ACM, a [certified](#) Inspector shall collect bulk samples from each [homogeneous area](#) of [friable miscellaneous material](#) that is not assumed to be ACM.

IV.D.4. Nonfriable suspected ACBM

If any [homogeneous area](#) of [nonfriable](#) suspected [ACBM](#) is not assumed to be [ACM](#), then a [certified](#) Inspector shall collect, in a manner sufficient to determine whether the material is ACM or not ACM, bulk samples from the homogeneous area of nonfriable suspected ACBM that is not assumed to be ACM.

IV.E. ANALYSIS

IV.E.1. Local education agencies shall have bulk samples, collected under subsection IV.D. (Sampling) and submitted for analysis, analyzed for [asbestos](#) using laboratories accredited by the National Institute of Standards and Technology ([NIST](#)). Local education agencies shall use laboratories which have received interim accreditation for [polarized light microscopy analysis](#) under the [EPA](#) Interim Asbestos Bulk Sample Analysis Quality Assurance Program until the National Institute of Standards and Technology (NIST) [PLM](#) laboratory accreditation program for PLM is operational.

IV.E.2. Bulk samples shall not be composited for analysis and shall be analyzed for [asbestos](#) content by [PLM](#), using the United States Environmental Protection Agency's August 1994 Method [EPA/600/R-93/116](#), "Method for the Determination of Asbestos in Bulk Building Materials."

IV.E.3. Interpreting Bulk Sample Results

IV.E.3.a. A [homogeneous area](#) is considered not to contain [ACM](#) only if the results of all samples required to be collected from the area show [asbestos](#) in amounts of one percent or less.

IV.E.3.b. A [homogeneous area](#) shall be determined to contain [ACM](#) based on a finding that the results of at least one sample collected from that area shows that [asbestos](#) is present in an amount greater than one percent.

IV.E.4. The name and address of each laboratory performing an analysis, the date of analysis, and the name and signature of the [person](#) performing the analysis shall be submitted to the person designated under subsection IV.B. (General LEA Responsibilities) for inclusion into the management plan within 30 days of the analysis.

IV.F. ASSESSMENT

IV.F.1. [Untitled]

IV.F.1.a. For each inspection and reinspection conducted under paragraph IV.C.1. and IV.C.2. (Inspections/Reinspections), and previous inspections specified under subsection IV.M. (Exclusions), the [LEA](#) shall have a [certified](#) Inspector provide a written [assessment](#) of all [friable](#) known or assumed [ACBM](#) in the [school building](#).

IV.F.1.b. Each [certified](#) Inspector providing a written [assessment](#) shall sign and date the assessment, provide his or her certification number, and submit a copy of the assessment to the [person](#) designated under subsection IV.B. (General LEA Responsibilities) for inclusion in the management plan within 30 days of the assessment.

IV.F.2. The Inspector shall classify and give reasons in the written [assessment](#) for classifying the [ACBM](#) and suspected ACBM assumed to be [ACM](#) in the [school building](#) into one of the following categories:

IV.F.2.a. [Damaged or significantly damaged thermal system insulation ACM.](#)

IV.F.2.b. [Damaged friable surfacing ACM.](#)

IV.F.2.c. [Significantly damaged friable surfacing ACM.](#)

IV.F.2.d. [Damaged](#) or [significantly damaged friable miscellaneous ACM.](#)

- IV.F.2.e. [ACBM](#) with [potential](#) for damage.
- IV.F.2.f. [ACBM](#) with [potential](#) for significant damage.
- IV.F.2.g. Any remaining [friable ACBM](#) or friable suspected [ACBM](#).

IV.F.3. [Assessment](#) may include the following considerations:

- IV.F.3.a. Location and the amount of the material, both in total quantity and as a percentage of the [functional space](#).
- IV.F.3.b. Condition of the material, specifying:
 - IV.F.3.b.(i). Type of damage or significant damage (e.g., flaking, blistering, water damage, or other signs of physical damage).
 - IV.F.3.b.(ii). Severity of damage (e.g., major flaking, severely torn jackets, as opposed to occasional flaking, minor tears to jackets).
 - IV.F.3.b.(iii). Extent or spread of damage over large areas or large percentages of the [homogeneous area](#).
- IV.F.3.c. Whether the material is [accessible](#).
- IV.F.3.d. The material's potential for disturbance.
- IV.F.3.e. Known or suspected causes of damage or significant damage (e.g., [air erosion](#), vandalism, [vibration](#), water).
- IV.F.3.f. [Preventive measures](#), which might eliminate the reasonable likelihood of undamaged [ACM](#) from becoming significantly damaged.
- IV.F.3.g. The [LEA](#) shall select a [person certified](#) to develop management plans to review the results of each inspection, reinspection, and [assessment](#) for the [school building](#) and to conduct any other necessary activities in order to recommend in writing to the [LEA](#) appropriate [response actions](#). The certified person shall sign and date the recommendation, and provide his or her certification number, and submit a copy of the recommendation to the person in the management plan.

IV.G. RESPONSE ACTIONS

- IV.G.1. The [LEA](#) shall select and implement in a timely manner the appropriate [response actions](#) in this section consistent with the [assessment](#) conducted in subsection IV.F. The response actions selected shall be sufficient to protect human health and the environment. The LEA may then select, from the response actions, which protect human health and the environment, that action which is the least burdensome method. Nothing in this section shall be construed to prohibit [removal](#) of [ACBM](#) from a

school building at any time, should removal be the preferred response action of the LEA.

- IV.G.2. If damaged or significantly damaged thermal system insulation ACM is present in a building, the LEA shall:
- IV.G.2.a. At least repair the damaged area.
 - IV.G.2.b. Remove the damaged material if it is not feasible, due to technological factors, to repair the damage.
 - IV.G.2.c. Maintain all thermal system insulation ACM and its covering in an intact state and undamaged condition.
- IV.G.3. Selecting the Response Action
- IV.G.3.a. If damaged friable surfacing ACM or damaged friable miscellaneous ACM is present in a building, the LEA shall select from among the following response actions: encapsulation, enclosure, removal, or repair of the damaged material.
 - IV.G.3.b. In selecting the response action from among those, which meet the definitional standards in subsection IV.I. (Training & Periodic Surveillance) the LEA shall determine which of these response actions protects human health and the environment. For purposes of determining which of these response actions are the least burdensome, the LEA may then consider local circumstances, including occupancy and use patterns within the school building, and its economic concerns, including short- and long-term costs.
- IV.G.4. If significantly damaged friable surfacing ACM or significantly damaged friable miscellaneous ACM is present in a building the LEA shall:
- IV.G.4.a. Immediately isolate the functional space and restrict access, unless isolation is not necessary to protect human health and the environment.
 - IV.G.4.b. Remove the material in the functional space or, depending upon whether enclosure or encapsulation would be sufficient to protect human health and the environment, enclose or encapsulate.
- IV.G.5. If any friable surfacing ACM, thermal system insulation ACM, or friable miscellaneous ACM that has potential for damage is present in a building, the LEA shall at least implement an operations and maintenance (O&M) program, as described under subsection IV.H. (Operations & Maintenance).
- IV.G.6. If any friable surfacing ACM, thermal system insulation ACM, or friable miscellaneous ACM that has potential for significant damage is present in a building, the LEA shall:

- IV.G.6.a. Implement an [O&M](#) program, as described under subsection IV.H. (Operations & Maintenance).
- IV.G.6.b. Institute [preventive measures](#) appropriate to eliminate the reasonable likelihood that the [ACM](#) or its covering will become significantly damaged, deteriorated, or delaminated.
- IV.G.6.c. Remove the material as soon as possible if appropriate [preventive measures](#) cannot be effectively implemented, or unless other [response actions](#) are determined to protect human health and environment. Immediately isolate the area and restrict access if necessary to avoid an imminent and substantial endangerment to human health or the environment.
- IV.G.7. [Response actions](#) including [removal](#), [encapsulation](#), [enclosure](#), or [repair](#), other than small-scale, short-duration repairs, shall be designed and conducted by [persons certified](#) to design and conduct response actions.
- IV.G.8. The requirements of this section IV of Regulation No. 8 in no way supersede the Worker protection and work practice requirements under 29 C.F.R. 1926.58 (Occupational Safety and Health Administration (OSHA 1988) Asbestos, 40 C.F.R. Part 763, Subpart G ([EPA](#) 1995) (Asbestos Abatement Projects), and 40 C.F.R. Part 61, Subpart M (EPA 1995) (National Emission Standards for Hazardous Air Pollutants-Asbestos) and section III of this regulation.
- IV.G.9. Completion of Response Actions.
- IV.G.9.a. At the conclusion of any action to remove, encapsulate, or enclose [ACBM](#) or material assumed to be ACBM, a [person](#) designated by the [LEA](#) shall visually inspect each [functional space](#) where such action was conducted to determine whether the action has been properly completed.
- IV.G.9.b. Collection and Analysis of Air Samples
- IV.G.9.b.(i). A [person](#) designated by the [LEA](#) shall collect air samples using aggressive sampling as described in 40 C.F.R. 763, Appendix A to Subpart E ([EPA](#) 1995), to monitor air for clearance after each [removal](#), [enclosure](#) and [encapsulation](#) project involving [ACBM](#), except for projects that are less than three square or three linear feet.
- IV.G.9.b.(ii). Local education agencies shall have air samples collected under this section analyzed for [asbestos](#) using laboratories accredited by the National Bureau of Standards to conduct such analysis using [transmission electron microscopy](#) or, under circumstances permitted in this section, laboratories enrolled in the American Industrial Hygiene Association Proficiency Analytical Testing Program for [phase contrast microscopy](#).
- IV.G.9.b.(iii). Until the National Bureau of Standards [TEM](#) laboratory accreditation program is operational, local educational agencies shall use laboratories

that use the protocol described in 40 C.F.R. 763, Appendix A to Subpart E ([EPA 1995](#)).

- IV.G.9.c. Except as provided in subparagraphs IV.G.9.d, IV.G.9.e., IV.G.9.f., or IV.G.9.g of this subsection, an action to remove, encapsulate, or enclose [ACBM](#) shall be considered complete when the average concentration of [asbestos](#) of five air samples collected within the affected [functional space](#) and analyzed by the [TEM](#) method in 40 C.F.R. 763, Appendix A to Subpart E ([EPA 1995](#)), is not statistically significantly different, as determined by the Z-test calculation found in Appendix A from the average asbestos concentration of five air samples collected at the same time outside the affected functional space and analyzed in the same manner, and the average asbestos concentration of the three field blanks described in Appendix A is below the filter background level, as defined in Appendix A, of 70 structures per square millimeter (70 s/mm²).
- IV.G.9.d. An action may also be considered complete if the volume of air drawn for each of the five samples collected within the affected [functional space](#) is equal to or greater than 1,199 L of air for a 25mm filter or equal to or greater than 2,799 L of air for a 37-mm filter, and the average concentration of [asbestos](#) as analyzed by the [TEM](#) method in 40 C.F.R. 763, Appendix A to Subpart E (1995), for the five air samples does not exceed the filter background level, as defined in Appendix A, of 70 structures per square millimeter (70 s/mm²). If the average concentration of asbestos of the five air samples within the affected functional space exceeds 70 s/mm², or if the volume of air in each of the samples is less than 1,199 L of air for a 25-mm filter or less than 2,799 L of air for a 37-mm filter, the action shall be considered complete only when the requirements of subparagraph IV.G.9.c, IV.G.9.e., IV.G.9.f., or IV.G.9.g of this section are met.
- IV.G.9.e. At any time, a [LEA](#) may analyze [air monitoring](#) samples collected for clearance purposes by [phase contrast microscopy](#) to confirm completion of [removal](#), [encapsulation](#), or [enclosure](#) of [ACBM](#) that is greater than small-scale, short-duration and less than or equal to the [trigger levels](#). The action shall be considered complete when the results of samples collected in the affected [functional space](#) and analyzed by [phase contrast microscopy](#) using the National Institute for Occupational Safety and Health (NIOSH) Method 7400 entitled "Fibers" published in the [NIOSH](#) Manual of Analytical Methods, 3rd Edition, Second Supplement, August 1987, show that the concentration of fibers for each of the five samples is less than or equal to a limit of quantification for [PCM](#) (0.01 fibers per cubic centimeter (0.01 [f/cm³](#), 10,000 [f/m³](#)) of air). The method is available at the Office of the Air Quality Control Commission.
- IV.G.9.f. Until October 7, 1989, a [LEA](#) may analyze [air monitoring](#) samples collected for clearance purposes by PCM to confirm completion of [removal](#), [encapsulation](#), or [enclosure](#) of [ACBM](#) that is less than or equal to 3,000 square

feet or 1,000 linear feet. The action shall be considered complete when the results of samples collected in the affected [functional space](#) and analyzed by [PCM](#) using the [NIOSH](#) Method 7400 entitled "Fibers" published in the NIOSH Manual of Analytical Methods, 3rd Edition, Second Supplement, August 1987, show that the concentration of fibers for each of the five samples is less than or equal to a limit of quantification for [PCM](#) (0.01 fibers per cubic centimeter, 0.01 f/cm^3 , 10,000 f/m^3). The method is available at the Office of the Colorado Air Quality Control Commission.

IV.G.9.g. From October 8, 1989, to October 7, 1990, a [LEA](#) may analyze [air monitoring](#) samples collected for clearance purposes by [PCM](#) to confirm completion of [removal](#), [encapsulation](#), or [enclosure](#) of [ACBM](#) that is less than or equal to 1,500 square feet or 500 linear feet. The action shall be considered complete when the results of samples collected in the affected [functional space](#) and analyzed by [PCM](#) using the [NIOSH](#) Method 7400 entitled "Fibers" published in the NIOSH Manual of Analytical Methods, 3rd Edition, Second Supplement, August 1987, show that the concentration of fibers for each of the five samples is less than or equal to a limit of quantification for [PCM](#) (0.01 fibers per cubic centimeter, 0.01 f/cm^3 , 10,000 f/m^3). The method is available at the Office of the Colorado Air Quality Control Commission.

IV.G.9.h. To determine the amount of [ACBM](#) affected under subparagraphs IV.G.9.e., IV.G.9.f., or IV.G.9.g of this subsection, the [LEA](#) shall add the total square or linear footage of [ACBM](#) within the containment barriers used to isolate the [functional space](#) for the action to remove, encapsulate, or enclose the [ACBM](#). Contiguous portions of material subject to such action conducted concurrently or at approximately the same time within the same [school building](#) shall not be separated to qualify under subparagraph IV.G.9.e., IV.G.9.f., or IV.G.9.g of this subsection.

IV.G.9.i. All air monitoring and final visual inspections required under this regulation shall be performed by certified Air Monitoring Specialists independent of the GAC to avoid possible conflict of interest.

IV.H. OPERATIONS AND MAINTENANCE

IV.H.1. Applicability

The [LEA](#) shall implement an operations, maintenance, and [repair \(O&M\)](#) program under this section whenever any [friable ACBM](#) is present or assumed to be present in a building that it leases, owns, or otherwise uses as a [school building](#). Any material identified as [nonfriable ACBM](#) or [nonfriable](#) assumed [ACBM](#) must be treated as friable [ACBM](#) for purposes of this section when the material is about to become friable as a result of activities performed in the school building.

IV.H.2. Cleaning

IV.H.2.a. Initial Cleaning

Unless the building has been cleaned using equivalent methods within the previous six months, all areas of a [school building](#) where [friable ACBM](#), [damaged or significantly damaged thermal system insulation ACM](#), or friable suspected ACBM assumed to be [ACM](#) are present shall be cleaned at least once after the completion of the inspection required by section IV.C.1. and before the initiation of any [response action](#), other than [O&M](#) activities or [repair](#), according to the following procedures:

IV.H.2.a.(i). [HEPA vacuum](#) or steam-clean all carpets.

IV.H.2.a.(ii). [HEPA vacuum](#) or wet-clean all other floor and all other horizontal surfaces.

IV.H.2.a.(iii). Dispose of all debris, filters, mop heads, and cloths in sealed, leak-tight containers.

IV.H.2.b. Additional Cleaning

The [certified](#) management planner shall make a written recommendation to the [LEA](#) whether additional cleaning is needed, and if so, the methods and frequency of such cleaning.

IV.H.3. Operations and Maintenance Activities

The [LEA](#) shall ensure that the procedures described below to protect building occupants shall be followed for any operations and maintenance activities disturbing [friable ACBM](#):

IV.H.3.a. Restrict entry into the area by [persons](#) other than those necessary to perform the maintenance project, either by physically isolating the area or by scheduling.

IV.H.3.b. Post signs to prevent entry by unauthorized [persons](#).

IV.H.3.c. Shut off or temporarily modify the air-handling system and restrict other sources of air movement.

IV.H.3.d. Use work practices or other controls, such as, wet methods, protective clothing, [HEPA vacuums](#), mini-enclosures, glovebags, as necessary to inhibit the spread of any released fibers.

IV.H.3.e. Clean all fixtures or other components in the immediate [work area](#).

IV.H.3.f. Place the [asbestos debris](#) and other cleaning materials in a sealed, leak-tight container.

IV.H.4. Maintenance Activities Other than Small-Scale, Short-Duration

The [response action](#) for any maintenance activities disturbing [friable ACBM](#), other than small-scale, short-duration maintenance activities, shall be designed by [persons certified](#) to design response actions and conducted by persons certified to conduct response actions.

IV.H.5. Fiber Release Episodes

IV.H.5.a. Minor [fiber release episode](#) - The [LEA](#) shall ensure that the procedures described below are followed in the event of a minor fiber release episode (i.e., the falling or dislodging of 3 square or linear feet or less of [friable ACBM](#)):

IV.H.5.a.(i). Thoroughly saturate the debris using wet methods.

IV.H.5.a.(ii). Clean the area, as described in subsection IV.H.2. of this section.

IV.H.5.a.(iii). Place the [asbestos debris](#) in a sealed, leak-tight container.

IV.H.5.a.(iv). [Repair](#) the area of damaged [ACM](#) with materials such as asbestos-free spackling, plaster, cement, or insulation, or seal with latex paint or an encapsulant, or immediately have the appropriate [response action](#) implemented as required by section IV.H.3. (Operations & Maintenance).

IV.H.5.b. Major [fiber release episode](#) - The [LEA](#) shall ensure that the procedures described below are followed in the event of a major fiber release episode (i.e., the falling or dislodging of more than 3 square or linear feet of [friable ACBM](#)):

IV.H.5.b.(i). Restrict entry into the area and post signs to prevent entry into the area by [persons](#) other than those necessary to perform the [response action](#).

IV.H.5.b.(ii). Shut off or temporarily modify the air-handling system to prevent the distribution of fibers to other areas in the building.

IV.H.5.b.(iii). The [response action](#) for any major [fiber release episode](#) must be designed by [persons certified](#) to design response actions and conducted by persons certified to conduct response actions, as specified in subsection II.A. (General Requirements).

IV.I. TRAINING AND PERIODIC SURVEILLANCE

IV.I.1. Training

IV.I.1.a. The [LEA](#) shall ensure, prior to the implementation of the [O&M](#) provisions of the management plan, that all members of its maintenance and custodial staff (custodians, electricians, heating/air conditioning engineers, plumbers, etc.) who may work in a building that contains [ACBM](#) receive awareness training of at least two hours, whether or not they are required to work with ACBM.

New custodial and maintenance employees shall be trained within 60 days after commencement of employment. Annual refresher training shall be provided and documented in the management plan for the school. Training shall include, but not be limited to:

- IV.I.1.a.(i). Information regarding [asbestos](#) and its various uses and forms.
 - IV.I.1.a.(ii). Information on the health effects associated with [asbestos](#) exposure.
 - IV.I.1.a.(iii). Locations of [ACBM](#) identified throughout each [school building](#) in which they work.
 - IV.I.1.a.(iv). Recognition of damage, deterioration, and delamination of [ACBM](#).
 - IV.I.1.a.(v). Name and telephone number of the [person](#) designated to carry out general [LEA](#) responsibilities under subsection IV.B. (General LEA Responsibilities) and the availability and location of the management plan.
- IV.I.1.b. The [LEA](#) shall ensure that all members of its maintenance and custodial staff who conduct any activities that will result in the disturbance of [ACBM](#) shall receive training described in subsection IV.I.1.a. above and 14 hours of additional training. Annual refresher training shall be provided and documented in the management plan for the school. Additional training shall include, but not be limited to:
- IV.I.1.b.(i). Descriptions of the proper methods of handling [ACBM](#).
 - IV.I.1.b.(ii). Information on the use of respiratory protection as contained in the EPA/NIOSH Guide to Respiratory Protection for the Asbestos Abatement Industry, September 1986 (EPA 560/OPTS-86-001), available from the office of the Colorado Air Quality Control Commission, and other personal protection measures.
 - IV.I.1.b.(iii). The provisions of section IV and Appendices A, B, C, and D of 52 Federal Register 41857-41898 (October 30, 1987), [EPA](#) regulations contained in 40 C.F.R. Part 763, Subpart G, and in 40 C.F.R. Part 61, Subpart M, and [OSHA](#) regulations contained in 29 C.F.R. 1926.1101.
 - IV.I.1.b.(iv). Hands-on training in the use of respiratory protection, other personal protection measures, and good work practices.
- IV.I.1.c. [LEA](#) maintenance and custodial staff who have attended [EPA](#)-approved [asbestos](#) training or received equivalent training for [O&M](#) and periodic surveillance activities involving asbestos shall be considered trained for the purposes of this section.

IV.I.2. Periodic Surveillance

IV.I.2.a. At least once every six months after a management plan is in effect, each [LEA](#) shall conduct periodic surveillance in each building that it leases, owns, or otherwise uses as a [school building](#) that contains [ACBM](#) or is assumed to contain ACBM.

IV.I.2.b. Each [person](#) performing periodic surveillance shall:

IV.I.2.b.(i). Visually inspect all areas that are identified in the management plan as [ACBM](#) or assumed ACBM.

IV.I.2.b.(ii). Record the date of the surveillance, his or her name, and any changes in the condition of the materials.

IV.I.2.b.(iii). Submit to the [person](#) designated to carry out general [LEA](#) responsibilities under subsection IV.B. (General LEA Responsibilities) a copy of such record for inclusion in the management plan.

IV.J. SCHOOL MANAGEMENT PLANS

IV.J.1. Submittal of Management Plans

IV.J.1.a. On or before October 12, 1988, or by May 9, 1989, if the [LEA](#) has applied for and received a deferral from the [Division](#) each LEA shall develop an [asbestos](#) management plan for each [school](#), including all buildings that they lease, own, or otherwise use as [school buildings](#), and submit the plan in the form specified by the Division. The plan may be submitted in stages that cover a portion of the school buildings under the authority of the LEA. The fee for Division review of management plans will be \$45.00.

IV.J.1.b. If a building to be used as part of a [school](#) is leased or otherwise acquired after October 12, 1988, the [LEA](#) shall include the new building in the management plan for the school prior to its use as a [school building](#). The revised portions of the management plan shall be submitted to the [Division](#).

IV.J.1.c. If a [LEA](#) begins to use a building as a [school](#) after October 12, 1988, the LEA shall submit a management plan for the school to the [Division](#) prior to its use as a school.

IV.J.2. If the [Division](#) does not disapprove a management plan within 90 days after receipt of the plan, the [LEA](#) shall implement the plan.

IV.J.3. Each [LEA](#) must begin implementation of its management plan on or before July 9, 1989, and complete implementation in a timely fashion.

IV.J.4. Each [LEA](#) shall maintain and update its management plan to keep it current with ongoing operations and maintenance, periodic surveillance, inspection, reinspection, and [response action](#) activities. All provisions required to be included in the

management plan under this section shall be retained as part of the management plan, as well as any information that has been revised to bring the plan up-to-date.

- IV.J.5. The management plan shall be developed by a [certified](#) management planner and shall include:
- IV.J.5.a. A list of the name and address of each [school building](#) and whether the school building contains [friable ACBM](#), [nonfriable ACBM](#), or friable and nonfriable suspected ACBM assumed to be [ACM](#).
 - IV.J.5.b. For each inspection conducted before December 14, 1987:
 - IV.J.5.b.(i). The date of the inspection.
 - IV.J.5.b.(ii). A blueprint, diagram, or written description of each [school building](#) that identifies clearly each location and approximate square or linear footage of any homogeneous or [sampling area](#) where material was sampled for [ACM](#), and, if possible, the exact locations where bulk samples were collected, and the dates of collection.
 - IV.J.5.b.(iii). A copy of the analyses of any bulk samples, dates of analyses, and a copy of any other laboratory reports pertaining to the analyses.
 - IV.J.5.b.(iv). A description of any [response actions](#) or [preventive measures](#) taken to reduce [asbestos](#) exposure, including if possible, the names and addresses of all contractors involved, start and completion dates of the work, and results of any air samples analyzed during and upon completion of the work.
 - IV.J.5.b.(v). A description of [assessments](#), required to be made under section IV.F. of material that was identified before December 14, 1987, as [friable ACBM](#) or friable suspected ACBM assumed to be [ACM](#), and the name and signature, and Colorado certification number of each [certified person](#) making the [assessments](#).
 - IV.J.5.c. For each inspection and reinspection conducted under section IV.C. (Inspections & Reinspections):
 - IV.J.5.c.(i). The date of the inspection or reinspection and the name and signature, and the Colorado certification number of each [certified](#) Inspector performing the inspection or reinspection.
 - IV.J.5.c.(ii). A blueprint, diagram, or written description of each [school building](#) that identifies clearly each location and approximate square or linear footage of [homogeneous areas](#) where material was sampled for [ACM](#), the exact location where each bulk sample was collected, date of collection, homogeneous areas where [friable](#) suspected [ACBM](#) is assumed to be ACM, and where [nonfriable](#) suspected ACBM is assumed to be ACM.

- IV.J.5.c.(iii). A description of the manner used to determine sampling locations, and the name and signature of each [certified](#) Inspector collecting samples, and his or her Colorado certification number.
- IV.J.5.c.(iv). A copy of the analyses of any bulk samples collected and analyzed, the name and address of any laboratory that analyzed bulk samples, a statement that the laboratory meets the applicable requirements of paragraph IV.E.1. the date of analysis, and the name and signature of the [person](#) performing the analysis.
- IV.J.5.c.(v). A description of [assessments](#), required to be made under subsection IV.F. (Assessment), of all [ACBM](#) and suspected ACBM assumed to be [ACM](#), and the name, signature, and Colorado certification number of each [person](#) making the assessments.
- IV.J.5.d. The name, address, and telephone number of the [person](#) designated under subsection IV.B. (General LEA Responsibilities) to ensure that the duties of the [LEA](#) are carried out, and the course name, and dates and hours of training taken by that person to carry out the duties.
- IV.J.5.e. The recommendations made to the [LEA](#) regarding [response actions](#), under subsection IV.F. (Assessment), the name, signature, and his or her Colorado certification number.
- IV.J.5.f. A detailed description of [preventive measures](#) and [response actions](#) to be taken, including methods to be used, for any [friable ACBM](#), the locations where such measures and action will be taken, reasons for selecting the response action or preventive measure, and a schedule for beginning and completing each preventive measure and response action.
- IV.J.5.g. A signed statement that the individual is [certified](#) under this Regulation No. 8 from each individual who inspects for [ACBM](#) or who will design or carry out [response actions](#), except for operations and maintenance.
- IV.J.5.h. A detailed description in the form of a blueprint, diagram, or in writing of any [ACBM](#) or suspected ACBM assumed to be [ACM](#) which remains in the [school](#) once [response actions](#) are undertaken pursuant to subsection IV.G. (Response Actions). This description shall be updated as response actions are completed.
- IV.J.5.i. A plan for reinspection under subsection IV.C. (Inspections & Reinspections) and a plan for operations and maintenance activities under subsection IV.H. (Operations & Maintenance), and a plan for periodic surveillance under subsection IV.I. (Training & Periodic Surveillance), a description of the recommendation made by the management planner regarding additional cleaning under subsection IV.H.2.b. (Additional Cleaning) as part of an operations and maintenance program, and the response of the [LEA](#) to that recommendation.

- IV.J.5.j. A description of steps taken to inform Workers and building occupants, or their legal guardians, about inspections, reinspections, [response actions](#), and post-response action activities that are planned or in progress.
- IV.J.5.k. An evaluation of the resources needed to complete [response actions](#) successfully and carry out reinspection, operations and maintenance activities, periodic surveillance and training.
- IV.J.5.l. The name of each consultant who contributed to the management plan, and a statement from each such consultant that the consultant is [certified](#) under Colorado State law, and a statement that the [person](#) is accredited by an [EPA](#) approved course (specify course title and sponsor) under section 206(c) of the Title II of [TSCA](#).
- IV.J.6. A [LEA](#) may require each management plan to contain a statement signed by a [certified](#) management plan developer that such plan is in compliance with this section IV (School Requirements). Such statement may not be signed by a [person](#) who, in addition to preparing or assisting in preparing the management plan, also implements (or will implement) the management plan.
- IV.J.7. Availability of Management Plan
- IV.J.7.a. Upon submission of a management plan to the [Division](#), a [LEA](#) shall keep a copy of the plan in its administrative office. The management plans shall be available, without cost or restriction, for inspection by representatives of [EPA](#) and the [Division](#), the public, including teachers, other [school](#) personnel and their representatives, and parents. The LEA may charge a reasonable cost to make copies of management plans.
- IV.J.7.b. Each [LEA](#) shall maintain in its administrative office a complete, updated copy of a management plan for each [school](#) under its administrative control or direction. The management plans shall be available, during normal business hours, without cost or restriction, for inspection by representatives of [EPA](#) and the [Division](#), the public, including teachers, other [school](#) personnel and their representatives, and parents. The [LEA](#) may charge a reasonable cost to make copies of management plans.
- IV.J.7.c. Each [school](#) shall maintain in its administrative office a complete, updated copy of the management plan for that school. Management plans shall be available for inspection, without cost or restriction, to Workers before work begins in any area of a [school building](#). The school shall make management plans available for inspection to representatives of [EPA](#) and the [Division](#), the public, including parents, teachers, and other school personnel and their representatives within five [working days](#) after receiving a request for inspection. The school may charge a reasonable cost to make copies of the management plan.

- IV.J.7.d. Upon submission of its management plan to the [Division](#) and at least once each [school](#) year, the [LEA](#) shall notify in writing parent, teacher, and employee organizations of the availability of management plans and shall include in the management plan a description of the steps taken to notify such organizations, and a dated copy of the notification. In the absence of any such employees, the LEA shall provide written notice to that relevant group of the availability of the management plan a description of the steps taken to notify such groups and a dated copy of the notification.
- IV.J.8. Records required under subsection IV.K. (Recordkeeping) shall be made by local education agencies and maintained as part of the management plan.
- IV.J.9. Each management plan must contain a true and correct statement, signed by the individual designated by the [LEA](#) under subsection IV.B. (General LEA Responsibilities) which certifies that the general, LEA responsibilities, as stipulated by subsection IV.B. (General LEA Responsibilities) have been met or will be met.
- IV.K. RECORDKEEPING
- IV.K.1. Records required under this section shall be maintained in a centralized location in the administrative office of both the [school](#) and the [LEA](#) as part of the management plan. For each [homogeneous area](#) where all [ACBM](#) has been removed, the LEA shall ensure that such records are retained for three years after the next reinspection required under subparagraph IV.C.2.a. or for an equivalent period.
- IV.K.2. For each [preventive measure](#) and [response action](#) taken for [friable](#) and [nonfriable](#) suspected [ACBM](#) assumed to be [ACM](#), the [LEA](#) shall provide:
- IV.K.2.a. A detailed written description of the measure or action, including methods used, the location where the measure or action was taken, reasons for selecting the measure or action, start and completion dates of the work, names and addresses of all contractors involved and Colorado Certification numbers, and if [ACBM](#) is removed, the name and location of storage or disposal site of the [ACM](#).
- IV.K.2.b. The name and signature of any [person](#) collecting any air sample required to be collected at the completion of certain [response actions](#) specified by section IV.G.9. the locations where samples were collected, date of collection, the name and address of the laboratory analyzing the samples, the date of analysis, the results of the analysis, the method of analysis, the name and signature of the person performing the analysis, and a statement that the laboratory meets the applicable requirements of clause IV.G.9.b.(ii).
- IV.K.3. For each [person](#) required to be trained under subparagraph IV.I.1.a. or b., the [LEA](#) shall provide the person's name and job title, the date that training was completed by that person, the location of the training, and the number of hours completed in such training.

- IV.K.4. For each time that periodic surveillance under subparagraph IV.I.2.a. is performed, the [LEA](#) shall record the name of each [person](#) performing the surveillance, the date of surveillance and any changes in the conditions of the materials.
- IV.K.5. For each time that cleaning under paragraph IV.H.2. (Cleaning) is performed, the [LEA](#) shall record the name of each [person](#) performing the cleaning, the date of such cleaning, the locations cleaned, and the methods used to perform such cleaning.
- IV.K.6. For each time that operations and maintenance activities under paragraph IV.H.3. (Operations & Maintenance Activities) are performed, the [LEA](#) shall record the name of each [person](#) performing the activity, the start and completion dates of the activity, the locations where such activity occurred, a description of the activity including [preventive measures](#) used, and if [ACBM](#) is removed, the name and location of storage or disposal site of the [ACM](#).
- IV.K.7. For each time that major [asbestos](#) activity under paragraph IV.H.4. (Maintenance Activities) is performed the [LEA](#) shall provide the name and signature, and the Colorado Certification number of each [person](#) performing the activity, the start and completion dates of the activity, the locations where such activity occurred, a description of the activity including [preventive measures](#) used, and if [ACBM](#) is removed, the name and location of storage or disposal site of the [ACM](#).
- IV.K.8. For each [fiber release episode](#) under paragraph IV.H.5. (Fiber Release Activities) the [LEA](#) shall provide the date and location of the episode, the method of [repair](#), [preventive measures](#) or [response action](#) taken, the name of each [person](#) performing the work, and if [ACBM](#) is removed, the name and location of storage or disposal site of the [ACM](#).

IV.L. WARNING LABELS

The [LEA](#) shall attach a warning label immediately adjacent to any [friable](#) and [nonfriable](#) [ACBM](#) and suspected [ACBM](#) assumed to be [ACM](#) located in [routine maintenance areas](#) (such as boiler rooms) at each [school building](#). This shall include:

- IV.L.1. [Friable](#) [ACBM](#) that was responded to by a means other than [removal](#).
- IV.L.2. [ACBM](#) for which no [response action](#) was carried out.
- IV.L.3. All labels shall be prominently displayed in readily visible locations and shall remain posted until the [ACBM](#) that is labeled is removed.
- IV.L.4. The warning label shall read, in print which is readily visible because of large size or bright color, as follows: CAUTION: ASBESTOS. HAZARDOUS. DO NOT DISTURB WITHOUT PROPER TRAINING AND EQUIPMENT.

IV.M. EXCLUSIONS

- IV.M.1. A LEA shall not be required to perform an inspection under paragraph IV.C.1. (Inspections) in any [sampling area](#) or [homogeneous area](#) of a [school building](#) where:
- IV.M.1.a. A [certified](#) Inspector has determined that, based on sampling records, [friable ACBM](#) was identified in that homogeneous or [sampling area](#) during an inspection conducted before December 14, 1987. The Inspector shall sign and date a statement to that effect with his or her Colorado Certification number and, within 30 days after such determination, submit a copy of the statement to the [person](#) designated under subsection IV.B. (General LEA Responsibilities) for inclusion in the management plan. However, a certified Inspector shall assess the friable ACBM under subsection IV.F. (Assessment).
- IV.M.1.b. A [certified](#) Inspector has determined that, based on sampling records, [nonfriable ACBM](#) was identified in that homogeneous or [sampling area](#) during an inspection conducted before December 14, 1987. The Inspector shall sign and date a statement to that effect with his or her certification number and, within 30 days after such determination, submit a copy of the statement to the [person](#) designated under subsection IV.B. (General LEA Responsibilities) for inclusion in the management plan. However, a certified Inspector shall identify whether material that was nonfriable has become [friable](#) since that previous inspection and shall assess the newly-friable ACBM under subsection IV.F. (Assessment)
- IV.M.1.c. Based on sampling records and inspection records, a [certified](#) Inspector has determined that no [ACBM](#) is present in the homogeneous or [sampling area](#) and the records show that the area was sampled, before December 14, 1987 in substantial compliance with paragraph IV.C.1. (Inspections) which for purposes of this section means in a random manner and with a sufficient number of samples to reasonably ensure that the area is not ACBM.
- IV.M.1.c.(i). The [certified](#) Inspector shall sign and date a statement, with his or her certification number, that the homogeneous or [sampling area](#) determined not to be [ACBM](#) was sampled in substantial compliance with paragraph IV.C.1. (Inspections).
- IV.M.1.c.(ii). Within 30 days after the Inspector's determination, the [LEA](#) shall submit a copy of the Inspector's statement to the [Division](#) and shall include the statement in the management plan for that [school](#).
- IV.M.1.d. The [Division](#) has determined that, based on sampling records and inspection records, no [ACBM](#) is present in the homogeneous or [sampling area](#) and the records show that the area was sampled before December 14, 1987, in substantial compliance with paragraph IV.C.1. (Inspections). Such determination shall be included in the management plan for that [school](#).
- IV.M.1.e. A [certified](#) Inspector has determined that, based on records of an inspection conducted before December 14, 1987, suspected [ACBM](#) identified in that

homogeneous or [sampling area](#) is assumed to be [ACM](#). The Inspector shall sign and date a statement to that effect, with his or her State of Colorado Certification number and, within 30 days of such determination, submit a copy of the statement to the [person](#) designated under subsection IV.B. (General LEA Responsibilities) for inclusion in the management plan. However, a certified Inspector shall identify whether material that was [nonfriable](#) suspected ACBM assumed to be ACM has become [friable](#) since the previous inspection and shall assess the newly friable material and previously identified friable suspected ACBM assumed to be ACM under subsection IV.F. (Assessment).

- IV.M.1.f. Based on inspection records and contractor and clearance records, a [certified](#) Inspector has determined that no [ACBM](#) is present in the homogeneous or [sampling area](#) where [asbestos removal](#) operations have been conducted before December 14, 1987, and shall sign and date a statement to that effect and include his or her State of Colorado Certification number. The [LEA](#) shall submit a copy of the statement to the [Division](#) and shall include the statement in the management plan for that [school](#).
- IV.M.1.g. An architect or project engineer responsible for the construction of a new [school building](#) built after October 12, 1988, or a [certified](#) Inspector signs a statement that no [ACBM](#) was specified as a building material in any construction document for the building, or, to the best of his or her knowledge, no ACBM was used as a building material in the building. The [LEA](#) shall submit a copy of the signed statement of the architect, project engineer, or certified Inspector to the [Division](#) and shall include the statement in the management plan for that [school](#).
- IV.M.2. The exclusion, under subparagraphs IV.M.1.a. through IV.M.1.d. of this subsection, from conducting the inspection under paragraph IV.C.1. (Inspections) shall apply only to homogeneous or [sampling areas](#) of a [school building](#) that were inspected and sampled before October 17, 1987. The [LEA](#) shall conduct an inspection under paragraph IV.C.1. (Inspections) of all areas inspected before October 17, 1987, that were not sampled or were not assumed to be [ACM](#).
- IV.M.3. If [ACBM](#) is subsequently found in a homogeneous or [sampling area](#) of a LEA [local education agency](#) that had been identified as receiving an exclusion by a [certified](#) Inspector under subparagraphs IV.M.1.c., d., and e., of this section, or an architect, project engineer or certified Inspector under subparagraph IV.M.1.g of this section, the [LEA](#) shall have 180 days following the date of identification of [ACBM](#) to comply with this section IV (School Requirements).

All underlined text in this regulation indicates defined terms.

V. STATE BUILDING REQUIREMENTS

V.A. SCOPE AND PURPOSE

State agencies shall follow the assessment procedures prescribed by this section prior to conducting any response action for friable ACM in an area of public access that exceeds the trigger levels. The prescribed assessment procedures require state agencies to identify friable and potentially friable ACM; sample such materials; assess the condition of suspected ACM; and conduct air monitoring to determine the level of fibers in the air. In addition, state agencies are required to use individuals who have been certified as Inspectors and Management Planners (see section II) to complete the inspections and make recommendations to building managers as to the appropriate response action to be taken.

V.B. GENERAL STATE AGENCY RESPONSIBILITIES

Each state agency shall:

V.B.1. Ensure that the activities of all persons who perform inspections or conduct asbestos abatement actions are carried out in accordance with sections I, II, III and V of this regulation.

V.B.2. Designated Asbestos Coordinator

V.B.2.a. Designate an asbestos coordinator to ensure that the requirements of this section are properly implemented.

V.B.2.b. Ensure that the asbestos coordinator receives adequate training to perform duties assigned under this section. Such training shall provide, as necessary, basic knowledge of:

V.B.2.b.(i). Health effects of asbestos.

V.B.2.b.(ii). Detection, identification, and assessment of ACM.

V.B.2.b.(iii). Options for controlling ACM.

V.B.2.b.(iv). Asbestos management programs.

V.B.2.b.(v). Relevant Federal and State regulations concerning asbestos, including those in this Regulation and those of the U.S. Department of Transportation and the U.S. Environmental Protection Agency.

V.B.2.c. A person who has received "Inspector" training and certification according to section II (Certification Requirements) is deemed to be adequately trained to function as the asbestos coordinator.

V.C. INSPECTIONS

- V.C.1. Prior to conducting an [asbestos response action](#) in an [area of public access](#) that exceeds the [trigger levels](#) in any [state-owned or state-leased building](#), state agencies shall inspect the affected area of such buildings to identify all locations of [friable](#) and potentially [friable ACM](#). Potentially friable [ACM](#) is any ACM that can reasonably be expected to become friable as a result of anticipated [renovation](#) or [demolition](#) work.
- V.C.2. Each inspection shall be made by a [certified](#) Inspector.
- V.C.3. Except as excluded under subsection V.H. (Exclusion), the [person](#) performing an inspection under this section shall:
- V.C.3.a. Visually inspect the area to identify the locations of all suspected [ACM](#).
 - V.C.3.b. Touch all suspected [ACM](#) to determine whether they are [friable](#).
 - V.C.3.c. Identify all [homogeneous areas](#) of [friable](#) suspected [ACM](#) and all homogeneous areas of potentially friable suspected ACM.
 - V.C.3.d. Pursuant to subsection V.D. (Sampling); collect bulk samples from each suspect [homogeneous area](#) and submit such samples for analysis pursuant to subsection V.E. (Analysis).
 - V.C.3.e. Develop a written [assessment](#) of the extent, condition and types of materials in the area. Such assessment shall be performed pursuant to subsection V.F. (Assessment).
 - V.C.3.f. Record the following and submit to the [Asbestos](#) Coordinator under subsection V.B. (General State Agency Responsibilities), a copy of such record.
 - V.C.3.f.(i). An inspection report with the date of the inspection signed by the [certified person](#) making the inspection, and his or her certification number.
 - V.C.3.f.(ii). An inventory of the locations of the [homogeneous areas](#) where samples are collected, exact locations where each bulk sample is collected, and dates that samples are collected.
 - V.C.3.f.(iii). A list identifying each [homogeneous area](#) listed under paragraph c. above as [surfacing material](#), [thermal system insulation](#), or [miscellaneous material](#).
 - V.C.3.f.(iv). [Assessments](#) made of [friable](#) and potentially friable material, the name and signature of each [certified](#) Inspector making the assessment, and his or her certification number.

V.D. SAMPLING

V.D.1. Surfacing material

Prior to conducting an [asbestos response action](#) in an [area of public access](#) that exceeds the [trigger levels](#) in any [state-owned or state-leased building](#), the State Agency shall insure that a [certified](#) Inspector shall collect, in a randomly distributed manner that is representative of the [homogeneous area](#), bulk samples from each [homogeneous area](#) of suspect [friable](#) and potentially friable, [surfacing material](#). The samples shall be collected as follows:

- V.D.1.a. At least three bulk samples shall be collected from each [homogeneous area](#) that is 1,000 square feet or less.
- V.D.1.b. At least five bulk samples shall be collected from each [homogeneous area](#) that is greater than 1,000 square feet but less than or equal to 5,000 square feet.
- V.D.1.c. At least seven bulk samples shall be collected from each [homogeneous area](#) that is greater than 5,000 square feet.

V.D.2. Thermal system insulation

- V.D.2.a. Except as provided in subparagraphs b., c. and d. of this section, a [certified](#) Inspector shall collect, in a randomly distributed manner, at least three bulk samples from each [homogeneous area](#) of [thermal system insulation](#) that is not assumed to be [ACM](#).
- V.D.2.b. Collect at least one bulk sample from each [homogeneous area](#) of patched [thermal system insulation](#) if the patched section is less than 6 linear or square feet.
- V.D.2.c. In a manner sufficient to determine whether the material is [ACM](#) or not ACM, collect bulk samples from each insulated mechanical system where cement or plaster is used on fittings such as tees, elbows, or valves. An area may be determined to contain ACM based on a single positive [asbestos](#) sample as described in subparagraph V.E.3.b.
- V.D.2.d. Bulk samples are not required to be collected from any [homogeneous area](#) where the [certified](#) Inspector has determined that the [thermal system insulation](#) is fiberglass, foam glass, rubber, or other non-[ACM](#).

V.D.3. Miscellaneous material

In a manner sufficient to determine whether material is [ACM](#) or not ACM, a [certified](#) Inspector shall collect bulk samples from each [homogeneous area](#) of [friable miscellaneous material](#) that is suspected to be ACM.

V.D.4. The state agency shall perform air sampling prior to any [response action](#) that in an [area of public access](#) exceeds the [trigger levels](#). The procedures described in paragraph III.U. (Maximum Allowable Asbestos Level), shall be followed.

V.E. ANALYSIS

V.E.1. State agencies shall have bulk samples, collected under subsection V.D. (Sampling) analyzed for [asbestos](#) by laboratories accredited by the National Bureau of Standards (NBS). State agencies shall use laboratories which have received interim accreditation for [polarized light microscopy](#) analysis under the [EPA](#) Interim Asbestos Bulk Sample Analysis Quality Assurance Program until the [NBS PLM](#) laboratory accreditation program for PLM is operational.

V.E.2. Bulk samples shall not be composited for analysis.

V.E.3. Interpreting Bulk Sample Results

V.E.3.a. A [homogeneous area](#) is considered not to contain [ACM](#) only if the results of all samples submitted for analysis show [asbestos](#) in amounts of one percent or less.

V.E.3.b. A [homogeneous area](#) shall be determined to contain [ACM](#) based on a finding that the results of at least one sample collected from that area shows that [asbestos](#) is present in an amount greater than one percent.

V.E.4. The name and address of each laboratory performing an analysis submitted to the [asbestos](#) coordinator designated under subsection V.B. (General State Agency Responsibilities).

V.E.5. Air samples shall be analyzed according to the procedures described in paragraph III.U. (Maximum Allowable [Asbestos](#) Level).

V.F. ASSESSMENT

V.F.1. [Untitled]

V.F.1.a. For each inspection conducted under subsection V.D. (Exclusion) and previous inspections specified under subsection V.H. The state agency shall have a [certified](#) Inspector provide a written [assessment](#) of all [friable](#) material that is known or assumed [ACM](#) in a state building.

- V.F.1.b. Each [certified](#) Inspector providing a written [assessment](#) shall sign and date the assessment, provide his or her certification number, and submit a copy of the assessment to the [Asbestos](#) Coordinator designated under subsection V.B. (General State Agency Requirements).
- V.F.2. The Inspector shall classify and give reasons in the written [assessment](#) for classifying the [ACM](#) and suspected ACM assumed to be ACM in the state building into one of the following categories:
- V.F.2.a. [Damaged or significantly damaged thermal system insulation ACM.](#)
 - V.F.2.b. [Damaged friable surfacing ACM.](#)
 - V.F.2.c. [Significantly damaged friable surfacing ACM.](#)
 - V.F.2.d. [Damaged](#) or [significantly damaged friable miscellaneous ACM.](#)
 - V.F.2.e. [ACM](#) with [potential](#) for damage.
 - V.F.2.f. [ACM](#) with [potential](#) for significant damage.
 - V.F.2.g. Any remaining [friable ACM](#) or friable material suspected to be ACM.
 - V.F.2.h. Undamaged material known or suspected to be [ACM](#).
- V.F.3. [Assessment](#) shall include the following considerations:
- V.F.3.a.(i). Location and the amount of the material, both in total quantity and as a percentage of the [functional space](#).
 - V.F.3.a.(ii). Condition of the material, specifying:
 - V.F.3.a.(iii). Type of damage or significant damage (e.g., flaking, blistering, water damage, or other signs of physical damage).
 - V.F.3.a.(iv). Severity of damage (e.g., major flaking, severely torn jackets, as opposed to occasional flaking, minor tears to jackets).
 - V.F.3.a.(v). Extent or spread of damage over large areas or large percentages of the [homogeneous area](#).
- V.F.3.b. Whether the material is [accessible](#) by building occupants.
- V.F.3.c. The material's potential for disturbance.
- V.F.3.d. Known or suspected causes of damage or significant damage (e.g., [air erosion](#), vandalism, [vibration](#), water).

V.F.3.e. [Preventive measures](#), which might eliminate the reasonable likelihood of undamaged [ACM](#) from becoming significantly damaged.

V.F.3.f. The results of any [air monitoring](#).

V.F.4. The state agency shall select a [person certified](#) to develop management plans (see section II) to recommend, in writing to the state agency the appropriate [response actions](#). Prior to making a recommendation, such certified person shall review all inspections and [assessments](#), and may conduct any other activities necessary to support his or her recommendations. The certified person shall sign and date the recommendation, and provide his or her certification number, and submit a copy of the recommendations to the [asbestos](#) coordinator.

V.G. RECORDKEEPING

V.G.1. For each [response action](#) taken, the [Asbestos](#) Coordinator for each state agency shall document in a file to be maintained with building records:

V.G.1.a. A detailed written description of the measure or action, including methods used; the location where the measure or action was taken; reasons for selecting the measure or action; start and completion dates of the work; names and addresses of all contractors involved and certification numbers; and if [ACM](#) is removed, the name and location of storage or disposal site of the ACM.

V.G.1.b. The name and signature of any [person](#) collecting any air samples required to be collected by subsection V.D. (Sampling), the locations where samples were collected, date of collection, the name and address of the laboratory analyzing the samples, the date of analysis, the results of the analysis, the method of analysis, the name and signature of the person performing the analysis, and a statement that the laboratory meets the accreditation requirements of clause III.D.1.a.(ii).

V.G.2. For each exclusion provided by subsection V.H. (Exclusions) below, a statement signed by a [certified](#) Inspector that meets the requirements of subsection V.H. (Exclusions) shall be included in the record.

V.H. EXCLUSIONS

V.H.1. A state agency shall not be required to perform an inspection under paragraph V.C.1. (Inspections) in any area of a state building where:

V.H.1.a. A [certified](#) Inspector has determined that, based on sampling records, [friable](#) or potentially [friable ACM](#) was identified in that homogeneous or [sampling area](#) during an inspection conducted before the effective date of this regulation. The Inspector shall sign and date a statement to that effect with his or her certification number and include such a statement as part of the record required by subsection V.G. (Recordkeeping). However, a certified

Inspector/management planner shall assess the friable [ACBM](#) under subsection V.F. and a certified [Air Monitoring Specialist](#) shall conduct [air monitoring](#), if not already completed.

- V.H.1.b. Based on sampling records and inspection records, a [certified](#) Inspector has determined that no [ACM](#) is present in the homogeneous or [sampling area](#) and the records show that the area was sampled, before the effective date of this regulation, in substantial compliance with section V.C.1. (Inspections), which for purposes of this section means in a random manner and with a sufficient number of samples to reasonably ensure that the area is free of ACM. The certified Inspector shall sign and date a statement, with his or her certification number that the homogeneous or sampling area determined not to be ACM was sampled in substantial compliance with section V.D.1. (Surfacing Materials).
- V.H.1.c. Based on inspection records a [certified](#) Inspector has determined that no [ACM](#) is present in the homogeneous or [sampling area](#) because [asbestos removal](#) operations have been conducted before the effective date of this regulation. The Inspector shall sign and date a statement to that effect and include his or her certification number. The state agency shall include the statement as part of the recordkeeping for that agency.
- V.H.1.d. An architect or project engineer responsible for the construction of a new state building built after the effective date of this regulation, or a [certified](#) Inspector signs a statement that no [ACM](#) was specified as a building material in any construction document for the building, or, to the best of his or her knowledge, no ACM was used as a building material in the building. The state agency shall place a copy of the signed statement in [asbestos](#) records for the agency.
- V.H.2. The exclusion, under subparagraph 1.a. through d. of this subsection, from conducting the inspection under paragraph V.C.1 (Inspections) shall apply only to homogeneous or [sampling areas](#) of a building that were inspected and sampled before the effective date of this regulation.

All underlined text in this regulation indicates defined terms.

VI. USE OF ASBESTOS IN THE MANUFACTURING, COMMERCE AND CONSTRUCTION INDUSTRIES

VI.A. STANDARD FOR ASBESTOS MILLS

Each owner or operator of an asbestos mill shall discharge no visible emissions to the ambient air from the asbestos mill and use the methods specified by paragraph III.J.1 (Air Cleaning and Negative Pressure Requirements) to clean emissions containing particulate asbestos material before they escape to, or are vented to, the ambient air.

VI.B. STANDARD FOR ROADWAYS

No owner or operator of a roadway may deposit asbestos tailings or asbestos-containing waste material on that roadway, unless it is a temporary roadway on an area of asbestos ore deposits.

VI.C. STANDARD FOR MANUFACTURING

VI.C.1. Applicability: This paragraph applies to the following manufacturing operations using commercial asbestos.

- VI.C.1.a. The manufacture of cloth, cord, wicks, tubing, tape, twine, rope, thread, yarn, roving, lap, or other textile materials.
- VI.C.1.b. The manufacture of cement products.
- VI.C.1.c. The manufacture of fireproofing and insulating materials.
- VI.C.1.d. The manufacture of friction products.
- VI.C.1.e. The manufacture of paper, millboard, and felt.
- VI.C.1.f. The manufacture of floor tile.
- VI.C.1.g. The manufacture of paints, coatings, caulks, adhesives, and sealants.
- VI.C.1.h. The manufacture of plastics and rubber materials.
- VI.C.1.i. The manufacture of chlorine utilizing asbestos diaphragm technology.
- VI.C.1.j. The manufacture of shotgun shell wads.
- VI.C.1.k. The manufacture of asphalt concrete.

VI.C.2. Standard: Each owner or operator of any of the manufacturing operations to which this paragraph 3. (Standards for Manufacturing) applies shall:

- VI.C.2.a. Discharge no [visible emissions](#) to the ambient air from these operations or from any building or structure in which they are conducted; and
- VI.C.2.b. Use the methods specified in paragraph III.J.1. (Air Cleaning and Negative Pressure Requirements) to clean emissions from these operations containing [particulate asbestos material](#) before they escape to, or are vented to, the ambient air.

VI.D. STANDARD FOR SPRAYING

The owner or operator of an operation in which [asbestos-containing materials](#) are spray applied shall comply with the following requirements:

- VI.D.1. Use materials that contain one percent [asbestos](#) or less on a dry weight basis for spray-on application on buildings, structures, pipes, and conduits, except as provided in paragraph b. below, and:

- VI.D.1.a. Notify the [Division](#) at least 20 days before beginning the spraying operation. Include the following information in the notice:

- (A) Name and address of owner or operator.
- (B) Location of spraying operation.
- (C) Procedures to be followed to meet the requirements of paragraph VI.D (Standard for Spraying).

- VI.D.1.b. Discharge no [visible emissions](#) to the ambient air from the spray-on application of the [asbestos-containing material](#) and/or use the methods specified by paragraph III.J.1. (Air Cleaning and Negative Pressure Requirements) to clean emissions containing [particulate asbestos material](#) before they escape to, or are vented to, the ambient air.

- VI.D.2. The requirements of subparagraph a. above do not apply to the spray-on application of materials where the [asbestos](#) fibers in the materials are encapsulated with a bituminous or resinous binder during spraying and the materials are not [friable](#) after drying.

VI.E. STANDARD FOR FABRICATING

- VI.E.1. Applicability. This paragraph applies to the following [fabricating](#) operations using [commercial asbestos](#):

- VI.E.1.a. The fabrication of cement building products.
- VI.E.1.b. The fabrication of friction products, except those operations that primarily install [asbestos](#) friction materials on motor vehicles.

VI.E.1.c. The fabrication of cement or silicate board for ventilation hoods; ovens; electrical panels; laboratory furniture; bulkheads, partitions, and ceilings for marine construction; and flow control devices for the molten metal industry.

VI.E.2. Standard. Each owner or operator of any of the [fabricating](#) operations to which this paragraph 5. (Standard for Fabricating) applies shall:

VI.E.2.a. Discharge no [visible emissions](#) to the ambient air from any of the operations or from any building or structure in which they are conducted; and

VI.E.2.b. Use the methods specified by paragraph III.J.1. (Air Cleaning and Negative Pressure Requirements) to clean emissions containing [particulate asbestos material](#) before they escape to, or are vented to, the ambient air.

VI.F. STANDARD FOR INSULATING MATERIALS

No owner or operator of a [facility](#) may install or reinstall on a [facility component](#) any insulating materials that contain [commercial asbestos](#) if the materials are either molded and friable or wet-applied and friable after drying. The provisions of this subsection do not apply to spray-applied insulating materials regulated under subsection VI.D. (Standard for Spraying).

All underlined text in this regulation indicates defined term.

VII. STATEMENT OF BASIS AND PURPOSE

VII.A. AMENDMENT TO SECTION II – INCORPORATION OF THE EPA MODEL ACCREDITATION PLAN BY REFERENCE (March 21, 1996)

Background

The Asbestos Hazard Emergency Response Act of 1986 (AHERA) (15 U.S.C. 2646) was enacted to identify, manage and reduce exposure to asbestos in schools. The Asbestos School Hazard Abatement Reauthorization Act of 1990 (ASHARA) (Public Law 101-637) extended the training and certification requirements of AHERA to public and commercial buildings. Both acts require the Environmental Protection Agency (EPA) to promulgate minimum standards for the conduct of this training. In addition, states are mandated by both acts to either adopt EPA's Model Accreditation Plan (MAP), as presented in 40 CFR Part 763, or create programs that are at least as stringent as the EPA MAP. The state act contemplates adoption of the pertinent federal training requirements in 25-7-503 (1)(f)(I). Through this rulemaking, the Commission is incorporating by reference the Model Accreditation Plan into Air Quality Control Commission Regulation Number 8, Part B, section II to comply with federal and state laws.

Specific Authority

The specific authority for this regulation is found in the Colorado Air Quality Control Act. Section 25-7-503 (1)(f)(I) provides authority to promulgate regulations regarding the training required to apply for state asbestos certification. This regulation will establish appropriate minimum training standards that will meet both state and federal mandates.

Purpose

Regulation 8 generally provides protection to Colorado citizens from exposure to asbestos, a Class A carcinogen, caused by improper abatements due to inadequate training of asbestos Workers, Supervisors, Inspectors, management planners and project designers. This rule will protect against potentially adverse economic impacts that might result against course providers in Colorado. This rule also helps protect against adverse health and environmental effects that may be caused by improperly trained asbestos Workers. In addition, this rule will meet the requirements of federal law (AHERA) and state law (Colorado Air Quality Control Act).

VII.B. REVISIONS RESULTING FROM HB 95-1016 (September 19, 1996)

Basis

The Commission adopted revisions to Regulation No. 8, Part B, recommended by the Division to comply with state legislative directives, and to make other revisions reflecting changes in the federal program and appropriate changes to make the state program more effective and clear. A variety of recommended revisions were appropriate given that Regulation No. 8 has not been reopened and revised for over three years, apart from a recent limited revision regarding the EPA Model Accreditation Plan, and it was necessary to bring the regulation up to date.

The state [asbestos](#) program is not part of the State Implementation Plan (SIP), and the revisions approved by the [Commission](#) today will not be submitted to [EPA](#) as part of Colorado's SIP.

Specific Statutory Authority

Specific authority exists for the [Commission](#)'s revisions in § 25-7-105(10), and § 25-7-501 et seq., C.R.S. In 1995 the Colorado legislature enacted HB 95-1016 amending Part 5, Asbestos Control, to require a variety of changes to the program. Section 25-7-503 provides the Commission with many separate specific authorities including, for example, specifying abatement practices and procedures, assessing notification fees, prescribing inspection and monitoring requirements, enforcing the maximum allowable [asbestos](#) level of 0.01 fibers per cubic centimeter, and requiring training and examinations. Other sections in Part 5 provide authority for specific requirements related, for example, to certification of personnel involved in [asbestos abatement](#). Each of the revisions adopted by the Commission today are supported by specific authority within Part 5.

Purpose

The [Commission](#) revises Regulation No. 8, Part B, regarding [asbestos](#) regulation to effectuate recent state legislative directives, to ensure the public is protected by minimizing the release of asbestos, to address changes to the federal National Emissions Standard for Hazardous Air Pollutants ([NESHAP](#)) Subpart M regarding asbestos, and to update the regulation for efficiency and clarity. The Commission adopts the substantive changes recommended by the [Division](#) and relies upon the record to support those changes. The Commission adopts the Division's proposals to eliminate unnecessary administrative text where it has been found in the regulation. Also, the Commission adopts various incorporations by reference recommended by the Division to bring Regulation No. 8, Part B, into conformity with the Colorado APA.

The [Commission](#) raises the minimum scope of [asbestos abatement](#) subject to the program as recommended by the [Division](#) to conform with the [NESHAP](#) for [asbestos](#) and as directed in § 25-7-503(1)(b), C.R.S. The Commission acknowledges certain statutory changes that are prescriptive from HB 95-1016, e.g., the effect of a plea of nolo contendere (§ 25-7-508(2)(a)(II)(C), C.R.S.), and prohibition from seeking recertification within one year after the Division revokes certification for a violation of the regulation (§ 25-7-508(6), C.R.S.). The Commission approves the Division devising application procedures to offer certificates for a one, three or five year period at the option of the applicant (§§ 25-7-506(2), -507.5(2)(b), C.R.S.).

The [Commission](#) has considered the record and adopts the [Division](#)'s proposals regarding the project manager discipline and [project design](#) requirements. The Commission believes the project manager duties are reasonable and appropriate, and determines at this time that imposing a college-level or higher education requirement would unnecessarily preclude otherwise qualified [persons](#) from performing these duties and that education at such a level was not required by the legislature (§§ 25-7-502(7.5), -503(1)(b)(V)). The Commission approves of the independence requirement for project managers from [GACs](#), and the separate independence requirement for Inspectors from GACs as reasonable and required by statute (§ 25-7-503(1)(b)(V), C.R.S.).

The [Commission](#) adopts the additional training and updated work practices appendix for the [removal](#) of sheet vinyl containing [asbestos](#) based on the record. The Commission believes this is generally consistent with EPA's [NESHAP](#) and with §§ 25-7-501 and -503(1)(a), C.R.S. by reducing the risk of the release of [asbestos](#) fibers. Further, the Commission approves revisions to the definitions of [asbestos-containing waste material](#), [facility](#), [cutting](#), and [grinding](#) as consistent with EPA's NESHAP. The Commission approves the disclosure regarding certification of Workers conducting abatement in [single-family residential dwellings](#) as required by § 25-7-504(3), C.R.S., to ensure that those doing the work are properly [certified](#) and therefore properly trained. The Commission also adopts revisions to procedures for use of [glove bags](#) on abatement projects as being reasonable and efficient, and providing practical assistance to those conducting abatements while protecting the public from exposure to asbestos.

Based upon documents submitted and considered pursuant to § 25-7-110.5, C.R.S., the [Commission](#) makes the following findings: (1) the Commission has considered and has based its decision upon the reasonably available, validated, reviewed and sound scientific methodologies and information made available by interested parties; (2) where these revisions are not administrative in nature, the record supports that the revisions will result in a demonstrable reduction in [asbestos](#) fiber releases or prevent asbestos releases where they might otherwise occur; (3) the revisions selected are the most cost-effective based upon the documents submitted pursuant to § 25-7-110.5(4), C.R.S., they provide the regulated community with flexibility, and achieve necessary reductions or prevention of the release of asbestos, and; (4) the revisions selected will maximize the air quality benefits of asbestos regulation in the most cost-effective manner.

VII.C. REVISIONS RESULTING FROM SB-01-121, THE DORA ASBESTOS CONTROL PROGRAM 2000 SUNSET REVIEW, AND THE REORGANIZATION OF REGULATION NO. 8, PART B (January 16, 2003)

This Statement of Basis, Specific Statutory Authority and Purpose complies with the requirements of the Colorado Administrative Procedure Act Sections 24-4-103(4) and (12.5), C.R.S. for new and revised regulations.

Basis

Regulation No. 8, Part B, sets forth the [Air Quality Control Commission's asbestos](#) control program. The statutory authority for this program is contained in the Colorado Air Pollution Prevention and Control Act ("Act"). In 2001, the legislature amended Part 5 of the Act dealing with asbestos control. These amendments, among other things, expanded the definition of [Area of Public Access](#) to include [single-family residential dwellings](#), mandated certification for [Air Monitoring Specialists](#) and changed the definition of [Friable Asbestos-Containing Material](#). As part of the legislative review of the Act, the Department of Regulatory Agencies ("DORA") examined potential problems with the Act and Regulation No. 8, Part B. Based on this review, DORA issued a report recommending a regulatory solution to perceived inequities in the Conflict of Interest provision set forth in Regulation No. 8, Part B, Section III.C.6.b.v. These revisions are needed to effect the statutory amendments and resolve the conflict of interest issue identified in the DORA report. In addition, the Regulation has been reorganized to make it more readable and easier to understand.

Specific Statutory Authority

The specific statutory authority for these revisions is set forth in various sections of the Colorado Air Pollution Prevention and Control Act. Section, 25-7-105(1), C.R.S., gives the [Air Quality Control Commission](#) general authority to promulgate rules and regulations necessary for the proper implementation of the Act. Additionally, the various provisions set forth in Part 5 of the Act give the Commission specific authority to promulgate regulations governing [asbestos abatement](#) and control. The provisions set forth in Sections 25-7-502 and 25-7-503, C.R.S. authorize the regulatory revisions governing [asbestos](#) control in [single-family residential dwellings](#), changes to the conflict of interest regulations and modification of the regulatory definition of [friable asbestos-containing material](#). Additional authority regarding single-family residential dwellings is set forth in Section 25-7-504, C.R.S. The revisions governing the certification of [Air Monitoring Specialists](#) are specifically authorized pursuant to Section 25-7-506.5, C.R.S.

Purpose

The purposes of these revisions are as follows: 1) to effectuate the legislative changes to the state's [asbestos](#) control program adopted through the passage of Senate Bill 01-121; 2) to address inequalities that DORA noted with respect to the conflict of interest provisions; and 3) to reorganize the Regulation to make it more readable and easier to understand.

VII.C.1. Senate Bill 01-121

In enacting Senate Bill 01-121, the Legislature made the following changes to Colorado's [asbestos](#) control program: 1) revisions to expand statutory and regulatory requirements to [single-family residential dwellings](#); 2) modification of the definition of [friable asbestos-containing material](#) to clarify that this term includes materials measured by area or volume as well as by weight; and 3) adoption of a certification requirement for persons conducting [Air Monitoring Specialist](#) activities. To accomplish these legislative changes the [Commission](#) has adopted a number of revisions to Regulation No. 8, Part B.

VII.C.1.a. Single Family Residential Dwellings

Prior to the adoption of Senate Bill 01-121, [single-family residential dwellings](#) were not included within the definition of [area of public access](#). Because the majority of requirements set forth in the Act and the Regulation apply only to areas of public access, this exclusion left homeowners without recourse to important regulatory protections in connection with either the abatement of [asbestos](#) or renovations impacting asbestos in their homes. To rectify this situation, the Legislature modified the statutory definition of area of public access to include single-family residential dwellings, but provided that such a dwelling would not be considered an area of public access at the request of the homeowner residing in that dwelling. The Commission has adopted essentially identical modifications to the regulatory definition. Modifications to the regulatory provisions governing permitting and use of [certified](#) personnel have also been made to provide that while single-family residential dwellings could constitute areas of public access, neither permits nor the use of certified abatement Workers was required for abatement projects in

such dwellings where the abatement was performed by an individual utilizing the dwelling as his or her primary residence. These provisions are consistent with the statutory mandate set forth in Senate Bill 01-121. Finally, the revisions create a new minimum scope of applicability with regard to single-family residential dwellings. Consistent with the authority set forth in Senate Bill 01-121 the Commission has set applicability levels for abatement projects in single-family residential dwellings at 50 linear feet on pipes or 32 square feet on other surfaces. These [levels](#) are lower than the levels currently set for projects in [public and commercial buildings](#). The lower levels have been adopted in view of the fact that residential projects are typically much smaller; nonetheless, they are likely to result in prolonged exposure to higher risk populations, such as small children, the elderly or the infirm, than projects in public or commercial buildings.

VII.C.1.b. Definition of Friable Asbestos-Containing Material

The previous definition of the term "[friable asbestos-containing material](#)" referenced material containing more than one percent [asbestos](#) by weight. Authorized laboratory analytical methods, however, have, in addition to weight, utilized measurements by area or volume. Consistent with these methods, and the change to the statutory definition, the new regulatory definition clarifies that friable asbestos-containing material includes material containing more than one percent asbestos by area or volume, as well as weight.

VII.C.1.c. Certification of Air Monitoring Specialists

[Air Monitoring Specialists](#) perform air sampling during and at the end of [asbestos abatement](#) projects as well as conduct final visual inspections to ensure that visible dust or debris is not left at the conclusion of the project. These activities are crucial to protecting the general public from [asbestos](#) exposure resulting from abatement projects. Despite the important role that they play in protecting the public, Air Monitoring Specialists were not previously required to obtain a state certification. This omission undermined the Division's ability to ensure that Air Monitoring Specialists were properly qualified, and precluded the Division from revoking certifications of unqualified individuals. In recognition of this, Senate Bill 01-121 required certification of Air Monitoring Specialists in accordance with [Commission](#) regulations setting forth experience, education and training requirements.

These revisions adopt requirements necessary to effectuate the certification of [Air Monitoring Specialists](#). The new requirements allow currently practicing Air Monitoring Specialists to obtain certification upon successful completion of an Air Monitoring Specialist refresher course and a Division administered exam. Individuals who are not qualified under the present regulation, must have a high school diploma and pass a Division approved exam, as well as complete an Air Monitoring Specialist course and on-the-job experience consisting of at least 80 hours of [air monitoring](#) under the supervision of an existing AMS and at least two final visual clearances and at least two final air clearances under the observation of an existing AMS. While an existing [AMS](#) must sign off on a trainee's completion of the on-the-job experience, such a sign off shall not subject the AMS to any enforcement action or liability based on the trainee's subsequent performance of AMS activities.

VII.C.2. DORA Recommendation

In connection with its review of Regulation No. 8, Part B, the Department of Regulatory Agencies recommended revisions to the provision governing potential conflicts of interest with respect to inspections for [asbestos](#). The new regulation requires that inspection and abatement firms be [independent](#) of each other but removes the prohibition against payments from abatement contractors to Inspectors. This change puts abatement and inspection firms on equal footing with respect to contracting with building owners, while giving owners the flexibility to contract with a single firm and allow that firm to sub-contract the abatement or inspection work with another firm.

VII.C.3. Reorganization

The regulation has been reorganized to make it more readable and easier to understand. This reorganization has not substantively changed any requirements, but rather has put these requirements into a more accessible format.

Section I.A. of the Regulation governing materials incorporated by reference, has been expanded to include not only a statement that certain materials have been incorporated by reference, but also a list of those materials. This change makes the substantive provisions citing these materials easier to read and allows the reader to know up front what additional rules, beyond the regulation itself, apply to [asbestos](#) control in Colorado.

The definition section has been changed to include a list of relevant acronyms. This allows the reader to quickly identify what a given acronym stands for. Additionally, throughout the reorganized regulation, electronic links have been created so that individuals electronically reviewing a particular provision can immediately link to a given definition or acronym used in that provision.

Section II of the rule, governing certifications, has been substantially re-written to systematically explain the steps necessary to obtain certification in each of the certified disciplines. The current regulation organizes this information by the different types of requirements rather than by discipline. For example, testing requirements for all the disciplines are contained in one subsection, while training requirements are contained in another. The proposed reorganization organizes this material by discipline. As such, a person seeking to become certified as a Building Inspector can turn directly to the Building Inspector section, and not have to flip back and forth between several subsections. In addition, the current rule includes provisions governing when use of certified personnel is required. Because these provisions substantively govern asbestos control, and do not address how certification is to be obtained, they have been moved to a new subsection in Section III governing abatement, renovation and demolition projects.

The substantive requirements in Section III have been reorganized to follow, as nearly as possible, the chronological steps that need to be taken in dealing with [asbestos-containing materials](#) in buildings. Given the complexity of the regulation, perfect sequencing was not possible, since certain requirements may be applicable at various stages, but generally the proposed revisions logically group related requirements together and in an order that should make sense to a layperson trying to determine how to properly proceed with respect to [asbestos](#)

control. In addition, statements have been added to clarify when the various requirements are applicable.

Because certain specialized rules apply to [asbestos](#) in [schools](#) and [state buildings](#), separate sections containing these rules have been maintained in the regulation. A new Section VI has been created governing standards associated with the manufacture and construction of asbestos materials. These requirements are currently placed in Section III governing project requirements. Because these rules are separate and distinct from the rules governing the removal and management of asbestos in buildings, the Division believes that they should be contained in a separate section. Finally, the section governing enforcement has been deleted from the proposed reorganization. This section unnecessarily duplicated the provisions of the Act, and its inclusion in the regulation was inconsistent with the other air regulations that rely on the Act for their enforcement mechanisms.

Findings Pursuant to § 25-7-110.8, C.R.S.

These revisions are based on reasonably available, validated and reviewed, and sound scientific methodologies demonstrating that exposure to asbestos creates a public health hazard. Interested parties did not provide the Commission with any other validated, reviewed and scientifically sound methodologies or information.

Based on the evidence presented on the record, the requirements of this revised regulation will reduce public exposure to harmful asbestos fibers and therefore reduce the risks to human health and the environment thereby justifying the costs associated with this regulation.

The revisions represent the regulatory alternative presented to the Commission, which best balances cost-effectiveness, flexibility to the regulated community and maximization of air quality benefits.

VII.D. REVISIONS TO ADDRESS INCORRECT LANGUAGE IN THE SINGLE-FAMILY RESIDENTIAL DWELLING OPT-OUT PROVISION, ROOFING MATERIALS AND TYPOGRAPHICAL ERRORS (December 18, 2003)

This Statement of Basis, Specific Statutory Authority and Purpose complies with the requirements of the Colorado Administrative Procedure Act Sections 24-4-103(4) and (12.5), C.R.S. for new and revised regulations.

Basis

Regulation No. 8, Part B, sets forth the Air Quality Control Commission's [asbestos](#) control program. The statutory authority for this program is contained in the Colorado Air Pollution Prevention and Control Act ("Act"). The Legislative Legal Services contacted the [Division](#) to identify a concern with the [single family residential dwelling](#) opt-out provision. Specifically, Legislative Legal Services indicated that the regulatory language governing single-family residential opt outs conflicted with the overriding statutory language. While the intent of the old provision was to be consistent with the statutory directive, the old regulatory language failed to

capture that intent. These revisions are needed to address the concerns of Legislative Legal Services. We have also fixed several typographical errors.

Specific Statutory Authority

The specific statutory authority for these revisions is set forth in various sections of the Colorado Air Pollution Prevention and Control Act. Section, 25-7-105(1), C.R.S., gives the Air Quality Control Commission general authority to promulgate rules and regulations necessary for the proper implementation of the Act. Additionally, the various provisions set forth in Part 5 of the Act give the Commission specific authority to promulgate regulations governing [asbestos abatement](#) and control. The provisions set forth in Sections 25-7-502 and 25-7-503, C.R.S. authorize the regulatory revisions governing asbestos control in [single-family residential dwellings](#), changes to the conflict of interest regulations and modification of the regulatory definition of friable asbestos-containing material. Additional authority regarding single-family residential dwellings is set forth in Section 25-7-504, C.R.S.

Purpose

These changes address issues identified by Legislative Legal Services with respect to the single-family residential dwelling opt-out provision and address typographical errors.

Findings Pursuant to § 25-7-110.8, C.R.S.

These revisions are based on reasonably available, validated and reviewed, and sound scientific methodologies demonstrating that exposure to asbestos creates a public health hazard. Interested parties did not provide the Commission with any other validated, reviewed and scientifically sound methodologies or information.

Based on the evidence presented on the record, the requirements of this revised regulation will reduce public exposure to harmful asbestos fibers and therefore reduce the risks to human health and the environment thereby justifying the costs associated with this regulation.

The revisions represent the regulatory alternative presented to the Commission, which best balances cost-effectiveness, flexibility to the regulated community and maximization of air quality benefits.

VII.E. REVISIONS TO ADDRESS LANGUAGE IN THE SINGLE-FAMILY RESIDENTIAL DWELLING OPT-OUT PROVISION (December 16, 2004)

This Statement of Basis, Specific Statutory Authority and Purpose complies with the requirements of the Colorado Administrative Procedure Act Sections 24-4-103(4) and (12.5), C.R.S. for new and revised regulations.

Basis

Regulation No. 8, Part B, sets forth the Air Quality Control Commission's asbestos control program. The statutory authority for this program is contained in the Colorado Air Pollution Prevention and Control Act ("Act"). The Legislative Legal Services contacted the Division to identify a concern with the [single family residential dwelling](#) opt-out provision. Specifically, Legislative Legal Services indicated that the regulatory language governing single-family residential opt-outs exceeded statutory language. While the intent of the current provision was thought to be consistent with the statutory directive, Legislative Legal Services disagreed. Therefore, this revision is needed to address the concern of Legislative Legal Services.

Specific Statutory Authority

The specific statutory authority for these revisions is set forth in various sections of the Colorado Air Pollution Prevention and Control Act. Section, 25-7-105(1), C.R.S., gives the Air Quality Control Commission general authority to promulgate rules and regulations necessary for the proper implementation of the Act. Additionally, the various provisions set forth in Part 5 of the Act give the Commission specific authority to promulgate regulations governing asbestos abatement and control. The provision set forth in Section 25-7-502, C.R.S. authorizes the regulatory revisions governing asbestos control in single-family residential dwellings. Additional authority regarding single-family residential dwellings is set forth in Section 25-7-504, C.R.S.

Purpose

This changes addresses the issue identified by Legislative Legal Services with respect to the single-family residential dwelling opt-out provision.

VII.F. REVISIONS TO REGULATION NUMBER 8, PART B (June 21, 2007)

This Statement of Basis, Specific Statutory Authority and Purpose comply with the requirements of the Colorado Administrative Procedure Act Sections 24-4-103(4) and (12.5), C.R.S. for new and revised regulations.

Basis

Regulation No. 8, Part B, sets forth the Air Quality Control Commission's asbestos control program. The statutory authority for this program is contained in the Colorado Air Pollution Prevention and Control Act ("Act"). In 2006, the Legislature amended Part 5 of the Act dealing with asbestos control. These amendments, among other things: extended the sunset period to July 1, 2013; mandated exams for Air Monitoring Specialists; allowed the Division to establish certification renewal cycles, and the need to retest, administratively; changed an incorrect Code of Federal Regulations reference; and applied the regulation consistently across all building types. This included requiring an Air Monitoring Specialist to be independent of the General Abatement Contractor. It also included requiring a Project Manager on abatement projects of specified amounts of friable asbestos-containing materials in all building types. In addition, the Regulation has been changed to fix several administrative, typographical and referencing errors.

Specific Statutory Authority

The specific statutory authority for these revisions is set forth in various sections of the Colorado Air Pollution Prevention and Control Act. Section, 25-7-105(1), C.R.S., gives the Air Quality Control Commission general authority to promulgate rules and regulations necessary for the proper implementation of the Act. Additionally, the various provisions set forth in Part 5 of the Act give the Commission specific authority to promulgate regulations governing asbestos abatement and control. The provisions set forth in Sections 25-7-505.5, C.R.S. authorize the regulatory revision to allow proficiency testing of Air Monitoring Specialists. Section 25-7-503, C.R.S., authorizes changes to the regulation for consistency and revises an incorrect Code of Federal Regulations reference. Additionally, authority to allow the Division to change certification periods is set forth in Sections 25-7-506, 25-7-506.5 and 25-7-507.5, C.R.S.

Purpose

The purposes of these revisions are as follows: 1) to effectuate the legislative changes to the State's asbestos control program adopted through the passage of House Bill 06-1177, and 2) to fix several administrative, typographical and referencing errors.

House Bill 06-1177

In enacting House Bill 06-1177, the Legislature made the following changes to Colorado's asbestos control program: 1) addition of a examination requirement for persons conducting Air Monitoring Specialist activities; 2) corrected an incorrect Code of Federal Regulation reference; 3) required an Air Monitoring Specialist to be independent of the General Abatement Contractor; and 4) required a Project Manager on abatement projects (over a specified minimum amount of

friable asbestos-containing materials) in all building types. To accomplish these legislative changes the Commission has adopted a number of revisions to Regulation No. 8, Part B.

1.Examinations for Air Monitoring Specialists

Air Monitoring Specialists perform air sampling during, and at the conclusion of, asbestos abatement projects. They also conduct final visual inspections to ensure that visible dust or debris is not left behind at the conclusion of the project. These activities are crucial to protecting the general public from asbestos exposure resulting from abatement projects. Several years ago, Legislative Legal Services determined that the Division did not have the specific statutory authority to administer tests to Air Monitoring Specialist applicants. This determination removed the Division's ability to ensure that Air Monitoring Specialists were properly trained and competent to perform their duties. In recognition of this, House Bill 06-1177 revised the statutory language to make it clearer that an examination was required in order for them to become certified.

2.Statutorily Established Certification Periods

Currently, it is a requirement that certified individuals take an annual refresher class and pass a state certification test for each discipline. Those who have renewed their certification for many years have often asked for relief from the annual testing requirement. It was recommended that the Division track pass/fail rates and other factors for a period of time to determine appropriate renewal cycles based on these rates.

3. Correct Code of Federal Regulations Provisions

In Section III.U.3.a. (Maximum Allowable Asbestos Level – Second Set by TEM) of the Regulation, a reference to a provision in the Code of Federal Regulations (CFR) is made that is no longer correct due to changes within that document. This provision must be changed in order to be consistent with the current CFR.

4. Consistency in Requirements of the Regulation

In connection with its review of Regulation No. 8, Part B, DORA recommended extending the provision governing potential conflicts of interest with respect to Air Monitoring Specialists and General Abatement Contractors. Additionally, the legislature adopted the use of Project Managers on qualifying abatement projects of friable asbestos containing material in all types of buildings. School buildings and single-family residential dwellings were not covered by this requirement. As abatement projects in these types of buildings may be just as complex as projects in public and commercial buildings, the legislature made the requirements apply to all buildings.

B. Corrections

A number of administrative, typographical and referencing errors were corrected. These corrections have not changed any requirements, but were necessary to correct errors that were present.

Findings Pursuant to § 25-7-110.8, C.R.S.

These revisions are based on reasonably available, validated and reviewed, and sound scientific methodologies demonstrating that exposure to asbestos creates a public health hazard. Based on the evidence presented on the record, the requirements of this revised regulation will reduce public exposure to harmful asbestos fibers and therefore reduce the risks to human health and the environment thereby justifying any costs associated with this regulation. The revisions represent the regulatory alternative presented to the Commission, which best balances cost-effectiveness, flexibility to the regulated community and maximization of air quality benefits.

VII.G. Revisions to Regulation Number 8, Part B (December 20 & 21, 2007)

This Statement of Basis, Specific Statutory Authority and Purpose complies with the requirements of the Colorado Administrative Procedure Act Sections 24-4-103(4), C.R.S. for new and revised regulations.

Basis

The Air Quality Control Commission has adopted revisions to Regulation No. 8, Part B, Sections I.B.13., I.B.14., I.B.15., (all other definition numbers will be updated to reflect these 3 additions), II.B.1., II.B.2., II.C.2., II.C.4., II.C.6., II.D.2., II.D.3.b.(iv)., II.E.1., II.E.1.a., II.G.1., II.G.2., II.L., II.M., II.N., III.E.1.b., III.E.1.c., III.E.1.d., III.F., III.G.1.b., III.G.1.c., III.G.3.c. and III.G.6., in order to raise current fees for certification of individuals and asbestos abatement firms and fees for asbestos abatement and demolition notices and permits. New fees are proposed for registration of asbestos training providers, asbestos consulting firms and asbestos laboratories. The fees will be adjusted commencing in 2008. The increases are necessary to cover current and rising program costs.

Specific Statutory Authority

The specific statutory authority for these revisions is set forth in Section 25-7-510 C.R.S., which allows the Commission to adjust fees so that the revenue generated is sufficient to cover direct and indirect costs to implement the Asbestos program.

Purpose

The revisions to Regulation No.8, Part B, Sections I.B.13., I.B.14., I.B.15., (all other definition numbers will be updated to reflect these 3 additions), II.B.1., II.B.2., II.C.2., II.C.4., II.C.6., II.D.2., II.D.3.b.(iv)., II.E.1., II.E.1.a., II.G.1., II.G.2., II.L., II.M., II.N., III.E.1.b., III.E.1.c., III.E.1.d., III.F., III.G.1.b., III.G.1.c., III.G.3.c. and III.G.6. will cover existing and anticipated shortfalls.

APPENDIX A

All [underlined text](#) in this regulation indicates defined terms.

This section is non-mandatory. It was designed to provide guidance to contractors in conducting [asbestos abatement](#) in a safe fashion.

A. SMALL SCALE PROJECTS

- A.1. If [friable asbestos-containing materials](#), in any amount less than or equal to the [trigger levels](#), will be abated, all of paragraph A.4. below should be followed.
- A.2. Nothing in this Appendix A shall prevent an owner or operator from employing the work practices contained in section III (Abatement, Renovation and Demolition Projects) if it is more prudent or practical to do so.
- A.3. For the purposes of this Appendix A, small scale, short-duration [renovation](#) and maintenance activities include but are not limited to:
 - A.3.a. [removal](#) of [asbestos-containing](#) insulation on pipes;
 - A.3.b. [removal](#) of small quantities of [asbestos-containing](#) insulation on beams or above ceilings;
 - A.3.c. replacement of an [asbestos-containing](#) gasket on a valve;
 - A.3.d. installation or [removal](#) of a small section of drywall;
 - A.3.e. installation of electrical conduits through or proximate to [asbestos-containing materials](#).
- A.4. The following controls and work practices may be used to reduce [asbestos](#) exposures during small maintenance and [renovation](#) operations:
 - A.4.a. All [movable objects](#) should be removed from the [work area](#) to protect them from [asbestos](#) contamination. Objects that cannot be removed should be covered completely with six (6) mil polyethylene plastic sheeting before work begins. If contamination has already occurred, they should be thoroughly cleaned with a [HEPA vacuum](#) or wet wiped before they are removed from the work area, or completely encased in plastic.

A.4.b. Wet methods

Whenever feasible, wet methods, such as those described in subparagraph III.O.1.a.(i). (Wetting) should be used during small scale, short-duration maintenance and [renovation](#) projects.

A.4.c. [Removal](#) methods

A.4.c.(i). Use of [glovebags](#) should be in accordance with subparagraph III.V.1. (Glovebags).

A.4.c.(ii). If a [facility component](#) is to be removed from a structure in order that abatement be performed at an alternate location, the facility component should be completely wrapped in polyethylene and removed to an area where the [stripping](#) can be done safely.

A.4.d. Containment Barriers

A.4.d.(i). Containment Barriers may be constructed in accordance with subparagraph III.N. (Containment Components);

A.4.d.(ii). Mini containment barriers may be constructed in the following manner:

A.4.d.(ii).(A). Affix polyethylene sheeting to the walls with spray adhesive and tape;

A.4.d.(ii).(B). Cover the floor with polyethylene and seal it to the polyethylene covering the walls;

A.4.d.(ii).(C). Seal any penetrations such as pipes or electrical conduits with tape; and

A.4.d.(ii).(D). Construct a small change room (approximately 3 feet square) made of 6 mil polyethylene supported by 2 inch by 4 inch lumber (the polyethylene should be attached to the lumber supports with staples or spray adhesive and tape).

A.4.d.(ii).(E). The change room should be contiguous to the [work area](#) and is necessary to allow the Worker to vacuum off his protective coveralls and remove them before leaving the work area.

A.4.d.(ii).(F). While inside the [work area](#), the Worker should wear Tyvek[®] disposable coveralls, in accordance with subparagraph III.K.2.b.

A.4.d.(ii).(G). Either a [HEPA vacuum](#) or a negative air [HEPA](#) unit should be used to establish negative air within the [enclosure](#), in accordance with subparagraph III.N. (Containment Components).

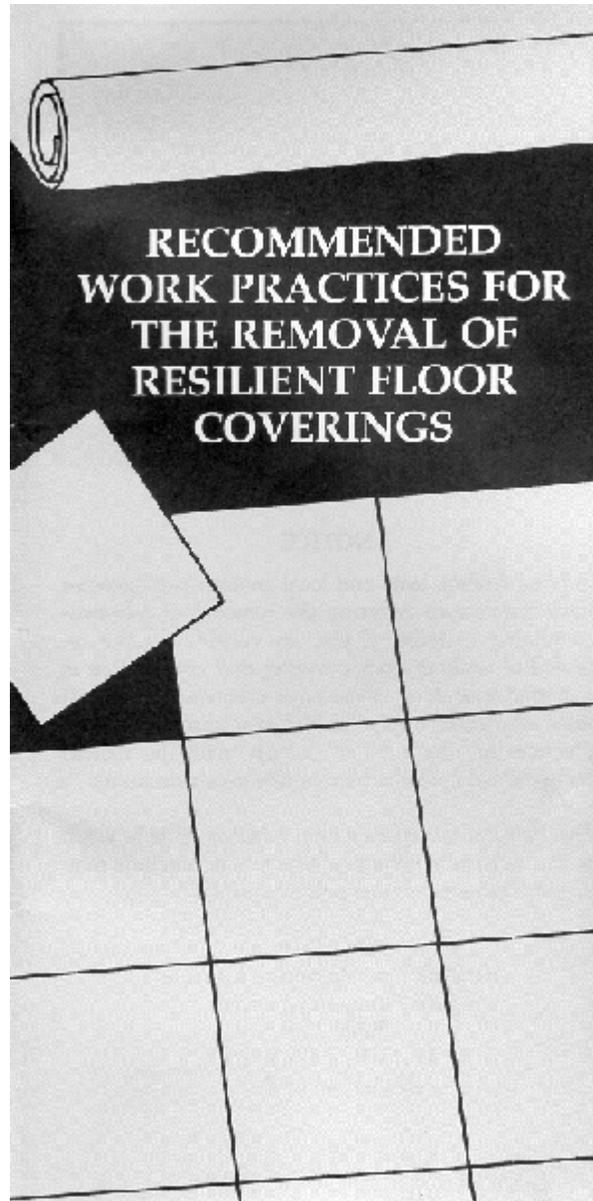
A.4.e. Clearance Air Monitoring

All requirements of subsection III.P. (Clearing Abatement Projects) are optional, except that if [air monitoring](#) is performed, and the area has public access, the maximum allowable [asbestos](#) level shall not be exceeded.

APPENDIX B

Brochure

“Recommended Work Practices for the Removal of Resilient Floor Coverings”





Do not sand, dry sweep, dry scrape, drill, saw, beadblast, or mechanically chip or pulverize existing resilient flooring, backing, lining felt or asphaltic “cut-back” adhesives.

These products may contain either *asbestos fibers* or *crystalline silica*.

Avoid creating dust. Inhalation of such dust is a cancer and respiratory tract hazard.

Smoking by individuals exposed to asbestos greatly increases the risk of serious bodily harm.

Unless positively certain that the product is a non-asbestos containing material, you must presume it contains asbestos. Regulations may require that the material be tested to determine asbestos content.

The RFCI’s *Recommended Work Practices for Removal of Resilient Floor Coverings* are a defined set of instructions which should be followed if you must remove existing resilient floor covering structures.

NOTICE

Various federal, state and local government agencies have regulations covering the removal of asbestos-containing material. If you are considering the removal of resilient floor covering that contains, or is presumed to contain, asbestos you should review and comply with the appropriate regulations.

This publication replaces prior editions of these work practices. Future editions of these work practices may be issued to replace this publication.

Issued by
Resilient Floor Covering Institute
966 Hungerford Drive
Suite 12-B
Rockville, MD 20850
(301) 340-8580

RECOMMENDED WORK PRACTICES FOR THE REMOVAL OF RESILIENT FLOOR COVERINGS

CONTENTS

Introduction2
 Recommended Work Practices5
 Preparation of Floors5
 General Information5
 Sheet Vinyl Flooring6
 General Information and Preparation6
 Special Precautions7
 Complete Removal, Peripheral8
 Complete Removal, Unadhered11
 Complete Removal, Adhered13
 Complete Removal, Underlayment18
 Resilient Tile Floor Covering23
 General Information23
 Complete Removal, Existing Resilient Tile Floor Covering23
 Complete Removal, Tile and Underlayment28
 Preparation of Adhesive Coated Subfloors31

Copyright 1995 by The Resilient Floor Covering Institute.
Printed in the U.S.A.

IMPORTANT INFORMATION FOR INSTALLERS OF RESILIENT FLOOR COVERINGS

Introduction

The member companies of the Resilient Floor Covering Institute are manufacturers of the following forms of Resilient Floor Coverings:

1. Sheet Vinyl
2. Vinyl Floor Tile

While today these products do not contain asbestos, it is possible that in the past some of these products, including asphalt tile, may have contained firmly encapsulated asbestos fibers. In the past decade much attention has been focused on the relationship between exposure to asbestos fibers and respiratory ailments. It has been determined that inhalation of free airborne asbestos fibers may be injurious to health. However, the asbestos fibers contained in the above types of resilient floor coverings are **not free** but firmly encapsulated or **locked in** the product during the manufacturing process.

The Resilient Floor Covering Institute is providing this booklet of recommended work practices for installing or removing resilient floors so that you may proceed with this work in a prudent and protected manner.

There are several general rules to follow:

1. Unless positively certain that the floor is a non-asbestos product, presume it contains asbestos and treat it in the manner prescribed in this pamphlet for a floor containing asbestos.
2. It is preferred to install a new floor over a floor which contains asbestos rather than to remove that floor. This can be done by several methods – directly over the existing floor; installing new underlayment; or use of leveling compound following

installation procedures recommended by the floor covering manufacturer.

3. Removal should be considered the last alternative.
4. Never sand any resilient floor or it's backing to remove them from the floor (See Warning).
5. Use a vacuum equipped with a HEPA filter, disposable dust bag, and metal floor attachment (no brush).
6. All sheet removal must be done using detergent solution.
7. All tile removal must be done by wetting (misting) the tile prior to removal with a garden sprayer, except when heat s being used for removal.
8. All felt scraping must be done wet.
9. Do not dry sweep.
10. Material removed must be placed in heavy-duty polyethylene bags at least 6 mils thick or in a closed leak-tight container, properly labeled and disposed of in an authorized landfill.

OSHA Requirements

In August 1994, OSHA published standards which affect some of the operations described in this booklet. OSHA has determine that "intact" resilient floor covering materials can be removed under a "negative exposure assessment" in compliance with the revised standards by appropriately trained Workers using the Recommended Work Practices.

- **"Intact"** is defined to mean that the asbestos-containing material has not crumbled, been pulverized or otherwise deteriorated so that it is no longer likely to be bound to its matrix. The incidental breakage of flooring materials, or slicing of sheet vinyl floor covering with a sharp edged instrument, during removal operations conducted in accordance with the Recommended Work Practices does not mean that the materials are not removed in an "intact" condition. OSHA has recognized that resilient floor covering materials are considered non-friable if intact and generally do not emit airborne fibers unless subjected to sanding, sawing, or other aggressive operations.
- Installers of resilient floor covering materials that plan to use the Recommended Work Practices outlined in this book to remove intact and nonfriable

asbestos-containing flooring materials are required to complete an 8-hour **training program**.

- Employers must designate a “**competent person**” with 4 hours of additional training to be responsible for the health and safety of the Workers at the floor removal job site.
- OSHA has determined that the competent person can make a “**negative exposure assessment,**” based upon data in the OSHA asbestos rulemaking record (including data from the ENVIRON reports) showing that the use of the Recommended Work Practices during removal of intact flooring material consistently results in Worker exposures below the levels permitted in the OSHA standards.
- Where other Workers or persons may have access to the flooring removal worksite, the employer must establish a demarcated “**regulated area**” and post warning signs.
- Workers who engage in the removal of asbestos-containing flooring materials for more than 30 days per year (one hour or more per day) must receive **medical surveillance**.

RECOMMENDED WORK PRACTICES

PREPARATION OF FLOORS WITH EXISTING RESILIENT FLOOR COVERINGS TO RECEIVE NEW RESILIENT FLOOR COVERINGS

Follow the installation instruction published by the manufacturer of the new floor covering when a new resilient sheet or tile floor covering is to be installed on a surface presently covered with a resilient floor covering. These instructions will tell you what must be done to the existing surface before the new resilient floor covering can be installed.

On the four general procedures listed below, Items 1a, b, and c are covered by manufactures’ instructions. Item 2 is covered specifically in this Work Practices Manual.

1. Resilient Floor Covering Installed Over...

- (a) **The Existing Surface.** Follow the manufacturer’s instruction for removing wax, filling in low spots, etc. **Use wet scrubbing. Never sand an existing resilient floor covering.**
- (b) **New Underlayment.** Install panels on top of the existing surface (wood subfloors only) and apply new floor coverings directly over this. Follow the manufacturer’s instructions.
- (c) **Leveling Compounds.** Follow the manufacturer’s instructions.

2. Completely Removed Existing Resilient Floor Covering

- (a) **Sheet Vinyl** – See instructions below:
 - (1) “Complete Removal of Peripherally Adhered Sheet Vinyl Floor Coverings,” page 8.
 - (2) “Complete Removal of Fully Adhered Sheet Vinyl Floor Covering,” page 13.
- (b) **Tile** – See instructions under heading, “Complete Removal of an Existing Resilient Tile Floor Covering,” page 23.

SHEET VINYL FLOOR COVERING

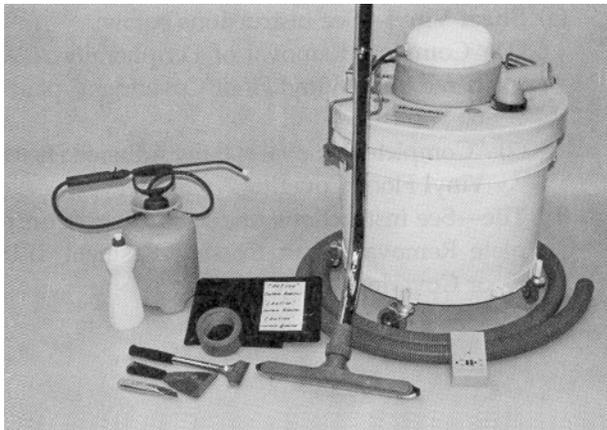
Preparation of Floors with Existing Sheet Vinyl Floor Covering to Receive a New Resilient Floor Covering

Sheet vinyl floor covering can be installed over existing resilient sheet vinyl floor covering under certain conditions. Be sure to follow the floor covering manufacturer's instructions regarding the conditions and floor preparations required.

If complete removal of the existing sheet vinyl floor covering is required, the following instructions are to be followed:

Supplies and Tools

1. Broad stiff-bladed wall scraper or floor scraper.
2. Utility or hook knife.
3. Tank type wet/dry HEPA (High Efficiency Particulate Air) filter vacuum cleaner with disposal dust bag and metal floor attachment (no brush).
4. Large size heavy-duty impermeable trash bags (at least 6 mils thick) or closed leak-tight containers, with ties, tapes, or string to tie shut and tags for labeling.
5. Garden sprayer.
6. A liquid dishwashing detergent which is stated to contain anionic, nonionic, and amphoteric surfactants. The detergent should be mixed with water to



Tools and supplies for sheet removal

6

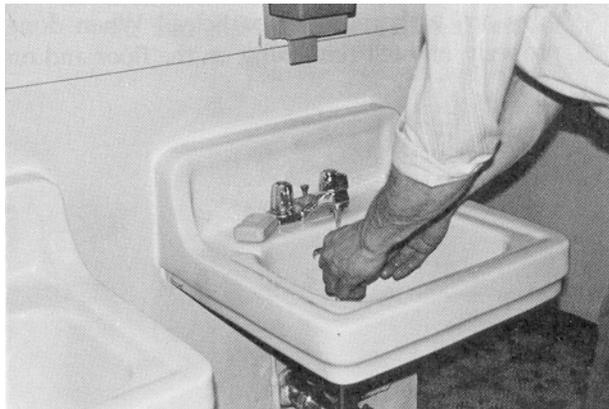


WARNING

Never sand an existing floor covering and never sand or dry scrape residual felt.

- make a dilute solution (1 oz. of detergent in one gallon of water).*
7. Pressure sensitive labels.
 8. Ground fault circuit interrupter for connection of HEPA vacuum and any other electrical equipment.

***PRECAUTION:** Resilient flooring becomes slippery when wet with a detergent solution. Use caution to contain the solution in the immediate work area. Standing on a *new sheet of plywood* or non-slip surface while working is recommended.



WARNING

Wash hands before eating and at the end of the work day.

7

COMPLETE REMOVAL OF PERIPHERALLY ADHERED SHEET VINYL FLOOR COVERING

A. Preparation

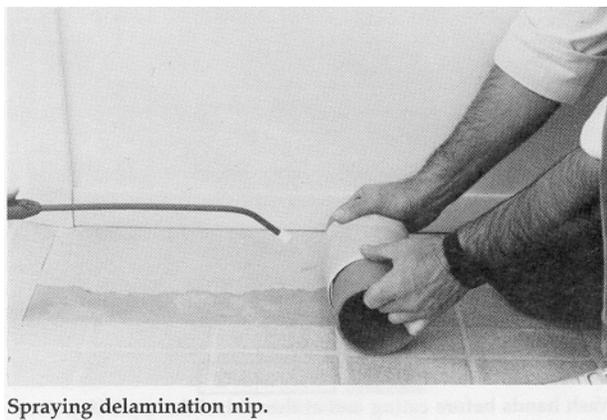
1. Move all appliances and furniture from the work area.
2. Remove all binding strips or other restrictive molding from doorways, walls, etc.
3. Mix a detergent solution (16 ounces of the specified liquid detergent [see Page 6, #6] to 1 gallon of warm water) and pour into a garden sprayer.
4. Clean the entire floor using a wet/dry vacuum cleaner equipped with a HEPA Filtration System and metal floor attachment (no brush). Do Not Sweep.



WARNING

ELECTRICAL SHOCK HAZARD EXISTS; USE A GROUND FAULT CIRCUIT INTERRUPTER FOR ANY ELECTRICAL CONNECTIONS IN A WET ENVIRONMENT.

- B. Make a slice in the adhered floor covering 4 to 8 inches wide, parallel with the walls, around the perimeter of the room.
- C. Start on either side of the entrance door, pry up the corner of the first strip, separating the backing layer. As the strip is being removed, a constant mist of the detergent solution must be sprayed into the delamination nip point to minimize any airborne dust particles.* When done properly, Any felt remaining on the floor and on the back of the strip



Spraying delamination nip.

8

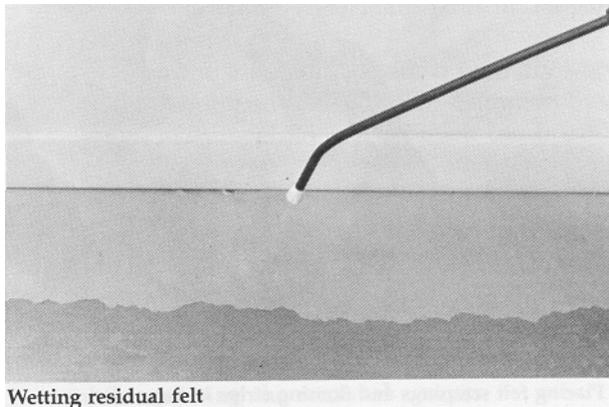
will be thoroughly wet. The strip is peeled by pulling upward at the angle that permits the best separation or by rolling around a core.

- D. Roll the strip tightly as it is removed. Tie or tape securely and place in a heavy-duty leak-tight trash bag or closed impermeable container for disposal.
- E. It may be necessary to remove a second strip following steps (B, C, D) if the unadhered subfloor area has not been exposed.
***PRECAUTION:** Resilient flooring becomes slippery when wet with detergent solution. Use caution to contain the solution in the immediate work area. Standing on a *new sheet of plywood* or non-slip surface while working is recommended.
- F. Remove all of the exposed residual felt by wet scraping before proceeding.

RESIDUAL FELT MUST BE REMOVED BY WET SCRAPING; DO NOT SAND OR DRY SCRAPE IN ANY WAY; DO NOT DRY SWEEP; AVOID CREATING DUST. SEE WARNING STATEMENT.

Wet Scraping Residual Felt

1. Thoroughly wet the residual felt with the detergent solution and allow a few minutes to soak.
2. Stand on the remaining floor covering (not the felt) and use the stiff-bladed scraper or a floor scraper with a replacement blade to remove the wet felt.



Wetting residual felt

9



WARNING

Never sand or dry scrape residual felt. See Warning Statement.

- 3. Re-wet the felt if the solution has not completely penetrated, if drying occurs or if dry felt is exposed during scraping. Scrape **all** felt from this floor area before proceeding further. Pick up the scrapings as they are removed from the floor and place in a heavy-duty impermeable trash bag or closed leak-tight container.

PRECAUTION: Wet residual felt as above but do not excessively soak or flood wood floors with detergent solution. Excessive water can damage wood floors to the extent that new underlayment could be required. A floor that has been wet scraped must be allowed to dry thoroughly before new resilient flooring is installed.

- G. Continue around the room completely removing the adhered flooring along the perimeter, one strip at a time following steps B through F. Do not remove the flooring in the entrance doorway until all other flooring has been completely removed.
- H. Place all flooring strips and felt scrapings immediately while wet into the recommended trash bags. Close full bags tightly and seal securely for disposal. Identify with a label stating, "Caution-Contains Asbestos. Avoid opening or breaking bag or container. Breathing asbestos may cause serious bodily harm." Dispose of in an approved landfill only.*



Placing felt scrapings and flooring strips in bag.

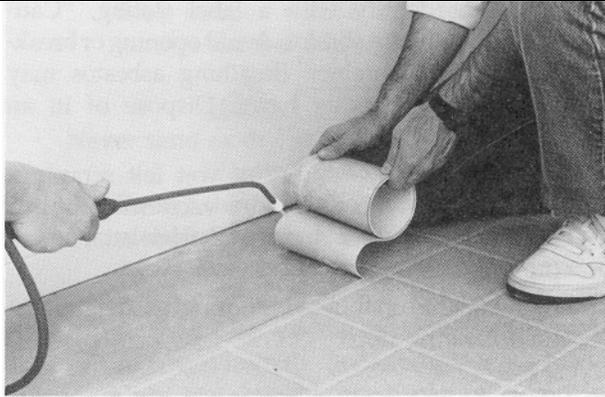
- I. Vacuum up any residue of wet felt scrapings immediately with a wet/dry vacuum equipped with a HEPA filter and metal floor attachment (no brush).
- J. Remove the unadhered flooring as detailed in the following steps.
- K. After vacuuming, used HEPA filters and cleaner bags should be removed according to the manufacturer's instructions and placed in a heavy-duty impermeable bag or leak-tight container with a label stating "Caution-Contains Asbestos. Avoid opening or breaking bag or container. Breathing asbestos may cause serious bodily harm." Dispose of in an approved landfill only.

***NOTICE**

Various federal, state and local government agencies have regulations covering the removal of asbestos-containing material. If you are considering the removal of resilient floor covering that contains, or is presumed to contain, asbestos you should review and comply with the appropriate regulations. The RFCI recommended work practices are designed to comply with the federal occupational asbestos permissible exposure limits.

COMPLETE REMOVAL OF SHEET VINYL FLOORING IN UNADHERED AREAS AND FLOORING INSTALLED LOOSE LAID (WITHOUT ADHESIVE)

- A. Preparation
 - Move all appliances and furniture from the work area.
 - Remove all binding strips or other restrictive molding from doorways, walls, etc.
 - Prepare a detergent solution (16 ounces of the specified liquid detergent [see Page 6, #6] to 1 gallon of warm water) and pour into a garden sprayer.
 - Clean the entire floor using a wet/dry vacuum cleaner equipped with a HEPA Filtration System and metal floor attachment (no brush). Do Not Sweep.
- B. Start at the end of the room farthest from the entrance doorway and slice a strip 18 inches wide in the unadhered flooring.
- C. Remove the sliced strips while spraying the detergent solution directly into the separation nip point.



Spraying the separation nip point.

Do not stand or kneel on the exposed subfloor during the removal process.*

***PRECAUTION:** Resilient flooring becomes slippery when with a detergent solution. Use caution to contain the solution in the immediate work area. Standing on a *new sheet of plywood* or non-slip surface while working is recommended.

- D. Roll the wet strip tightly and tie or tape to secure. Continue working toward the doorway, slicing each strip and removing it while spraying the separation nip point with the detergent solution. Place the strips while still wet into a heavy-duty impermeable trash bag or closed leak-tight container. Close full bags tightly and seal securely for disposal. Identify with a label stating, "Caution-Contains Asbestos. Avoid opening or breaking bag or container. Breathing asbestos may cause serious bodily harm." Dispose of in an approved landfill only. (See NOTICE page 11).
- E. After removing three strips of flooring, vacuum the exposed floor using a wet/dry vacuum equipped with a HEPA filter and metal floor attachment (no brush).
- F. Seams and other adhered areas should be removed as they are encountered by stripping the wear surface while spraying the detergent solution into the delamination nip point and wet scraping the residual felt as previously described in complete removal of peripherally adhered flooring.
- G. Continue removing flooring doing only **one** three-strip area at a time until the entire floor has been completely removed.



Vacuuming exposed floor after removing three strips of flooring.

- H. When the whole floor has been completely removed, let it dry and vacuum up any dust using a vacuum with a HEPA Filtration System and a metal floor attachment (no brush). Stand only in vacuumed areas as you proceed across the floor. Position the vacuum cleaner so that discharge air does not blow on the floor being cleaned.



Do not dry sweep; avoid creating dust. SEE WARNING STATEMENT.

- I. After vacuuming, used HEPA filters and cleaner bags should be removed according to manufacturer's instructions and placed into a heavy-duty impermeable trash bag or closed leak-tight container. Close full bags tightly and seal securely for disposal. Identify with a label stating, "Caution-Contains Asbestos. Avoid opening or braking bag or container. Breathing asbestos may cause serious bodily harm." Dispose of in an approved landfill only.
- J. When the floor is dry, install the new resilient floor covering following manufacturer's installation recommendations.

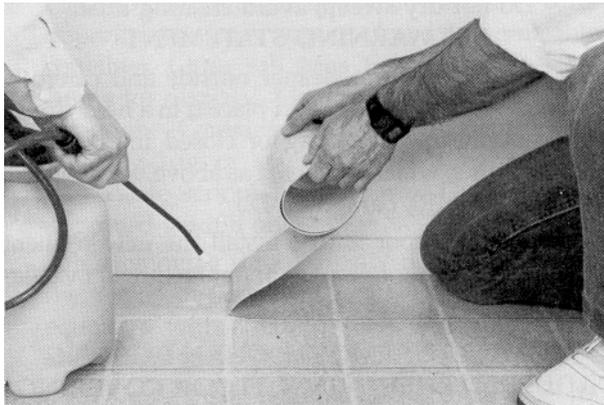
COMPLETE REMOVAL OF AN EXISTING ADHERED SHEET VINYL FLOOR COVERING

If complete removal is required, follow these instructions:



Never Sand an Existing Floor Covering

- A. Preparation
1. Move all appliances and furniture from the work area.
 2. Remove all binding strips or other restrictive molding from doorways, walls, etc.
 3. Prepare a detergent solution (16 ounces of the specified detergent [See page 6] to 1 gallon of warm water) and pour into a garden sprayer.
 4. Clean the entire floor with a wet/dry vacuum equipped with a HEPA Filtration System and metal floor attachment (no brush). Do Not Sweep.
- B. Make a series of parallel slices 4 to 8 inches apart, parallel to a wall.
- C. Start at the end of the room farthest from the entrance door; pry up the corner of the first strip, separating the backing layer. As the strip is being removed, a constant mist of the detergent solution must be sprayed into the delamination nip point to minimize any airborne dust particles. When done properly, the felt remaining on the floor and on the back of the strip will be thoroughly wet. The strip is peeled by pulling upward at an angle that permits the best separation or by rolling around a core.



Spraying delamination nip.

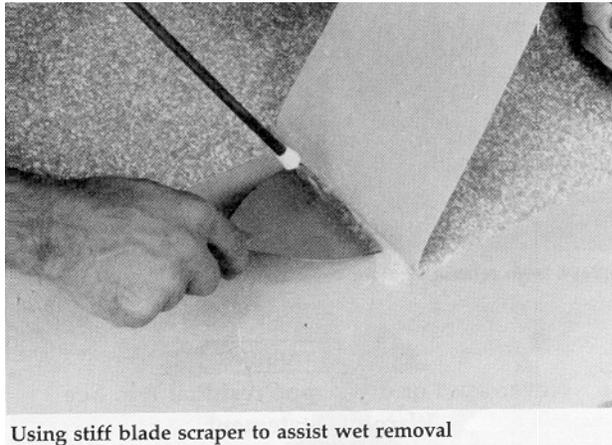


ELECTRICAL SHOCK HAZARD EXISTS. USE A GROUND FAULT CIRCUIT INTERRUPTER FOR ANY ELECTRICAL CONNECTIONS IN A WET ENVIRONMENT.

- D. Roll the strip tightly as it is removed. Tie or tape securely and place in a heavy duty leak-tight trash bag or closed impermeable container for disposal.
- E. Occasionally, parts of the foam inner-layer will remain stuck to the backing. This condition can sometimes be eliminated by pulling the strips loose from the opposite end. Peel the foam inner-layer from the floor while spraying the detergent solution into the delamination nip point.

Some resilient flooring is not readily strippable by hand. When those conditions are encountered, it may be necessary to employ a sharp, stiff blade scraper to assist cleavage of the wearlayer from felt (distance between cuts in wearlayer should be narrower, 3" to 5" wide).

NOTE: Regardless of which one of the previously mentioned methods is used for stripping the wear surface, the detergent solution must be sprayed into the delamination nip point to minimize any airborne dust particles.



Using stiff blade scraper to assist wet removal

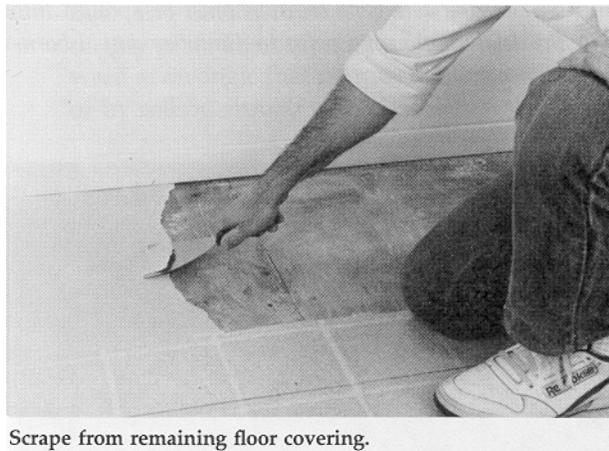
- F. Repeat the wetting and removal process on the next two strips, placing them immediately into the recommended trash bags or closed leak-tight containers for disposal.
- NOTE:** During the stripping process, do not stand or walk on the exposed felt.
- G. After removing three strips of the wear surface, the remaining residual felt must be removed by wet scraping before proceeding.



RESIDUAL FELT MUST BE REMOVED BY WET SCRAPING; DO NOT SAND OR DRY SCRAPE IN ANY WAY; DO NOT DRY SWEEP; AVOID CREATING DUST. SEE WARNING STATEMENT.

H. Wet Scraping Residual Felt

1. Thoroughly wet the residual felt with the detergent solution. Avoid excessive wetting or standing water. Wait a few minutes to allow the solution to soak into the felt.
2. Stand on the remaining floor covering (not the felt) and use the stiff-bladed scraper or a floor scraper with a replaceable blade to remove the wet felt.



Scrape from remaining floor covering.

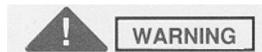


Never sand or dry scrape residual felt. See Warning Statement.

3. Re-wet the felt if the solution has not completely penetrated, if drying occurs or if dry felt is exposed during scraping. Scrape **all** felt from this floor area before proceeding further. Pick up the scrapings as they are removed from the floor and place in a heavy-duty impermeable trash bag or closed leak-tight container.
PRECAUTION: Wet residual felt as above but do not excessively soak or flood wood floors with detergent solution. Excessive water can damage

wood floors to the extent that new underlayment could be required. A floor that has been wet scraped must be allowed to dry thoroughly before new resilient flooring is installed.

4. After removing the three strips of flooring, vacuum the exposed floor using a wet/dry vacuum equipped with a HEPA filter and metal floor attachment (no brush).
- I. Repeat the operation (wetting the delamination nip point while removing the next three strips, then wet scrape the residual felt, then vacuum the exposed floor). Do only **one** three-strip area at a time until the entire floor has been completely removed.



ELECTRICAL SHOCK HAZARD EXISTS, USE A GROUND FAULT CIRCUIT INTERRUPTER FOR ANY ELECTRICAL CONNECTIONS IN A WET ENVIRONMENT.

- J. Place all flooring strips and felt scrapings immediately while wet into the recommended trash bags or closed leak-tight container. Close full bags tightly and seal securely for disposal.

Identify with a label stating, "Caution—Contains Asbestos. Avoid opening or breaking bag or container. Breathing asbestos may cause serious bodily harm." Dispose in an approved landfill only. (See NOTICE page 11.)



Proper disposal.



WARNING

DO NOT DRY SWEEP; AVOID CREATING DUST. SEE WARNING STATEMENT.

- K. When the whole floor has been completely removed, let it dry and vacuum up any dirt using a vacuum with a HEPA Filtration System and a metal floor attachment (no brush). Stand only in vacuumed area as you proceed across the floor. Position the vacuum cleaner so the discharged air does not blow on the floor being cleaned.



Vacuuming entire floor.

- L. Carefully remove the dust bag and place it in a heavy-duty impermeable trash bag or closed leak-tight container for disposal, which is labeled as above.
- M. When the floor is dry, it is ready to have a new resilient floor covering installed. Follow the floor covering manufacturer's instructions.

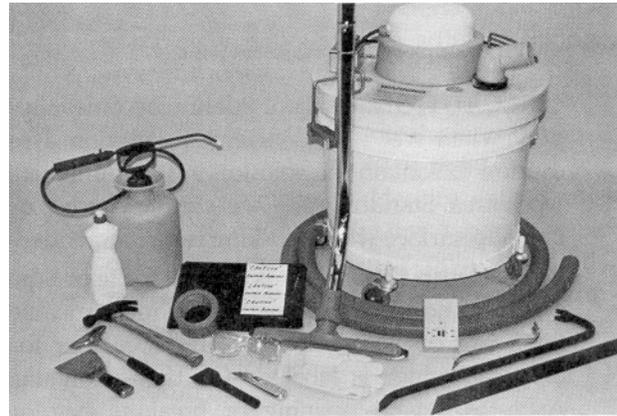
COMPETE REMOVAL OF THIN WOOD UNDERLAYMENT COVERED WITH EXISTING SHEET VINYL RESILIENT FLOORING

The removal of resilient flooring over wood subfloors using the wet stripping/wet scraping method may not be practical in cases where multiple layers of floor covering are present, where non-recommended underlayments were used, or where the flooring was made with a heavy foam backing. As an alternative, the

wood underlayment can be removed with the flooring adhered to it. Following are the details.

A. Preparation

- Move all appliances and furniture from the work area.
- Remove all binding strips or other restrictive molding from doorways, walls, etc.
- Prepare a detergent solution (16 ounces of the specified liquid detergent [See page 6] to 1 gallon of warm water) and pour into a garden sprayer.



Tools needed.

- Clean the entire floor with a wet/dry vacuum equipped with a HEPA Filtration System and metal floor attachment (no brush).
- B. Locate the joints of the underlayment panel farthest from the entrance door.
 - C. Slice a strip of the flooring 4 to 8 inches wide centered over the underlayment joint in the panel being removed.
 - D. Pry up the corner of the strip separating the backing layer. As the strip is being removed, a constant mist of the detergent solution must be sprayed into the delamination nip point to minimize any airborne dust particles.* When done properly, any felt remaining on the floor and on the back of the strip will be thoroughly wet. The strip is peeled by pulling upward at an angle that permits the best separation or by rolling around a core.



Wet removal of strip over underlayment joint.

***PRECAUTION:** Resilient flooring becomes slippery when wetted with a detergent solution. Use caution to contain the solution in the immediate work area. Standing on a *new sheet of plywood* or non-slip surface while working is recommended.

- E. Roll the strip tightly as it is removed. Tie or tape securely and place in a heavy-duty impermeable trash bag or closed impermeable container for disposal, which is labeled “Caution—Contains Asbestos. Avoid opening or breaking bag or container. Breathing asbestos may cause serious bodily harm.” Dispose of in an approved landfill only.



RESIDUAL FELT MUST BE REMOVED BY WET SCRAPING; DO NOT SAND OR DRY SCRAPE IN ANY WAY; DO NOT DRY SWEEP; AVOID CREATING DUST. SEE WARNING STATEMENT.

- F. Remove all of the exposed residual felt by wet scraping before proceeding.

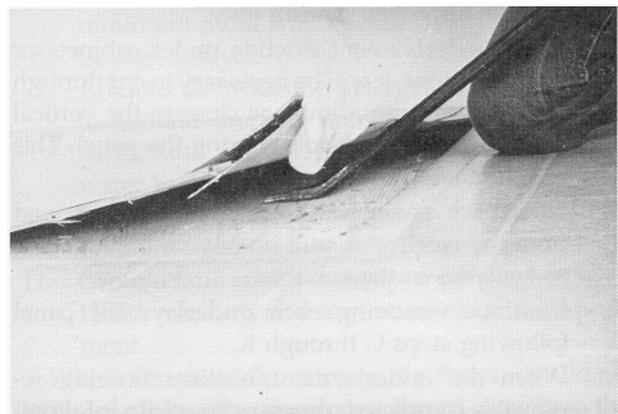
Wet Scraping Residual Felt

1. Thoroughly wet the residual felt with the detergent solution and allow a few minutes to soak.
2. Stand on the remaining floor covering (not the felt) and use the stiff-bladed scraper or a floor scraper with a replaceable blade to remove the wet felt.



Never sand or dry scrape residual felt. See Warning Statement.

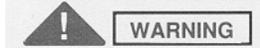
3. Re-wet the felt if the solution has not completely penetrated, if drying occurs or if dry felt is exposed during scraping. Scrape all felt from this floor area before proceeding further. Pick up the scrapings as they are removed from the floor and place in a heavy-duty impermeable trash bag or closed impermeable container.
 4. Continue around the underlayment panel completely removing the adhered flooring over the joints.
 5. Place all flooring strips and felt scrapings immediately while wet into the recommended trash bags or closed leak-tight containers. Close full bags tightly and seal securely for disposal. Identify with a label stating. “Caution—Contains Asbestos. Avoid opening or breaking bag or container. Breathing asbestos may cause serious bodily harm.” Dispose in an approved landfill only. (See NOTICE page 11.)
 6. Vacuum the exposed floor area using a wet/dry vacuum equipped with a HEPA filter and metal floor attachment (no brush).
- G. Drive a cold chisel using a hammer or mallet into the joint at a corner of the panel. Now use the chisel to pry the panel up far enough to insert a pry bar. Continue working around the panel, lifting all edges slowly. Use one or two pry bars to pry up the underlayment panel a little at a time until the panel



Prying up underlayment panel.

is completely loose and can be removed. Every attempt should be made to remove the panel in one piece.

- H. If the underlayment panel breaks, cut the resilient flooring at the break and spray the detergent solution onto the exposed felt. Allow the solution to penetrate for a few minutes, then continue lifting the broken underlayment.



ELECTRICAL SHOCK HAZARD EXISTS. USE A GROUND FAULT CIRCUIT INTERRUPTER FOR ANY ELECTRICAL CONNECTIONS IN A WET ENVIRONMENT.

- I. Remove each underlayment panel or piece from the work area as it is lifted to avoid injury. Wear heavy gloves when handling removed panels. Be very careful of wood splinters and protruding fasteners. Flatten the fasteners with a hammer and stack the panels back to back on pallets or place in dumpster. Identify panels with a label stating, "Caution—Contains Asbestos. Avoid breaking panels. Breathing asbestos may cause serious bodily harm." Dispose of in an approved landfill only. Place any small wood or flooring scraps in a heavy-duty impermeable trash bag or closed leak-tight container for disposal. Identify all of the containers and bags with a label stating, "Caution—Contains Asbestos. Avoid opening or breaking bag or container. Breathing asbestos may cause serious bodily harm." Dispose of in an approved landfill only.
- J. If the underlayment extends under cabinets or wall partitions, it will be necessary to slice through the flooring with a knife as close to the vertical surfaces as possible, deeply scoring the panel. This should allow removal.
- K. After each panel has been lifted and removed from the work area, pull up any remaining nails or fasteners in the subfloor.
- L. Continue removing each underlayment panel following steps G through K.
- M. When the underlayment/resilient flooring removal is completed, vacuum with a HEPA filter and metal floor attachment (no brush). Prepare the subfloor following the manufacturer's installation recommendations.

RESILIENT TILE FLOOR COVERING

Preparation of Floors with Existing Resilient Tiles to Receive New Resilient Floor Covering

Some resilient floor coverings can be installed over existing resilient tile installations. Follow the installation instructions published by the manufacturer of the new floor covering when a new resilient floor covering is to be installed on a surface presently covered with a resilient floor covering.

These instructions will tell you what must be done to the existing surface before the new resilient floor covering can be installed.



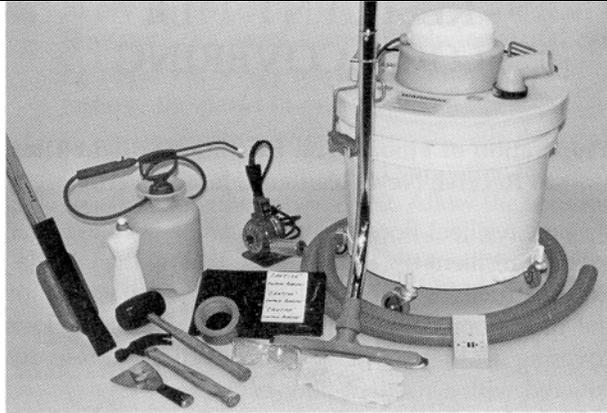
Never Sand an Existing Tile Installation

COMPLETE REMOVAL OF EXISTING RESILIENT FLOOR COVERING

Supplies and Tools

1. Sharp stiff blade floor scraper.
2. Weighted scraper with long handle.
3. Safety glasses.
4. Hammer.
5. Hot air gun or a radiant heat source.
6. Wet/dry vacuum with a HEPA Filtration System and metal floor attachment (no brush).
7. Heavy-duty, impermeable, plastic trash bags with minimum 6 mil wall thickness or leak-tight containers.
8. Garden sprayer.
9. A liquid dishwashing detergent which is stated to contain anionic, nonionic, and amphoteric surfactants. The detergent should be mixed with water to make a dilute solution (1 oz. of detergent to one gallon of water).
10. Pressure-sensitive labels 3" x 5" or larger.
11. Ground fault circuit interrupter for connection of HEPA vacuum and any other electrical equipment.

Whenever possible, existing tile floors should be left in place and the new floor adhered directly to the tile following manufacturer's directions.



Tools needed.

Occasionally, there is no alternative except to remove the tile; curling, poor bond and breakage are common reasons. If removal is unavoidable, consideration must also be given to subfloors coated with asphalt tile adhesive. The following procedures address the recommended work practice for removal of floor tile and preparation of adhesive-coated floors.

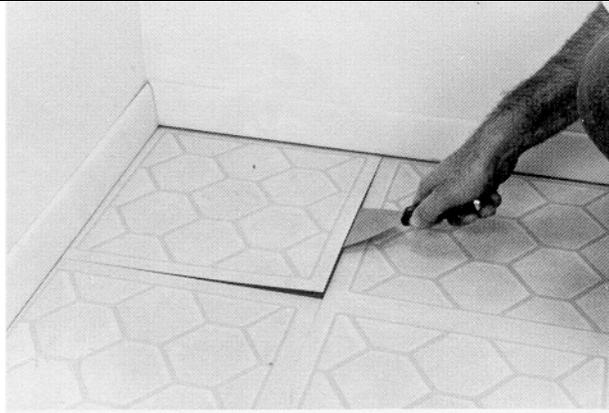
Removal Procedure

A. Preparation

1. Move all appliances and furniture from the work area.
2. Remove all binding strips or other restrictive molding from the doorways, walls, etc.
3. The entire floor should be cleaned with a wet/dry vacuum equipped with a HEPA Filtration System and a metal floor attachment (no brush). Do Not Sweep.
4. Floor tiles must be wetted (misted with a garden sprayer) before actual removal begins, unless heat will be used to remove tiles.

B. Those areas normally exposed to heavy foot traffic patterns usually have tiles adhered the tightest. As a matter of good practice in starting the tile removal, those sections which receive the least traffic should be the locations selected for starting the removal of the tile. It should be the goal to remove individual tiles as a complete unit although breakage of tiles is unavoidable.

C. Start the removal by carefully wedging the wall scraper in the seam of two adjoining tiles and gradually forcing the edge of one of the tiles up and



Start tile removal in corner

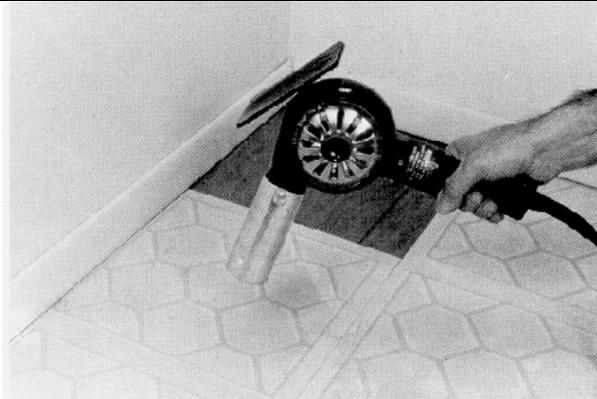
away from the floor. Continue to force the balance of the tile up by working the scraper beneath the tile and exerting both a forward pressure and a twisting action on the blade to promote release of the tile from the adhesive and the floor.

- D. When the first tile is removed, place it, without breaking it further into smaller pieces, in a heavy-duty impermeable trash bag or closed leak-tight container which will be used for disposal.
- E. With the removal of the first tile accessibility of the other tile is improved. Force the wall scraper under the exposed edge of another tile and continue to exert a prying twisting force to the scraper as it is moved under the tile until the tile releases from the floor. Again, dispose of the tile, and succeeding tiles, by placing in the heavy-duty bag or closed leak-tight container without additional breaking.
- F. Some tiles will release quite easily while others require varying degrees of force. Where the adhesive is spread heavily or is quite hard, it may prove easier to force the scraper through the tightly adhered areas by striking the scraper handle with a hammer using blows of moderate force while maintaining the scraper at a 25° to 30° angle to the floor.

Continue to wet (mist) the tiles with a garden sprayer.

Caution: Use safety goggles.

- G. If some areas are encountered where even the technique detailed in the previous paragraph proves to be inadequate, the removal procedure can be simplified by thoroughly heating the tile(s) with a hot air blower or a radiant heat source until the heat penetrates through the tile and softens the adhesive.



Use hot air blower to assist removal.

NOTE: Handle the hot air blower or a radiant heat source, tiles and adhesive carefully to avoid personal burns.

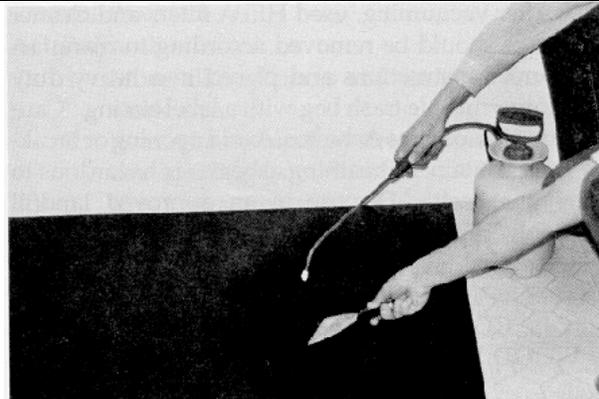
NOTE: Do not handle the heated tiles and adhesive without suitable glove protection for the hands.

- H. As small areas of subfloor are cleared of tile, the adhesive remaining on the floor must be treated. The degree of treatment for residual cut-back adhesive is dependent upon the type of new resilient floor covering material to be installed and the type of subfloor. See page 31 **Preparation of Adhesive Coated Subfloor** for special recommendations.

If new resilient floor tile is to be installed over a concrete subfloor using an asphaltic adhesive, the residual asphaltic “cut-back” adhesive must be left so that no ridges or puddles are evident and what remains is a thin, smooth film.

Wet Scraping Residual Adhesive

- (1) Start in the corner of the room farthest from the entrance door and moisten an area approximately 3' x 10' with water mixed with the specified liquid dishwashing detergent (1 oz. specified liquid dishwashing detergent to one gallon of water) to aid in wetting the adhesive. Wet scrape with a stiff-bladed wall or floor scraper removing ridges and any loose adhesive.
- (2) Place loosened adhesive residues into a heavy-duty impermeable trash bag or other leak-tight container and seal with ties, tape or string and label “Caution—Contains Asbestos. Avoid opening or breaking container. Breathing asbestos is hazardous to your health.” Dispose in an approved landfill



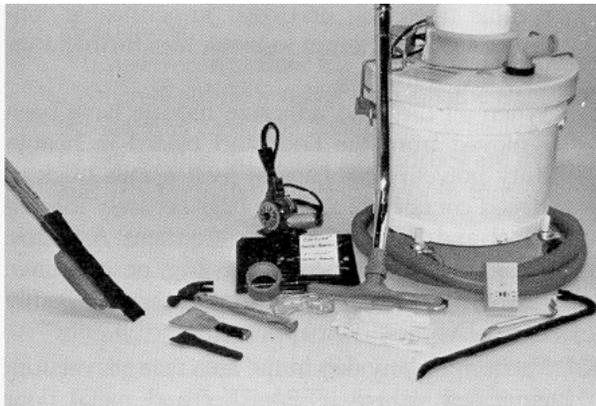
Wet scraping adhesive ridges.

- only.
 - (3) Wet vacuum standing water with HEPA wet/dry vacuum.
 - (4) Continue steps (1) through (3) until what remains of the residual asphaltic “cut-back” adhesive is a thin, smooth film.
- I. As indicated in previous paragraphs, tiles should be placed immediately in a heavy-duty impermeable trash bag or closed leak-tight container. Do not attempt to break tiles further after they are in the bag.
 - J. When all tiles and adhesive residue have been removed from the floor and placed in heavy-duty polyethylene bags at least 6 mils thick or closed containers, seal the bags securely for disposal and label, “Caution—Contains Asbestos. Avoid opening or breaking bag or container. Breathing asbestos may cause serious bodily harm.” Dispose in an approved landfill only.
 - K. Vacuum up any dirt in the area using a vacuum equipped with a HEPA filter and metal floor attachment (no brush).
 - L. After vacuuming, used HEPA filters and cleaner bags should be removed according to manufacturer’s instructions and placed in a heavy-duty impermeable trash bag or a leak-tight container with a label stating “Caution—Contains Asbestos. Avoid opening or breaking container. Breathing asbestos is hazardous to your health.” Dispose in an approved landfill only. Close and seal the trash bags securely for disposal.

COMPLETE REMOVAL OF THIN WOOD UNDERLAYMENT COVERED WITH EXISTING TILE

Supplies and Tools

1. Chisel.
2. Hammer or mallet.
3. Short- and long-handled pry bars.
4. Heavy gloves.
5. Sharp stiff-blade floor scraper.
6. Weighted scraper with long handle.
7. Safety goggles.
8. Garden Sprayer.
9. Hammer.
10. Hot air gun.
11. Wet/dry vacuum with a HEPA Filtration System and metal floor attachment (no brush).
12. Heavy-duty, impermeable, plastic trash bags with minimum 6 mil wall thickness.
13. Pressure-sensitive labels 3" x 5" or larger.
14. Ground fault circuit interrupter for connection of HEPA vacuum and any other electrical equipment.



Tools and supplies.

Removal Procedure

- A. Preparation
1. Move all appliances and furniture from the work area.
 2. Remove any binding strips or other restrictive molding from doorways, walls, etc.
 3. The entire floor should be cleaned with a wet/dry vacuum equipped with a HEPA Filtration System and a metal floor attachment (no

brush). Do Not Sweep.

4. Floor tiles must be wetted (misted with a garden sprayer) before actual removal begins, unless heat will be used to remove tiles.
- B. Starting at the doorway or a floor ventilation vent, locate a joint in an underlayment board.
- C. Start the removal by carefully wedging the wall scraper in the seam of two adjoining tiles and gradually forcing the edge of one of the tiles up and away from the floor. Continue to force the balance of the tile up by working the scraper beneath the tile and exerting both a forward pressure and a twisting action on the blade to promote release of the tile from the adhesive and the floor. Continue to remove tile in this manner at all joints, until all board joints are exposed.
- D. When the first tile is removed, place it, without breaking it further into smaller pieces, in a heavy-duty impermeable trash bag or closed leak-tight container which will be used for disposal.
- E. With the removal of the first tile accessibility of the other tile is improved. Force the wall scraper under the exposed edge of another tile and continue to exert a prying twisting force to the scraper as it is moved under the tile until the tile releases from the floor. Again, dispose of the tile, and succeeding tiles, by placing in the heavy-duty bag or closed leak-tight container without additional breaking.
- F. Some tiles will release quite easily while others require varying degrees of force. Where the adhesive is spread heavily or is quite hard, it may prove easier to force the scraper through the tightly adhered areas by striking the scraper handle with a



Removal of tile over subfloor joint.

hammer using blows of moderate force while maintaining the scraper at a 25° to 30° angle to the floor.

Continue to wet (mist) the tiles with a garden sprayer.

Caution: Use safety goggles.

- G. If some areas are encountered where even the technique detailed in the previous paragraph proves to be inadequate, the removal procedure can be simplified by thoroughly heating the tile(s) with a hot air gun until the heat penetrates through the tile and softens the adhesive.

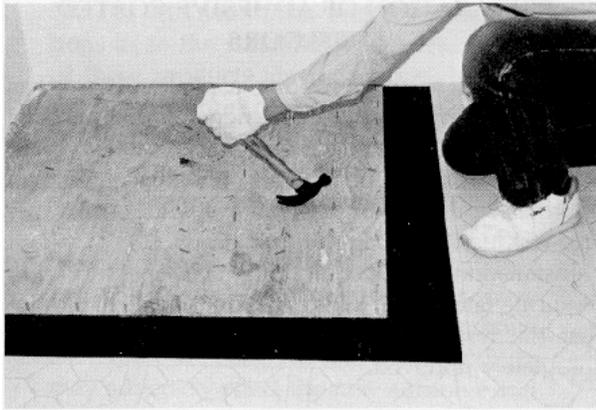
NOTE: Handle the hot air gun, tiles and adhesive carefully to avoid personal burns.

NOTE: Do not handle the heated tiles and adhesive without suitable glove protection for the hands.

- H. After all the tiles have been removed from the underlayment joints, drive a chisel, using a hammer or a mallet, between the underlayment board and the subfloor. Use the chisel to pry up the underlayment enough to insert a pry bar and remove the chisel. Slowly and carefully use pry bars to pry up the underlayment board a little at a time until the board is completely loose and can be removed.

- I. Caution must be used to avoid breaking the underlayment board. The underlayment board should be removed in one piece. If the underlayment board breaks, heat and slice the tile at the break, then continue to remove broken underlayment.

- J. Wear heavy gloves and be very careful of wood splinters and fasteners sticking out of the back of the underlayment. Each underlayment board (or piece of board) should be removed from the work area as soon as it has been pried up to avoid injuries



Removing nails and staples from underlayment.

(such as stepping on a nail). Fasteners protruding from a removed board should be flattened with a hammer. Place removed underlayment boards on skids with the nails pointing downward. Wrap skid with 6 mil polyethylene plastic sheeting and secure with duct tape. Identify with a label stating "Caution-Contains Asbestos. Avoid opening or breaking container. Breathing asbestos may cause serious bodily harm." Dispose in an approved landfill only.

- K. After each board has been removed, pull out any nails or fasteners still in the subfloor. Dispose of these and any other nails or fasteners which have been removed but are still lying in the work area.
- L. A chisel is not needed to start the removal of boards after the first board has been removed. Simply work the pry bar under the exposed edge of the next board.
- M. When removal of the underlayment/existing tile floor is complete, thoroughly check the exposed subfloor. Renail loose areas and reset any "popped" nails or fasteners.
- N. Vacuum up any dirt in the area using the vacuum cleaner equipped with the HEPA filter and metal floor attachment (no brush).
- O. After the underlayment is completely removed, install the new underlayment and/or floor covering according to the manufacturer's installation instructions.



Warning Regarding Complete Adhesive Removal: Some Solvent Based "Cut-Back" Asphaltic Adhesives May Contain Asbestos Fibers That Are Not Readily Identifiable. Do Not Use Power Devices Which Create Asbestos Dust in Removing These Adhesives. The Inhalation of Asbestos Dust May Cause Asbestosis or Other Serious Bodily Harm. Smoking Greatly Increases the Risk of Serious Bodily Harm.

PREPARATION OF ADHESIVE COATED SUBFLOORS

The removal of latex based adhesives commonly used with vinyl sheet floors and some tiles can be accomplished by wetting the adhesive residue (which will soften the adhesive) and scraping. Do not use an excessive amount of water which can damage wood subfloors.

The degree to which residual asphalt adhesive has

to be removed depends on the new flooring material which is being installed. Generally installation of Vinyl Composition Tile requires only the wet removal of adhesive ridges, excess adhesive, and loose adhesive residues. (See page 26, paragraph H).

Installation of sheet flooring and specialty tiles requiring latex, resin, or epoxy adhesives will require that the residual asphaltic adhesive be essentially completely removed.

I. Recommended Method for Preparing Concrete Subfloors Coated with Cut-Back or Emulsion Tile Adhesive.

Unless positively certain that the adhesive is a non-asbestos product presume it contains asbestos and treat it in the manner prescribed in the pamphlet for a cut-back or emulsion tile adhesive containing asbestos.

A. Trowelable Underlayment

Cover the adhesive residue with trowelable underlayment following the manufacturer's recommended application procedures. (Recommended for residential use only.) Patching compounds are not effective barriers to material migrating from asphaltic adhesives.

B. Self-Leveling Cementitious Underlayment

Follow manufacturer's recommendations for use of these types of underlayments as a covering for adhesive coated concrete.

NOTE: All warranties and recommendations as to the suitability and performance of these products are the responsibility of the manufacturer of the underlayment.

C. Adhesive Removers

The Resilient Floor Covering Institute does not recommend or approve the use of those products. There are a number of commercial adhesive removers on the market that will properly remove cut-back or emulsion adhesive residue from a subfloor; however, there are concerns that these products may adversely effect the new adhesive and new floor covering.

D. Wet Removal

Supplies and Tools

1. Broad stiff-bladed wall or floor scrapers, a 4-inch wide blade with handle is recommended.
2. No. 1 sandblasting sand (clean, sharp, coarse cutting sand).

3. Terrazzo or low-speed floor machine fitted with a floor plate attachment (Clark Assy. 500212-6).
4. Hand-held rubbing stones.
5. Wet/dry tank-type vacuum cleaner equipped with High Efficiency Particulate Air (HEPA) filter and metal floor attachment (no brush).
6. Heavy-duty polyethylene bags at least 6 mil thick, tape or ties, and labels.
7. Slip-resistant shoes or rubber heels.
8. Ground fault circuit interrupter for electrical connection of the HEPA vacuum and any other electrical connections required.
9. Garden sprayer.
10. A liquid dishwashing detergent which is stated to contain anionic, nonionic, and amphoteric surfactants. The detergent should be mixed with water to make a dilute solution (1 oz. of liquid in one gallon of water).

Procedure

1. Start in the corner of the room farthest from the entrance door and moisten an area of the adhesive approximately 3' x 10' with water mixed with liquid dishwashing detergent (to aid in wetting the adhesive). Wet scrape with a stiff-bladed wall or floor scraper removing ridges and any loose adhesives, until only a thin smooth film remains.
2. Place loosened adhesive residues into a heavy-duty impermeable trash bag or other impermeable container and seal with ties, tape or string and label "Caution—Contains Asbestos. Avoid opening or breaking bag or container. Breathing asbestos may cause bodily harm." Dispose in an approved landfill only.
3. Wet vacuum standing water with HEPA wet/dry vacuum.
4. Continue steps 1 through 3 until entire area is wet scraped.
5. Place cutting sand into a container (enough to cover an approximate 6' x 6' area), add water mixed with liquid detergent (1 oz. of the specified detergent [See #10 above] to one gallon of water) to the sand to dampen (20 lbs. of sand to ½ gallon of solution).
6. Place sand over a 6' x 6' area and wet remove the existing adhesive residue using a terrazzo floor machine. Keep sand under rubbing stones when operating the machine. The sand and the subfloor

must be continuously kept wet.

7. Occasionally push away cutting sand from the subfloor with a wall or floor scraper to check for complete removal.
8. Adhesive around the edge of the room and areas that were missed can be removed with dampened, clean, sharp cutting sand and a hand-held rubbing stone.
9. Wet scrape sand into a pile using a stiff-bladed floor or wall scraper and place sand and adhesive residue in a heavy-duty impermeable container, seal with ties or tape and label "Caution—Contains Asbestos. Avoid opening or breaking bag or container. Breathing asbestos may cause bodily harm." Dispose in an approved landfill only.
10. Rinse area with clear, clean water using the hand sprayer. Worker boots should also be rinsed and cleaned.
11. Wet vacuum standing water with a wet/dry vacuum equipped with a HEPA filter and metal floor attachment (no brush).
12. Continue steps 1 through 8 until the entire room is complete.
13. Allow subfloor to dry and vacuum up any remaining dirt or sand using a vacuum equipped with a HEPA filter and metal attachment (no brush).
14. After vacuuming, used HEPA filters and cleaner bags should be removed according to manufacturer's instructions and placed in a heavy-duty impermeable trash bag or a leak-tight container with a label stating "Caution—Contains Asbestos. Avoid opening or breaking container. Breathing asbestos is hazardous to your health." Close and seal the trash bags or container securely for disposal. Dispose in an approved landfill only.

E. Alternate Wet Removal Method

Supplies and Tools

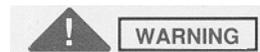
1. Supplies and tools listed as items 1, 5, 6, 7, 8, 9 and 10 in Section D above, as well as the following:
2. Floor machine fitted with a 3M black floor pad (or equivalent).
3. Removal solution: "mop on, mop off, no machine scrub," stripping solution.
4. Water-absorbent material.

Procedure

1. Start in corner of the room farthest from the entrance door. Put the removal solution onto the residual

adhesive with a hand sprayer or mop over a 6' x 6' area. Put enough removal solution ("mop on, mop off, no machine scrub," stripping solution) on to ensure that the area is thoroughly wet. Allow the area to soak for 5-10 minutes. Remove the adhesive using a floor machine equipped with a 3M black floor pad (or equivalent). **The subfloor must be continuously kept wet.**

2. Occasionally push away the adhesive slurry from the subfloor with a wall or floor scraper to check for complete removal. Continue to use the floor machine, equipped with the black pad, in the same area until the concrete subfloor is cleaned to the desired degree. (This depends on what material will be reinstalled.)
3. Adhesive around the edge of the room and areas that were missed or difficult to reach with the machine can be removed with handheld piece of the black floor pad using the above procedures.
4. Wet HEPA vacuum the adhesive slurry. When the HEPA vacuum is full, place a commercially suitable water absorbent into the HEPA container until the adhesive slurry is absorbed. Place adhesive waste from The HEPA vacuum into heavy-duty impermeable bags or leak-tight container and seal with ties or tape and label "Caution—Contains Asbestos. Avoid Creating Dust. Breathing Asbestos May Cause Bodily Harm." Dispose in an approved landfill only.
5. Rinse floor area with clear, clean water using a hand sprayer or mop.
6. Wet vacuum standing water with HEPA wet/dry vacuum.
7. Continue steps 1 through 6 until the entire room is complete.
8. Allow subfloor to dry and vacuum with a HEPA vacuum.



ELECTRICAL SHOCK HAZARD EXISTS. USE A GROUND FAULT CIRCUIT INTERRUPTER FOR ANY ELECTRICAL CONNECTIONS IN A WET ENVIRONMENT.

II. Recommended Methods for Preparing Wood Subfloor Coated with Cut-Back or Emulsion Adhesive

A. Trowelable Underlayment

Cover the adhesive residue with trowelable underlayment following manufacturer's recom-

mended application procedures. (Recommended for residential use only.)

B. Wood Panel Underlayment

Normally it will not be necessary to remove the old tile when installing underlayment* over a single layer of tile. However, if the tile must be removed, the tackiness of the adhesive must be “dried-up” before installing new underlayment. This can be done by spreading a layer of powder from latex patching compound (either type) and vacuuming up the excess. Another method is to place a layer of asphalt saturated pattern scribing felt or two layers of newspaper over the tacky adhesive residue before the underlayment is installed. If the old adhesive is not “dried-up” before the underlayment is installed, there is the possibility that a “cracking” sound will be heard when the new floor is walked on, creating an unsatisfactory condition. This occurs because the underlayment is pressed into the tacky adhesive by foot traffic. When the pressure is released, the underlayment sticks momentarily and then springs from the tacky adhesive, creating a “cracking” noise.

C. Removal of Adhesive Coated Underlayment Panels

If removal of the existing underlayment panels is necessary, follow the procedure outlined under “Complete Removal of Thin Wood Underlayment Covered with Existing Resilient Flooring” steps G-M (page 28-31).

*See manufacturer’s recommendations for approved underlayment types.



Do not sand, dry sweep, dry scrape, drill, saw, beadblast, or mechanically chip or pulverize existing resilient flooring, backing, lining felt or asphaltic “cut-back” adhesives.

These products may contain either *asbestos fibers* or *crystalline silica*.

Avoid creating dust. Inhalation of such dust is a cancer and respiratory tract hazard.

Smoking by individuals exposed to asbestos fibers greatly increases the risk of serious bodily harm.

Unless positively certain that the product is a non-asbestos containing material, you must presume it contains asbestos. Regulations may require that the material be tested to determine asbestos content.

The RFCI’s *Recommended Work Practices for Removal of Resilient Floor Coverings* are a defined set of instructions which should be followed if you must remove existing resilient floor covering structures.

Issued by
Resilient Floor Covering Institute
966 Hungerford Drive, Suite 12B
Rockville, MD 20850
(301) 340-8580

August 1995

This publication replaces prior editions of these work practices. Future editions of these work practices may be issued to replace this publication.

APPENDIX C
Training Course Outline
Removal of Resilient Floor Coverings in Accordance with Appendix B

All underlined text in this regulation indicates defined terms; clicking on underlined text will take you to its definition in Section I.

These courses are designed to train Workers to remove asbestos containing flooring materials in accordance with Appendix B to this regulation. Unless the flooring materials are removed in accordance with sections I, II, and III of this regulation, persons who remove asbestos-containing flooring materials must complete the 8-hour employee training course, including receiving a passing examination grade; persons who supervise the removal of asbestos-containing flooring materials must complete the 8-hour employee training course (including receiving a passing examination grade) and then successfully complete the additional course, including receiving a passing grade on a separate examination covering sections 10-13 of this outline. NOTE: Completion of these training courses does not satisfy the training requirements for Colorado certification as an asbestos abatement Worker or asbestos abatement Supervisor as provided in section II of this regulation.

8-HOUR EMPLOYEE TRAINING COURSE

- Section 1 Background Information on Asbestos (slides, lecture, workbook, quiz)
- Characteristics of asbestos
 - Categories of asbestos-containing building materials
 - Friable and nonfriable condition of materials
 - List of suspect asbestos-containing materials
 - Determination/identification of asbestos-containing materials (including presumptions regarding flooring materials)
 - Control options
 - Potential health effects related to exposure to airborne asbestos
 - Hazards of smoking and asbestos exposure
 - Protective work practices and controls to minimize asbestos exposure
- Section 2 Laws and Regulations (video, slides, lecture, workbook, quiz)
- Current regulations concerning the removal and disposal of asbestos-containing materials
 - Regulated areas/Respirators/Negative Air Pressure/Protective Clothing/Decontamination Procedures
 - How regulations are enforced
 - Federal Government agencies that regulate asbestos removal
OSHA Asbestos Standard
EPA NESHP
EPA AHERA and ASHARA
DOT Regulations
 - Difference between federal and state asbestos laws
 - State and local asbestos regulations
 - Hazard Communication Standard and safety issues

- Section 3 [Asbestos-Containing Resilient Flooring Materials](#)
(slides, lecture, workbook, quiz)
- Walk through survey versus bulk sample analysis
 - Types of floor coverings, which contain [asbestos](#)
 - Determining friability of resilient floor coverings ([EPA](#) Recommended Test)
 - Flooring adhesives, which contain asbestos
 - Alternatives to removing [asbestos-containing](#) floor covering and adhesives
 - Methods which should not be used to remove resilient floor covering materials
 - Waste disposal procedures
 - Notification requirements
- Section 4 [Removal of Resilient Floor Tile](#)
- Video demonstration of properly removing floor tile
 - Live demonstration of properly removing floor tile
 - "Hands on" student practice removing floor tiles using heat and without heat
 - Quiz
- Section 5 [Removal of Residual Asphaltic Adhesive](#)
- Video demonstration of proper procedure for removing adhesive
 - Review of proper procedure for removing adhesive
 - "Hands on" student practice removing adhesive
 - Quiz
- Section 6 [Removal of Resilient Sheet Flooring](#)
- Video demonstration of proper procedure for removing sheet flooring
 - Live demonstration of proper procedure for removing sheet flooring
 - "Hands on" student practice removing sheet flooring
 - Quiz
- Section 7 [Complete Removal of Wood Underlayment](#)
- Video demonstration of proper procedures for removing resilient flooring complete with underlayment
 - Review of proper procedures for complete [removal](#) of wood underlayment
- Section 8 [Review](#)
- Review previous instruction and clarify any unanswered questions
- Section 9 [Examination Covering sections 1-7](#)

**ADDITIONAL TRAINING COURSE FOR PERSONS SUPERVISING
THE REMOVAL OF FLOORING MATERIALS
(4-Hour Minimum)**

- Section 10 [Prewrite Activities and Considerations](#)
- Determination of [asbestos-containing materials](#)
 - Methods of identification
 - Walk through survey/bulk sampling
 - Common building materials containing [asbestos](#)

- Review of regulations
 - [OSHA](#)
 - [EPA](#)
 - DOT
 - State and Local

Section 11 [Assessment of the Work Area](#)

- Site preparation considerations
- Conducting a Negative Exposure [Assessment](#)
- Isolating the [work area](#)
- Adjacent areas
- Regulated areas
- Safety hazards

Section 12 [Notification, Recordkeeping, and Waste Disposal](#)

- Recordkeeping requirements
- Notification requirements
- Warning signs
- Special equipment
- Transport and disposal of [asbestos](#) waste

Section 13 [Supervising Workers](#)

- Establishing goals
- Providing clear instructions
- Establishing expectations
- Use of Supervisory authority
- Motivating Workers

Section 14 [Review and Examination](#)

- Review
- Examination (covering sections 10-13)

A

ACBM, 2, 5, 8, 9, 10, 13, 57, 58, 59, 60, 61, 62, 63, 65, 66, 67, 68, 69, 70, 71, 72, 73, 75, 76, 77, 78, 85. (see asbestos containing building material)

ACM, 2, 3, 4, 5, 6, 8, 9, 10, 11, 12, 13, 27, 30, 33, 35, 39, 41, 42, 43, 44, 45, 49, 50, 51, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 67, 69, 72, 73, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85. (see asbestos containing material)

ACWM, 3, 13, 38, 39, 46, 47, 54. (see asbestos containing waste material)

adequately wet, 2, 41, 42, 49, 54, 55

air cleaning, 37, 86, 87, 88

air monitoring, 2, 19, 20, 21, 22, 24, 25, 26, 29, 35, 36, 43, 44, 45, 50, 51, 52, 54, 66, 67, 79, 84, 85, 92, 93, 100

- clearance air monitoring, 36, 54
- maximum allowable asbestos level, 52, 82, 90, 100
- negative air machine exhaust, 36

Air Monitoring Specialist, 19, 20, 21, 22, 24, 25, 26, 29, 30, 43, 44, 46, 51, 52, 85, 92, 93

airless sprayers, 54

alternative procedures, 32, 42, 55

analysis, 27, 45, 46, 52, 53, 58, 59, 61, 62, 65, 73, 75, 80, 82, 84, 124

asbestos abatement, 3, 4, 8, 9, 16, 25, 26, 28, 29, 30, 31, 32, 34, 35, 36, 38, 39, 40, 41, 43, 46, 47, 48, 50, 53, 79, 90, 92, 93, 98, 123

asbestos cement, 48

asbestos cement products, 48

asbestos containing building material, 2

asbestos containing material, 2, 3, 4, 5, 6, 8, 9, 10, 11, 12, 27, 30, 33, 35, 39, 41, 42, 43, 44, 45, 49, 50, 51, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 67, 68, 69, 72, 73, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 103, 121

asbestos containing waste material, 3, 12, 38, 39, 46, 47, 49, 54, 91

asbestos spill, 50, 51, 52, 53

asbestos-contaminated soil, 39, 49

asphaltic, 49, 103, 116, 119, 121

asphaltic materials, 49

assessment, 57, 59, 62, 63, 79, 80, 82, 83, 104, 105

B

bulk, 8, 58, 59, 60, 61, 72, 73, 80, 81, 82, 124

bulk sample analysis, 61, 82, 124

C

certification and training requirements, 48, 49, 55

- course approval, 23
- examinations, 25
- reciprocity, 24

clearance air monitoring, 35, 36, 54

clearing abatement projects, 37, 44, 45, 50, 54, 100

containment, 4, 8, 9, 35, 37, 39, 40, 41, 42, 43, 49, 52, 53, 54, 55, 67, 99

contaminated soil, 39, 49

course approval, 23

coveralls, 39, 99

critical barriers, 35, 36, 44, 46

D

decontamination unit, 12, 30, 38, 39, 41, 46

demolition, 5, 9, 27, 30, 31, 32, 55, 80, 94

disposal, 6, 39, 42, 47, 49, 75, 76, 84, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 120, 123, 124, 125

E

emergencies, 5, 30, 31, 37, 39, 43, 56, 58, 89

encapsulation, 6, 10, 45, 64, 65, 66, 67

examinations, 90

exclusion, 78, 84, 85, 92

F

fabricating, 6, 87, 88
facility, 2, 4, 5, 6, 7, 10, 11, 14, 27, 30, 31, 33, 38, 41, 42, 43, 48, 54, 55, 88, 91, 99
facility components, 3, 10, 11, 42, 54
final visual inspection, 6, 19, 21, 22, 29, 36, 43, 44, 54, 93
floor tile, 10, 15, 48, 86, 115, 116, 124. (see resilient floor coverings)

G

GAC, 14, 17, 27, 28, 29, 30, 31, 32, 33, 34, 37, 41, 42, 43, 44, 47, 49, 51, 52, 53, 54, 55
General Abatement Contractor, 14, 16, 17, 28
glovebags, 38, 53, 54, 68, 91, 99

H

handling, 5, 20, 36, 46, 50, 51, 68, 69, 70, 114
HEPA vacuuming, 8, 54

I

independence requirement, 90
independent, 7, 27, 30, 43, 44, 51, 55, 94
 air monitoring specialist, 43
 project manager, 29
initial training, 18, 23
inspection and reinspection, 62, 72
inspections, 2, 21, 22, 27, 31, 33, 43, 56, 62, 73, 79, 80, 82, 84, 93, 94
inspector, 3, 27, 28, 55, 58, 59, 60, 61, 62, 72, 76, 77, 78, 80, 81, 82, 83, 84, 85, 94
insulating materials, 10, 86, 88

L

large contiguous facility complexes, 31, 33
linoleum. (see sheet vinyl and resilient floor coverings)
local education agency responsibilities, 70, 71, 75
Local Education Agency Responsibilities, 56

M

MAAL, 14, 51, 52, 53. (see maximum allowable asbestos level)
major fiber release episode, 69
major fiber release episode in schools, 69
management planner, 19, 68, 71, 73, 85, 89
management plans, 7, 56, 57, 63, 71, 74, 84
manufacturing, 7, 8, 86, 104
maximum allowable asbestos level, 51, 52, 90, 100
maximum allowable asbestos level (MAAL), 52, 90, 100
mills, 86

N

notification, 25, 29, 30, 31, 32, 41, 50, 57, 75, 90, 124, 125
 notices, 29, 30, 31, 48, 50
 notification procedures, 25
notification procedures
 asbestos abatement, 25
 asbestos abatement, 3, 8, 9, 26, 28, 29, 30, 31, 32, 34, 43, 48, 50, 79, 90, 98, 123
 demolition, 5, 9, 27, 28, 30, 31, 32, 55, 80

O

operations and maintenance, 9, 10, 56, 64, 68, 71, 73, 74, 76

P

PCM, 15, 44, 45, 46, 52, 53, 66, 67. (see phase contrast microscopy)
permit, 30, 31, 33, 34, 35, 38, 50
permits, 30, 31, 33, 34, 35, 93, 107, 110, 112
phase contrast microscopy, 8, 46, 65, 66
phase contrast microscopy (PCM), 46, 65, 66
point counting, 27
project design, 9, 24, 25, 29, 30, 89, 90
project designer, 19, 25, 26, 29, 30, 89
project management
 project manager, 29, 30, 34, 35, 90

waiver requests, 29
Project Management
Project Manager, 26
project manager, 29, 30, 34, 35, 55, 90
project managers
independence requirement, 90,
91
project modification, 34
public access, 2, 16, 27, 29, 31, 33, 34, 35,
36, 38, 39, 40, 41, 43, 46, 47, 49, 50, 51,
52, 53, 55, 79, 80, 81, 82, 92, 100
public and commercial building, 9, 27, 28,
29, 89, 93

R

reciprocity, 24
recordkeeping, 56, 85
refresher training, 18, 23
reinspection, 56, 57, 58, 59, 60, 62, 63, 71,
72, 73, 74, 75
renovation, 9, 10, 27, 80, 94, 98, 99
resilient floor covering, 4, 103, 104, 105,
108, 109, 112, 114, 116, 121, 124
resilient floor coverings, 4, 104, 114, 123,
124
training course outline, 123
resilient floor tile, 10, 116. (see resilient
floor coverings)
response actions, 7, 10, 56, 63, 64, 65, 69,
72, 73, 74, 75, 84
roadway, 86
roadways, 10, 86
roofing materials
asphaltic, 49, 124
transite (asbestos cement), 48

S

sample analysis, 12, 61, 82, 124
sampling, 22, 27, 35, 44, 56, 59, 60, 65, 72,
76, 77, 78, 80, 82, 84, 85, 93, 124
air monitoring, 2
bulk, 58, 59, 60, 61, 62, 72, 73,
80, 81, 82, 124
school requirements, 51, 56, 74, 78
analysis, 27, 45, 46, 52, 53, 58,
59, 61, 62, 65, 73, 75, 80, 82, 84

assessment, 27, 30, 57, 59, 60,
62, 63, 72, 73, 79, 80, 82, 83, 84
exclusions, 58, 62, 76, 84
inspection and reinspection, 62
local education agency
responsibilities, 70, 71, 75
major fiber release episode, 69
management plans, 7, 56, 57, 63,
71, 74, 84
operations and maintenance, 9,
10, 56, 64, 67, 68, 71, 73, 74, 76
recordkeeping, 56, 75, 84, 85,
125
response actions, 7, 10, 43, 56,
63, 64, 65, 69, 72, 73, 74, 75, 84
sampling, 27, 44, 56, 58, 59, 60,
61, 65, 72, 76, 77, 78, 80, 82, 84,
85, 124
training and periodic
surveillance, 69
warning labels, 47, 57

School Requirements

Local Education Agency
Responsibilities, 56

sheet vinyl flooring, 11, 48
single family residential dwelling, 11
single family residential dwellings, 11
single-family residential dwellings, 34
Small Scale Projects, 98
soil, 39, 49
spill, 4, 50, 51, 52, 53
spill response, 49, 50, 52, 53
major fiber release episode, 69
requirements for major asbestos
spills, 50
spraying, 87, 88, 108, 109, 110
state building requirements
analysis, 80
assessment, 79
exclusion, 78, 80, 82, 84, 85
inspections, 76, 77, 78, 79, 80,
82, 84, 85
state agency responsibilities, 79,
80, 82
State Building Requirements, 79
structurally unsound buildings, 32

supervisor, 17, 24, 25, 28, 48, 50, 55, 89,
123

T

TEM, 12, 15, 44, 45, 52, 53, 65, 66. (see
transmission electron microscopy)
temporary storage of ACWM, 47
transite, 48
transmission electron microscopy, 12, 45,
52, 53, 65
trigger levels, 12, 27, 28, 30, 33, 34, 35, 36,
38, 39, 40, 41, 43, 44, 46, 47, 48, 49, 50,
51, 53, 55, 66, 79, 80, 81, 82, 98

V

variances, 24, 42, 55
VAT, 10, 15. (vinyl asbestos tile)
vinyl asbestos tile, 10
visible emissions, 2, 6, 12, 47, 86, 87, 88

W

waiver
notification requirements, 29
project manager, 34
Waiver
Project Manager, 26
warning labels, 47, 57, 76
waste material, 3, 12, 13, 46, 47, 49, 54, 86,
91
handling, 39, 49, 50, 51, 54
waste shipment procedures, 47
waste water, 38, 47
wastewater, 38, 47
wet wiping, 42, 54
wetting, 12, 42, 54, 104, 110, 111, 116, 118,
119
worker, 4, 5, 6, 8, 10, 11, 16, 24, 28, 38, 39,
48, 50, 56, 57, 65, 73, 74, 89, 91, 99, 105,
123, 125

Appendix C Environmental Protection Agency Regional Screening Levels-Residential and Composite Worker, EPA Toxicity Maximum Concentrations of Contaminants, CDPHE-Hazardous Materials and Waste Management Division Groundwater Protection Values Soil Cleanup Table

Toxicity and Chemical-specific Information													Contaminant		Screening Levels										Protection of Ground Water SSLs		
SFO (mg/kg-day) ¹	key	IUR (ug/m ³) ¹	key	RfD _o (mg/kg-day)	key	RfC ₁ (mg/m ³)	key	muta- gen	GIABS	ABS	C _{sat} (mg/kg)	Analyte	CAS No.	Resident Soil (mg/kg)	key	Industrial Soil (mg/kg)	key	Resident Air (ug/m ³)	key	Industrial Air (ug/m ³)	key	Tapwater (ug/L)	key	MCL (ug/L)	Risk-based SSL (mg/kg)	key	MCL-based SSL (mg/kg)
2.2E-06	I			1.2E-03	O	9.0E-03	I	V	1	0.1	1.1E+05	Acetophate	30560-19-1	7.6E+01	n	9.8E+02	n	1.3E+00	c**	5.6E+00	c**	2.4E+01	n		5.3E-03	n	
				2.0E-02	I				1	0.1		Acetaldehyde	75-07-0	1.1E+01	c**	4.9E+01	c**	1.3E+00	c**	1.3E+00	c**	2.6E+00	c**		5.2E-04	c**	
				9.0E-01	I	3.1E+01	A	V	1		1.1E+05	Acetochlor	34256-82-1	1.3E+03	n	1.6E+04	n					3.5E+02	n		2.8E-01	n	
						2.0E-03	X		1	0.1		Acetone	67-64-1	6.1E+04	n	6.7E+05	nms	3.2E+04	n	1.4E+05	n	1.4E+04	n		2.9E+00	n	
						6.0E-02	I	V	1		1.3E+05	Acetone Cyanohydrin	75-86-5	2.8E+06	nm	1.2E+07	nm	2.1E+00	n	8.8E+00	n				2.6E-02	n	
									1		2.5E+03	Acetonitrile	75-05-8	8.1E+02	n	3.4E+03	n	6.3E+01	n	2.6E+02	n	1.3E+02	n		2.6E-02	n	
3.8E+00	C	1.3E-03	C	1.0E-01	I			V	1	0.1	2.3E+04	Acetophenone	98-86-2	7.8E+03	ns	1.2E+05	nms					1.9E+03	n		5.8E-01	n	
				5.0E-04	I	2.0E-05	I	V	1	0.1		Acetylaminofluorene, 2-Acrolein	53-96-3	1.4E-01	c	6.0E-01	c	2.2E-03	c	9.4E-03	c	1.6E-02	c		7.2E-05	c	
									1		1.1E+05	Acrylamide	107-02-8	1.4E-01	n	6.0E-01	n	2.1E-02	n	8.8E-02	n	4.2E-02	n		8.4E-06	n	
5.0E-01	I	1.0E-04	I	2.0E-03	I	6.0E-03	I	M	1	0.1		Acrylonitrile	79-06-1	2.4E-01	c	4.6E+00	c	1.0E-02	c	1.2E-01	c	5.0E-02	c		1.1E-05	c	
				5.0E-01	I	1.0E-03	I	V	1		1.1E+05	Acrylic Acid	79-10-7	9.9E+01	n	4.2E+02	n	1.0E+00	n	4.4E+00	n	2.1E+00	n		4.2E-04	n	
5.4E-01	I	6.8E-05	I	4.0E-02	A	2.0E-03	I	V	1		1.1E+04	Acrylonitrile	107-13-1	2.5E-01	c*	1.1E+00	c*	4.1E-02	c*	1.8E-01	c*	5.2E-02	c*		1.1E-05	c*	
5.6E-02	C			1.0E-02	I	6.0E-03	P		1	0.1		Adiponitrile	111-69-3	8.5E+06	nm	3.6E+07	nm	6.3E+00	n	2.6E+01	n				8.7E-04	c	1.6E-03
				1.0E-03	I				1	0.1		Alachlor	15972-60-8	9.7E+00	c*	4.1E+01	c					1.1E+00	c	2.0E+00	4.9E-03	n	7.5E-04
				1.0E-03	I				1	0.1		Aldicarb	116-06-3	6.3E+01	n	8.2E+02	n					2.0E+01	n	2.0E+00	4.4E-03	n	4.4E-04
1.7E+01	I	4.9E-03	I	3.0E-05	I			V	1	0.1		Aldicarb Sulfone	1646-88-4	6.3E+01	n	8.2E+02	n					2.0E+01	n	2.0E+00	4.4E-03	n	4.4E-04
									1	0.1		Aldicarb sulfonide	1646-87-3									4.0E+00	n	4.0E+00	4.4E-03	n	8.8E-04
									1		1.1E+05	Aldrin	309-00-2	3.9E-02	c*	1.8E-01	c	5.7E-04	c	2.5E-03	c	9.2E-04	c		1.5E-04	c	
2.1E-02	C	6.0E-06	C	5.0E-03	I	1.0E-04	X	V	1	0.1	1.4E+03	Allyl Alcohol	107-18-6	3.5E+00	n	1.5E+01	n	1.0E-01	n	4.4E-01	n	2.1E-01	n		4.2E-05	n	
				1.0E-03	I	1.0E-03	I	V	1		1.4E+03	Allyl Chloride	107-05-1	7.2E-01	c**	3.2E+00	c**	4.7E-01	c**	2.0E+00	c**	7.3E-01	c**		2.3E-04	c**	
				1.0E+00	P	5.0E-03	P		1			Aluminum	7429-90-5	7.7E+04	n	1.1E+06	nm	5.2E+00	n	2.2E+01	n	2.0E+04	n		3.0E+04	n	
2.1E+01	C	6.0E-03	C	4.0E-04	I				1			Aluminum Phosphide	20859-73-8	3.1E+01	n	4.7E+02	n					8.0E+00	n		1.6E-01	n	
				9.0E-03	I				1	0.1		Ametryn	834-12-8	5.7E+02	n	7.4E+03	n					1.5E+02	n		1.5E-05	c	
									1	0.1		Aminobiphenyl, 4-	92-67-1	2.6E-02	c	1.1E-01	c	4.7E-04	c	2.0E-03	c	3.0E-03	c		1.6E-01	n	
				8.0E-02	P				1	0.1		Aminophenol, m-	591-27-5	5.1E+03	n	6.6E+04	n					1.6E+03	n		6.1E-01	n	
				4.0E-03	X				1	0.1		Aminophenol, o-	95-55-6	2.5E+02	n	3.3E+03	n					7.9E+01	n		3.0E-02	n	
				2.0E-02	P				1	0.1		Aminophenol, p-	123-30-8	1.3E+03	n	1.6E+04	n					4.0E+02	n		1.5E-01	n	
				2.5E-03	I				1	0.1		Amtraz	33089-61-1	1.6E+02	n	2.1E+03	n					8.2E+00	n		4.2E+00	n	
						5.0E-01	I	V	1			Ammonia	7664-41-7					5.2E+02	n	2.2E+03	n				4.0E+03	n	
				2.0E-01	I				1		1.4E+04	Ammonium Sulfamate	7773-06-0	1.6E+04	n	2.3E+05	nm					4.0E+03	n		4.0E+03	n	
5.7E-03	I	1.6E-06	C	7.0E-03	P	1.0E-03	I		1	0.1	1.4E+04	Amyl Alcohol, tert-	75-85-4	8.2E+01	n	3.4E+02	n	3.1E+00	n	1.3E+01	n	6.3E+00	n		1.3E-03	n	
4.0E-02	P			2.0E-03	X				1	0.1		Aniline	62-53-3	9.5E+01	c**	4.0E+02	c**	1.0E+00	n	4.4E+00	n	1.3E+01	n		4.6E-03	c*	
									1	0.1		Anthraquinone, 9,10-	84-65-1	1.4E+01	c**	5.7E+01	c*					1.4E+00	c*		1.4E-02	c*	
				4.0E-04	I				0.15			Antimony (metallic)	7440-36-0	3.1E+01	n	4.7E+02	n					7.8E+00	n	6.0E+00	3.5E-01	n	2.7E-01
				5.0E-04	H				0.15			Antimony Pentoxide	1314-60-9	3.9E+01	n	5.8E+02	n					9.7E+00	n		1.6E-01	n	
				4.0E-04	H				0.15			Antimony Tetroxide	1332-81-6	3.1E+01	n	4.7E+02	n					7.8E+00	n		1.6E-01	n	
1.5E+00	I	4.3E-03	I	2.0E-04	I	1.5E-05	C		0.15	0.03		Antimony Trioxide	1309-64-4	2.8E+05	nm	1.2E+06	nm	2.1E-01	n	8.8E-01	n				1.5E-03	c	2.9E-01
				3.5E-06	C	5.0E-05	I		1			Arsenic, Inorganic	7440-38-2	6.8E-01	c*R	3.0E+00	cR	6.5E-04	c*	2.9E-03	c*	5.2E-02	c	1.0E+01	1.5E-03	c	2.9E-01
									1			Arsine	7784-42-1	2.7E-01	n	4.1E+00	n	5.2E-02	n	2.2E-01	n	7.0E-02	n		1.8E-01	n	
2.3E-01	C			3.6E-02	O				1	0.1		Asulam	3337-71-1	2.3E+03	n	3.0E+04	n					7.2E+02	n		6.1E-04	c	1.9E-03
8.8E-01	C	2.5E-04	C	3.5E-02	I				1	0.1		Atrazine	1912-24-9	2.4E+00	c	1.0E+01	c					3.0E-01	c	3.0E+00	2.0E-04	c	1.9E-03
									1	0.1		Auramine	492-80-8	6.2E-01	c	2.6E+00	c	1.1E-02	c	4.9E-02	c	6.7E-02	c		6.1E-04	c	
1.1E-01	I	3.1E-05	I	4.0E-04	I				1	0.1		Avermectin B1	65195-55-3	2.5E+01	n	3.3E+02	n					8.0E+00	n		1.4E+01	n	
				3.0E-03	A	1.0E-02	A		1	0.1		Azinphos-methyl	86-50-0	1.9E+02	n	2.5E+03	n	1.0E+01	n	4.4E+01	n	5.6E+01	n		1.7E-02	n	
									1	0.1		Azobenzene	103-33-3	5.6E+00	c	2.6E+01	c	9.1E-02	c	4.0E-01	c	1.2E-01	c		9.3E-04	n	
				1.0E+00	P	7.0E-06	P		1	0.1		Azodicarbonamide	123-77-3	8.6E+03	n	4.0E+04	n	7.3E-03	n	3.1E-02	n	2.0E+04	n		6.8E+00	n	
				2.0E-01	I	5.0E-04	H		0.07			Barium	7440-39-3	1.5E+04	n	2.2E+05	nm	5.2E-01	n	2.2E+00	n	3.8E+03	n	2.0E+03	1.6E+02	n	8.2E+01
				5.0E-03	O				1			Benfluralin	1861-40-1	3.9E+02	n	5.8E+03	n					2.8E+01	n		9.4E-01	n	
				5.0E-02	I				1	0.1		Benomyl	17804-35-2	3.2E+03	n	4.1E+04	n					9.7E+02	n		8.5E-01	n	
				2.0E-01	I				1	0.1		Bensulfuron-methyl	83055-99-6	1.3E+04	n	1.6E+05	nm					3.9E+03	n		1.0E+00	n	
				3.0E-02	I				1	0.1		Bentazon	25057-89-0	1.9E+03	n	2.5E+04	n					5.7E+02	n		1.2E-01	n	
4.0E-03	P			1.0E-01	I																						

Key: I = IRIS; P = PPRTV; D = DWSHA; O = OPP; A = ATSDR; C = Cal EPA; X = APPENDIX PPRTV SCREEN (See FAQ #29); H = HEAST; F = See FAQ; E = see user guide Section 2.3.5; W = see user guide Section 2.3.6; L = see user guide on lead; M = mutagen; S = see user guide Section 5; V = volatile; R = RBA applied (See User Guide for Arsenic notice) ; c = cancer; n = noncancer; * = where n SL < 100X c SL; ** = where n SL < 10X c SL; SSL values are based on DAF=1; m = Concentration may exceed ceiling limit (See User Guide); s = Concentration may exceed Csat (See User Guide)

Toxicity and Chemical-Specific Information											Contaminant		Screening Levels										Protection of Ground Water SSLs							
SFO (mg/kg-day) ¹	ky	IUR (ug/m ³) ¹	ky	RfD _o (mg/kg-day)	ky	RfC ₁ (mg/m ³) ¹	ky	VO ₁ (mg/m ³) ¹	ky	muta-gen	GIABS	ABS	C _{sat} (mg/kg)	Analyte	CAS No.	Resident Soil (ug/kg)	key	Industrial Soil (mg/kg)	key	Resident Air (ug/m ³)	key	Industrial Air (ug/m ³)	key	Tapwater (ug/L)	key	MCL (ug/L)	Risk-based SSL (mg/kg)	key	MCL-based SSL (mg/kg)	
				2.0E+00		P	2.0E-02							Boron Trichloride	10294-34-5	1.6E+05	nm	2.3E+06	nm	2.1E+01	n	8.8E+01	n	4.2E+01	n					
				4.0E-02		C	1.3E-02							Boron Trifluoride	7637-07-2	3.1E+03	n	4.7E+04	n	1.4E+01	n	5.7E+01	n	2.6E+01	n					
7.0E-01	I			4.0E-03		I								Bromate	15541-45-4	9.9E-01	c	4.7E+00	c	4.7E-03	c	2.0E-02	c	1.1E-01	c	1.0E+01	8.5E-04	c	7.7E-02	
2.0E+00	X	6.0E-04	X										2.4E+03	Bromo-2-chloroethane, 1-	107-04-0	2.6E-02	c	1.1E-01	c	4.7E-03	c	2.0E-02	c	7.4E-03	c		2.1E-06	c		
				3.0E-04		X							9.0E+02	Bromo-3-fluorobenzene, 1-	1073-06-9	2.3E+01	n	3.5E+02	n	3.5E+02	n	3.5E+02	n	4.9E+00	n		4.7E-03	n		
				3.0E-04		X							3.2E+02	Bromo-4-fluorobenzene, 1-	460-00-4	2.3E+01	n	3.5E+02	ns	6.3E+01	n	2.6E+02	n	4.6E+00	n		4.4E-03	n		
				8.0E-03		I	6.0E-02						6.8E+02	Bromobenzene	108-86-1	2.9E+02	n	1.8E+03	ns	6.3E+01	n	2.6E+02	n	6.2E+01	n		4.2E-02	n		
				4.0E-02		X							4.0E+03	Bromochloromethane	74-97-5	1.5E+02	n	6.3E+02	n	4.2E+01	n	1.8E+02	n	8.3E+01	n		2.1E-02	n		
6.2E-02	I	3.7E-05	C	2.0E-02		I							9.3E+02	Bromodichloromethane	75-27-4	2.9E-01	c	1.3E+00	c	7.6E-02	c	3.3E-01	c	1.3E-01	c	8.0E+01(F)	3.6E-05	c	2.2E-02	
7.9E-03	I	1.1E-06	I	2.0E-02		I							9.2E+02	Bromoform	75-25-2	1.9E+01	c*	8.6E+01	c	2.6E+00	c	1.1E+01	c	3.3E+00	c	8.0E+01(F)	8.7E-04	c	2.1E-02	
				1.4E-03		I	5.0E-03						3.6E+03	Bromomethane	74-83-9	6.8E+00	n	3.0E+01	n	5.2E+00	n	2.2E+01	n	7.5E+00	n		1.9E-03	n		
				5.0E-03		H								Bromophos	2104-96-3	3.9E+02	n	5.8E+03	n					3.5E+01	n		1.5E-01	n		
1.0E-01	O			1.5E-02		O	1.0E-01					0.1	9.7E+02	Bromopropane, 1-	106-94-5	2.2E+02	n	9.4E+02	n	1.0E+02	n	4.4E+02	n	2.1E+02	n		6.4E-02	n		
				1.5E-02		O								Bromoxynil	1689-84-5	5.3E+00	c	2.2E+01	c					6.1E-01	c		5.2E-04	c		
3.4E+00	C	3.0E-05	I				2.0E-03					0.1	6.7E+02	Bromoxynil Octanoate	1689-99-2	1.2E+03	n	1.8E+04	n					1.0E+02	n		9.0E-01	n		
				3.0E-02		O								Butadiene, 1,3-	106-99-0	5.8E-02	c*	2.6E-01	c*	9.4E-02	c*	4.1E-01	c*	1.8E-02	c		9.9E-06	c		
				1.0E-01		I							7.6E+03	Butanoic acid, 4-(2,4-dichlorophenoxy)-	94-82-6	1.9E+03	n	2.5E+04	n					4.5E+02	n		4.2E-01	n		
				2.0E+00		P	3.0E+01						2.1E+04	Butanol, N-	71-36-3	7.8E+03	ns	1.2E+05	nms					2.0E+03	n		4.1E-01	n		
				5.0E-02		I								Butyl alcohol, sec-	78-92-2	1.3E+05	nms	1.5E+06	nms	3.1E+04	n	1.3E+05	n	2.4E+04	n		5.0E+00	n		
				5.0E-02		I								Butylate	2008-41-5	3.9E+03	n	5.8E+04	n					4.6E+02	n		4.5E-01	n		
2.0E-04	C	5.7E-08	C									0.1		Butylated hydroxyanisole	25013-16-5	2.7E+03	c	1.1E+04	c	4.9E+01	c	2.2E+02	c	1.5E+02	c		2.9E-01	c		
3.6E-03	P			3.0E-01		P						0.1		Butylated hydroxytoluene	128-37-0	1.5E+02	c	6.4E+02	c					3.4E+00	c		1.0E-01	c		
				5.0E-02		P							1.1E+02	Butylbenzene, n-	104-51-8	3.9E+03	ns	5.8E+04	ns					1.0E+03	n		3.2E+00	n		
				1.0E-01		X							1.5E+02	Butylbenzene, sec-	135-98-8	7.8E+03	ns	1.2E+05	nms					2.0E+03	n		5.9E+00	n		
				1.0E-01		X							1.8E+02	Butylbenzene, tert-	98-06-6	7.8E+03	ns	1.2E+05	nms					6.9E+02	n		1.6E+00	n		
				2.0E-02		A						0.1		Cacodylic Acid	75-60-5	1.3E+03	n	1.6E+04	n					4.0E+02	n		1.1E-01	n		
1.8E-03	I			1.0E-03		I	1.0E-05				0.025	0.001		Cadmium (Diet)	7440-43-9	7.1E+01	n	9.8E+02	n					9.2E+00	n	5.0E+00	6.9E-01	n	3.8E-01	
1.8E-03	I			5.0E-04		I	1.0E-05				0.05	0.001		Cadmium (Water)	7440-43-9	3.1E+04	n	4.0E+05	nm	1.6E-03	c**	6.8E-03	c**	9.6E+00	n		2.5E+00	n		
				5.0E-01		I	2.2E-03					0.1		Caprolactam	105-60-2	3.1E+04	n	4.0E+05	nm					9.9E+03	n		6.9E-01	n	3.8E-01	
1.5E-01	C	4.3E-05	C	2.0E-03		I						0.1		Captafol	2425-06-1	3.6E+00	c*	1.5E+01	c	6.5E-02	c	2.9E-01	c	4.0E-01	c*		7.1E-04	c*		
2.3E-03	C	6.6E-07	C	1.3E-01		I						0.1		Captan	133-06-2	2.4E+02	c*	1.0E+03	c	4.3E+00	c	1.9E+01	c	3.1E+01	c*		2.2E-02	c*		
				1.0E-01		I						0.1		Carbaryl	63-25-2	6.3E+03	n	8.2E+04	n					1.8E+03	n		1.7E+00	n		
				5.0E-03		I						0.1		Carbofuran	15693-66-2	3.2E+02	n	4.1E+03	n					9.4E+01	n	4.0E+01	3.7E-02	n	1.6E-02	
				1.0E-01		I	7.0E-01						7.4E+02	Carbon Disulfide	75-15-0	7.7E+02	ns	3.5E+03	ns	7.3E+02	n	3.1E+03	n	8.1E+02	n		2.4E-01	n		
7.0E-02	I	6.0E-06	I	4.0E-03		I	1.0E-01						4.6E+02	Carbon Tetrachloride	56-23-5	6.5E-01	c	2.9E+00	c	4.7E-01	c	2.0E+00	c	4.6E-01	c	5.0E+00	1.8E-04	c	1.9E-03	
				1.0E-02		I							5.9E+03	Carbonyl Sulfide	463-58-1	6.7E+01	n	2.8E+02	n	1.0E+02	n	4.4E+02	n	2.1E+02	n		5.1E-01	n		
				1.0E-02		I						0.1		Carbosulfan	55285-14-8	6.3E+02	n	8.2E+03	n					5.1E+01	n		1.2E+00	n		
				1.0E-01		I						0.1		Carboxin	5234-68-4	6.3E+03	n	8.2E+04	n					1.9E+03	n		1.0E+00	n		
							9.0E-04							Ceric oxide	1306-38-3	1.3E+06	nm	5.4E+06	nm	9.4E-01	n	3.9E+00	n				4.0E-01	n		
				1.0E-01		I						0.1		Chloral Hydrate	302-17-0	7.8E+03	n	1.2E+05	nm					2.0E+03	n		7.0E-02	n		
				1.5E-02		I						0.1		Chloramben	133-90-4	9.5E+02	n	1.2E+04	n					2.9E+02	n		1.5E-04	c		
4.0E-01	H											0.1		Chloranil	118-75-2	1.7E+00	c	5.7E+00	c					1.8E-01	c	2.0E+00	3.7E-02	c	2.7E-01	
3.5E-01	I	1.0E-04	I	5.0E-04		I	7.0E-04					0.04		Chlordane	12789-03-6	1.7E+00	c*	7.7E+00	c*	2.8E-02	c*	1.2E-01	c*	2.0E-02	c*		2.7E-03	c*		
1.0E+01	I	4.6E-03	C	3.0E-04		I						0.1		Chlordecone (Kepone)	143-50-0	5.4E-02	c	2.3E-01	c	6.1E-04	c	2.7E-03	c	3.5E-03	c		1.2E-04	c		
				7.0E-04		A						0.1		Chlorfenvinphos	470-90-6	4.4E+01	n	5.7E+02	n					1.1E+01	n		3.1E-02	n		
				9.0E-02		O						0.1		Chlorimuron, Ethyl-	90982-32-4	5.7E+03	n	7.4E+04	n					1.8E+03	n		6.0E-01	n		
				1.0E-01		I	1.5E-04						2.8E+03	Chlorine	7782-50-5	1.8E-01	n	7.8E+01	n	1.5E-01	n	6.4E-01	n	3.0E-01	n		1.4E-04	n		
				3.0E-02		I	2.0E-04							Chlorine Dioxide	10049-04-4	2.3E+03	n	3.4E+04	n	2.1E-01	n	8.8E-01	n	4.2E-01	n			n		

Key: I = IRIS; P = PPRTV; D = DWSHA; O = OPP; A = ATSDR; C = Cal EPA; X = APPENDIX PPRTV SCREEN (See FAQ #29); H = HEAST; F = See FAQ; E = see user guide Section 2.3.5; W = see user guide Section 2.3.6; L = see user guide on lead; M = mutagen; S = see user guide Section 5; V = volatile; R = RBA applied (See User Guide for Arsenic notice) ; c = cancer; n = noncancer; * = where n SL < 100X c SL; ** = where n SL < 10X c SL; SSL values are based on DAF=1; m = Concentration may exceed ceiling limit (See User Guide); s = Concentration may exceed Csat (See User Guide)																											
Toxicity and Chemical-specific Information										Contaminant		Screening Levels							Protection of Ground Water SSLs								
SFO (mg/kg-day) ¹	k _e (y)	IUR (ug/m ³ -day) ¹	k _e (y)	RfD _o (mg/kg-day)	k _e (y)	RfC ₁ (mg/m ³ -day)	k _e (y)	muta-gen	GIABS	ABS	C _{sat} (mg/kg)	Analyte	CAS No.	Resident Soil (mg/kg)	key	Industrial Soil (mg/kg)	key	Resident Air (ug/m ³)	key	Industrial Air (ug/m ³)	key	Tapwater (ug/L)	key	MCL (ug/L)	Risk-based SSL (mg/kg)	key	MCL-based SSL (mg/kg)
				5.0E-03	I		V		1		2.7E+04	Chlorophenol, 2-	95-57-8	3.9E+02	n	5.8E+03	n					9.1E+01	n		8.9E-02	n	
3.1E-03	C	8.9E-07	C	1.5E-02	I	4.0E-04	C	V	1	0.1	6.2E+02	Chloropicrin	76-06-2	2.0E+00	n	8.2E+00	n	4.2E-01	n	1.8E+00	n	9.3E-01	n		2.5E-04	n	
				2.0E-02	I		V		1		9.1E+02	Chloroethalonil	1897-45-6	1.8E+02	c**	7.4E+02	c*	3.2E+00	c	1.4E+01	c	2.2E+01	c*		5.0E-02	c*	
				2.0E-02	X		V		1		2.5E+02	Chlorotoluene, o-	95-49-8	1.6E+03	ns	2.3E+04	ns					2.4E+02	n		2.3E-01	n	
2.4E+02	C	6.9E-02	C	5.0E-02	O				1	0.1		Chlorotoluene, p-	106-43-4	1.6E+03	ns	2.3E+04	ns					2.5E+02	n		2.4E-01	n	
				1.0E-03	A				1	0.1		Chlorozotocin	54749-90-5	2.3E-03	c	9.6E-03	c	4.1E-05	c	1.8E-04	c	3.2E-04	c		7.1E-08	c	
				1.0E-02	H				1	0.1		Chlorpropham	101-21-3	3.2E+03	n	4.1E+04	n					7.1E+02	n		6.4E-01	n	
				2.0E-02	O				1	0.1		Chlorpyrifos	2921-88-2	6.3E+01	n	8.2E+02	n					8.4E+00	n		1.2E-01	n	
				1.0E-02	H				1	0.1		Chlorpyrifos Methyl	5598-13-0	6.3E+02	n	8.2E+03	n					1.2E+02	n		5.4E-01	n	
				2.0E-02	O				1	0.1		Chlorsulfuron	64902-72-3	1.3E+03	n	1.6E+04	n					3.9E+02	n		3.3E-01	n	
				1.0E-02	I				1	0.1		Chlorthal-dimethyl	1861-32-1	6.3E+02	n	8.2E+03	n					1.2E+02	n		1.5E-01	n	
				8.0E-04	H				1	0.1		Chlorthiophos	60238-56-4	5.1E+01	n	6.6E+02	n					2.8E+00	n		7.3E-02	n	
				1.5E+00	I				0.013			Chromium(III), Insoluble Salts	16065-83-1	1.2E+05	nm	1.8E+06	nm					2.2E+04	n		4.0E+07	n	
5.0E-01	C	8.4E-02	S	3.0E-03	I	1.0E-04	I	M	0.025			Chromium(VI)	18540-29-9	3.0E-01	c	6.3E+00	c	1.2E-05	c	1.5E-04	c	3.5E-02	c		6.7E-04	c	
				1.3E-02	I				1	0.1		Chromium, Total	7440-47-3											1.0E+02			1.8E+05
				9.0E-03	P	3.0E-04	P	6.0E-06	P	1		Clofentezine	74115-24-5	8.2E+02	n	1.1E+04	n					2.3E+02	n		1.4E+01	n	
6.2E-04	I			4.0E-02	H				1			Cobalt	7440-48-4	2.3E+01	n	3.5E+02	n	3.1E-04	c*	1.4E-03	c*	6.0E+00	n		2.7E-01	n	
				5.0E-02	I	6.0E-01	C		1	0.1		Coke Oven Emissions	8007-45-2					1.6E-03	c	2.0E-02	c						
				1.0E-01	A	6.0E-01	C		1	0.1		Copper	7440-50-8	3.1E+03	n	4.7E+04	n					8.0E+02	n	1.3E+03	2.8E+01	n	4.6E+01
				5.0E-02	I	6.0E-01	C		1	0.1		Cresol, m-	108-39-4	3.2E+03	n	4.1E+04	n	6.3E+02	n	2.6E+03	n	9.3E+02	n		7.4E-01	n	
				1.0E-01	A	6.0E-01	C		1	0.1		Cresol, o-	95-48-7	3.2E+03	n	4.1E+04	n	6.3E+02	n	2.6E+03	n	9.3E+02	n		7.5E-01	n	
				1.0E-01	A	6.0E-01	C		1	0.1		Cresol, p-	106-44-5	3.2E+03	n	8.2E+04	n	6.3E+02	n	2.6E+03	n	1.9E+03	n		1.5E+00	n	
				1.0E-01	A				1	0.1		Cresol, p-chloro-m-	59-50-7	6.3E+03	n	8.2E+04	n					1.4E+03	n		1.7E+00	n	
1.9E+00	H			1.0E-01	A	6.0E-01	C		1	0.1		Cresols	1319-77-3	6.3E+03	n	8.2E+04	n	6.3E+02	n	2.6E+03	n	1.5E+03	n		1.3E+00	n	
				1.0E-03	P				1		1.7E+04	Crotonaldehyde, trans-	123-73-9	3.7E-01	c	1.7E+00	c					4.0E-02	c		8.2E-06	c	
2.2E-01	C	6.3E-05	C	1.0E-01	I	4.0E-01	I	V	1		2.7E+02	Cumene	98-82-8	1.9E+03	ns	9.9E+03	ns	4.2E+02	n	1.8E+03	n	4.5E+02	n		7.4E-01	n	
8.4E-01	H			2.0E-03	H				1	0.1		Cupferron	135-20-6	2.5E+00	c	1.0E+01	c	4.5E-02	c	1.9E-01	c	3.5E-01	c		6.1E-04	c	
				2.0E-03	H				1	0.1		Cyanazine	21725-46-2	6.5E-01	c	2.7E+00	c					8.8E-02	c		4.1E-05	c	
				1.0E-03	I				1			Cyanides															
				5.0E-03	I				1			-Calcium Cyanide	892-01-8	7.8E+01	n	1.2E+03	n					2.0E+01	n				
				6.0E-04	I	8.0E-04	S	V	1		9.5E+05	-Copper Cyanide	544-92-3	3.9E+02	n	5.8E+03	n					1.0E+02	n				
				1.0E-03	I		V		1			-Cyanide (CN-)	57-12-5	2.3E+01	n	1.5E+02	n	8.3E-01	n	3.5E+00	n	1.5E+00	n	2.0E+02	1.5E-02	n	2.0E+00
				9.0E-02	I		V		1			-Cyanogen	460-19-5	7.8E+01	n	1.2E+03	n					2.0E+01	n				
				5.0E-02	I		V		1			-Cyanogen Bromide	506-68-3	7.0E+03	n	1.1E+05	nm					1.8E+03	n				
				5.0E-02	I		V		1			-Cyanogen Chloride	506-77-4	3.9E+03	n	5.8E+04	n					1.0E+03	n				
				6.0E-04	I	8.0E-04	I	V	1		1.0E+07	-Hydrogen Cyanide	74-90-8	2.3E+01	n	1.5E+02	n	8.3E-01	n	3.5E+00	n	1.5E+00	n		1.5E-02	n	
				2.0E-03	I				1			-Potassium Cyanide	151-50-8	1.6E+02	n	2.3E+03	n					4.0E+01	n				
				5.0E-03	I				0.04			-Potassium Silver Cyanide	506-61-6	3.9E+02	n	5.8E+03	n					8.2E+01	n				
				1.0E-01	I				0.04			-Silver Cyanide	506-64-9	7.8E+03	n	1.2E+05	nm					1.8E+03	n				
				1.0E-03	I				1			-Sodium Cyanide	143-33-9	7.8E+01	n	1.2E+03	n					2.0E+01	n	2.0E+02			
				2.0E-04	P				1			-Thiocyanates	E1790664	1.6E+01	n	2.3E+02	n					4.0E+00	n				
				2.0E-04	X				1			-Thiocyanic Acid	463-56-9	1.6E+01	n	2.3E+02	n					4.0E+00	n				
				5.0E-02	I				1			-Zinc Cyanide	557-21-1	3.9E+03	n	5.8E+04	n					1.0E+03	n				
2.0E-02	X			6.0E+00	I	V			1		1.2E+02	Cyclohexane	110-82-7	6.5E+03	ns	2.7E+04	ns	6.3E+03	n	2.6E+04	n	1.3E+04	n		1.3E+01	n	
				2.0E-02	X				1	0.1		Cyclohexane, 1,2,3,4,5-pentabromo-6-chloro-	87-84-3	2.7E+01	c*	1.1E+02	c					2.8E+00	c		1.6E-02	c	
				5.0E+00	I	7.0E-01	P	V	1		5.1E+03	Cyclohexanone	108-94-1	2.8E+04	ns	1.3E+05	nms	7.3E+02	n	3.1E+03	n	1.4E+03	n		3.4E-01	n	
				5.0E-03	P	1.0E+00	X	V	1		2.8E+02	Cyclohexene	110-83-8	3.1E+02	ns	3.1E+03	ns	1.0E+03	n	4.4E+03	n	7.0E+01	n		4.6E-02	n	
				2.0E-01	I				1		2.9E+05	Cyclohexylamine	108-91-8	1.6E+04	n	2.3E+05	nm					3.8E+03	n		1.0E+00	n	
				2.5E-02	I				1	0.1		Cyfluthrin	68359-37-5	1.6E+03	n	2.1E+04	n					1.2E+02	n		3.1E+01	n	
				1.0E-03	O				1	0.1		Cyhalothrin	68085-85-8	6.3E+01	n	8.2E+02	n					2.0E+01	n		1.4E+01	n	
				6.0E-02	O				1	0.1		Cypermethrin	52315-07-8	3.8E+03	n	4.9E+04	n					1.2E+03	n		1.9E+02	n	
				1.5E-02	O				1	0.1		Cyromazine	66215-27-8	9.5E+02	n	1.2E+04	n					3.0E+02	n		7.6E-02	n	
2.4E-01	I	6.9E-05	C	3.0E-05	X				1	0.1		DDD, p,p'- (DDD)	72-54-8	1.9E+00</													

Key: I = IRIS; P = PPRTV; D = DWSHA; O = OPP; A = ATSDR; C = Cal EPA; X = APPENDIX PPRTV SCREEN (See FAQ #29); H = HEAST; F = See FAQ; E = see user guide Section 2.3.5; W = see user guide Section 2.3.6; L = see user guide on lead; M = mutagen; S = see user guide Section 5; V = volatile; R = RBA applied (See User Guide for Arsenic notice) ; c = cancer; n = noncancer; * = where n SL < 100X c SL; ** = where n SL < 10X c SL; SSL values are based on DAF=1; m = Concentration may exceed ceiling limit (See User Guide); s = Concentration may exceed csat (See User Guide)																											
Toxicity and Chemical-specific Information										Contaminant		Screening Levels						Protection of Ground Water SSLs									
SFO (mg/kg-day) ¹	k _e (y)	IUR (ug/m ³ -day) ¹	k _e (y)	RfD _o (mg/kg-day)	k _e (y)	RfC ₁ (mg/m ³ -day)	k _e (y)	muta-gen	GIABS	ABS	C _{sat} (mg/kg)	Analyte	CAS No.	Resident Soil (ug/m ²)	key	Industrial Soil (mg/kg)	key	Resident Air (ug/m ³)	key	Industrial Air (ug/m ³)	key	Tapwater (ug/L)	key	MCL (ug/L)	Risk-based SSL (mg/kg)	key	MCL-based SSL (mg/kg)
				3.0E-02	I				1	0.1		Dicamba	1918-00-9	1.9E+03	n	2.5E+04	n					5.7E+02	n		1.5E-01	n	
		4.2E-03	P								5.5E+02	Dichloro-2-butene, 1,4-	764-41-0	2.1E-03	c	9.4E-03	c	6.7E-04	c	2.9E-03	c	1.3E-03	c		6.6E-07	c	
		4.2E-03	P								5.2E+02	Dichloro-2-butene, cis-1,4-	1476-11-5	7.4E-03	c	3.2E-02	c	6.7E-04	c	2.9E-03	c	1.3E-03	c		6.2E-07	c	
		4.2E-03	P								7.6E+02	Dichloro-2-butene, trans-1,4-	110-57-6	7.4E-03	c	3.2E-02	c	6.7E-04	c	2.9E-03	c	1.3E-03	c		6.2E-07	c	
		5.0E-02	I		4.0E-03	I					0.1	Dichloroacetic Acid	79-43-6	1.1E+01	c*	4.6E+01	c*					1.5E+00	c*	6.0E+01	3.1E-04	c*	1.2E-02
				9.0E-02	I	2.0E-01	H	V			3.8E+02	Dichlorobenzene, 1,2-	95-50-1	1.8E+03	ns	9.3E+03	ns	2.1E+02	n	8.8E+02	n	3.0E+02	n	6.0E+02	3.0E-01	n	5.8E-01
		5.4E-03	C	1.1E-05	C	7.0E-02	A	8.0E-01	I	V		Dichlorobenzene, 1,4-	106-46-7	2.6E+00	c	1.1E+01	c	2.6E-01	c	1.1E+00	c	4.8E-01	c	7.5E+01	4.6E-04	c	7.2E-02
		4.5E-01	I	3.4E-04	C						1.0	Dichlorobenzidine, 3,3'-	91-94-1	1.2E+00	c	5.1E+00	c	8.3E-03	c	3.6E-02	c	1.3E-01	c		8.2E-04	c	
				9.0E-03	X						1.0	Dichlorobenzophenone, 4,4'-	90-98-2	5.7E+02	n	7.4E+03	n					7.8E+01	n		4.7E-01	n	
				2.0E-01	I	1.0E-01	X	V			1	Dichlorodifluoromethane	75-71-8	8.7E+01	n	3.7E+02	n	1.0E+02	n	4.4E+02	n	2.0E+02	n		3.0E-01	n	
		5.7E-03	C	1.6E-06	C	2.0E-01	P				1.7	Dichloroethane, 1,1-	75-34-3	3.6E+00	c	1.6E+01	c	1.8E+00	c	7.7E+00	c	2.8E+00	c		7.8E-04	c	
		9.1E-02	I	2.6E-05	I	6.0E-03	X	7.0E-03	P	V		Dichloroethane, 1,2-	107-06-2	4.6E-01	c*	2.0E+00	c*	1.1E-01	c*	4.7E-01	c*	1.7E-01	c*	5.0E+00	4.8E-05	c*	1.4E-03
				5.0E-02	I	2.0E-01	I	V			1.2	Dichloroethylene, 1,1-	75-35-4	2.3E+02	n	1.0E+03	n	2.1E+02	n	8.8E+02	n	2.8E+02	n	7.0E+00	1.0E-01	n	2.5E-03
				2.0E-03	I						1.2	Dichloroethylene, 1,2-cis-	156-59-2	1.6E+02	n	2.3E+03	n					3.6E+01	n	7.0E+01	1.1E-02	n	2.1E-02
				2.0E-02	I						1.9	Dichloroethylene, 1,2-trans-	156-60-5	1.6E+03	n	2.3E+04	ns					3.6E+02	n	1.0E+02	1.1E-01	n	3.1E-02
				3.0E-03	I						0.1	Dichlorophenol, 2,4-	120-83-2	1.9E+02	n	2.5E+03	n					4.6E+01	n		2.3E-02	n	
				1.0E-02	I						0.05	Dichlorophenoxy Acetic Acid, 2,4-	94-75-7	7.0E+02	n	9.6E+03	n					1.7E+02	n	7.0E+01	4.5E-02	n	1.8E-02
		3.7E-02	P	3.7E-06	P	4.0E-02	P	4.0E-03	I	V		Dichloropropane, 1,2-	78-87-5	2.5E+00	c**	1.1E+01	c**	7.6E-01	c**	3.3E+00	c**	8.5E-01	c**	5.0E+00	2.8E-04	c**	1.7E-03
				2.0E-02	P						1.5	Dichloropropane, 1,3-	142-28-9	1.6E+03	ns	2.3E+04	ns					3.7E+02	n		1.3E-01	n	
				3.0E-03	I						1.0	Dichloropropanol, 2,3-	616-23-9	1.9E+02	n	2.5E+03	n					5.9E+01	n		1.3E-02	n	
		1.0E-01	I	4.0E-06	I	3.0E-02	I	2.0E-02	I	V		Dichloropropene, 1,3-	542-75-6	1.8E+00	c*	8.2E+00	c*	7.0E-01	c*	3.1E+00	c*	4.7E-01	c*		1.7E-04	c*	
		2.9E-01	I	8.3E-05	C	5.0E-04	I	5.0E-04	I		0.1	Dichlorvos	62-73-7	1.9E+00	c*	7.9E+00	c*	3.4E-02	c*	1.5E-01	c*	2.6E-01	c*		8.1E-05	c*	
				7.0E-05	O						0.1	Dicorotophos	141-66-2	4.4E+00	n	5.7E+01	n					1.4E+00	n		3.3E-04	n	
				8.0E-02	P	3.0E-04	X	V			2.6	Dicyclopentadiene	77-73-6	1.3E+00	n	5.4E+00	n	3.1E-01	n	1.3E+00	n	6.3E-01	n		2.2E-03	n	
		1.6E+01	I	4.6E-03	I	5.0E-05	I				0.1	Dieldrin	60-57-1	3.4E-02	c*	1.4E-01	c	6.1E-04	c	2.7E-03	c	1.8E-03	c		7.1E-05	c	
				3.0E-04	C						0.1	Diesel Engine Exhaust	E17136615					9.4E-03	c	4.1E-02	c						
				2.0E-03	P	5.0E-03	I				0.1	Diethanolamine	111-42-2	1.3E+02	n	1.6E+03	n	2.1E-01	n	8.8E-01	n	4.0E+01	n		8.1E-03	n	
				6.0E-02	P	1.0E-04	P				0.1	Diethylene Glycol Monoethyl Ether	112-34-5	1.9E+03	n	2.4E+04	n	1.0E-01	n	4.4E-01	n	6.0E+02	n		1.3E-01	n	
				1.0E-03	P	3.0E-04	P				0.1	Diethylene Glycol Monoethyl Ether Diethylformamide	111-90-0	3.8E+03	n	4.8E+04	n	3.1E-01	n	1.3E+00	n	1.2E+03	n		2.4E-01	n	
				1.0E-03	P						1.1	Diethylformamide	617-84-5	7.8E+01	n	1.2E+03	n					2.0E+01	n		4.1E-03	n	
		3.5E+02	C	1.0E-01	C						0.1	Diethylstilbestrol	56-53-1	1.6E-03	c	6.6E-03	c	2.8E-05	c	1.2E-04	c	5.1E-05	c		2.8E-05	c	
				8.3E-02	O						0.1	Difenoquat	43222-48-6	5.2E+03	n	6.8E+04	n					1.7E+03	n		2.6E+02	n	
				2.0E-02	I						0.1	Diflubenzuron	35367-38-5	1.3E+03	n	1.6E+04	n					2.9E+02	n		3.3E-01	n	
				4.0E+01	I	V					1.4	Difluoroethane, 1,1-	75-37-6	4.8E+04	ns	2.0E+05	nms	4.2E+04	n	1.8E+05	n	8.3E+04	n		2.8E+01	n	
				3.0E+01	X	V					6.9	Difluoropropane, 2,2-	420-45-1	2.4E+04	ns	1.0E+05	ns	3.1E+04	n	1.3E+05	n	6.3E+04	n		1.4E+02	n	
		4.4E-02	C	1.3E-05	C						1	Dihydrosafrole	94-58-6	9.9E+00	c	4.5E+01	c	2.2E-01	c	9.4E-01	c	3.0E-01	c		1.9E-04	c	
				7.0E-01	P	V					2.3	Diisopropyl Ether	108-20-3	2.2E+03	n	9.4E+03	ns	7.3E+02	n	3.1E+03	n	1.5E+03	n		3.7E-01	n	
				8.0E-02	I						0.1	Diisopropyl Methylphosphonate	1445-75-6	6.3E+03	ns	9.3E+04	ns					1.6E+03	n		4.5E-01	n	
				2.2E-02	O						0.1	Dimethipin	55290-64-7	1.4E+03	n	1.8E+04	n					4.4E+02	n		9.6E-02	n	
		1.6E+00	P								0.1	Dimethoate	60-51-5	1.4E+02	n	1.8E+03	n					4.4E+01	n		9.9E-03	n	
		1.7E-03	P	6.0E-02	P						0.1	Dimethoxybenzidine, 3,3'-	119-90-4	3.4E-01	c	1.4E+00	c					4.7E-02	c		5.8E-05	c	
				6.0E-02	P						0.1	Dimethyl methylphosphonate	756-79-6	3.2E+02	c*	1.4E+03	c*					4.6E+01	c*		9.6E-03	c*	
		4.6E+00	C	1.3E-03	C						0.1	Dimethylamino azobenzene [p-]	60-11-7	1.2E-01	c	5.0E-01	c	2.2E-03	c	9.4E-03	c	5.0E-03	c		2.1E-05	c	
		5.8E-01	H								0.1	Dimethylaniline HCl, 2,4-	21436-96-4	9.4E-01	c	4.0E+00	c					1.3E-01	c		1.2E-04	c	
		2.0E-01	P	2.0E-03	X						0.1	Dimethylaniline, 2,4-	95-68-1	2.7E+00	c*	1.1E+01	c					3.7E-01	c		2.1E-04	c	
		2.7E-02	P	2.0E-03	I						8.3	Dimethylaniline, N,N-	121-69-7	2.6E+01	c**	1.2E+02	c*					2.5E+00	c*		9.0E-04	c*	
		1.1E+01	P								0.1	Dimethylbenzidine, 3,3'-	119-93-7	4.9E-02	c	2.1E-01	c					6.5E-03	c		4.3E-05	c	
				1.0E-01	P	3.0E-02	I	V			1.1	Dimethylformamide	68-12-2	2.6E+03	n	1.5E+04	n	3.1E+01	n	1.3E+02	n	6.1E+01	n		1.2E-02	n	
		5.5E+02	C	1.6E-01	C						1.7	Dimethylhydrazine, 1,1-	57-14-7	5.7E-02	n	2.4E-01	n	2.1E-03	n	8.8E-03	n	4.2E-03	n		9.3E-07	n	
				2.0E-02	I						0.1	Dimethylhydrazine, 1,2-	540-73-8	8.8E-04	c	4.1E-03	c	1.8E-05	c	7.7E-05	c	2.8E-05	c				

Toxicity and Chemical-specific Information													Contaminant		Screening Levels								Protection of Ground Water SSLs				
SFO (mg/kg-day) ¹	key	IUR (ug/m ³) ¹	key	RfD _o (mg/kg-day)	key	RfC ₁ (mg/m ³) ¹	key	muta- gen	GIABS	ABS	C _{sat} (mg/kg)	Analyte	CAS No.	Resident Soil (mg/kg)	key	Industrial Soil (mg/kg)	key	Resident Air (ug/m ³)	key	Industrial Air (ug/m ³)	key	Tapwater (ug/L)	key	MCL (ug/L)	Risk-based SSL (mg/kg)	key	MCL-based SSL (mg/kg)
1.3E+05	C	3.8E+01	C	7.0E-10 3.0E-02	I	4.0E-08 4.0E-04	C X	V	1	0.03	0.1	-TCDD, 2,3,7,8-Diphenamid	1746-01-6 957-51-7	4.8E-06 1.9E+03	c*	2.2E-05 2.5E+02	c*	7.4E-08	c	3.2E-07	c	1.2E-07 5.3E+02	c	3.0E-05	5.9E-08 5.2E+00	c	1.5E-05
8.0E-01	I	2.2E-04	I	2.2E-03	I				1	0.1	0.1	Diphenyl Ether Diphenyl Sulfone Diphenylamine	101-84-8 127-63-9 122-39-4	3.4E+01 5.1E+01 6.3E+03	n	1.4E+02 6.6E+02 8.2E+04	n	4.2E-01	n	1.8E+00	n	8.3E-01 1.5E+01 1.3E+03	n		3.4E-03 3.6E-02 2.3E+00	n	
7.1E+00	C	1.4E-01	C						1	0.1	0.1	Diphenylhydrazine, 1,2-Diquat Direct Black 38	122-66-7 85-00-7 1937-37-7	6.8E-01 1.4E+02 7.6E-02	c	2.9E+00 1.8E+03 3.2E-01	c	1.3E-02	c	5.6E-02	c	7.8E-02 4.4E+01 1.1E-02	c	2.0E+01	2.5E-04 8.3E-01 5.3E+00	c	3.7E-01
7.4E+00	C	1.4E-01	C						1	0.1	0.1	Direct Blue 6 Direct Brown 95 Disulfoton	2602-46-2 16071-86-6 298-04-4	7.3E-02 8.1E-02 2.5E+00	c	3.1E-01 3.4E-01 3.3E+01	c	2.0E-05	c	8.8E-05	c	1.1E-02 1.2E-02 5.0E-01	c		1.7E+01 1.6E-01 9.4E-04	c	
6.7E+00	C	1.4E-01	C	4.0E-05	I				1	0.1	0.1	Dithiane, 1,4-Diuron Dodine	505-29-3 330-54-1 2439-10-3	7.8E-02 1.3E-02 1.3E+03	n	1.2E+04 1.6E+03 1.6E+04	n					2.0E+02 3.6E+01 4.0E+02	n		9.7E-02 1.5E-02 2.1E+00	n	
				5.0E-02 6.0E-03 2.0E-02	O	V	V		1		0.1	EPTC Endosulfan Endothal	759-94-4 115-29-7 145-73-3	3.9E+03 4.7E+02 1.3E+03	n	5.8E+04 7.0E+03 1.6E+04	n					7.5E+02 1.0E+02 3.8E+02	n	1.0E+02	4.0E-01 1.4E+00 9.1E-02	n	2.4E-02
9.9E-03	I	1.2E-06	I	6.0E-03	P	1.0E-03 2.0E-02	I V	V	1		1.1E+04 1.5E+04	Endrin Epichlorohydrin Epoxybutane, 1,2-	72-20-8 106-89-8 106-88-7	1.9E+01 1.9E+01 1.6E+02	n	2.5E+02 8.2E+01 6.7E+02	n	1.0E+00 2.1E+01	n	4.4E+00 8.8E+01	n	2.3E+00 2.0E+00 4.2E+01	n	2.0E+00	9.2E-02 4.5E-04 9.2E-03	n	8.1E-02
				4.0E-02 5.0E-03 5.0E-04	P				1	0.1	0.1	Ethanol, 2-(2-methoxyethoxy)- Ethephon Ethion	111-77-3 16672-87-0 563-12-2	2.5E+03 3.2E+02 3.2E+01	n	3.3E+04 4.1E+03 4.1E+02	n					8.0E+02 1.0E+02 4.3E+00	n		1.6E-01 2.1E-02 8.5E-03	n	
				1.0E-01 9.0E-02 9.0E-01	P	6.0E-02 2.0E-01 7.0E-02	P V P	V	1		2.4E+04 1.1E+05 1.1E+04	Ethoxyethanol Acetate, 2- Ethoxyethanol, 2- Ethyl Acetate	111-15-9 110-80-5 141-78-6	2.6E+03 5.2E+03 6.2E+02	n	1.4E+04 4.7E+04 2.6E+03	n	6.3E+01 2.1E+02 7.3E+01	n	2.6E+02 8.8E+02 3.1E+02	n	1.2E+02 3.4E+02 1.4E+02	n		2.5E-02 6.8E-02 3.1E-02	n	
				5.0E-03 2.0E-01	P	8.0E-03 1.0E+01	P V	V	1		2.5E+03 2.1E+03 1.0E+04	Ethyl Acrylate Ethyl Chloride (Chloroethane) Ethyl Ether	140-88-5 75-00-3 60-29-7	4.7E+01 1.4E+04 1.6E+04	n	2.1E+02 5.7E+04 2.3E+05	ns	8.3E+00 1.0E+04	ns	3.5E+01 4.4E+04	n	1.4E+01 2.1E+04 3.9E+03	n		3.2E-03 5.9E+00 8.8E-01	n	
1.1E-02	C	2.5E-06	C	1.0E-05 1.0E-01	I	3.0E-01 1.0E+00	P I	V	1	0.1	4.8E+02	Ethyl Methacrylate Ethyl-p-nitrophenyl Phosphonate Ethylbenzene	97-63-2 2104-64-5 100-41-4	1.8E+03 6.3E-01 5.8E+00	ns	7.6E+03 8.2E+00 2.5E+01	ns	3.1E+02	n	1.3E+03	n	6.3E+02 8.9E-02 1.5E+00	n	7.0E+02	1.5E-01 2.8E-03 1.7E-03	n	7.8E-01
				7.0E-02 9.0E-02 2.0E+00	P		V		1	0.1	1.9E+05	Ethylene Cyanohydrin Ethylene Diamine Ethylene Glycol	109-78-4 107-15-3 107-21-1	4.4E+03 7.0E+03 1.3E+05	n	5.7E+04 1.1E+05 1.6E+06	nm	4.2E+02	n	1.8E+03	n	1.4E+03 1.8E+03 4.0E+04	n		2.8E-01 4.1E-01 8.1E+00	n	
3.1E-01	C	3.0E-03	I	1.0E-01	I	1.6E+00 3.0E-02	I C	V	1	0.1	1.2E+05	Ethylene Glycol Monobutyl Ether Ethylene Oxide Ethylene Thiourea	111-76-2 75-21-8 96-45-7	6.3E+03 2.0E-03 5.1E+00	n	8.2E+04 2.5E-02 5.1E+01	n	1.7E+03 3.4E-04	n	7.0E+03 4.1E-03	n	2.0E+03 6.7E-04 1.6E+00	n		4.1E-01 1.4E-07 3.6E-04	n	
6.5E+01	C	1.9E-02	C	3.0E+00 2.5E-04	I				1	0.1	1.5E+05	Ethyleneimine Ethylphthalyl Ethyl Glycolate Fenamiphos	151-56-4 84-72-0 22224-92-6	2.7E-03 1.9E+05 1.6E+01	c	1.2E-02 2.5E+06 2.1E-02	c	1.5E-04	c	6.5E-04	c	2.4E-04 5.8E+04 4.4E+00	n		5.2E-08 1.3E+02 4.3E-03	c	
				2.5E-02 2.5E-02 1.3E-02	I				1	0.1	0.1	Fenpropathrin Fenvalerate Fluometuron	39515-41-8 51630-58-1 2164-17-2	1.6E+03 1.6E+03 8.2E+02	n	2.1E+04 2.1E+04 1.1E+04	n					6.4E+01 5.0E+02 2.4E+02	n		2.9E+00 3.2E+02 1.9E-01	n	
				4.0E-02 6.0E-02 8.0E-02	C	1.3E-02	C		1			Fluoride Fluorine (Soluble Fluoride) Fluridone	16984-48-8 7782-41-4 59756-60-4	3.1E+03 4.7E+03 5.1E+03	n	4.7E+04 7.0E+04 6.6E+04	n	1.4E+01 1.4E+01	n	5.7E+01 5.7E+01	n	8.0E+02 1.2E+03 1.4E+03	n	4.0E+03	1.2E+02 1.8E+02 1.6E+02	n	6.0E+02
				1.5E-02 2.0E-03 5.0E-01	O				1	0.1	0.1	Flurprimidol Flusilazole Flutolanil	56425-91-3 85509-19-9 66332-96-5	9.5E+02 1.3E+02 3.2E+04	n	1.2E+04 1.6E+03 4.1E+05	n					2.6E+02 3.1E+01 7.9E+03	n		1.2E+00 5.1E+00 4.2E+01	n	
				1.0E-02 9.0E-02 2.5E-03	I				1	0.1	0.1	Fluvalinate Folpet Fomesafen	69409-94-5 133-07-3 72178-02-0	6.3E+02 5.7E+03 1.6E+02	n	8.2E+03 7.4E+04 2.1E+03	n					2.0E+02 1.6E+03 4.8E+01	n		2.9E+02 3.9E-01 1.6E-01	n	
				2.0E-03 1.3E-05	I				1	0.1	4.2E+04 1.1E+05	Fonofos Formaldehyde Formic Acid	944-22-9 50-00-0 64-18-6	1.3E+02 1.7E+01 2.9E+01	n	1.6E+03 7.3E+01 1.2E+02	n	2.2E-01 2.2E-01	c*	9.4E-01 4.3E-01	c*	2.4E+01 4.3E-01 6.3E-01	c*		4.7E-02 8.7E-05 1.3E-04	c*	
				2.5E+00	O				1	0.1		Fosetyl-AL Furans	39148-24-8	1.6E+05	nm	2.1E+06	nm					5.0E+04	n		6.6E+02	n	
				1.0E-03 9.0E-01	X	V	V		1	0.03	6.2E+03 1.7E+05	-Dibenzofuran -Furan -Tetrahydrofuran Furazolidone	132-64-9 110-00-9 109-99-9 67-45-8	7.3E+01 7.3E+01 1.8E+04 1.4E-01	n	1.0E+03 1.0E+03 9.4E+04 6.0E-01	n	2.1E+03	n	8.8E+03	n	7.9E+00 1.9E+01 3.4E+03 2.0E-02	n		1.5E-01 7.3E-03 7.5E-01 3.9E-05	n	
1.5E+00	C	4.3E-04	C	3.0E-03	I	5.0E-02	H	V	1	0.1	1.0E+04	Furfural Furium Furmecycloz	98-01-1 531-82-8 60568-05-0	2.1E+02 3.6E-01 1.8E+01	n	2.6E+03 1.5E+00 7.7E-01	n	5.2E+01 6.5E-03 3.3E-01	n	2.2E+02 2.9E-02 1.4E+00	n	3.8E+01 5.1E-02 1.1E+00	n		8.1E-03 6.8E-05 1.2E-03	n	
				6.0E-03 1.0E-01 4.0E-04	O	A	8.0E-05	C	1	0.1	1.1E+05	Glufofenate, Ammonium Glutaraldehyde Glycidyl	77182-82-2 111-30-8 765-34-4	3.8E+02 6.0E+03 2.3E+01	n	4.9E+03 7.0E+04 2.1E+02	n	1.2E+01 8.3E-02 1.0E+00	n	3.5E-01 3.5E-01 4.4E+00	n	1.2E+02 2.0E+03 1.7E+00	n		2.6E-02 4.0E-01 3.3E-04	n	
				1.0E-01 1.0E-02	I				1	0.1	0.1	Glyphosate Guanidine	1071-83-6 113-00-8	6.3E+03 7.8E+02	n	8.2E+04 1.2E+04	n					2.0E+03 2.0E+02	n	7.0E+02	8.8E+00 4.5E-02	n	3.1E+00

TR=1E-06
THQ=1.0

Key: I = IRIS; P = PPRTV; D = DWSHA; O = OPP; A = ATSDR; C = Cal EPA; X = APPENDIX PPRTV SCREEN (See FAQ #29); H = HEAST; F = See FAQ; E = see user guide Section 2.3.5; W = see user guide Section 2.3.6; L = see user guide on lead; M = mutagen; S = see user guide Section 5; V = volatile; R = RBA applied (See User Guide for Arsenic notice); c = cancer; n = noncancer; * = where n SL < 100X c SL; ** = where n SL < 10X c SL; SSL values are based on DAF=1; m = Concentration may exceed ceiling limit (See User Guide); s = Concentration may exceed Csat (See User Guide)

Toxicity and Chemical-specific Information											Contaminant		Screening Levels										Protection of Ground Water SSLs					
SFO (mg/kg-day) ¹	k _e (y)	IUR (ug/m ³) ¹	k _e (y)	RfD _o	k _e (y)	RfC ₁ (mg/m ³) ¹	k _e (y)	muta-gen	GIABS	ABS	C _{sat} (mg/kg)	Analyte	CAS No.	Resident Soil (mg/kg)	key	Industrial Soil (mg/kg)	key	Resident Air (ug/m ³)	key	Industrial Air (ug/m ³)	key	Tapwater (ug/L)	key	MCL (ug/L)	Risk-based SSL (mg/kg)	key	MCL-based SSL (mg/kg)	
				2.0E-02		P					1	0.1	Guandinine Chloride	50-01-1	1.3E+03	n	1.6E+04	n					4.0E+02	n			n	
				3.0E-02		X					1	0.1	Guandinine Nitrate	506-93-4	1.9E+03	n	2.5E+04	n					6.0E+02	n		1.5E-01	n	
				5.0E-05		I					1	0.1	Haloxypop, Methyl	69806-40-2	3.2E+00	n	4.1E+01	n					7.6E-01	n		8.4E-03	n	
4.5E+00	I	1.3E-03	I	5.0E-04		I		V			1		Heptachlor	76-44-8	1.3E-01	c	6.3E-01	c	2.2E-03	c	9.4E-03	c	1.4E-03	c	4.0E-01	1.2E-04	c	3.3E-02
9.1E+00	I	2.6E-03	I	1.3E-05		I		V			1		Heptachlor Epoxide	1024-57-3	7.0E-02	c*	3.3E-01	c*	1.1E-03	c	4.7E-03	c	1.4E-03	c*	2.0E-01	2.8E-05	c*	4.1E-03
				3.0E-04		X	3.0E-03	X	V		1	2.1E+02	Heptanal, n-	111-71-7	2.4E+01	n	1.0E+02	n	3.1E+00	n	1.3E+01	n	6.3E+00	n		1.4E-03	n	
				3.0E-04		X	4.0E-01	P	V		1	5.8E+01	Heptane, N-	142-82-5	2.2E+01	n	2.9E+02	ns	4.2E+02	n	1.8E+03	n	6.0E+00	n		4.8E-02	n	
				2.0E-03		I		V			1		Hexabromobenzene	87-82-1	1.6E+02	n	2.3E+03	n					4.0E+01	n		2.3E-01	n	
1.6E+00	I	4.6E-04	I	2.0E-04		I					1	0.1	Hexabromodiphenyl ether, 2,2',4,4',5,5'- (BDE-153)	68631-49-2	1.3E+01	n	1.6E+02	n					4.0E+00	n		n	n	
				8.0E-04		I		V			1		Hexachlorobenzene	118-74-1	2.1E-01	c	9.6E-01	c	6.1E-03	c	2.7E-02	c	9.8E-03	c	1.0E+00	1.2E-04	c	1.3E-02
7.8E-02	I	2.2E-05	I	1.0E-03		P		V			1	1.7E+01	Hexachlorobutadiene	87-68-3	1.2E+00	c*	5.3E+00	c	1.3E-01	c	5.6E-01	c	1.4E-01	c*		2.7E-04	c*	
6.3E+00	I	1.8E-03	I	8.0E-03		A					1	0.1	Hexachlorocyclohexane, Alpha-	319-84-6	8.6E-02	c	3.6E-01	c	1.6E-03	c	6.8E-03	c	7.2E-03	c		4.2E-05	c	
1.8E+00	I	5.3E-04	I			I					1	0.1	Hexachlorocyclohexane, Beta-	319-85-7	3.0E-01	c	1.3E+00	c	5.3E-03	c	2.3E-02	c	2.5E-02	c		1.5E-04	c	
1.1E+00	C	3.1E-04	C	3.0E-04		I					1	0.04	Hexachlorocyclohexane, Gamma- (Lindane)	58-89-9	5.7E-01	c*	2.5E+00	c	9.1E-03	c	4.0E-02	c	4.2E-02	c*	2.0E-01	2.4E-04	c*	1.2E-03
1.8E+00	I	5.1E-04	I			I					1	0.1	Hexachlorocyclohexane, Technical	608-73-1	3.0E-01	c	1.3E+00	c	5.5E-03	c	2.4E-02	c	2.5E-02	c		1.5E-04	c	
				6.0E-03		I	2.0E-04	I	V		1	1.6E+01	Hexachlorocyclopentadiene	77-47-4	1.8E+00	n	7.5E+00	n	2.1E-01	n	8.8E-01	n	4.1E-01	n	5.0E+01	1.3E-03	n	1.6E-01
4.0E-02	I	1.1E-05	C	7.0E-04		I	3.0E-02	I	V		1		Hexachloroethane	67-72-1	1.8E+00	c*	8.0E+00	c*	2.6E-01	c	1.1E+00	c	3.3E-01	c*		2.0E-04	c*	
				3.0E-04		I					1	0.1	Hexachlorophene	70-30-4	1.9E+01	n	2.5E+02	n					6.0E+00	n		8.0E+00	n	
1.1E-01	I			3.0E-03		I					1	0.015	Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	121-82-4	6.1E+00	c*	2.8E+01	c					7.0E-01	c*		2.7E-04	c*	
				1.0E-05		I	V				1		Hexamethylene Diisocyanate, 1,6-	822-06-0	3.1E+00	n	1.3E+01	n	1.0E-02	n	4.4E-02	n	2.1E-02	n		2.1E-04	n	
				4.0E-04		P					1	0.1	Hexamethylphosphoramide	680-31-9	2.5E+01	n	3.3E+02	ns					8.0E+00	n		1.8E-03	n	
				7.0E-01		I	V				1	1.4E+02	Hexane, N-	110-54-3	6.1E+02	ns	2.5E+03	ns	7.3E+02	n	3.1E+03	n	1.5E+03	n		1.0E+01	n	
				2.0E+00		P					1	0.1	Hexanoic Acid	124-04-9	1.3E+05	nm	1.6E+06	nm					4.0E+04	n		9.9E+00	n	
				5.0E-03		I	3.0E-02	I	V		1	3.3E+03	Hexanone, 2-	591-78-6	2.0E+02	n	1.3E+03	n	3.1E+01	n	1.3E+02	n	3.8E+01	n		8.8E-03	n	
				3.3E-02		I					1	0.1	Hexazinone	51235-04-2	2.1E+03	n	2.7E+04	n					6.4E+02	n		3.0E-01	n	
				2.5E-02		I					1	0.1	Hexythiazox	78587-05-0	1.6E+03	n	2.1E+04	n					1.1E+02	n		5.0E-01	n	
3.0E+00	I	4.9E-03	I	1.7E-02		O					1	0.1	Hydramethylnon	67485-29-4	1.1E+03	n	1.4E+04	n					3.4E+02	n		1.2E+05	n	
				3.0E-05		P	V				1		Hydrazine	302-01-2	2.3E-01	c	1.1E+00	c	5.7E-04	c*	2.5E-03	c*	1.1E-03	c*		c	c	
3.0E+00	I	4.9E-03	I			I					1		Hydrazine Sulfate	10034-93-2	2.3E-01	c	1.1E+00	c	5.7E-04	c	2.5E-03	c	2.6E-02	c		c	c	
				2.0E-02		I	V				1		Hydrogen Chloride	7647-01-0	2.8E+07	nm	1.2E+08	nm	2.1E+01	n	8.8E+01	n	4.2E+01	n		n	n	
				4.0E-02		C	1.4E-02	C	V		1		Hydrogen Fluoride	7664-39-3	3.1E+03	n	4.7E+04	n	1.5E+01	n	6.1E+01	n	2.8E+01	n		n	n	
				2.0E-03		I	V				1		Hydrogen Sulfide	7783-06-4	2.8E+06	nm	1.2E+07	nm	2.1E+00	n	8.8E+00	n	4.2E+00	n		n	n	
6.0E-02	P			4.0E-02		P					1	0.1	Hydroquinone	123-31-9	9.0E+00	c	3.8E+01	c					1.3E+00	c		8.7E-04	c	
6.1E-02	O			2.5E-03		O					1	0.1	Imazalil	35554-44-0	8.9E+00	c*	3.8E+01	c*					9.0E-01	c*		1.5E-02	c*	
				2.5E-01		I					1	0.1	Imazaquin	81335-37-7	1.6E+04	n	2.1E+05	nm					4.9E+03	n		2.4E+01	n	
				2.5E+00		O					1	0.1	Imazethapyr	81335-77-5	1.6E+05	nm	2.1E+06	nm					4.7E+04	n		4.1E+01	n	
				1.0E-02		A					1		Iodine	7553-56-2	7.8E+02	n	1.2E+04	n					2.0E+02	n		1.2E+01	n	
				4.0E-02		I					1	0.1	Iprodione	36734-19-7	2.5E+03	n	3.3E+04	n					7.4E+02	n		2.2E-01	n	
				7.0E-01		P					1		Iron	7439-89-6	5.5E+04	n	8.2E+05	nm					1.4E+04	n		3.5E+02	n	
				3.0E-01		I		V			1	1.0E+04	Isobutyl Alcohol	78-83-1	2.3E+04	ns	3.5E+05	nms					5.9E+03	n		1.2E+00	n	
9.5E-04	I			2.0E-01		I	2.0E+00	C			1	0.1	Isophorone	78-59-1	5.7E+02	c*	2.4E+03	c*	2.1E+03	n	8.8E+03	n	7.8E+01	c*		2.6E-02	c*	
				1.5E-02		I		V			1		Isopropalin	33820-53-0	1.2E+03	n	1.8E+04	n					4.0E+01	n		9.2E-01	n	
				2.0E+00		P	2.0E-01	P	V		1	1.1E+05	Isopropanol	67-63-0	5.6E+03	n	2.4E+04	n	2.1E+02	n	8.8E+02	n	4.1E+02	n		8.4E-02	n	
				1.0E-01		I					1	0.1	Isopropyl Methyl Phosphonic Acid	1832-54-8	6.3E+03	n	8.2E+04	n					2.0E+03	n		4.3E-01	n	
				5.0E-02		I					1	0.1	Isoxaben	82558-50-7	3.2E+03	n	4.1E+04	n					7.3E+02	n		2.0E+00	n	
				3.0E-01		A	V				1		JP-7	E1737665	4.3E+08	nm	1.8E+09	nm	3.1E+02	n	1.3E+03	n	6.3E+02	n		n	n	
				8.0E-03		O					1	0.1	Lactofen	77501-63-4	5.1E+02	n	6.6E+03	n					1.0E+02	n		4.6E+00	n	
				2.0E-04		X					1	0.1	Lactonitrile	78-97-7	1.3E+01	n	1.6E+02	n					4.0E+00	n		8.1E-04	n	
													Lead Compounds															
8.5E-03	C	1.2E-05	C								1		-Lead Phosphate	7446-27-7	8.2E+01	c	3.8E+02	c	2.3E-01	c	1.0E+00	c	9.1E+00	c		1.8E-03	c	
8.5E-03	C	1.2E-05	C								1	0.1	-Lead acetate	301-04-2	6.4E+01	c	2.7E+02	c	2.3E-01	c	1.0E+00	c						

Key: I = IRIS; P = PPRTV; D = DWSHA; O = OPP; A = ATSDR; C = Cal EPA; X = APPENDIX PPRTV SCREEN (See FAQ #29); H = HEAST; F = See FAQ; E = see user guide Section 2.3.5; W = see user guide Section 2.3.6; L = see user guide on lead; M = mutagen; S = see user guide Section 5; V = volatile; R = RBA applied (See User Guide for Arsenic notice); c = cancer; n = noncancer; * = where n SL < 100X c SL; ** = where n SL < 10X c SL; SSL values are based on DAF=1; m = Concentration may exceed ceiling limit (See User Guide); s = Concentration may exceed Csat (See User Guide)

Toxicity and Chemical-specific Information										Contaminant		Screening Levels							Protection of Ground Water SSLs									
SFO (mg/kg-day) ¹	k _e (y ⁻¹)	IUR (ug/m ³ -y) ¹	k _e (y ⁻¹)	RfD _o (mg/kg-day)	k _e (y ⁻¹)	RfC ₁ (mg/m ³ -y)	k _e (y ⁻¹)	muta-gen	GIABS	ABS	C _{sat} (mg/kg)	Analyte	CAS No.	Resident Soil (mg/kg)	key	Industrial Soil (mg/kg)	key	Resident Air (ug/m ³)	key	Industrial Air (ug/m ³)	key	Tapwater (ug/L)	key	MCL (ug/L)	Risk-based SSL (mg/kg)	key	MCL-based SSL (mg/kg)	
1.1E-02	P			4.0E-03	P					1	0.1	Mercaptobenzothiazole, 2-Mercury Compounds	149-30-4	4.9E+01	c**	2.1E+02	c*					6.3E+00	c*		1.8E-02	c*		
				3.0E-04	I	3.0E-04	S		0.07			-Mercuric Chloride (and other Mercury salts)	7487-94-7	2.3E+01	n	3.5E+02	n	3.1E-01	n	1.3E+00	n	5.7E+00	n	2.0E+00		n		
				1.0E-04	I						3.1E+00	-Mercury (elemental)	7439-97-6	1.1E+01	ns	4.6E+01	ns	3.1E-01	n	1.3E+00	n	6.3E-01	n	2.0E+00	3.3E-02	n	1.0E-01	
				8.0E-05	I					1	0.1	-Methyl Mercury	22967-92-6	7.8E+00	n	1.2E+02	n					2.0E+00	n			n		
												-Phenylmercuric Acetate	62-38-4	5.1E+00	n	6.6E+01	n					1.6E+00	n		5.0E-04	n		
				3.0E-05	I			V				Merphos	150-50-5	2.3E+00	n	3.5E+01	n					6.0E-01	n		5.9E-02	n		
				1.0E-04	O					1	0.1	Merphos Oxide	78-48-8	6.3E+00	n	8.2E+01	n					2.8E-01	n		1.4E-03	n		
				6.0E-02	I					1	0.1	Metalaxyl	57837-19-1	3.8E+03	n	4.9E+04	n					1.2E+03	n		3.3E-01	n		
				1.0E-04	I	3.0E-02	P V			1		4.6E+03	Methacrylonitrile	126-98-7	7.5E+00	n	1.0E+02	n	3.1E+01	n	1.3E+02	n	1.9E+00	n		4.3E-04	n	
				5.0E-05	I					1	0.1	Methamidophos	10265-92-6	3.2E+00	n	4.1E+01	n					1.0E+00	n		2.1E-04	n		
				2.0E+00	I	2.0E+01	I V			1		1.1E+05	Methanol	67-56-1	1.2E+05	nms	1.2E+06	nms	2.1E+04	n	8.8E+04	n	2.0E+04	n		4.1E+00	n	
				1.5E-03	O					1	0.1	Methidathion	950-37-8	9.5E+01	n	1.2E+03	n					2.9E+01	n		7.1E-03	n		
				2.5E-02	I					1	0.1	Methomyl	16752-77-5	1.6E+03	n	2.1E+04	n					5.0E+02	n		1.1E-01	n		
4.9E-02	C	1.4E-05	C									Methoxy-5-nitroaniline, 2-	99-59-2	1.1E+01	c	4.7E+01	c	2.0E-01	c	8.8E-01	c	1.5E+00	c		5.3E-04	c		
				5.0E-03	I					1	0.1	Methoxychlor	72-43-5	3.2E+02	n	4.1E+03	n					3.7E+01	n	4.0E+01	2.0E+00	n	2.2E+00	
				8.0E-03	P	1.0E-03	P V			1	1.2E+05	Methoxyethanol Acetate, 2-	110-49-6	1.1E+02	n	5.1E+02	n	1.0E+00	n	4.4E+00	n	2.1E+00	n		4.2E-04	n		
				5.0E-03	P	2.0E-02	I V			1	1.1E+05	Methoxyethanol, 2-	109-86-4	3.3E+02	n	3.5E+03	n	2.1E+01	n	8.8E+01	n	2.9E+01	n		5.9E-03	n		
				1.0E+00	X		V			1	2.9E+04	Methyl Acetate	79-20-9	7.8E+04	ns	1.2E+06	nms					2.0E+04	n		4.1E+00	n		
						2.0E-02	P V			1	6.8E+03	Methyl Acrylate	96-33-3	1.5E+02	n	6.1E+02	n	2.1E+01	n	8.8E+01	n	4.2E+01	n		8.9E-03	n		
				6.0E-01	I	5.0E+00	I V			1	2.8E+04	Methyl Ethyl Ketone (2-Butanone)	78-93-3	2.7E+04	n	1.9E+05	nms	5.2E+03	n	2.2E+04	n	5.6E+03	n		1.2E+00	n		
				1.0E-03	X	1.0E-03	P	2.0E-05	X V	1	1.8E+05	Methyl Hydrazine	60-34-4	1.4E-01	c**	6.2E-01	c**	2.8E-03	c**	1.2E-02	c**	5.6E-03	c**		1.3E-06	c**		
						3.0E+00	I V			1	3.4E+03	Methyl Isobutyl Ketone (4-methyl-2-pentanone)	108-10-1	3.3E+04	ns	1.4E+05	nms	3.1E+03	n	1.3E+04	n	6.3E+03	n		1.4E+00	n		
						1.0E-03	C V			1	1.0E+04	Methyl Isocyanate	624-83-9	4.6E+00	n	1.9E+01	n	1.0E+00	n	4.4E+00	n	2.1E+00	n		5.9E-04	n		
				1.4E+00	I	7.0E-01	I V			1	2.4E+03	Methyl Methacrylate	80-62-6	4.4E+03	ns	1.9E+04	ns	7.3E+02	n	3.1E+03	n	1.4E+03	n		3.0E-01	n		
				2.5E-04	I					1	0.1	Methyl Parathion	298-00-0	1.6E+01	n	2.1E+02	n					4.5E+00	n		7.4E-03	n		
				6.0E-02	X					1	0.1	Methyl Phosphonic Acid	993-13-5	3.8E+03	n	4.9E+04	n					1.2E+03	n		2.4E-01	n		
				6.0E-03	H	4.0E-02	H V			1	3.9E+02	Methyl Styrene (Mixed Isomers)	25013-15-4	3.2E+02	n	2.6E+03	ns	4.2E+01	n	1.8E+02	n	2.3E+01	n		3.8E-02	n		
9.9E-02	C	2.8E-05	C							1	0.1	Methyl methanesulfonate	66-27-3	5.5E+00	c	2.3E+01	c	1.0E-01	c	4.4E-01	c	7.9E-01	c		1.6E-04	c		
1.8E-03	C	2.6E-07	C			3.0E+00	I V			1	8.9E+03	Methyl tert-Butyl Ether (MTBE)	1634-04-4	4.7E+01	c	2.1E+02	c	1.1E+01	c	4.7E+01	c	1.4E+01	c		3.2E-03	c		
				3.0E-04	X					1	0.1	Methyl-1,4-benzenediamine dihydrochloride, 2-	615-45-2	1.9E+01	n	2.5E+02	n					6.0E+00	n		3.6E-03	n		
						3.0E+00	X V			1	2.5E+03	Methyl-2-Pentanol, 4-	108-11-2	5.4E+04	ns	2.3E+05	nms	3.1E+03	n	1.3E+04	n	6.3E+03	n		1.4E+00	n		
9.0E-03	P			2.0E-02	X					1	0.1	Methyl-5-Nitroaniline, 2-	99-55-8	6.0E+01	c*	2.6E+02	c*					8.2E+00	c*		4.6E-03	c*		
8.3E+00	C	2.4E-03	C							1	0.1	Methyl-N-nitro-N-nitrosoguanidine, N-	70-25-7	6.5E-02	c	2.8E-01	c	1.2E-03	c	5.1E-03	c	9.4E-03	c		3.2E-06	c		
1.3E-01	C	3.7E-05	C							1	0.1	Methylaniline Hydrochloride, 2-	636-21-5	4.2E+00	c	1.8E+01	c	7.6E-02	c	3.3E-01	c	6.0E-01	c		2.6E-04	c		
				1.0E-02	A					1	0.1	Methylarsonic acid	124-58-3	6.3E+02	n	8.2E+03	n					2.0E+02	n		5.8E-02	n		
				2.0E-04	X					1	0.1	Methylbenzene, 1,4-diamine monohydrochloride, 2-	74612-12-7	1.3E+01	n	1.6E+02	n					4.0E+00	n			n		
1.0E-01	X			3.0E-04	X					1	0.1	Methylbenzene-1,4-diamine sulfate, 2-	615-50-9	5.4E+00	c**	2.3E+01	c*					7.8E-01	c**			c**		
2.2E+01	C	6.3E-03	C					M		1	0.1	Methylcholanthrene, 3-	56-49-5	5.5E-03	c	1.0E-01	c	1.6E-04	c	1.9E-03	c	1.1E-03	c		2.2E-03	c		
2.0E-03	I	1.0E-08	I	6.0E-03	I	6.0E-01	I V M			1	0.1	3.3E+03	Methylene Chloride	75-09-2	5.7E+01	c**	1.0E+03	c**	1.0E+02	c**	1.2E+03	c**	1.1E+01	c**	5.0E+00	2.9E-03	c**	1.3E-03
1.0E-01	P	4.3E-04	C	2.0E-03	P			M		1	0.1	Methylene-bis(2-chloroaniline), 4,4'	101-14-4	1.2E+00	c	2.3E+01	c*	2.4E-03	c	2.9E-02	c	1.6E-01	c		1.8E-03	c		
4.6E-02	I	1.3E-05	C							1	0.1	Methylene-bis(N,N-dimethyl) Aniline, 4,4'	101-61-1	1.2E+01	c	5.0E+01	c	2.2E-01	c	9.4E-01	c	4.8E-01	c		2.6E-03	c		
1.6E+00	C	4.6E-04	C			2.0E-02	C			1	0.1	Methylenebisbenzenamine, 4,4'	101-77-9	3.4E-01	c	1.4E+00	c	6.1E-03	c	2.7E-02	c	4.7E-02	c		2.1E-04	c		
				6.0E-04	I					1	0.1	Methylenediphenyl Diisocyanate	101-68-8	8.5E+05	nm	3.6E+06	nm	6.3E-01	n	2.6E+00	n					n		
				7.0E-02	H			V		1	0.1	5.0E+02	Methylstyrene, Alpha-	98-83-9	5.5E+03	ns	8.2E+04	ns					7.8E+02	n		1.2E+00	n	
				1.5E-01	I					1	0.1	Metolachlor	51218-45-2	9.5E+03	n	1.2E+05	nm					2.7E+03	n		3.2E+00	n		
				2.5E-02	I					1	0.1	Metribuzin	21087-64-9	1.6E+03	n	2.1E+04	n					4.9E+02	n		1.5E-01	n		
				2.5E-01	I					1	0.1	Metsulfuron-methyl	74223-64-6	1.6E+04	n	2.1E+05	nm					4.9E+03	n		1.9E+00	n		
1.8E+01	C	5.1E-03	C			3.0E+00	P	V		1	3.4E-01	3.4E-01	Mineral oils	8012-95-1	2.3E+05	nms	3.5E+06	nms					6.0E+04	n		2.4E+03	n	
				2.0E-04	I			V		1		Mirex	2385-85-5	3.6E-02	c	1.7E-01	c	5.5E-04	c	2.4E-03	c	8.8E-04	c		6.3E-04	c		
				2.0E-03	I					1	0.1	Molinate	2212-67-1	1.3E+02	n	1.6E+03	n					3.0E+01	n					

Key: I = IRIS; P = PPRTV; D = DWSHA; O = OPP; A = ATSDR; C = Cal EPA; X = APPENDIX PPRTV SCREEN (See FAQ #29); H = HEAST; F = See FAQ; E = see user guide Section 2.3.5; W = see user guide Section 2.3.6; L = see user guide on lead; M = mutagen; S = see user guide Section 5; V = volatile; R = RBA applied (See User Guide for Arsenic notice) ; c = cancer; n = noncancer; * = where: n SL < 100X c SL; ** = where n SL < 10X c SL; SSL values are based on DAF=1; m = Concentration may exceed ceiling limit (See User Guide); s = Concentration may exceed csat (See User Guide)																											
Toxicity and Chemical-specific Information										Contaminant		Screening Levels							Protection of Ground Water SSLs								
SFO (mg/kg-day) ¹	k _e (y)	IUR (ug/m ³) ¹	k _e (y)	RfD _o (mg/kg-day)	k _e (y)	RfC ₁ (mg/m ³) ¹	k _e (y)	muta-gen	GIABS	ABS	C _{sat} (mg/kg)	Analyte	CAS No.	Resident Soil (mg/kg)	key	Industrial Soil (mg/kg)	key	Resident Air (ug/m ³)	key	Industrial Air (ug/m ³)	key	Tapwater (ug/L)	key	MCL (ug/L)	Risk-based SSL (mg/kg)	key	MCL-based SSL (mg/kg)
				1.0E-01	I							Nitrate + Nitrite (as N)	E701177	7.8E+03	n	1.2E+05	nm					2.0E+03	n	1.0E+04		n	
				1.0E-02	X	5.0E-05	X			1	0.1	Nitroaniline, 2-	88-74-4	6.3E+02	n	8.0E+03	n	5.2E-02	n	2.2E-01	n	1.9E+02	n	1.0E+03	8.0E-02	n	
2.0E-02	P			4.0E-03	P	6.0E-03	P			1	0.1	Nitroaniline, 4-	100-01-6	2.7E+01	c**	1.1E+02	c*	6.3E+00	n	2.6E+01	n	3.8E+00	c*		1.6E-03	c*	
		4.0E-05	I	2.0E-03	I	9.0E-03	I	V				3.1E+03	98-95-3	5.1E+00	c*	2.2E+01	c*	7.0E-02	c	3.1E-01	c	1.4E-01	c*		9.2E-05	c*	
1.3E+00	C	3.7E-04	C	3.0E+03	P						0.1	Nitrocellulose	9004-70-0	1.9E+08	nm	2.5E+09	nm					6.0E+07	n		1.3E+04	n	
				7.0E-02	H						0.1	Nitrofurantoin	67-20-9	4.4E+03	n	5.7E+04	n					1.4E+03	n		6.1E-01	n	
1.7E-02	P			1.0E-04	P						0.1	Nitrofurazone	59-87-0	4.2E-01	c	1.8E+00	c	7.6E-03	c	3.3E-02	c	6.0E-02	c		5.4E-05	c	
		8.8E-06	P	1.0E-01	I						0.1	Nitroglycerin	55-63-0	6.3E+00	n	8.2E+01	n					2.0E+00	n		8.5E-04	n	
				5.0E-03	P	V					1	Nitroguanidine	556-88-7	6.3E+03	n	8.2E+04	n					2.0E+03	n		4.8E-01	n	
				2.0E-02	I	V					1	Nitromethane	75-52-5	5.4E+00	c*	2.4E+01	c*	3.2E-01	c*	1.4E+00	c*	6.4E-01	c*		1.4E-04	c*	
		2.7E-03	H								1	Nitropropane, 2-	79-46-9	1.4E-02	c	6.0E-02	c	1.0E-03	c	4.5E-03	c	2.1E-03	c		5.4E-07	c	
2.7E+01	C	7.7E-03	C						M		0.1	Nitroso-N-ethylurea, N-	759-73-9	4.5E-03	c	8.5E-02	c	1.3E-04	c	1.6E-03	c	9.2E-04	c		2.2E-07	c	
1.2E+02	C	3.4E-02	C						M		0.1	Nitroso-N-methylurea, N-	684-93-5	1.0E-03	c	1.9E-02	c	3.0E-05	c	3.6E-04	c	2.1E-04	c		4.6E-08	c	
5.4E+00	I	1.6E-03	I					V			1	Nitroso-di-N-butylamine, N-	924-16-3	9.9E-02	c	4.6E-01	c	1.8E-03	c	7.7E-03	c	2.7E-03	c		5.5E-06	c	
7.0E+00	I	2.0E-03	C								0.1	Nitroso-di-N-propylamine, N-	621-64-7	7.8E-02	c	3.3E-01	c	1.4E-03	c	6.1E-03	c	1.1E-02	c		8.1E-06	c	
2.8E+00	I	8.0E-04	C								0.1	Nitrosodiethanolamine, N-	1116-54-7	1.9E-01	c	8.2E-01	c	3.5E-03	c	1.5E-02	c	1.7E-02	c		5.6E-06	c	
1.5E+02	I	4.3E-02	I								0.1	Nitrosodihethylamine, N-	55-18-5	8.1E-04	c	1.5E-02	c	2.4E-05	c	2.9E-04	c	2.8E-04	c		6.1E-08	c	
5.1E+01	I	1.4E-02	I	8.0E-06	P	4.0E-05	X	V	M		0.1	Nitrosodimethylamine, N-	62-75-9	2.0E-03	c	3.4E-02	c	7.2E-05	c	8.8E-04	c	1.2E-04	c		2.7E-08	c	
4.9E-03	I	2.6E-06	C								0.1	Nitrosodiphenylamine, N-	86-30-6	1.1E+02	c	4.7E+02	c	1.1E+00	c	4.7E+00	c	1.1E+01	c		6.7E-02	c	
2.2E+01	I	6.3E-03	C					V			1	Nitrosomethylthylamine, N-	10595-95-6	2.0E-02	c	9.1E-02	c	4.5E-04	c	1.9E-03	c	7.1E-04	c		2.0E-07	c	
6.7E+00	C	1.9E-03	C								0.1	Nitrosomorpholine [N-]	59-89-2	8.1E-02	c	3.4E-01	c	1.5E-03	c	6.5E-03	c	1.2E-02	c		2.8E-06	c	
9.4E+00	C	2.7E-03	C								0.1	Nitrosopiperidine [N-]	100-75-4	5.8E-02	c	2.4E-01	c	1.0E-03	c	4.5E-03	c	8.2E-03	c		4.4E-06	c	
2.1E+00	I	6.1E-04	I								0.1	Nitrosopyrrolidine, N-	990-55-2	2.6E-01	c	1.1E+00	c	4.6E-03	c	2.0E-02	c	3.7E-02	c		1.4E-05	c	
2.2E-01	P			1.0E-04	X						0.1	Nitrotoluene, m-	99-08-1	6.3E+00	n	8.2E+01	n					1.7E+00	n		1.6E-03	n	
1.6E-02	P			9.0E-04	P	V					0.1	Nitrotoluene, o-	88-72-2	3.2E+00	c**	1.5E+01	c*					3.1E-01	c*		3.0E-04	c*	
				4.0E-03	P						0.1	Nitrotoluene, p-	99-99-0	3.4E+01	c**	1.4E+02	c*					4.3E+00	c*		4.0E-03	c*	
				3.0E-04	X	2.0E-02	P	V			1	Nonane, n-	111-84-2	1.1E+01	ns	7.2E+01	ns	2.1E+01	n	8.8E+01	n	5.3E+00	n		7.5E-02	n	
				1.5E-02	O						0.1	Norflurazon	27314-13-2	9.5E+02	n	1.2E+04	n					2.9E+02	n		1.9E+00	n	
				3.0E-03	I						0.1	Octabromodiphenyl Ether	32536-52-0	1.9E+02	n	2.5E+03	n					6.0E+01	n		1.2E+01	n	
				5.0E-02	I					0.006		2691-41-0	3.9E+03	n	5.7E+04	n					1.0E+03	n		1.3E+00	n		
				2.0E-03	H						0.1	Octamethylpyrophosphoramide	152-16-9	1.3E+02	n	1.6E+03	n					4.0E+01	n		9.6E-03	n	
7.8E-03	O			1.4E-01	O						0.1	Oryzalin	19044-88-3	7.0E+01	c	2.9E+02	c					7.9E+00	c		1.5E-02	c	
				5.0E-03	I						0.1	Oxadiazon	19666-30-9	3.2E+02	n	4.1E+03	n					4.7E+01	n		4.8E-01	n	
				2.5E-02	I						0.1	Oxamyl	23135-22-0	1.6E+03	n	2.1E+04	n					5.0E+02	n	2.0E+02	1.1E-01	n	
7.3E-02	O			3.0E-02	O						0.1	Oxyfluorfen	42874-03-3	7.4E+00	c	3.1E+01	c					5.4E-01	c		4.3E-02	c	
				1.3E-02	I						0.1	Paclitaxel	76738-62-0	8.2E+02	n	1.1E+04	n					2.3E+02	n		4.6E-01	n	
				4.5E-03	I						0.1	Paraquat Dichloride	1910-42-5	2.8E+02	n	3.7E+03	n					9.0E+01	n		1.2E+00	n	
				6.0E-03	H						0.1	Parathion	56-38-2	3.8E+02	n	4.9E+03	n					8.6E+01	n		4.3E-01	n	
				5.0E-02	H			V			1	Pebulate	1114-71-2	3.9E+03	n	5.8E+04	n					5.6E+02	n		4.5E-01	n	
				3.0E-02	O						0.1	Pendimethalin	40487-42-1	1.9E+03	n	2.5E+04	n					1.4E+02	n		1.6E+00	n	
				2.0E-03	I			V			1	Pentabromodiphenyl Ether	32534-81-9	1.6E+02	ns	2.3E+03	ns					4.0E+01	n		1.7E+00	n	
				1.0E-04	I						0.1	Pentabromodiphenyl ether, 2,2',4,4',5'- (BDE-99)	60348-60-9	6.3E+00	n	8.2E+01	n					2.0E+00	n		8.7E-02	n	
				8.0E-04	I			V			1	Pentachlorobenzene	608-93-5	6.3E+01	n	9.3E+02	n					3.2E+00	n		2.4E-02	n	
9.0E-02	P							V			1	Pentachloroethane	76-01-7	7.7E+00	c	3.6E+01	c					6.5E-01	c		3.1E-04	c	
2.6E-01	H			3.0E-03	I			V			1	Pentachloronitrobenzene	82-68-8	2.7E+00	c*	1.3E+01	c					1.2E-01	c		1.5E-03	c	
4.0E-01	I	5.1E-06	C	5.0E-03	I						0.25	Pentachlorophenol	87-86-5	1.0E+00	c	4.0E+00	c	5.5E-01	c	2.4E+00	c	4.1E-02	c	1.0E+00	5.7E-05	c	
4.0E-03	X			2.0E-03	P						0.1	Pentaerythritol tetranitrate (PETN)	78-11-5	1.3E+02	n	5.7E+02	c**					1.9E+01	c**		2.8E-02	c**	
						1.0E+00	P	V			1	Pentane, n-Perchlorates	109-66-0	8.1E+02	ns	3.4E+03	ns	1.0E+03	n	4.4E+03	n	2.1E+03	n		1.0E+01	n	
				7.0E-04	I						1	-Ammonium Perchlorate	7790-98-9	5.5E+01	n	8.2E+02	n					1.4E+01	n			n	
				7.0E-04	I						1	-Lithium Perchlorate	7791-03-9	5.5E+01	n	8.2E+02	n					1.4E+01	n			n	
				7.0E-04	I						1	-Perchlorate and Perchlorate Salts	14797-73-0	5.5E+01	n	8.2E+02	n					1.4E+01	n	1.5E+01(F)		n	
				7.0E-04	I						1	-Potassium Perchlorate	7778-74-7	5.5E+01	n	8.2E+02	n					1.4E+01	n			n	
				7.0E-04	I						1	-Sodium Perchlorate	7601-89-0	5.5E+01	n	8.2E+02	n					1.4E+					

Toxicity and Chemical-Specific Information												Contaminant		Screening Levels								Protection of Ground Water SSLs					
SFO (mg/kg-day) ¹	ke y	IUR (ug/m ³ -y) ¹	ke y	RfD _o (mg/kg-day)	ke y	RfC ₁ (mg/m ³ -y)	ke y	muta- gen	GIABS	ABS	C _{sat} (mg/kg)	Analyte	CAS No.	Resident Soil (mg/kg)	key	Industrial Soil (mg/kg)	key	Resident Air (ug/m ³)	key	Industrial Air (ug/m ³)	key	Tapwater (ug/L)	key	MCL (ug/L)	Risk-based SSL (mg/kg)	key	MCL-based SSL (mg/kg)
2.0E-02	I								1	0.1		Phosmet	732-11-6	1.3E+03	n	1.6E+04	n					3.7E+02	n		8.2E-02	n	
4.9E+01	P								1			Phosphates, Inorganic		3.8E+06	nm	5.7E+07	nm					9.7E+05	n			n	
4.9E+01	P								1			-Aluminum metaphosphate	13776-88-0	3.8E+06	nm	5.7E+07	nm					9.7E+05	n			n	
4.9E+01	P								1			-Ammonium polyphosphate	68333-79-9	3.8E+06	nm	5.7E+07	nm					9.7E+05	n			n	
4.9E+01	P								1			-Calcium pyrophosphate	7790-76-3	3.8E+06	nm	5.7E+07	nm					9.7E+05	n			n	
4.9E+01	P								1			-Diammonium phosphate	7783-28-0	3.8E+06	nm	5.7E+07	nm					9.7E+05	n			n	
4.9E+01	P								1			-Dicalcium phosphate	7757-93-9	3.8E+06	nm	5.7E+07	nm					9.7E+05	n			n	
4.9E+01	P								1			-Dimagnesium phosphate	7782-75-4	3.8E+06	nm	5.7E+07	nm					9.7E+05	n			n	
4.9E+01	P								1			-Dipotassium phosphate	7758-11-4	3.8E+06	nm	5.7E+07	nm					9.7E+05	n			n	
4.9E+01	P								1			-Disodium phosphate	7558-79-4	3.8E+06	nm	5.7E+07	nm					9.7E+05	n			n	
4.9E+01	P								1			-Monoaluminum phosphate	13530-50-2	3.8E+06	nm	5.7E+07	nm					9.7E+05	n			n	
4.9E+01	P								1			-Monoammonium phosphate	7722-76-1	3.8E+06	nm	5.7E+07	nm					9.7E+05	n			n	
4.9E+01	P								1			-Monocalcium phosphate	7758-23-8	3.8E+06	nm	5.7E+07	nm					9.7E+05	n			n	
4.9E+01	P								1			-Monomagnesium phosphate	7757-86-0	3.8E+06	nm	5.7E+07	nm					9.7E+05	n			n	
4.9E+01	P								1			-Monopotassium phosphate	7778-77-0	3.8E+06	nm	5.7E+07	nm					9.7E+05	n			n	
4.9E+01	P								1			-Monosodium phosphate	7558-80-7	3.8E+06	nm	5.7E+07	nm					9.7E+05	n			n	
4.9E+01	P								1			-Polyphosphoric acid	8017-16-1	3.8E+06	nm	5.7E+07	nm					9.7E+05	n			n	
4.9E+01	P								1			-Potassium tripolyphosphate	13845-36-8	3.8E+06	nm	5.7E+07	nm					9.7E+05	n			n	
4.9E+01	P								1			-Sodium acid pyrophosphate	7758-16-9	3.8E+06	nm	5.7E+07	nm					9.7E+05	n			n	
4.9E+01	P								1			-Sodium aluminum phosphate (acidic)	7785-88-8	3.8E+06	nm	5.7E+07	nm					9.7E+05	n			n	
4.9E+01	P								1			-Sodium aluminum phosphate (anhydrous)	10279-59-1	3.8E+06	nm	5.7E+07	nm					9.7E+05	n			n	
4.9E+01	P								1			-Sodium aluminum phosphate (tetrahydrate)	10305-76-7	3.8E+06	nm	5.7E+07	nm					9.7E+05	n			n	
4.9E+01	P								1			-Sodium hexametaphosphate	10124-56-8	3.8E+06	nm	5.7E+07	nm					9.7E+05	n			n	
4.9E+01	P								1			-Sodium polyphosphate	68915-31-1	3.8E+06	nm	5.7E+07	nm					9.7E+05	n			n	
4.9E+01	P								1			-Sodium trimetaphosphate	7785-84-4	3.8E+06	nm	5.7E+07	nm					9.7E+05	n			n	
4.9E+01	P								1			-Sodium tripolyphosphate	7758-29-4	3.8E+06	nm	5.7E+07	nm					9.7E+05	n			n	
4.9E+01	P								1			-Tetrapotassium phosphate	7320-34-5	3.8E+06	nm	5.7E+07	nm					9.7E+05	n			n	
4.9E+01	P								1			-Tetrasodium pyrophosphate	7722-88-5	3.8E+06	nm	5.7E+07	nm					9.7E+05	n			n	
4.9E+01	P								1			-Trialuminum sodium tetra decahydrogenoctaorthophosphate (dihydrate)	15136-87-5	3.8E+06	nm	5.7E+07	nm					9.7E+05	n			n	
4.9E+01	P								1			-Tricalcium phosphate	7758-87-4	3.8E+06	nm	5.7E+07	nm					9.7E+05	n			n	
4.9E+01	P								1			-Trimagnesium phosphate	7757-87-1	3.8E+06	nm	5.7E+07	nm					9.7E+05	n			n	
4.9E+01	P								1			-Tripotassium phosphate	7778-53-2	3.8E+06	nm	5.7E+07	nm					9.7E+05	n			n	
4.9E+01	P								1			-Trisodium phosphate	7601-54-9	3.8E+06	nm	5.7E+07	nm					9.7E+05	n			n	
3.0E-04	I	3.0E-04	I	V					1			Phosphine	7803-51-2	2.3E+01	n	3.5E+02	n	3.1E-01	n	1.3E+00	n	5.7E-01	n			n	
4.9E+01	P	1.0E-02	I						1			Phosphoric Acid	7664-38-2	3.0E+06	nm	2.9E+07	nm	1.0E+01	n	4.4E+01	n	9.7E+05	n			n	
2.0E-05	I		V						1			Phosphorus, White	7723-14-0	1.6E+00	n	2.3E+01	n					4.0E-01	n			1.5E-03	n
1.4E-02	I	2.4E-06	C	2.0E-02	I				1	0.1		Phthalates	117-81-7	3.9E+01	c*	1.6E+02	c	1.2E+00	c	5.1E+00	c	5.6E+00	c*	6.0E+00	1.3E+00	c*	1.4E+00
1.9E-03	P			2.0E-01	I				1	0.1		-Bis(2-ethylhexyl)phthalate	85-68-7	2.9E+02	c*	1.2E+03	c					1.6E+01	c			2.4E-01	c
				1.0E+00	I				1	0.1		-Butyl Benzyl Phthalate	85-70-1	6.3E+04	n	8.2E+05	nm					1.3E+04	n			3.1E+02	n
				1.0E-01	I				1	0.1		-Diethyl Phthalate	84-74-2	6.3E+03	n	8.2E+04	n					9.0E+02	n			2.3E+00	n
				8.0E-01	I				1	0.1		-Diethyl Phthalate	84-66-2	5.1E+04	n	6.6E+05	nm					1.5E+04	n			6.1E+00	n
				1.0E-01	I		V		1			-Dimethylterephthalate	120-61-6	7.8E+03	n	1.2E+05	nm					1.9E+03	n			4.9E-01	n
				1.0E-02	P				1	0.1		-Octyl Phthalate, di-N-	117-84-0	6.3E+02	n	8.2E+03	n					2.0E+02	n			5.7E+01	n
				1.0E+00	H				1	0.1		-Phthalic Acid, P-	100-21-0	6.3E+04	n	8.2E+05	nm					1.9E+04	n			6.8E+00	n
				2.0E+00	I	2.0E-02	C		1	0.1		-Phthalic Anhydride	85-44-9	1.3E+05	nm	1.6E+06	nm	2.1E+01	n	8.8E+01	n	3.9E+04	n			8.5E+00	n
				7.0E-02	I				1	0.1		Picloram	1918-02-1	4.4E+03	n	5.7E+04	n					1.4E+03	n	5.0E+02	3.8E-01	n	1.4E-01
				1.0E-04	X				1	0.1		Picramic Acid (2-Amino-4,6-dinitrophenol)	96-91-3	6.3E+00	n	8.2E+01	n					2.0E+00	n			1.3E-03	n
				9.0E-04	X				1	0.1		Picric Acid (2,4,6-Trinitrophenol)	88-89-1	5.7E+01	n	7.4E+02	n					1.8E+01	n			8.4E-02	n
3.0E+01	C	8.6E-03	C	6.7E-05	O				1	0.1		Pirimiphos, Methyl	29232-93-7	4.2E+00	n	5.5E+01	n					8.1E-01	n			7.7E-04	n
				7.0E-06	H				1	0.1		Polybrominated Biphenyls	95936-65-1	1.8E-02	c*	7.7E-02	c*	3.3E-04	c	1.4E-03	c	2.6E-03	c*				c*
									1	0.14		Polychlorinated Biphenyls (PCBs)															
7.0E-02	S	2.0E-05	S	7.0E-05	I		V		1	0.14		-Aroclor 1016	12674-11-2	4.1E+00	n	2.7E+01	c**	1.4E-01	c	6.1E-01	c	2.2E-01	c**			2.1E-02	c**
2.0E+00	S	5.7E-04	S				V		1	0.14		-Aroclor 1221	11104-28-2	2.0E-01	c	8.3E-01	c	4.9E-03	c	2.1E-02	c	4.7E-03	c			8.0E-05	c
2.0E+00	S	5.7E-04	S				V		1	0.14		-Aroclor 1232	11141-16-5	1.7E-01	c	7.2E-01	c	4.9E-03	c	2.1E-02	c	4.7E-03	c			8.0E-05	c
2.0E+00	S	5.7E-04	S				V		1	0.14		-Aroclor 1242	53469-21-9	2.3E-01	c	9.5E-01	c	4.9E-03	c	2.1E-02	c	7.8E-03	c			1.2E-03	c
2.0E+00	S	5.7E-04	S				V		1	0.14		-A															

Toxicity and Chemical-specific Information													Contaminant		Screening Levels								Protection of Ground Water SSLs				
SFO (mg/kg-day) ¹	ky	IUR (ug/m ³) ¹	ky	RfD _o (mg/kg-day)	ky	RfC ₁ (mg/m ³) ¹	ky	muta- gen	GIABS	ABS	C _{sat} (mg/kg)	Analyte	CAS No.	Resident Soil (mg/kg)	key	Industrial Soil (mg/kg)	key	Resident Air (ug/m ³)	key	Industrial Air (ug/m ³)	key	Tapwater (ug/L)	key	MCL (ug/L)	Risk-based SSL (mg/kg)	key	MCL-based SSL (mg/kg)
2.0E+00	I	5.7E-04	I					V	1	0.14		-Polychlorinated Biphenyls (high risk)	1336-36-3	2.3E-01	c	9.4E-01	c	4.9E-03	c	2.1E-02	c			5.0E-01			
4.0E-01	I	1.0E-04	I					V	1	0.14		-Polychlorinated Biphenyls (low risk)	1336-36-3					2.8E-02	c	1.2E-01	c	4.4E-02	c	5.0E-01			
7.0E-02	I	2.0E-05	I					V	1	0.14		-Polychlorinated Biphenyls (lowest risk)	1336-36-3					1.4E-01	c	6.1E-01	c			5.0E-01			
1.3E+01	E	3.8E-03	E	7.0E-06	E	4.0E-04	E		1	0.14		-Tetrachlorobiphenyl, 3,3',4,4'- (PCB 77)	32598-13-3	3.8E-02	c*	1.6E-01	c*	7.4E-04	c	3.2E-03	c	6.0E-03	c*		9.4E-04	c*	
3.9E+01	E	1.1E-02	E	2.3E-06	E	1.3E-04	E	V	1	0.14		-Tetrachlorobiphenyl, 3,4,4',5'- (PCB 81)	70362-50-4	1.2E-02	c*	4.8E-02	c*	2.5E-04	c	1.1E-03	c	4.0E-04	c		6.2E-05	c	
						6.0E-04	I		1	0.1		Polymeric Methylene Diphenyl Diisocyanate (PMDI)	9016-87-9	8.5E+05	nm	3.6E+06	nm	6.3E-01	n	2.6E+00	n						
												Polynuclear Aromatic Hydrocarbons (PAHs)															
		6.0E-02	I					V	1	0.13		-Acenaphthene	83-32-9	3.6E+03	n	4.5E+04	n					5.3E+02	n		5.5E+00	n	
		3.0E-01	I					V	1	0.13		-Anthracene	120-12-7	1.8E+04	n	2.3E+05	nm					1.8E+03	n		5.8E+01	n	
1.0E-01	E	6.0E-05	E					V	M	1	0.13	-Benz[a]anthracene	56-55-3	1.1E+00	c	2.1E+01	c	1.7E-02	c	2.0E-01	c	3.0E-02	c		1.1E-02	c	
1.2E+00	C	1.1E-04	C						1	0.13		-Benzo[j]fluoranthene	205-82-3	4.2E-01	c	1.8E+00	c	2.6E-02	c	1.1E-01	c	6.5E-02	c		7.8E-02	c	
1.0E+00	I	6.0E-04	I	3.0E-04	I	2.0E-06	I	M	1	0.13		-Benzo[a]pyrene	50-32-8	1.1E-01	c	2.1E+00	c	1.7E-03	c**	8.8E-03	n	2.5E-02	c	2.0E-01	2.9E-02	c	2.4E-01
1.0E-01	E	6.0E-05	E						M	1	0.13	-Benzo[b]fluoranthene	205-99-2	1.1E+00	c	2.1E+01	c	1.7E-02	c	2.0E-01	c	2.5E-01	c		3.0E-01	c	
1.0E-02	E	6.0E-06	E						M	1	0.13	-Benzo[k]fluoranthene	207-08-9	1.1E+01	c	2.1E+02	c	1.7E-01	c	2.0E+00	c	2.5E+00	c		2.9E+00	c	
				8.0E-02	I			V	1	0.13		-Chloronaphthalene, Beta-	91-58-7	4.8E+03	n	6.0E+04	n					7.5E+02	n		3.9E+00	n	
1.0E-03	E	6.0E-07	E						M	1	0.13	-Chrysene	218-01-9	1.1E+02	c	2.1E+03	c	1.7E+00	c	2.0E+01	c	2.5E+01	c		9.0E+00	c	
1.0E+00	E	6.0E-04	E						M	1	0.13	-Dibenz[a,h]anthracene	53-70-3	1.1E-01	c	2.1E+00	c	1.7E-03	c	2.0E-02	c	2.5E-02	c		9.6E-02	c	
1.2E+01	C	1.1E-03	C						1	0.13		-Dibenzo[a,e]pyrene	192-65-4	4.2E-02	c	1.8E-01	c	2.6E-03	c	1.1E-02	c	6.5E-03	c		8.4E-02	c	
2.5E+02	C	7.1E-02	C						M	1	0.13	-Dimethylbenz(a)anthracene, 7,12-	57-97-6	4.6E-04	c	8.4E-03	c	1.4E-05	c	1.7E-04	c	1.0E-04	n		9.9E-05	c	
				4.0E-02	I				1	0.13		-Fluoranthene	206-44-0	2.4E+03	n	3.0E+04	n					8.0E+02	n		8.9E+01	n	
				4.0E-02	I			V	1	0.13		-Fluorene	86-73-7	2.4E+03	n	3.0E+04	n					2.9E+02	n		5.4E+00	n	
1.0E-01	E	6.0E-05	E						M	1	0.13	-Indeno[1,2,3-cd]pyrene	193-39-5	1.1E+00	c	2.1E+01	c	1.7E-02	c	2.0E-01	c	2.5E-01	c		9.8E-01	c	
2.9E-02	P			7.0E-02	A			V	1	0.13	3.9E+02	-Methylnaphthalene, 1-	90-12-0	1.8E+01	c	7.3E+01	c					1.1E+00	n		6.0E-03	c	
				4.0E-03	I			V	1	0.13		-Methylnaphthalene, 2-	91-57-6	2.4E+02	n	3.0E+03	n					3.6E+01	n		1.9E-01	n	
		3.4E-05	C	2.0E-02	I	3.0E-03	I	V	1	0.13		-Naphthalene	91-20-3	3.8E+00	c*	1.7E+01	c*	8.3E-02	c*	3.6E-01	c*	1.7E-01	c*		5.4E-04	c*	
1.2E+00	C	1.1E-04	C						1	0.13		-Nitropyrene, 4-	57835-92-4	4.2E-01	c	1.8E+00	c	2.6E-02	c	1.1E-01	c	1.9E-02	c		3.3E-03	c	
				3.0E-02	I			V	1	0.13		-Pyrene	129-00-0	1.8E+03	n	2.3E+04	n					1.2E+02	n		1.3E+01	n	
1.5E-01	I			2.0E-02	P				1	0.1		Potassium Perfluorobutane Sulfonate	29420-49-3	1.3E+03	n	1.6E+04	n					4.0E+02	n		1.9E-03	c	
				9.0E-03	I				1	0.1		Prochloraz	67747-09-5	3.6E+00	c	1.5E+01	c					3.8E-01	c		1.6E+00	n	
				6.0E-03	H			V	1	0.1		Profluralin	26399-36-0	4.7E+02	n	7.0E+03	n					2.6E+01	n		1.5E-01	n	
				1.5E-02	I				1	0.1		Prometon	1610-18-0	9.5E+02	n	1.2E+04	n					2.5E+02	n		1.2E-01	n	
				4.0E-02	O				1	0.1		Prometryn	7287-19-6	2.5E+03	n	3.3E+04	n					6.0E+02	n		9.0E-01	n	
				1.3E-02	I				1	0.1		Propachlor	1918-16-7	8.2E+02	n	1.1E+04	n					2.5E+02	n		1.5E-01	n	
				5.0E-03	I				1	0.1		Propanil	709-98-8	3.2E+02	n	4.1E+03	n					8.2E+01	n		4.5E-02	n	
3.3E-02	O			4.0E-02	O				1	0.1	1.1E+05	Propargite	2312-35-8	1.7E+01	c	7.0E+01	c					9.2E-01	c		6.8E-02	c	
				2.0E-03	I			V	1	0.1		Propargyl Alcohol	107-19-7	1.6E+02	n	2.3E+03	n					4.0E+01	n		8.1E-03	n	
				2.0E-02	I				1	0.1		Propazine	139-40-2	1.3E+03	n	1.6E+04	n					3.4E+02	n		3.0E-01	n	
				2.0E-02	I				1	0.1		Propham	122-42-9	1.3E+03	n	1.6E+04	n					3.5E+02	n		2.2E-01	n	
				1.0E-01	O				1	0.1		Propiconazole	60207-90-1	6.3E+03	n	8.2E+04	n					1.6E+03	n		5.3E+00	n	
						8.0E-03	I	V	1		3.3E+04	Propionaldehyde	123-38-6	7.5E+01	n	3.1E+02	n	8.3E+00	n	3.5E+01	n	1.7E+01	n		3.4E-03	n	
				1.0E-01	X	1.0E+00	X	V	1		2.6E+02	Propyl benzene	103-65-1	3.8E+03	ns	2.4E+04	ns	1.0E+03	n	4.4E+03	n	6.6E+02	n		1.2E+00	n	
						3.0E+00	C	V	1		3.5E+02	Propylene	115-07-1	2.2E+03	ns	9.3E+03	ns	3.1E+03	n	1.3E+04	n	6.3E+03	n		6.0E+00	n	
				2.0E+01	P				1	0.1		Propylene Glycol	57-55-6	1.3E+06	nm	1.6E+07	nm					4.0E+05	n		8.1E+01	n	
						2.7E-04	A		1	0.1		Propylene Glycol Dinitrate	6423-43-4	3.9E+05	nm	1.6E+06	nm	2.8E-01	n	1.2E+00	n				5.6E-05	c	
				7.0E-01	H	2.0E+00	I	V	1		1.1E+05	Propylene Glycol Monomethyl Ether	107-98-2	4.1E+04	n	3.7E+05	nms	2.1E+03	n	8.8E+03	n	3.2E+03	n		6.5E-01	n	
2.4E-01	I	3.7E-06	I						1	0.1	7.8E+04	Propylene Oxide	75-56-9	2.1E+00	c	9.7E+00	c	7.6E-01	c*	3.3E+00	c*	2.7E-01	c		5.6E-05	c	
				7.5E-02	I				1	0.1		Propyzamide	23950-58-5	4.7E+03	n	6.2E+04	n					1.2E+03	n		1.2E+00	n	
				1.0E-03	I			V	1	0.1	5.3E+05	Pyridine	110-86-1	7.8E+01	n	1.2E+03	n					2.0E+01	n		6.8E-03	n	
3.0E+00	I			5.0E-04	I				1	0.1		Quinalphos	13593-03-8	3.2E+01	n	4.1E+02	n					5.1E+00	n		4.3E-02	n	
				9.0E-03	I				1	0.1		Quinoline	91-22-5	1.8E-01	c	7.7E-01	c					2.4E-02	n		7.8E-05	c	
									1	0.1		Quizalofop-ethyl	76578-14-8	5.7E+02	n	7.4E+03	n					1.2E+02	n		1.9E+00	n	
						3.0E-02	A		1			Refractory Ceramic Fibers	E715557	4.3E+07	nm	1.8E+08	nm	3.1E+01	n	1.3E+02	n				4.2E+01	n	
				3.0E-02	I				1	0.1		Resmethrin	10453-86-8	1.9E+03	n	2.5E+04	n					6.7E+01	n		3.7E+00	n</	

Toxicity and Chemical-specific Information													Contaminant		Screening Levels										Protection of Ground Water SSLs				
SFO (mg/kg-day) ¹	k _e (y)	IUR (ug/m ³) ¹	k _e (y)	RfD _o (mg/kg-day)	k _e (y)	RfC ₁ (mg/m ³) ¹	k _e (y)	VO	muta-gen	GIABS	ABS	C _{sat} (mg/kg)	Analyte	CAS No.	Resident Soil (mg/kg)	key	Industrial Soil (mg/kg)	key	Resident Air (ug/m ³)	key	Industrial Air (ug/m ³)	key	Tapwater (ug/L)	key	MCL (ug/L)	Risk-based SSL (mg/kg)	key	MCL-based SSL (mg/kg)	
2.4E-02	H			8.0E-04	P						1		Sodium Tungstate Dihydrate	10213-10-2	6.3E+01	n	9.3E+02	n					1.6E+01	n					n
				3.0E-02	I						1		Stirofos (Tetrachlorovinphos)	961-11-5	2.3E+01	c*	9.6E+01	c					2.8E+00	c					c
				6.0E-01	I						1		Strontium, Stable	7440-24-6	4.7E+04	n	7.0E+05	nm					1.2E+04	n					n
				3.0E-04	I						1	0.1	Strychnine	57-24-9	1.9E+01	n	2.5E+02	n					5.9E+00	n					n
				2.0E-01	I	1.0E+00	I	V			1		Styrene	100-42-5	6.0E+03	ns	3.5E+04	ns	1.0E+03	n	4.4E+03	n	1.2E+03	n	1.0E+02				1.1E-01
				3.0E-03	P						1	0.1	Styrene-Acrylonitrile (SAN) Trimer		1.9E+02	n	2.5E+03	n					4.8E+01	n					n
				1.0E-03	P	2.0E-03	X				1	0.1	Sulfolane	126-33-0	6.3E+01	n	8.2E+02	n	2.1E+00	n	8.8E+00	n	2.0E+01	n					n
				8.0E-04	P						1	0.1	Sulfonylbis(4-chlorobenzene), 1,1'-	80-07-9	5.1E+01	n	6.6E+02	n					1.1E+01	n					n
						1.0E-03	C	V			1		Sulfur Trioxide	7446-11-9	1.4E+06	nm	6.0E+06	nm	1.0E+00	n	4.4E+00	n	2.1E+00	n					n
						1.0E-03	C				1		Sulfuric Acid	7664-93-9	1.4E+06	nm	6.0E+06	nm	1.0E+00	n	4.4E+00	n							n
2.5E-02	I	7.1E-06	I	5.0E-02	H						1	0.1	Sulfurous acid, 2-chloroethyl 2-[4-(1,1-dimethylethyl)phenoxy]-1-methylethyl ester	140-57-8	2.2E+01	c	9.2E+01	c	4.0E-01	c	1.7E+00	c	1.3E+00	c					c
				3.0E-02	H						1	0.1	TCMTB	21564-17-0	1.9E+03	n	2.5E+04	n					4.8E+02	n					n
				7.0E-02	I						1	0.1	Tebuthiuron	34014-18-1	4.4E+03	n	5.7E+04	n					1.4E+03	n					n
				2.0E-02	H						1	0.1	Temephos	3383-96-8	1.3E+03	n	1.6E+04	n					4.0E+02	n					n
				1.3E-02	I						1	0.1	Terbacil	5902-51-2	8.2E+02	n	1.1E+04	n					2.5E+02	n					n
				2.5E-05	H						1	0.1	Terbufos	13071-79-9	2.0E+00	n	2.9E+01	n					2.4E-01	n					n
				1.0E-03	I						1	0.1	Terbutyn	886-50-0	6.3E+01	n	8.2E+02	n					1.3E+01	n					n
				1.0E-04	I						1	0.1	Tetrabromodiphenyl ether, 2,2',4,4'- (BDE-47)	5436-43-1	6.3E+00	n	8.2E+01	n					2.0E+00	n					n
2.6E-02	I	7.4E-06	I	3.0E-04	I						1		Tetrachlorobenzene, 1,2,4,5-	95-94-3	2.3E+01	n	3.5E+02	n					1.7E+00	n					n
				3.0E-02	I						1		Tetrachloroethane, 1,1,1,2-	630-20-6	2.0E+00	c	8.8E+00	c	3.8E-01	c	1.7E+00	c	5.7E-01	c					c
2.0E-01	I	5.8E-05	C	2.0E-02	I						1	1.9E+03	Tetrachloroethane, 1,1,2,2-	79-34-5	6.0E-01	c	2.7E+00	c	4.8E-02	c	2.1E-01	c	7.6E-02	c					n
2.1E-03	I	2.6E-07	I	6.0E-03	I	4.0E-02	I	V			1	1.7E+02	Tetrachloroethylene	127-18-4	2.4E+01	c**	1.0E+02	c**	1.1E+01	c**	4.7E+01	c**	1.1E+01	c**	5.0E+00				c**
				3.0E-02	I						1	0.1	Tetrachlorophenol, 2,3,4,6-	58-90-2	1.9E+03	n	2.5E+04	n					2.4E+02	n					n
2.0E+01	H			5.0E-04	I						1	0.1	Tetrachlorotoluene, p-alpha, alpha, alpha-	5216-25-1	3.5E-02	c	1.6E-01	c					1.3E-03	n					c
						8.0E+01	I	V			1	2.1E+03	Tetraethyl Dithiopyrophosphate	3689-24-5	3.2E+01	n	4.1E+02	n					7.1E+00	n					n
											1		Tetrafluoroethane, 1,1,1,2-	811-97-2	1.0E+05	nms	4.3E+05	nms	8.3E+04	n	3.5E+05	n	1.7E+05	n					n
				2.0E-03	P						1	0.0007	Tetryl (Trinitrophenylmethyltriamine)	479-45-8	1.6E+02	n	2.3E+03	n					3.9E+01	n					n
				2.0E-05	S						1		Thallic Oxide	1314-32-5	1.6E+00	n	2.3E+01	n					4.0E-01	n					n
				1.0E-05	X						1		Thallium (I) Nitrate	10102-45-1	7.8E-01	n	1.2E+01	n					2.0E-01	n					n
				1.0E-05	X						1		Thallium (Soluble Salts)	7440-28-0	7.8E-01	n	1.2E+01	n					2.0E-01	n	2.0E+00				1.4E-02
				1.0E-05	X						1		Thallium Acetate	563-68-8	7.8E-01	n	1.2E+01	n					2.0E-01	n					n
				2.0E-05	X						1		Thallium Carbonate	6533-73-9	1.6E+00	n	2.3E+01	n					4.0E-01	n					n
				1.0E-05	X						1		Thallium Chloride	7791-12-0	7.8E-01	n	1.2E+01	n					2.0E-01	n					n
				1.0E-05	S						1		Thallium Selenite	12039-52-0	7.8E-01	n	1.2E+01	n					2.0E-01	n					n
				2.0E-05	X						1		Thallium Sulfate	7446-18-6	1.6E+00	n	2.3E+01	n					4.0E-01	n					n
				4.3E-02	O						1	0.1	Thiifensulfuron-methyl	79277-27-3	2.7E+03	n	3.5E+04	n					8.6E+02	n					n
				1.0E-02	I						1	0.1	Thiobencarb	28249-77-6	6.3E+02	n	8.2E+03	n					1.6E+02	n					n
				7.0E-02	X						1	0.0075	Thiodiglycol	111-48-8	5.4E+03	n	7.9E+04	n					1.4E+03	n					n
1.2E-02	O			3.0E-04	H						1	0.1	Thiofanox	39196-18-4	1.9E+01	n	2.5E+02	n					5.3E+00	n					n
				2.7E-02	O						1	0.1	Thiophanate, Methyl	23564-05-8	4.7E+01	c*	2.0E+02	c					6.7E+00	c*					c*
				1.5E-02	O						1	0.1	Thiram	137-26-8	9.5E+02	n	1.2E+04	n					2.9E+02	n					n
				6.0E-01	H						1		Tin	7440-31-5	4.7E+04	n	7.0E+05	nm					1.2E+04	n					n
						1.0E-04	A	V			1		Titanium Tetrachloride	7550-45-0	1.4E+05	nm	6.0E+05	nm	1.0E-01	n	4.4E-01	n	2.1E-01	n					n
				8.0E-02	I	5.0E+00	I	V			1	8.2E+02	Toluene	108-88-3	4.9E+03	ns	4.7E+04	ns	5.2E+03	n	2.2E+04	n	1.1E+03	n	1.0E+03				6.9E-01
1.8E-01	X	1.1E-05	C	2.0E-04	X						1	0.1	Toluene-2,4-diisocyanate	584-84-9	6.4E+00	n	2.7E+01	n	8.3E-03	n	3.5E-02	n	1.7E-02	n					n
				1.1E-05	C						1	1.7E+03	Toluene-2,5-diamine	95-70-5	3.0E+00	c**	1.3E+01	c*					4.3E-01	c**					c**
				5.0E-03	P						1	0.1	Toluene-2,6-diisocyanate	91-08-7	5.3E+00	n	2.2E+01	n	8.3E-03	n	3.5E-02	n	1.7E-02	n					n
1.6E-02	P	5.1E-05	C	4.0E-03	X						1	0.1	Toluic Acid, p-	99-94-5	3.2E+02	n	4.1E+03	n					9.0E+01	n					n
3.0E-02	P			4.0E-03	X						1	0.1	Toluidine, o- (Methylaniline, 2-)	95-53-4	3.4E+01	c	1.4E+02	c	5.5E-02	c	2.4E-01	c	4.7E+00	c					c
											1	0.1	Toluidine, p-	106-49-0	1.8E+01	c*	7.7E+01	c*					2.5E+00	c*					c*
				3.0E+00	P						1	3.4E-01	Total Petroleum Hydrocarbons (Aliphatic High)	E1790670	2.3E+05	nms	3.5E+06	nms					6.0E+04	n					n
						6.0E-01	P	V			1	1.4E+02	Total Petroleum Hydrocarbons (Aliphatic Low)	E1790666	5.2E+02	ns	2.2E+03	ns	6.3E+02	n	2.6E+03	n	1.3E+03	n					n

Toxicity and Chemical-specific Information													Contaminant		Screening Levels							Protection of Ground Water SSLs					
SFO (mg/kg-day) ¹	key	IUR (ug/m ³ -day) ¹	key	RfD _o (mg/kg-day)	key	RfC ₁ (mg/m ³ -day)	key	muta- gen	GIABS	ABS	C _{sat} (mg/kg)	Analyte	CAS No.	Resident Soil (mg/kg)	key	Industrial Soil (mg/kg)	key	Resident Air (ug/m ³)	key	Industrial Air (ug/m ³)	key	Tapwater (ug/L)	key	MCL (ug/L)	Risk-based SSL (mg/kg)	key	MCL-based SSL (mg/kg)
7.0E-02	I			2.0E-02	I					1	0.1	Trichloroacetic Acid	76-03-9	7.8E+00	c	3.3E+01	c					1.1E+00	c	6.0E+01	2.2E-04	c	1.2E-02
2.9E-02	H									1	0.1	Trichloroaniline HCl, 2,4,6-	33663-50-2	1.9E+01	c	7.9E+01	c					2.7E+00	c		7.4E-03	c	
7.0E-03	X			3.0E-05	X					1	0.1	Trichloroaniline, 2,4,6-	634-93-5	1.9E+00	n	2.5E+01	n					4.0E-01	n		3.6E-03	n	
				8.0E-04	X					1		Trichlorobenzene, 1,2,3-	87-61-6	6.3E+01	n	9.3E+02	n					7.0E+00	n		2.1E-02	n	
2.9E-02	P			1.0E-02	I	2.0E-03	P	V		1	4.0E+02	Trichlorobenzene, 1,2,4-	120-82-1	2.4E+01	c**	1.1E+02	c**	2.1E+00	n	8.8E+00	n	1.2E+00	c**	7.0E+01	3.4E-03	c**	2.0E-01
				2.0E+00	I	5.0E+00	I	V		1	6.4E+02	Trichloroethane, 1,1,1-	71-55-6	8.1E+03	ns	3.6E+04	ns	5.2E+03	n	2.2E+04	n	8.0E+03	n	2.0E+02	2.8E+00	n	7.0E-02
5.7E-02	I	1.6E-05	I	4.0E-03	I	2.0E-04	X	V		1	2.2E+03	Trichloroethane, 1,1,2-	79-00-5	1.1E+00	c**	5.0E+00	c**	1.8E-01	c**	7.7E-01	c**	2.8E-01	c**	5.0E+00	8.9E-05	c**	1.6E-03
4.6E-02	I	4.1E-06	I	5.0E-04	I	2.0E-03	I	V	M	1	6.9E+02	Trichloroethylene	79-01-6	9.4E-01	c**	6.0E+00	c**	4.8E-01	c**	3.0E+00	c**	4.9E-01	c**	5.0E+00	1.8E-04	c**	1.8E-03
				3.0E-01	I			V		1	1.2E+03	Trichlorofluoromethane	75-69-4	2.3E+04	ns	3.5E+05	nms					5.2E+03	n		3.3E+00	n	
				1.0E-01	I			V		1	0.1	Trichlorophenol, 2,4,5-	95-95-4	6.3E+03	n	8.2E+04	n					1.2E+03	n		4.0E+00	n	
1.1E-02	I	3.1E-06	I	1.0E-03	P					1	0.1	Trichlorophenol, 2,4,6-	88-06-2	4.9E+01	c**	2.1E+02	c**	9.1E-01	c	4.0E+00	c	4.1E+00	c**		4.0E-03	c**	
				1.0E-02	I					1	0.1	Trichlorophenoxyacetic Acid, 2,4,5-	93-76-5	6.3E+02	n	8.2E+03	n					1.6E+02	n		6.8E-02	n	
				8.0E-03	I					1	0.1	Trichlorophenoxypropionic acid, -2,4,5	93-72-1	5.1E+02	n	6.6E+03	n					1.1E+02	n	5.0E+01	6.1E-02	n	2.8E-02
3.0E+01	I			5.0E-03	I			V		1	1.3E+03	Trichloropropane, 1,1,2-	598-77-6	3.9E+02	n	5.8E+03	ns					8.8E+01	n		3.5E-02	n	
				4.0E-03	I	3.0E-04	I	V	M	1	1.4E+03	Trichloropropane, 1,2,3-	96-18-4	5.1E-03	c	1.1E-01	c	3.1E-01	n	1.3E+00	n	7.5E-04	c		3.2E-07	c	
				3.0E-03	X	3.0E-04	P	V		1	3.1E+02	Trichloropropene, 1,2,3-	96-19-5	7.3E-01	n	3.1E+00	n	3.1E-01	n	1.3E+00	n	6.2E-01	n		3.1E-04	n	
				2.0E-02	A					1	0.1	Tricresyl Phosphate (TCP)	1330-78-5	1.3E+03	n	1.6E+04	n					1.6E+02	n		1.5E+01	n	
				3.0E-03	I			V		1	0.1	Tridiphenylamine	58138-08-2	1.9E+02	n	2.5E+03	n					1.8E+01	n		1.3E-01	n	
				7.0E-03	I	V				1	2.8E+04	Triethylene Glycol	121-44-8	1.2E+02	n	4.8E+02	n	7.3E+00	n	3.1E+01	n	1.5E+01	n		4.4E-03	n	
				2.0E+00	P					1	0.1	Trifluoroethane, 1,1,1-	112-27-6	1.3E+05	nm	1.6E+06	nm					4.0E+04	n		8.8E+00	n	
7.7E-03	I			7.5E-03	I			V		1	4.8E+03	Trifluoromethane, 1,1,1-	420-46-2	1.5E+04	ns	6.2E+04	ns	2.1E+04	n	8.8E+04	n	4.2E+04	n		1.3E+02	n	
				1.0E-02	P					1	0.1	Trifluralin	1582-09-8	9.0E+01	c**	4.2E+02	c*					2.6E+00	c*		8.4E-02	c*	
2.0E-02	P			1.0E-02	P					1	0.1	Trimethyl Phosphate	512-56-1	2.7E+01	c*	1.1E+02	c*					3.9E+00	c*		8.6E-04	c*	
				1.0E-02	I	6.0E-02	I	V		1	2.9E+02	Trimethylbenzene, 1,2,3-	526-73-8	3.4E+02	ns	2.0E+03	ns	6.3E+01	n	2.6E+02	n	5.5E+01	n		8.1E-02	n	
				1.0E-02	I	6.0E-02	I	V		1	2.2E+02	Trimethylbenzene, 1,2,4-	95-63-6	3.0E+02	ns	1.8E+03	ns	6.3E+01	n	2.6E+02	n	5.6E+01	n		8.1E-02	n	
				1.0E-02	I	6.0E-02	I	V		1	1.8E+02	Trimethylbenzene, 1,3,5-	108-67-8	2.7E+02	ns	1.5E+03	ns	6.3E+01	n	2.6E+02	n	6.0E+01	n		8.7E-02	n	
				1.0E-02	X			V		1	3.0E+01	Trimethylpentene, 2,4,4-	25167-70-8	7.8E+02	ns	1.2E+04	ns					6.5E+01	n		2.2E-01	n	
				3.0E-02	I					1	0.019	Trinitrobenzene, 1,3,5-	99-35-4	2.2E+03	n	3.2E+04	n					5.9E+02	n		2.1E+00	n	
3.0E-02	I			5.0E-04	I					1	0.032	Trinitrotoluene, 2,4,6-	118-96-7	2.1E+01	c**	9.6E+01	c**					2.5E+00	c**		1.5E-02	c**	
				2.0E-02	P					1	0.1	Triphenylphosphine Oxide	791-28-6	1.3E+03	n	1.6E+04	n					3.6E+02	n		1.5E+00	n	
				2.0E-02	A					1	0.1	Tris(1,3-Dichloro-2-propyl) Phosphate	13674-87-8	1.3E+03	n	1.6E+04	n					3.6E+02	n		8.0E+00	n	
2.3E+00	C	6.6E-04	C	1.0E-02	X					1	0.1	Tris(1-chloro-2-propyl)phosphate	13674-84-5	6.3E+02	n	8.2E+03	n					1.9E+02	n		6.5E-01	n	
2.0E-02	P			7.0E-03	P					1	0.1	Tris(2,3-dibromopropyl)phosphate	126-72-7	2.8E-01	c	1.3E+00	c	4.3E-03	c	1.9E-02	c	6.8E-03	c		1.3E-04	c	
				1.0E-02	P					1	0.1	Tris(2-chloroethyl)phosphate	115-96-8	2.7E+01	c*	1.1E+02	c*					3.8E+00	c*		3.8E-03	c*	
3.2E-03	P			1.0E-01	P					1	0.1	Tris(2-ethylhexyl)phosphate	78-42-2	1.7E+02	c*	7.2E+02	c					2.4E+01	c*		1.2E+02	c*	
				8.0E-04	P					1		Tungsten	7440-33-7	6.3E+01	n	9.3E+02	n					1.6E+01	n		2.4E+00	n	
				2.0E-04	A	4.0E-05	A			1		Uranium (Soluble Salts)	E715565	1.6E+01	n	2.3E+02	n	1.0E-01	n	4.4E-01	n	4.0E+00	n	3.0E+01	1.8E+00	n	1.4E+01
1.0E+00	C	2.9E-04	C	1.0E-03	I					1	0.1	Urethane	51-79-6	1.2E-01	c	2.3E+00	c	3.5E-03	c	4.2E-02	c	2.5E-02	c		5.6E-06	c	
		8.3E-03	P	9.0E-03	I	7.0E-06	P		0.026			Vanadium Pentoxide	1314-62-1	4.6E+02	c**	2.0E+03	c**	3.4E-04	c*	1.5E-03	c*	1.5E+02	n			n	
				5.0E-03	S	1.0E-04	A		0.026			Vanadium and Compounds	7440-62-2	3.9E+02	n	5.8E+03	n	1.0E-01	n	4.4E-01	n	8.6E+01	n		8.6E+01	n	
				1.2E-03	O					1	0.1	Vernolate	1929-77-7	7.8E+01	n	1.2E+03	n					1.1E+01	n		8.9E-03	n	
				1.0E+00	H	2.0E-01	I	V		1	2.8E+03	Vincolozolin	50471-44-8	7.6E+01	n	9.8E+02	n					2.1E+01	n		1.6E-02	n	
				3.2E-05	H					1	2.5E+03	Vinyl Acetate	108-05-4	9.1E+02	n	3.8E+03	ns	2.1E+02	n	8.8E+02	n	4.1E+02	n		8.7E-02	n	
7.2E-01	I	4.4E-06	I	3.0E-03	I	1.0E-01	I	V	M	1	3.9E+03	Vinyl Bromide	593-60-2	1.2E-01	c*	5.2E-01	c*	8.8E-02	c*	3.8E-01	c*	1.8E-01	c*		5.1E-05	c*	
				3.0E-04	I					1	0.1	Vinyl Chloride	75-01-4	5.9E-02	c	1.7E+00	c	1.7E-01	c	2.8E+00	c	1.9E-02	c	2.0E+00	6.5E-06	c	6.9E-04
				2.0E-01	S	1.0E-01	S	V		1	3.9E+02	Warfarin	81-81-2	1.9E+01	n	2.5E+02	n					5.6E+00	n		5.9E-03	n	
				2.0E-01	S	1.0E-01	S	V		1	3.9E+02	Xylene, p-	106-42-3	5.6E+02	ns	2.4E+03	ns	1.0E+02	n	4.4E+02	n	1.9E+02	n		1.9E-01	n	
				2.0E-01	S	1.0E-01	S	V		1	3.9E+02	Xylene, m-	108-38-3	5.5E+02	ns	2.4E+03	ns	1.0E+02	n	4.4E+02	n	1.9E+02	n		1.9E-01	n	
				2.0E-01	S	1.0E-01	S	V		1	4.3E+02	Xylene, o-	95-47-6	6.5E+02	ns	2.8E+03	ns	1.0E+02	n	4.4E+02	n	1.9E+02	n		1.9E-01	n	
				3.0E-01	I					1	2.6E+02	Xylenes	1330-20-7	5.8E+02	ns	2.5E+03	ns	1.0E+02	n	4.4E							

Toxicity Characteristic - Maximum Concentration of Contaminants
(Determine Levels using TCLP, Test Method 1311, EPA SW-846)
40CFR 261.24

USEPA Hazardous Waste Number	Constituent	CAS Number	Regulatory Level (mg/l)
D004	Arsenic	7440-38-2	5.0
D005	Barium	7440-39-3	100.0
D018 vol	Benzene	71-43-2	0.5
D006	Cadmium	7440-43-9	1.0
D019 vol	Carbon Tetrachloride	56-23-5	0.5
D020 pest	Chlordane	57-74-9	0.03
D021 vol	Chlorobenzene	108-90-7	100.0
D022 vol	Chloroform	67-66-3	6.0
D007	Chromium	7440-47-3	5.0
D023 semivol	o-Cresol	95-48-7	200.0*
D024 semivol	m-Cresol	108-39-4	200.0*
D025 semivol	p-Cresol	106-44-5	200.0*
D026 semivol	Cresol	-----	200.0*
D016 herbicide	2,4-D	94-75-7	10.0
D027 vol	1,4-Dichlorobenzene	106-46-7	7.5
D028 vol	1,2-Dichloroethane	107-06-2	0.5
D029 vol	1,1-Dichloroethylene	75-35-4	0.7
D030 semivol	2,4-Dinitrotoluene	121-14-2	0.13
D012 pest	Endrin	72-20-8	0.02
D031 pest	Heptachlor, and its epoxide	76-44-8	0.008
D032 semivol	Hexachlorobenzene	118-74-1	0.13
D033 semivol	Hexachloro-1,3-butadiene	87-68-3	0.5
D034 semivol	Hexachloroethane	67-72-1	3.0
D008	Lead	7439-92-1	5.0
D013 pest	Lindane	58-89-9	0.4
D009	Mercury	7439-97-6	0.2
D014 pest	Methoxychlor	72-43-5	10.0
D035 vol	Methyl Ethyl Ketone (MEK) (2-Butanone)	78-93-3	200.0
D036 semivol	Nitrobenzene	98-95-3	2.0
D037 semivol	Pentachlorophenol	87-86-5	100.0
D038 semivol	Pyridine	110-86-1	5.0
D010	Selenium	7782-49-2	1.0
D011	Silver	7440-22-4	5.0
D039 vol	Tetrachloroethylene	127-18-4	0.7
D015 pest	Toxaphene	8001-35-2	0.5
D040 vol	Trichloroethylene	79-01-6	0.5
D041 semivol	2,4,5-Trichlorophenol	95-95-4	400.
D042 semivol	2,4,6-Trichlorophenol	88-06-2	2.0
D017 herbicide	2,4,5-TP (Silvex)	93-72-1	1.0
D043 vol	Vinyl Chloride	75-01-4	0.2

* If the o-, m-, and/or p-Cresol concentrations cannot be differentiated, then the total cresol (D026) concentration (200 ppm) is used.

Compounds presented in **blue** are the RCRA eight priority metals

Vol – Volatile organic compound

Semivol – Semi volatile organic compound

Pest - Pesticide



COLORADO

Water Quality
Control Commission

Department of Public Health & Environment

DEPARTMENT OF PUBLIC HEALTH AND ENVIRONMENT

Water Quality Control Commission

REGULATION NO. 41 - THE BASIC STANDARDS FOR GROUND WATER

5 CCR 1002-41

ADOPTED: January 5, 1987
EFFECTIVE: March 2, 1987
AMENDED: August 7, 1989
EFFECTIVE: September 30, 1989
AMENDED: September 11, 1990
EFFECTIVE: October 30, 1990
AMENDED: October 8, 1991
EFFECTIVE: November 30, 1991
AMENDED: December 6, 1993
EFFECTIVE: January 31, 1994
AMENDED: February 8, 1994
EFFECTIVE: March 30, 1994
AMENDED: January 10, 1995
EFFECTIVE: March 2, 1995
AMENDED: March 13, 1996
EFFECTIVE: April 30, 1996
AMENDED: January 13, 1997
EFFECTIVE: March 3, 1997
AMENDED: July 14, 1997
EFFECTIVE: August 30, 1997
AMENDED: January 11, 1999
EFFECTIVE: March 2, 1999
TRIENNIAL REVIEW: October 10, 2000
AMENDED: November 13, 2001
EFFECTIVE: December 30, 2001
AMENDED: November 8, 2004
EFFECTIVE: March 22, 2005
AMENDED: January 14, 2008
EFFECTIVE: May 31, 2008
AMENDED: October 13, 2009
EFFECTIVE: November 30, 2009
AMENDED: September 11, 2012
EFFECTIVE: January 31, 2013
AMENDED: May 9, 2016
EFFECTIVE: June 30, 2016
AMENDED: November 14, 2016
EFFECTIVE: December 30, 2016



TABLE OF CONTENTS

41.1 AUTHORITY..... 1

41.2 PURPOSE..... 1

41.3 DEFINITIONS..... 1

41.4 CLASSIFICATION OF GROUND WATERS 2

41.5 GROUND WATER QUALITY STANDARDS 4

41.6 POINT OF COMPLIANCE 17

41.7 IMPLEMENTATION 20

41.8 SEVERABILITY..... 22

41.9 Reserved..... 24

41.10 Reserved..... 25

41.11 Reserved..... 25

41.12 STATEMENT OF BASIS AND PURPOSE 25

41.13 STATEMENT OF BASIS, SPECIFIC STATUTORY AUTHORITY AND PURPOSE(1989 REVISIONS) 34

41.14 STATEMENT OF BASIS, SPECIFIC STATUTORY AUTHORITY, AND PURPOSE (1990 REVISIONS) 41

41.15 STATEMENT OF BASIS, SPECIFIC STATUTORY AUTHORITY, AND PURPOSE (1991 REVISIONS) 45

41.16 STATEMENT OF BASIS, SPECIFIC STATUTORY AUTHORITY, AND PURPOSE (1993 REVISIONS-DIMP STANDARD) 47

41.17 STATEMENT OF BASIS, SPECIFIC STATUTORY AUTHORITY, AND PURPOSE (1993 REVISIONS) 55

41.18 STATEMENT OF BASIS, SPECIFIC STATUTORY AUTHORITY, AND PURPOSE (1994 REVISIONS) 57

41.19 STATEMENT OF BASIS, SPECIFIC STATUTORY AUTHORITY, AND PURPOSE (1996 REVISIONS) 58

41.20 STATEMENT OF BASIS, SPECIFIC STATUTORY AUTHORITY, AND PURPOSE (1996 REVISIONS) 58

41.21 STATEMENT OF BASIS, SPECIFIC STATUTORY AUTHORITY AND PURPOSE; JULY, 1997 RULEMAKING 60

41.22	STATEMENT OF BASIS, SPECIFIC STATUTORY AUTHORITY AND PURPOSE; JANUARY, 1999 RULEMAKING	60
41.23	STATEMENT OF BASIS, SPECIFIC STATUTORY AUTHORITY, AND PURPOSE (2001 REVISIONS)	60
41.24	STATEMENT OF BASIS, SPECIFIC STATUTORY AUTHORITY AND PURPOSE; SEPTEMBER 2004 RULEMAKING	61
41.25	STATEMENT OF BASIS, SPECIFIC STATUTORY AUTHORITY AND PURPOSE; DECEMBER 10, 2007 RULEMAKING; EFFECTIVE MAY 31, 2008	66
41.26	STATEMENT OF BASIS, SPECIFIC STATUTORY AUTHORITY AND PURPOSE; OCTOBER 13, 2009 RULEMAKING; EFFECTIVE NOVEMBER 30, 2009.....	68
41.27	STATEMENT OF BASIS, SPECIFIC STATUTORY AUTHORITY AND PURPOSE; AUGUST 13, 2012 RULEMAKING; FINAL ACTION SEPTEMBER 11, 2012; EFFECTIVE JANUARY 31, 2013.....	68
41.28	STATEMENT OF BASIS, SPECIFIC STATUTORY AUTHORITY AND PURPOSE; APRIL 11, 2016 RULEMAKING; FINAL ACTION MAY 9, 2016; EFFECTIVE DATE JUNE 30, 2016	70
41.29	STATEMENT OF BASIS, SPECIFIC STATUTORY AUTHORITY AND PURPOSE: AUGUST 8, 2016 RULEMAKING; FINAL ACTION OCTOBER 11, 2016; EFFECTIVE DATE NOVEMBER 30, 2016.	71

DEPARTMENT OF PUBLIC HEALTH AND ENVIRONMENT

Water Quality Control Commission

REGULATION NO. 41 - THE BASIC STANDARDS FOR GROUND WATER

5 CCR 1002-41

41.1 AUTHORITY

These regulations are promulgated pursuant to the Colorado Water Quality Control Act, sections 25-8-101 through 25-8-703 C.R.S., (1982 and 1985 Supp.). In particular, they are promulgated under the following sections 25-8-202, 25-8-203, and 25-8-204.

41.2 PURPOSE

The purpose of these regulations is to establish statewide standards and a system for classifying ground water and adopting water quality standards for such classifications to protect existing and potential beneficial uses of ground waters.

41.3 DEFINITIONS

The following definitions are applicable to these regulations.

1. "Activity" is any operation that may discharge or cause a discharge of pollutants to ground waters including but not limited to, point source discharges, pits, ponds, and lagoons used for storage, treatment and/or disposal of pollutants, land application of wastewater, and non-point source discharges. Activity shall not include related operations, no matter how closely integrated physically or legally.
2. "Agricultural Uses" are the existing or potential future uses of ground water for the cultivation of soil, the production of crops, and/or the raising of livestock.
3. "Background Level" is the level of any parameter in the ground water within a specified area as determined by representative measurements of the ground water quality unaffected by the activity.
4. "Contamination" is that condition where the concentration level of a pollutant exceeds naturally occurring background levels.
5. "Domestic Uses" are those existing or potential future uses of ground water for household or family use, including, but not limited to: drinking, gardening, municipal, and/or farmstead uses.
6. "Existing Activity" means any activity whose plans and specifications have been approved by the Division, or which has commenced or completed construction, prior to the effective date of the 1990 amendments to this regulation.
7. "Ground Water" are subsurface waters in a zone of saturation which are or can be brought to the surface of the ground or to surface waters through wells, springs, seeps or other discharge areas.
8. "New Activity" means any activity that does not qualify as an existing activity.

9. "Parameter" is the physical, chemical, biological, or radiological constituent or characteristic of the ground water such as; temperature, pH, and ground water level.
10. "Point Of Compliance" means a vertical surface that is located at some specified distance hydrologically downgradient of the activity being monitored for compliance; provided that the Commission may establish a point of compliance other than a vertical surface on a site-specific basis pursuant to section 41.6 (E).
11. "Site Boundary" means the outermost perimeter of the property or lease boundary of a facility for which the owner and/or operator has control.
12. "Specified Area" is that area within which the ground water is classified.
13. "Standard" is a narrative and/or numeric restriction established by these regulations and applied to ground waters to protect one or more existing or potential future uses.
14. "TDS" is the total dissolved solids in water.

41.4 CLASSIFICATION OF GROUND WATERS

A. Ground Water Classifications

The Commission hereby establishes the following classifications for ground water:

1. Domestic Use - Quality
2. Agricultural Use - Quality
3. Surface Water Quality Protection
4. Potentially Usable Quality
5. Limited Use and Quality

B. Criteria Used to Identify Classifications for Ground Water

The ground water classifications shall be implemented and applied to ground waters within a specified area (as determined in accordance with section 41.4(c) based upon use, quality and other information demonstrating the following:

1. Ground water within a specified area shall be classified "Domestic Use - Quality" when:
 - a. Ground water is used for domestic use within the specified area; or
 - b. If ground water is not currently used for domestic use within the specified area, the available information, including information regarding background levels, demonstrates that future domestic use of water within the specified area is reasonably probable; or
 - c. The most recent State Engineer's well records or applicable water court decrees reveal that ground water is permitted or decreed for domestic use within the specified area, unless other information demonstrates that domestic use is not being made of the ground water and is not likely to be made; or

- d. The background levels are generally adequate to assure compliance with the Human Health Standards listed in Table 1 and TDS levels are less than 10,000 mg/l.

The determination of whether or not background levels are generally adequate shall be made considering the number of parameters that meet or exceed table Values, the extent of any exceedances of table Values, the risk to the public health associated with any such exceedance, and the adequacy of the database available for such determinations.

2. Ground water within a specified area shall be classified "Agricultural Use - Quality" when:

- a. Ground water is used for agricultural use within the specified area; or
- b. If ground water is not used for agricultural use within the specified area, the available information, including information regarding background levels, demonstrates that future agricultural use of water within the specified area is reasonably probable; or
- c. The most recent State Engineer's well records or applicable water court decrees reveal that ground water is permitted or decreed for agricultural use within the specified area, unless other information demonstrates that agricultural use is not being made of the ground water and is not likely to be made; or
- d. The background levels are generally adequate to assure compliance with the Agricultural Standards listed in Table 3 and TDS levels are less than 10,000 mg/l.

The determination of whether or not background levels are generally adequate shall be made considering the number of parameters that meet or exceed table values, the extent of any exceedances of table values, the risk to crops and/or livestock associated with any such exceedance, and the adequacy of the database available for such determinations.

3. Ground water within a specified area shall be classified "Surface Water Quality Protection" when:

A proposed or existing activity does or will impact ground waters such that water quality standards of classified surface water bodies within the specified area will be exceeded.

4. Ground water within a specified area shall be classified "Potentially Usable Quality" when:

- a. TDS levels are less than 10,000 mg/l; and
- b. Ground water is not used for domestic or agricultural uses within the specified area; and
- c. Background levels are generally not adequate to assure compliance with the Human Health and Agricultural Standards listed in Tables 1 and 3, or the information is insufficient to make such a determination; and
- d. Domestic or agricultural use of the ground water can be reasonably expected in the future, considering background levels of water quality; geologic and hydrologic conditions; the degree to which any particular types of pollutants present are subject to treatment; the economic reasonableness of such treatment; the impact of treatment requirements on water quantity; whether or not pollution arises from natural sources; and other relevant factors.

5. Ground water within a specified area shall be classified "Limited Use and Quality" when:

- a. TDS levels are equal to or in excess of 10,000 mg/l; or

- b. The ground water has been exempted under Rule 324(B) of the “Rules and Regulations, Rules of Practice and Procedure” (2 CCR 404-1) of the Oil and Gas Conservation Commission, pursuant to the Colorado Oil and Gas Conservation Act, Title 60, Article 34, C.R.S. (1982); or
- c. The criteria specified in sections 41.4(B)1, 2, 3, or 4 are not met.

C. Specified Area

1. When an activity exists or is proposed, the shape, depth, boundaries, and extent of a specified area shall be determined by considering:
 - a. the presence, extent, and nature of existing uses of ground water that may be affected by the activity, and the nature of reasonably expected future uses of ground water that may be affected by the activity; and
 - b. the nature and location of the activity and of its discharge; and
 - c. existing ground water quality that may be affected by the activity; and
 - d. relevant geologic and hydrogeologic conditions, including but not limited to the presence of ground water hydrologically connected to surface waters and recharge areas.
2. In the absence of an existing or proposed activity, the shape, depth, boundaries, and extent of a specified area may be determined by considering:
 - a. the presence, extent, and nature of existing uses of ground water and the nature of reasonably expected future uses of ground water; and
 - b. existing ground water quality; and
 - c. relevant geologic and hydrogeologic conditions, including but not limited to the presence of ground water hydrologically connected to surface waters and recharge areas.

41.5 GROUND WATER QUALITY STANDARDS

The water quality standards specified in subsection B below are deemed necessary and appropriate to protect ground water uses as specified in section 41.4, and shall be adopted to protect such classified uses. The standards specified in subsections A and C apply to all State ground waters, unless alternative site-specific standards have been adopted for a specified area pursuant to subsection D below.

A. Narrative Standards

1. Ground Water shall be free from pollutants not listed in the tables referred to in section 41.5(B), which alone or in combination with other substances, are in concentrations shown to be:
 - a. Carcinogenic, mutagenic, teratogenic, or toxic to human beings, and/or,
 - b. A danger to the public health, safety, or welfare.
2. Determinations made pursuant to section 41.7 of specific numerical limitations under this subsection shall be based upon the best scientific information currently available.

B. Numeric Standards

1. The numeric standards shall be measured as total concentrations unless otherwise specified in Tables 1 through 4.
2. When a ground water has a multi-use classification, the most restrictive standard for a parameter shall apply.
3. The following numeric standards shall apply:
 - a. "Domestic Use-Quality" - The Human Health and Secondary Drinking Water Standards listed in Tables 1 and 2, respectively, except as specified in section 41.5(B)5 or 41.5(B)6.
 - b. "Agricultural Use - Quality" - The Agricultural Standards listed in Table 3, except as specified in section 41.5(B)5.
 - c. "Surface Water Quality Protection" - The standards necessary to prevent the exceedance of surface waters standards.
 - d. "Potentially Usable Quality" - appropriate standards considering those factors listed in section 41.4(B)4(d).
4. The TDS limitation listed in Table 4 shall apply to the following classes:

"Agricultural Use - Quality"

"Surface Water Quality Protection"

"Potentially Usable Quality"
5. For ground water classified "Domestic Use - Quality" or "Agricultural Use - Quality," where a table value is exceeded by the background level, the applicable standard for that parameter shall be either 1) the table value or 2) the background level for that parameter. This determination shall be made considering the increased risk to public health, crops, or livestock associated with the background levels, the extent of the exceedance above the table value, the degree to which the pollution is deemed correctable and subject to treatment; and the economic reasonableness of such treatment requirements.
6. The Commission may adopt site-specific standards in lieu of those listed in Tables 1, 2, 3 and 4 taking into account the factors prescribed in Section 25-8-204(4), C.R.S. and section 41.4. The downgrading factors described in Regulation No. 31, section 6(2)(B) of the Basic Standards and Methodology for Surface Water shall not apply to the establishment of site-specific standards under this subsection.

C. Statewide Standards

1. Radioactive materials and Organic pollutants in ground waters shall not exceed the following levels, unless alternative, site-specific standards for these substances have been adopted by the Commission:
 - a. For radioactive materials and organic pollutants listed in subsections 2 and 3 below, levels shall not exceed those specified in those subsections.

- b. For all other radioactive materials and organic pollutants, they shall be maintained at the lowest practical level.
- c. Where site-specific standards have been adopted, they shall apply in lieu of the standards set forth in this subsection.

2. Radioactive Materials Standards:

Radioactive Materials Standards¹

Parameter	Standard
Americium ²	0.15
Cesium 134	80
Plutonium 239 ² , and 240 ²	0.15
Radium 226 ² and 228 ²	5
Strontium 90 ²	8
Thorium 230 ² and 232 ²	60
Tritium	20,000

pCi/l = Picocuries Per Liter

¹ In site-specific cases, when it has been demonstrated that there are negligible differences between the results of dissolved (filtered) samples and total (unfiltered) samples, then dissolved results may be utilized for implementing the radioactive material standards.

² Radionuclide samples for these materials should be analyzed using unfiltered (total) samples.

3. Interim Organic Pollutant Standards:

Note that all standards in table A are being adopted as "interim standards." These interim standards will remain in effect until alternative permanent standards are adopted by the Commission in revisions to this regulation or site-specific standards determinations. Although fully effective with respect to current regulatory applications, these interim standards shall not be considered final or permanent standards subject to restrictions such as antibacksliding or downgrading.

TABLE A		
GROUND WATER ORGANIC CHEMICAL STANDARDS		
(in micrograms per liter)		
Parameter	CAS No.	STANDARD¹
Acenaphthene	83-32-9	420
Acetochlor	34256-82-1	140
Acetone	67-64-1	6300
Acrolein	107-02-8	3.5
Acrylamide ^{C,8}	79-06-1	0.022
Acrylonitrile ^C	107-13-1	0.065
Alachlor	15972-60-8	2.0 ^M
Aldicarb	116-06-3	7.0 ^M
Aldicarb Sulfone	1646-88-4	7.0 ^M
Aldicarb Sulfoxide	1646-87-3	7.0 ^M
Aldrin ^C	309-00-2	0.0021
Aniline ^C	62-53-3	6.1
Anthracene (PAH)	120-12-7	2100
Aramite ^C	140-57-8	1.4
Atrazine	1912-24-9	3.0 ^M
Azobenzene ^C	103-33-3	0.32
Benzene ^{C,2}	71-43-2	5.0 ^M
Benzidine ^C	92-87-5	0.00015
Benzo(a)anthracene (PAH) ^C	56-55-3	0.0048
Benzo(a)pyrene (PAH) ^{C,6}	50-32-8	0.0048 to 0.2 ^M
Benzo(b)fluoranthene (PAH) ^C	205-99-2	0.0048

TABLE A		
GROUND WATER ORGANIC CHEMICAL STANDARDS		
(in micrograms per liter)		
Parameter	CAS No.	STANDARD¹
Benzo(k)fluoranthene (PAH) ^C	207-08-9	0.0048
Benzotrichloride ^C	98-07-7	0.0027
Benzyl chloride ^C	100-44-7	0.21
Bis(chloromethyl)ether (BCME) ^C	542-88-1	0.00016
Biphenyl	92-52-4	4.4
Bromate ^C	15541-45-4	0.05
Bromobenzene	108-86-1	56
Bromodichloromethane (THM) ^{C, 7}	75-27-4	0.56
Bromoform (THM) ^{C, 7}	75-25-2	4
Butyl benzyl phthalate	85-68-7	1,400
Carbofuran ⁶	1563-66-2	35 to 40 ^M
Carbon tetrachloride ^{C, 6}	56-23-5	0.5 to 5 ^M
Chlordane ^{C, 6}	57-74-9	0.10 to 2 ^M
Chlordecone ^C	143-50-0	.0035
Chlorethyl ether (BIS-2) ^C	111-44-4	0.032
4-Chloro-3-methylphenol	59-50-7	210
Chlorobenzene	108-90-7	100 ^M
Chloroform (THM) ^{C, 7}	67-66-3	3.5
Chloroisopropyl ether (BIS-2)	108-60-1	280
Chloronaphthalene	91-58-7	560
Chlorophenol, 2-	95-57-8	35
Chlorphrifos	2921-88-2	21

TABLE A		
GROUND WATER ORGANIC CHEMICAL STANDARDS		
(in micrograms per liter)		
Parameter	CAS No.	STANDARD¹
Chrysene (PAH) ^C	218-01-9	0.0048
Dalapon	75-99-0	200 ^M
DDD ^C	72-54-8	0.15
DDE ^C	72-55-9	0.1
DDT ^C	50-29-3	0.1
Di(2-ethylhexyl)adipate	103-23-1	400 ^M
Dibenzo(a,h)anthracene (PAH) ^C	53-70-3	0.0048
1,2-Dibromo-3-Chloropropane (DBCP)	96-12-8	0.2 ^M
Dibromochloromethane (THM) ^{3, 7}	124-48-1	14
Dibromoethane 1,2 ^C	106-93-4	0.018
Dicamba	1918-00-9	210
Dichloroacetic acid ^C	79-43-6	0.7
Dichlorobenzene 1,2	95-50-1	600 ^M
Dichlorobenzene 1,3	541-73-1	94
Dichlorobenzene 1,4	106-46-7	75 ^M
Dichloroethane 1,2 ^{C, 6}	107-06-2	0.38 to 5 ^M
Dichloroethylene 1,1	75-35-4	7 ^M
Dichloroethylene 1,2-cis ⁶	156-59-2	14 to 70 ^M
Dichloroethylene 1,2-trans ⁶	156-60-5	140 or 100 ^M
Dichloromethane (methylene chloride) ^{C, 6, 8}	75-09-2	5.6 or 5 ^M
Dichlorophenol 2,4	120-83-2	21
Dichlorophenoxyacetic acid (2,4-D)	94-75-7	70 ^M

TABLE A GROUND WATER ORGANIC CHEMICAL STANDARDS (in micrograms per liter)		
Parameter	CAS No.	STANDARD¹
Dichloropropane 1,2 ^{C, 6}	78-87-5	0.52 to 5 ^M
Dichlorvos ^C	62-73-7	0.12
Diclorobenzidine ^C	91-94-1	0.078
Dieldrin ^C	60-57-1	0.002
Diethyl phthalate	84-66-2	5,600
Diisopropylmethylphosphonate (DIMP) ⁴	1445-75-6	8
Dimethylphenol 2,4	105-67-9	140
Di-n-butyl phthalate	84-74-2	700
Dinitro-o-cresol 4,6	534-52-1	0.27
Dinitrophenol 2,4	51-28-5	14
Dinitrotoluene 2,4 ^C	121-14-2	0.11
Dinoseb	88-85-7	7 ^M
Dioxane 1,4- ^C	123-91-1	0.35
Dioxin (2,3,7,8 TCDD) ^{C, 6}	1746-01-6	2.2x10 ⁻⁷ to 3.0x10 ^{-5, M}
Diphenylhydrazine 1,2 ^C	122-66-7	0.044
Diquat ⁶	85-00-7	15 to 20 ^M
Endosulfan	115-29-7	42
Endosulfan sulfate	1031-07-8	42
Endosulfan, alpha	959-98-8	42
Endosulfan, beta	33213-65-9	42
Endothall	145-73-3	100 ^M
Endrin	72-20-8	2 ^M

TABLE A		
GROUND WATER ORGANIC CHEMICAL STANDARDS		
(in micrograms per liter)		
Parameter	CAS No.	STANDARD¹
Endrin aldehyde	7421-93-4	2.1
Epichlorohydrin ^C	106-89-8	3.5
Ethylbenzene	100-41-4	700 ^M
Ethylene Dibromide ^{C, 6} (1,2-dibromoethane)	106-93-4	0.02 to 0.05 ^M
Ethylene glycol monobutyl ether (EGBE) (2-Butoxyethanol)	111-76-2	700
Ethylhexyl phthalate (BIS-2) ^{C, 6} (DEHP)	117-81-7	2.5 to 6 ^M
Fluoranthene (PAH)	206-44-0	280
Fluorene (PAH)	86-73-7	280
Folpet ^C	133-07-3	10
Furmecyclo ^C	60568-05-0	1.2
Glyphosate	1071-83-6	700 ^M
Heptachlor ^{C, 6}	76-44-8	0.008 to 0.4 ^M
Heptachlor epoxide ^{C, 6}	1024-57-3	0.004 to 0.2 ^M
Hexachlorobenzene ^{C, 6}	118-74-1	0.022 to 1.0 ^M
Hexachlorobutadiene	87-68-3	0.45
Hexachlorocyclohexane, Alpha ^C	319-84-6	0.0056
Hexachlorocyclohexane, Gamma (Lindane)	58-89-9	0.2 ^M
Hexachlorocyclopentadiene ⁶ 50 ^M	77-47-4	42 to 50 ^M
Hexachlorodibenzo-p-dioxin (1,2,3,7,8,9- hccd) ^C	19408-74-3	5.60E-06
Hexachloroethane ^C	67-72-1	0.88
Hexanone 2	591-78-6	35

TABLE A		
GROUND WATER ORGANIC CHEMICAL STANDARDS		
(in micrograms per liter)		
Parameter	CAS No.	STANDARD¹
Hydrazine/Hydrazine sulfate ^C	302-01-2	0.012
Indeno (1,2,3-cd) pyrene (PAH) ^C	193-39-5	0.0048
Isophorone ³	78-59-1	140
Malathion	121-75-5	140
Methanol	67-56-1	14,000
Methoxychlor ⁶	72-43-5	35 to 40 ^M
Methylene bis(N,N'-dimethyl)aniline 4,4' ^C	101-61-1	0.76
Metribuzin	21087-64-9	180
Mirex	2385-85-5	1.4
Naphthalene (PAH)	91-20-3	140
Nitrobenzene	98-95-3	14
Nitrophenol 4	100-02-7	56
Nitrosodimethylamine N ^C (NDMA)	62-75-9	0.00069
Nitrosodiphenylamine N ^C	86-30-6	7.1
N-Nitrosodiethanolamine ^C	1116-54-7	0.013
N-Nitrosodi-n-propylamine ^C	621-64-7	0.005
N-Nitroso-N-Methylethylamine ^C	10595-95-6	0.0016
Oxamyl (vydate) ⁶	23135-22-0	175 to 200 ^M
PCBs ^{C, 5, 6}	1336-36-3	0.0175 to 0.5 ^M
Pentachlorobenzene	608-93-5	5.6
Pentachlorophenol ^{C, 6}	87-86-5	0.088 to 1.0 ^M
Perchlorate	7790-98-9	4.9

TABLE A		
GROUND WATER ORGANIC CHEMICAL STANDARDS		
(in micrograms per liter)		
Parameter	CAS No.	STANDARD¹
Phenol	108-95-2	2,100
Picloram	1918-02-1	490
Prometon	1610-18-0	100
Propylene oxide ^C	75-56-9	0.15
Pyrene (PAH)	129-00-0	210
Quinoline ^C	91-22-5	0.012
Simazine	122-34-9	4 ^M
Styrene	100-42-5	100 ^M
Tetrachlorobenzene 1,2,4,5	95-94-3	2.1
Tetrachloroethane 1,1,2,2	79-34-5	0.18
Tetrachloroethylene (PCE) ⁶	127-18-4	17 or 5 ^M
Tetrahydrofuran	109-99-9	6,300
Toluene ⁶	108-88-3	560 to 1,000 ^M
Total Trihalomethanes (TTHMs) ⁷	N/A	80 ^M
Toxaphene ^{C, 6}	8001-35-2	0.032 to 3 ^M
Trichlorobenzene 1,2,4	120-82-1	70 ^M
Trichloroacetic acid ^C	76-03-9	0.52
Trichloroethane 1,1,1 (1,1,1-TCA) ⁶	71-55-6	14,000 or 200 ^M
Trichloroethane 1,1,2 ^{3, 6} (1,1,2-TCA)	79-00-5	2.8 to 5 ^M
Trichloroethylene (TCE)	79-01-6	5 ^M
Trichloropropane 1,2,3 ^{C, 8}	96-18-4	3.7E-4

TABLE A		
GROUND WATER ORGANIC CHEMICAL STANDARDS		
(in micrograms per liter)		
Parameter	CAS No.	STANDARD¹
Trichlorophenol 2,4,5	95-95-4	700
Trichlorophenol 2,4,6 ^C	88-06-2	3.2
Trichlorophenoxypropionic acid (2,4,5-tp) (Silvex)	93-72-1	50 ^M
Vinyl Chloride ^{C, 6}	75-01-4	0.023 to 2 ^M
Xylenes (total) ⁶	1330-20-7	1,400 to 10,000 ^M

Notes and Abbreviations:

¹ All standards are chronic or 30-day standards. They are based on information contained in EPA's Integrated Risk Information System (IRIS) and/or EPA lifetime health advisories for drinking water using a 10⁻⁶ incremental risk factor unless otherwise noted.

² The standard for Benzene has been established at the MCL (q.v. 41.17)

³ Standards for Group C compounds that have both published toxicity and carcinogenic risk data are calculated based on toxicity data and then adjusted downward using an uncertainty factor of 10.

⁴ The Diisopropylmethylphosphonate (DIMP) standard was adopted in 1993 (q.v. 41.16)

⁵ PCBs are a class of chemicals that include aroclors, 1242, 1254, 1221, 1232, 1248, 1260, and 1016, CAS numbers 53469-21-9, 11097-69-1, 11104-28-2, 11141-16-5, 12672-29-6, 11096-82-5, and 12674-11-2 respectively. The human-health criteria apply to total PCBs, i.e. the sum of all congener or all isomer analyses.

⁶ Whenever a range of standards is listed and referenced to this footnote, the first number in the range is a strictly health-based value, based on the Commission's established methodology for human health-based standards. The second number in the range is a maximum contaminant level, established under the federal Safe Drinking Water Act has been determined to be an acceptable level of this chemical in public water supplies, taking treatability and laboratory detection limits into account. The Commission intends that control requirements for this chemical be implemented to attain a level of ambient water quality that is at least equal to the first number in the range except as follows:

- Wherever the Commission has adopted alternative, site-specific standards for the chemical, the site-specific standards shall apply instead of these statewide standards.
- The implementing agency has determined that setting the protection level to the second number in the range is consistent with the current and reasonably anticipated future uses of the groundwater, factoring in site-specific information, such as: existing prohibitions on groundwater use; whether the location is within the boundaries of an existing or reasonably anticipated public water supply; the proximity of the site to existing and reasonably anticipated water wells; whether or not the aquifer can produce water at a rate capable of supporting the anticipated use; or it can be demonstrated that access to groundwater is prohibited, unavailable or present at insufficient quantities for reliable use.

The Commission does not intend the adoption of this range of standards to result in changes to clean-up requirements previously established by an implementing agency, unless such change is mandated by the implementing agency pursuant to its independent statutory authority.

⁷ For aquifer storage and recovery facilities, if the source of this chemical in ground water is potable water provided by a drinking water system with a Colorado PWSID that meets all applicable federal Safe Drinking Water Act and corresponding State requirements at the time that it is utilized for aquifer storage and recovery or artificial recharge, then the separate total trihalomethane standard will apply to the ground water in question, rather than the individual standards for bromodichloromethane, bromoform, chloroform, and/or dibromochloromethane. For any parameter for which there is a Maximum Containment Level (MCL) established by the Safe Drinking Water Act, as identified in Table A with Footnote "M", the MCL shall apply as the standard for groundwater when potable water is used for ASR or artificial recharge.

⁸ Mutagenic compound, age dependent factors were used in calculating standard.

N/A – not applicable

^c Carcinogens classified by the EPA as A, B1, or B2.

^M Drinking water MCL.

CAS No. - Chemical Abstracts Service Registry Number

THM - Halomethanes

4. Whenever the practical quantitation limit, or PQL, for a pollutant is higher (less stringent) than a standard listed in subsection 2 or 3 above, the PQL shall be used in regulating specific activities. PQL's may be established by the applicable implementing agency or in consultation with the Water Quality Control Division.
5. Nothing in this regulation shall be interpreted to preclude:
 - a. An agency responsible for implementation of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), 42 U.S.C. 9601, et seq., as amended, from selecting a remedial action and a point of compliance that are more or less stringent than would be achieved by compliance with the statewide numerical standards established in this subsection, or alternative site-specific standards adopted by the Commission, where a determination is made that such a variation is authorized pursuant to the applicable provisions of CERCLA; or
 - b. An agency responsible for implementation of Subtitle C of the Resource Conservation and Recovery Act (RCRA), 42 U.S.C. 6901, et seq., as amended, or the Colorado Hazardous Waste Act, C.R.S. 25-15-101, et seq., as amended, from applying background levels or establishing "alternate concentration limits" and a point of compliance that differ from the statewide numerical standards established in this subsection, or alternative site-specific standards adopted by the Commission, for purposes of establishing hazardous waste management or corrective action requirements, where a determination is made that such background levels or alternate concentration limits are authorized by the regulations adopted pursuant to these statutory authorities; or
 - c. An agency responsible for implementation of a storage tank (ST) program, pursuant to C.R.S. 25-18-101 et seq., as amended, from issuing a regulatory determination, including a point of compliance, that is more or less stringent than would be achieved by compliance with the statewide numerical standards established in this subsection, or alternative site-specific standards adopted by the Commission, where a determination is made that the ground water quality protection criteria identified in applicable ST regulations are satisfied.
6. Interim Narrative Standard
 - a. The "Interim Narrative Standard" in 41.5(C)(6)(b)(i) below is applicable to all ground water, to which standards have not already been assigned in the state, with the exception of those areas where the total dissolved solids (TDS) are equal to or exceed 10,000 mg/l. This standard is applicable independent of and in addition to the statewide standards for radioactive materials and organic pollutants established in this section 41.5.C.
 - b.
 - i. Until such time as use classifications and numerical standards are adopted for the ground water on a site-specific basis throughout the state, and subject to the provisions of subsection (ii) below, ground-water quality shall be maintained for each parameter at whichever of the following levels is less restrictive:
 - (A) existing ambient quality as of January 31, 1994, or

- (B) that quality which meets the most stringent criteria set forth in Tables 1 through 4 of "The Basic Standards for Ground Water."
- ii. The interim standard shall not be interpreted or applied as defining or limiting the potential need for remediation of contaminated ground water where remedial requirements are established under state or federal law. It is the Commission's intent that, to the maximum degree technically feasible and economically reasonable, remedial efforts should be directed at cleaning up ground water contaminated by human activities to a degree such that it is usable for all existing and potential beneficial uses; this interim narrative standard is not intended to define when such remediation is or is not feasible. Where contamination already exists, this interim standard is merely intended to assure that conditions are not allowed to deteriorate further pending remedial action. The appropriate level of clean-up to be achieved may be addressed by this Commission in a future classification and standard-setting proceeding, or by other agencies with jurisdiction over remedial actions.
- iii. In applying this interim narrative standard, the Commission intends that agencies with authority to implement this standard will exercise their best professional judgment as to what constitutes adequate information to determine or estimate existing ambient quality, taking into account the location, sampling date, and quality of all available data. Data generated subsequent to January 31, 1994, shall be presumed to be representative of existing quality as of January 31, 1994, if the available information indicates that there have been no new or increased sources of ground water contamination initiated in the area in question subsequent to that date. If available information is not adequate to otherwise determine or estimate existing ambient quality as of January 31, 1994, such ground water quality for each parameter shall be assumed to be no worse than the most stringent levels provided for in Tables 1 through 4 of "The Basic Standards for Ground Water," unless the Commission has adopted alternative numerical standards for a given specified area.

D. Site-specific radioactive materials and organic pollutant standards

1. In determining whether to adopt site-specific standards to apply in lieu of the statewide standards established in subsection C above, the Commission shall first determine the appropriate ground water classifications within a specified area, in accordance with section 41.4.
2. The Commission shall then determine whether numerical standards other than some or all of the statewide standards established in subsection C above would be more appropriate for protection of the classified uses, taking into account the factors prescribed in section 25-8-204(4), C.R.S. and section 41.4. The downgrading factors described in Regulation No. 31, section 6(2)(B) of the Basic Standards and Methodologies for Surface Water shall not apply to the establishment of site-specific standards under this subsection.

41.6 POINT OF COMPLIANCE

A. In order to effect compliance with ground water standards, one or more points of compliance shall be established. The term "point of compliance" shall be assumed to cover situations with one or several points of compliance. An activity shall comply with ground water quality standards established under section 41.5 at the point of compliance. The establishment of a point of compliance shall not be required at the time of classification of any ground water pursuant to section 41.4. The point of compliance for those activities regulated by an implementing agency is discussed in subsection B of this section. Unless modified by the applicable implementing agency or the Commission, the criteria for establishing a point of compliance for the statewide standards established in section 41.5(C)(2) and (3) are set forth in subsection (C) of this section. For those activities regulated by the Water Quality Control Division through permit or control regulations, the point of compliance shall be established under the provisions of subsection (D) of this section. Nothing in this regulation shall lessen the Division's existing authority to consider these ground water standards when setting limits for surface water discharges which impact ground water. The Commission may establish points of compliance in lieu of those established by the Division or this rule, on a case-by-case basis as described in subsection (E).

B. For the purposes of this subsection, the following agencies are referred to as "implementing agencies":

The Division of Reclamation, Mining and Safety; the State Engineer; the Oil and Gas Conservation Commission; and the state agencies responsible for activities related to the federal "Resource Conservation and Recovery Act of 1976", as amended, and related state programs.

Per the provisions of section 25-8-202 C.R.S., implementing agencies shall establish the point of compliance for those activities under their control. The points of compliance established in section 41.6 (C) and (D) of this regulation shall not apply to activities regulated by an implementing agency, unless the Commission has determined after rulemaking that the point of compliance established by the implementing agency is not adequate to satisfy the requirements of section 25-8-202(7). The Commission may then establish, through rulemaking, a site-specific point of compliance which shall supersede any point of compliance established by the implementing agencies.

C. In the absence of a point of compliance established by the Division, and unless modified by the Commission in accordance with section 41.6 (E) or subject to alternative regulatory requirements in accordance with section 41.5 (C)(5), the point of compliance for the statewide standards established in section 41.5 (C)(2) and (3) shall be located as follows.

1. For facilities at which ground water contamination existed as of September 30, 1989:

a. If the contamination is identified and reported to the division or other appropriate implementing agency on or before September 30, 1992, then the point of compliance shall be at whichever of the following locations is closest to the contamination source:

i. The site boundary; or

ii. The hydrologically downgradient limit of the area in which contamination exists when identified.

- b. If the contamination is not identified and reported to the division or other appropriate implementing agency on or before September 30, 1992, then the point of compliance shall be at whichever of the following locations is closest to the contamination source:
 - i. The site boundary; or
 - ii. The hydrologically downgradient limit of the area in which contamination exists as of September 30, 1989; or
 - iii. If the location specified in (ii) can not be identified, then at the hydrologically downgradient limit of the area below the activity potentially impacting ground water quality.
 2. For all other facilities, at the hydrologically downgradient limit of the area below the activity potentially impacting ground water quality.
- D. Within a specified area for which ground water quality classifications have been established and unless modified by the Commission in a site-specific hearing in accordance with section 41.6 (E), the point of compliance for those activities regulated by the Division through discharge permit regulations or control regulations shall be established by the Water Quality Control Division in accordance with the following criteria.
1. For all existing activities the point of compliance will be set as follows:
 - a. Except for surface water discharges, at some distance hydrologically downgradient from the activity that is causing, or which has the potential to cause, the contamination, based on one of the following criteria, and selecting that distance closest to the activity:
 - i. A specified distance, as determined by (b) below; or
 - ii. The hydrologically downgradient limit of the area in which contamination has been identified; or
 - iii. The site boundary.
 - b. In determining a specified distance the division shall take into consideration the following factors;
 - i. The classified use, established by the Commission, for any ground water or surface water which could be impacted by contamination from the activity;
 - ii. The geologic and hydrologic characteristics of the site, such as depth to ground water, ground water flow direction and velocity, soil types, surface water impacts, and climate;
 - iii. The toxicity, mobility, and persistence in the environment of contaminants used or stored at the facility or discharged from the facility;
 - iv. Established wellhead protection areas;
 - v. The potential of the site as an aquifer recharge area; and

- vi. Recommendations submitted by the facility owner or operator, including technical and economic feasibility.
 - c. For surface water discharges that impact ground water, the point of compliance shall be established in accordance with the provisions of the Colorado Discharge Permit System Regulations, Regulation No. 61 (5 CCR 1002-61).
 - 2. For any new activity the point of compliance will be set as follows:
 - a. Unless modified by the division as specified in (b) below, the point of compliance will be set at the hydrologically downgradient limit of the area below the activity potentially impacting ground water quality.
 - b. The point of compliance determined in (a) above may be modified by the Division on a case-by-case basis with consideration of the following factors:
 - i. The classified use, established by the Commission, for any ground water or surface water which could be impacted by contamination from the activity;
 - ii. The geologic and hydrologic characteristics of the site, such as depth to ground water, ground water flow direction and velocity, soil types, surface water impacts, and climate;
 - iii. The toxicity, mobility, and persistence in the environment of contaminants used or stored at the facility or discharged from the facility;
 - iv. Established wellhead protection areas;
 - v. The potential of the site as an aquifer recharge area; and
 - vi. Recommendations submitted by the facility owner or operator, including technical and economic feasibility.
- E. When considering a request to adopt a site-specific point of compliance to apply in lieu of that established in subsection (C) or (D) above:
 - 1. The Commission shall establish a more stringent site-specific point of compliance where determined necessary to protect human health and the environment, taking into account the potential for vertical migration of contamination, the number, quantity, nature, and persistence in the environment of the contaminants present, technological feasibility, economic reasonableness, upgradient levels of contamination, geohydrological data and features, the classified uses established by the Commission for any ground water or surface water which would be impacted by contamination from the activity, and other environmental data or other relevant information as determined by the Commission; or

2. If the Commission determines that a less stringent point of compliance would protect human health and the environment, and the point of compliance established pursuant to subsection (C) or (D) is technologically infeasible or economically unreasonable, it shall establish an alternate site-specific point of compliance, taking into account the potential for vertical migration of contamination, the number, quantity, nature, and persistence in the environment of the contaminants present, technological feasibility, economic reasonableness, upgradient levels of contamination, point of use treatment, geohydrological data and features, the classified uses established by the Commission for any ground water or surface water which would be impacted by contamination from the activity, and other environmental data or other relevant information as determined by the Commission.

41.7 IMPLEMENTATION

- A. Except for sections 41.5(C) and 41.6(A) and (B), these regulations shall not be deemed automatically applicable to any ground waters of the State.

- B. The Commission is responsible for classifying the ground waters of the State and promulgating water quality standards as set forth in sections 25-8-202(1)(a), 25-8-203 and 25-8-204, C.R.S.

The Commission may classify ground waters and promulgate water quality standards in accordance with the provisions of sections 41.4 and 41.5 of the regulations, upon its own motion or upon petition submitted by the division, any other state agency, or any interested person, including a regulated entity or a person who may be affected by ground water quality.

- C. The determination to accept or deny a petition for consideration under this section, and the scheduling of such petitions for hearing, shall be at the discretion of the Commission, provided, however, that the Commission shall be required to hear any petition for a sitespecific standard or a site-specific point of compliance for radioactive materials and organic pollutant standards submitted pursuant to section 41.5(D). In making such determinations the Commission shall consider the hardship or impact that inaction may have upon the petitioner, other interested persons, and the ground waters of the State; the relative hardships or impacts that may be caused where more than one petition is submitted or is pending; the stage of development of an appropriate data base for decision-making; the Commission's workload and priorities for action; and other relevant factors.
- D. Hearings under this section shall be held in accordance with section 24-4-103, C.R.S. and the Commission's Procedural Regulations.
- E. The Commission may consider a change in classifications or water quality standards based upon substantial new information demonstrating that the current classifications or standards should no longer apply. The determination to accept or deny a petition for consideration under this subsection shall be made in accordance with subsection B, above, provided that no ground waters shall be considered for reclassification or changes in water quality standards more than once in any twelve month period.
- F. The Commission may grant variances from the standards specified in section 41.5 of these regulations on a case-by-case basis considering the factors listed in section 25-8-204(4) C.R.S., and where it is demonstrated by a preponderance of the evidence that a variance from the water quality standards specified in section 41.5 is most appropriate to the protection of the classified uses. The extent and duration of any such variance shall be made on a case-by-case basis.

- G. When the Commission has established statewide standards or classification(s) and standards for ground water in a specified area, those classifications and standards shall be used with respect to the regulation and subsequent enforcement of specific activities by the Commission, the Administration and other State agencies, consistent with applicable law.
- H. When the Commission has not established classification(s) and standards for ground water in a specified area, the Commission recommends the classifications and standards set forth in these regulations as guidance for use by other State agencies in the implementation of ground water protection responsibilities, on a case-by-case basis, consistent with applicable law. This shall not be construed as a delegation by the Commission of its authority to classify ground water and promulgate water quality standards.
- I. Existing discharges of pollutants to ground water shall be deemed “activities” as defined in section 41.3(1), and are not exempt from regulation, unless specific statutory or regulatory provisions require otherwise.

41.8 SEVERABILITY

The provisions of these regulations are severable, and if any provisions or the application of the provisions to any circumstances is held invalid, the application of such provision to other circumstances, and the remainder of these regulations, shall not be affected thereby.

TABLE 1

TABLE 1	
Domestic Water Supply – Human Health Standards	
Parameter	Standard ¹
Biological	
Total Coliforms (30 day average)	2.2 ^a org/100 ml
Total Coliforms (max in 30 days)	23org/100 ml
Inorganic	
Antimony (Sb) ^{d, M}	0.006mg/l
Asbestos ^M	7,000,000fibers/Liter
Arsenic (As) ^{d, M}	0.01mg/l
Barium (Ba) ^{d, M}	2.0mg/l
Beryllium (Be) ^{d, M}	0.004mg/l
Cadmium (Cd) ^{d, M}	0.005mg/l
Chromium (Cr) ^{c, d, M}	0.1mg/l
Cyanide [Free] (CN) ^M	0.2mg/l
Fluoride (F) ^{d, M}	4.0mg/l
Lead (Pb) ^d	0.05mg/l
Mercury (inorganic) (Hg) ^{d, M}	0.002mg/l
Molybdenum (Mo) ^d	0.21 mg/l
Nickel (Ni) ^d	0.1mg/l
Nitrate (NO ₃) ^{d, M}	10.0mg/l as N
Nitrite (NO ₂) ^{d, M}	1.0mg/l as N
Total Nitrate+Nitrite (NO ₂ +NO ₃ -N) ^{d, f}	10.0mg/l as N
Selenium (Se) ^{d, M}	0.05mg/l
Silver (Ag) ^d	0.05mg/l
Thallium (Tl) ^{d, M}	0.002mg/l
Uranium (U) ^{d, 2}	0.0168 to 0.03 ^M mg/l
Radiological^{b, d}	
Gross Alpha Particle Activity ^{i, M}	15pCi/l
Beta and Photon Emitters ^e	4mrem/year

TABLE 2 Domestic Water Supply – Drinking Water Standards

Parameter	Standard
Chlorophenol	0.0002 mg/l
Chloride (Cl) d	250 mg/l
Color	15 color units
Copper (Cu) d	1 mg/l
Corrosivity	Noncorrosive
Foaming Agents	0.5 mg/l
Iron (Fe) d	0.3 mg/l
Manganese (Mn) d	0.05 mg/l
Odor	3 threshold odor numbers
pH	6.5 - 8.5
Phenol	0.3 mg/l
Sulfate (SO ₄) d	250 mg/l
Zinc (Zn) d	5 mg/l

Table 3 Agricultural Standards

Parameter	Standard
Aluminum (Al) d, f	5 mg/l
Arsenic (As) d	0.1 mg/l
Beryllium (Be) d	0.1 mg/l
Boron (B) d, g	0.75 mg/l
Cadmium (Cd) d	0.01 mg/l
Chromium (Cr) d	0.1 mg/l
Cobalt (Co) d	0.05 mg/l
Copper (Cu) d	0.2 mg/l
Fluoride (F) d	2 mg/l
Iron (Fe) d	5 mg/l
Lead (Pb) d, f	0.1 mg/l
Lithium (Li) d, h	2.5 mg/l
Manganese (Mn) d, j	0.2 mg/l
Mercury (Hg) d, f	0.01 mg/l
Nickel (Ni) d	0.2 mg/l
Nitrite (NO ₂ -N) d, f	10 mg/l as N
Nitrite & Nitrate (NO ₂ +NO ₃ -N) d, f	100 mg/l as N
Selenium (Se) d	0.02 mg/l
Vanadium (V) d	0.1 mg/l
Zinc (Zn) d	2 mg/l
pH	6.5 - 8.5

TABLE 4 TDS Water Quality Standards

Background TDS Value (mg/l)	Maximum Allowable TDS Concentrations
0 - 500	400 mg/l or 1.25 times the background level, whichever is least restrictive
501 - 10,000	1.25 times the background value
10,001 or greater	No limit

1 Chronic or 30-day standard based on information contained in EPA's Integrated Risk Information System (IRIS) using a 10⁻⁶ incremental risk factor.

2 Whenever a range of standards is listed and referenced to this footnote, the first number in the range is a strictly health-based value, based on the Commission's established methodology for human health-based standards. The second number in the range is a maximum contaminant level, established under the federal Safe Drinking Water Act that has been determined to be an acceptable level of this chemical in public water supplies, taking treatability and laboratory detection limits into account. The Commission intends that control requirements for this chemical be implemented to attain a level of ambient water quality that is at least equal to the first number in the range except as follows:

- Where ground water quality exceeds the first number in the range due to a release of contaminants that occurred prior to September 15, 2012, (regardless of the date of discovery or subsequent migration of such contaminants) clean-up levels for the entire contaminant plume shall be no more restrictive than the second number in the range or the ground water quality resulting from such release, whichever is more protective.
- Wherever the Commission has adopted alternative, site-specific standards for the chemical, the site-specific standards shall apply instead of these statewide standards.

The Commission does not intend the adoption of this range of standards to result in changes to clean-up requirements previously established by an implementing agency, unless such change is mandated by the implementing agency pursuant to its independent statutory authority.

a When the Membrane Filter Technique is used for analysis, the average of all samples taken within thirty days must be less than 1 organism per 100 milliliters of sample. When the Multiple Tube Fermentation Method is used for analysis, the limit is less than 2.2 org/100 ml.

b If the identity and concentration of each radionuclide in a mixture are known, the limiting value would be derived as follows: Determine, for each radionuclide in the mixture, the ratio between the quantity present in the mixture and the limit specified. The sum of such ratios for all radionuclides in the mixture shall not exceed "1" (i.e. unity). A radionuclide may be considered as not present in a mixture if the ratio of the concentration to the limit does not exceed 1/10 and the sum of such ratios for all radionuclides considered as not present in the mixture does not exceed 1/4.

c The chromium standard is based on the total concentration of both trivalent and hexavalent forms of dissolved chromium.

d Measured as dissolved concentration. The sample water shall be filtered through a 0.45 micron membrane filter prior to preservation. The total concentration (not filtered) may be required on a case-by-case basis if deemed necessary to characterize the pollution caused by the activity.

e If two or more radionuclides are present, the sum of their annual dose equivalent to the total body or to any organ shall not exceed 4 mrem per year. Except for Tritium and Strontium 90 the concentration of man-made radionuclides causing 4 mrem total body or organ dose equivalents shall be calculated on the basis of a 2 liter per day drinking water intake using the 168-hour data listed in "Maximum Permissible Body Burden and Maximum Permissible Concentration of Radionuclides in Air or Water for Occupational Exposure," NBS Handbook 69, as amended, August 1963, US Department of Commerce.

f These more stringent levels are necessary to protect livestock watering. Levels for parameters without this footnote are set to protect irrigated crops at the same level. Where a party can demonstrate that a livestock watering use of ground water is not reasonably expected, the applicable standard for lead is 5.0 mg/l.

g This level is set to protect the following plants in ascending order of sensitivity: Pecan, Black Walnut, Persian (English) Walnut, Jerusalem Artichoke, Navy Bean, American Elm, Plum, Pear, Apple, Grape (Sultanina and Malaga), Kadota Fig, Persimmon, Cherry, Peach, Apricot, Thornless Blackberry, Orange, Avocado, Grapefruit, Lemon. Where a party can demonstrate that a crop watering use of ground water is not reasonably expected, the applicable standard for boron is 5.0 mg/l.

h This level protects all crops, except citrus which do not grow in Colorado and therefore a more stringent level of protection is not required.

i The Gross Alpha Activity standard excludes alpha activity due to Radon and Uranium.

j This standard is only appropriate where irrigation water is applied to soils with pH values lower than 6.0.

M Drinking water MCL.

41.9 Reserved.

41.10 Reserved.**41.11 Reserved.****41.12 STATEMENT OF BASIS AND PURPOSE**

Statement of Basis and Purpose for adopting the Regulations entitled: "The Basic Standards for Ground Waters". In accordance with 24-4-103(4), CRS (1982 and 1985 Supp.), the Commission adopts this Statement of Basis and Purpose.

PURPOSE

"The Basic Standards for Ground Waters" establishes a system of classifications (classes) for determining the appropriate degree of protection (standards) necessary to maintain beneficial uses of ground waters. These standards and classes are intended to complement regulations 3.1.0, "The Basic Standards and Methodologies" which are primarily applicable to surface waters. Together, regulations 3.1.0 and 3.11.0 protect all state waters as defined in Section 25-8-203, CRS (1982). Separate regulations for surface and ground waters are appropriate, because the surface water classification system is not easily adopted to ground waters.

These regulations are the first step in developing a comprehensive, statewide ground water protection program. The complete program will include control regulations which will enforce the water quality standards. These additional regulations may include amending the current CDPS permit regulations and adopting activity-specific control regulations.

It is not the intent of the Commission to control existing or future uses of ground water (i.e., domestic, agricultural, or industrial uses). The intent is to protect ground water quality from uncontrolled degradation and thereby protect existing and future uses of ground water.

It is not the intent of the Commission or the Division by virtue of adoption of these regulations or subsequent control regulations, to duplicate ground water regulations adopted by other state or federal programs. When an activity that impacts ground water appears to be unregulated or inadequately regulated with respect to those impacts, the Division will conduct a thorough review of any applicable authorities prior to proposing a control regulation.

NEED FOR REGULATIONS

Ground water is the primary water source for seventy-five percent of the public water supply systems of the state (defined in the Colorado Primary Drinking Water Regulations).

There are approximately 825,000 people in Colorado that rely either wholly or partially on ground water. Ground water use to support new urban areas is increasing as surface water supplies become more difficult to obtain in some metropolitan areas. Agriculture also relies heavily on ground water for the production of crops and livestock. An estimated 1.5 million acres are presently being irrigated with ground water and approximately 12,500 well permits have been issued for livestock watering.

Currently, public water supply systems using ground water are not required to treat the water prior to distribution except for disinfection. In 1974, the federal "Safe Drinking Water Act" (SDWA) was passed which required regular testing of public water supplies to ensure compliance with the maximum contaminant levels (MCLs). However, the regulations do not require testing for even 1% of the synthetic chemicals in use in the nation today. The 1986 amendments to the Safe Drinking Water Act will increase the number of chemicals to be tested by public water systems. However, neither the SDWA nor the 1986 amendments required testing of private or agricultural supply wells.

Although the state's lack of a comprehensive data base prevents demonstrating a widespread contamination problem, there are many reasons for adopting a regulation which creates a framework for further ground water quality protection. These reasons are:

1. The increasing reliance on ground water by public and private water supply systems in a watershed state mandates protection of subsurface water quality. There may not be any alternative surface supplies available in the event of contamination.
2. Severe ground water contamination has occurred in several specific locations in Colorado. This regulation is a necessary step to prevent a proliferation of ground water problems.
3. The high expense of clean up of already polluted ground water fully justifies a strong, thorough effort to prevent any contamination which will impair the usefulness of ground water.
4. The Commission has been recognized, at the state level, as the agency responsible for coordinating a state ground water protection program. Examples of this responsibility include:
 - i. By its enabling statute, the Water Quality Control Commission is the ultimate state agency authority for the protection of the waters of the State, including subsurface waters.
 - ii. In an executive order issued on July 15, 1985, Governor Lamm stated that the Colorado Department of Health is given primary responsibility for coordinating the state's ground water quality protection effort.
5. Coordination of various federal and state ground water protection programs is consistent with federal policy. In 1984, EPA developed a ground water protection strategy. One of the main objectives of the strategy was to achieve greater consistency in decision making on ground water protection and clean-up. EPA is providing the Water Quality Control Division with technical and financial support for the development and implementation of a ground water protection program. In 1986, Congress amended the Safe Drinking Water Act so as to encourage state programs for well head protection.
6. Since other state agencies (and counties) are required to protect ground water incidental to regulating other activities, the Commission should assume-at the least-a coordinating role in assuring consistent protection of ground water quality. By promulgating a definition of the various uses of ground water and the numerical maximum chemical concentrations necessary to protect those uses, the Commission is establishing a common denominator such that ground waters will be classified and protected.
7. In the future, other causes of ground water contamination which are not now regulated may be found. A regulatory structure in place now which defines the level of risk of contamination and levels of control required will be useful when addressing future problems. Relying upon a framework of uses to be protected, future legislation, control regulations by the Commission, or regulations by other agencies, may be developed to address presently unregulated causes of contamination.
8. With standards defined to protect uses, the Division will be able to develop permit limits for surface and subsurface discharges to ground water, where other regulations authorize Division control of such surface activity.

PUBLIC INPUT AND COMMISSION GOAL

The Commission and Division appointed an AD Hoc Ground Water Advisory Committee in 1982. The Committee represented the various entities who would be most affected by a ground water protection program. On May 15, 1984, the Committee recommended, and the Colorado Water Quality Control Commission adopted, the following statement pertaining to ground water protection:

“The goal of the Water Quality Control Commission is to provide maximum beneficial use of ground water resources, while assuring the safety of the users by preventing or controlling those activities which have the potential to impair existing or future beneficial uses of ground water or to adversely affect the public health. The necessary program is to be instituted in a manner that is consistent with and complementary to the provisions of the Colorado Water Quality Control Act.”

This Basic Standards Regulation for ground water, which is adopted after exhaustive public rulemaking hearings, is consistent with this goal. The focus of the Basic Standards Regulation for ground water is the identification of ground water use or uses and the quality level to be maintained to assure its usefulness. This is a framework around which existing and future licensing and permitting regulations revolve in authorizing, conditioning, limiting and denying activities which could impair existing or future beneficial uses of ground water.

DISCUSSION OF REGULATIONS**Classification System**

The classification system is a framework of uses of ground water which are to be assigned on a site-specific basis by the Commission so that standards for chemical pollutants can be assigned on a site-specific basis by the Commission so that standards for chemical pollutants can be assigned at levels necessary to protect the use.

A five (5) class system was developed for these regulations. This system is based on existing and potential future uses and actual water quality data.

1. Domestic Use - Quality
2. Agricultural Use - Quality
3. Surface Water Quality Protection
4. Potentially Usable Quality
5. Limited Use and Quality

Ground water may be assigned more than one class because it may have more than one existing or potential use.

While selection of any of these classes for a specific site is to protect the quality of the water for that beneficial use, because the classification may be based on a potential use, the classification is no warranty that the existing quality is entirely fit for that use by one who does or intends to put it to such use.

The selection of classifications for particular ground water within a specified area shall be by the Commission. The selection of particular classes shall be based upon specific criteria found in the regulations which describe each class.

The regulations provide that ground water may be classified “Domestic Use - Quality” or “Agricultural Use - Quality” if the ground water is either “used” or reasonably likely to be used for domestic or agricultural purposes within the specified area, or if the most recent state engineer’s well records or applicable court decrees reveal that ground water is “permitted” or “decreed” for such uses within the specified area. For purposes of classification of ground water pursuant to these two provisions, the Commission presumes (1) that the “use” of ground water is after a legal withdrawal, and (2) that the pertinent state engineer’s well record reveals a valid permit, and that the applicable court decree is perfected. If a domestic or agricultural use classification is based solely upon well records or court decrees, that classification may be rebutted by information demonstrating that domestic or agricultural use of ground water is not being made and is not likely to be made in the future.

Selection of applicable classes for a specified area shall occur when there is an activity which affects or has the potential to affect ground water quality within a specified area, and when a specified area for that activity is determined. Upon identification of the activity and determination of the specified area by the Commission, the owner/operator of the activity gathers information within the specified area. The owner/operator of the activity then submits this information to the Commission, pursuant to Section 3.11.7.

SPECIFIED AREA

The specified area is that area within which the ground water is classified. The Commission must determine the appropriate shape, depth, boundaries, and extent of a specified area such that existing and potential uses of ground waters are identified and protected from discharges to ground water by activities.

A specified area will be determined as early as possible after an activity has been identified. The Commission assumes that the specified area may be modified as more hydrologic and geologic information is acquired. The Commission may determine a specified area in the absence of an activity.

A conservative area of two lateral miles around the activity in question will presumptively be used as the initial specified area. The Commission finds this area to be reasonable for the following reasons:

- a. Geraghty and Miller, Inc. performed a national survey, for USEPA Headquarters, of 68 ground water contamination sites. The study revealed that 95% of the plumes of contamination were limited to within 2 miles of the source. Geraghty and Miller, Inc. performed an in-house survey of 73 more such sites (a total of 141 sites) which also revealed that 95% of these plumes of contamination were limited to 2 miles from the source;
- b. The ICF Corporation performed a national survey, for USEPA Headquarters, of 150 RCRA sites. In this study, ICF found that 95% of the distances from the source to ground water discharge boundaries were within 2 miles.
- c. Geraghty and Miller, Inc. performed a national survey, for USEPA Headquarters, of large ground water pumping systems (i.e., municipal water supply wells). This survey revealed that approximately 95% of these wells had a capture zone (i.e., zone of influence) within a 2 mile radius.

GROUND WATER QUALITY STANDARDS

The promulgated Water Quality Standards include narrative and numeric standards.

NARRATIVE STANDARDS

The narrative standards consider all man-induced alterations of ground water. Since the Commission cannot, and will not, control the withdrawal and use of ground water, the narrative standards are designed to protect all potential uses of the waters. The narrative standards prohibit the introduction of non-natural chemicals where best available information indicates a potential threat to the public health, safety or welfare.

The Colorado Primary Drinking Water Regulations (CPDWR) do not include MCLs (maximum contaminant levels) for many chemicals such as dioxin, TCE, and EDB. There are often health advisories and other scientific studies indicating that a specific chemical is carcinogenic, mutagenic, toxic, or poses a danger to public health, safety, or welfare. The Commission will have the ability to make a specific determination of a limit for that constituent in ground water. This section allows the Commission to make such a determination in the absence of an MCL for the chemical. The toxic and hazardous pollutant lists developed pursuant to sections 301 (a)(1) and 311 (b)(2)(A) of the federal Clean Water Act and contaminants (pollutants) that have had an EPA Health Advisory developed for them will be used as a basis for determining what specific compounds will be included.

NUMERIC STANDARDS

The numeric standards are contained in Tables 1, 2, 3, and 4. These standards apply to classified ground water.

The majority of the numeric standards listed in Table 1 are the maximum contaminant levels (MCLs) for public drinking water supplies, as established by the National Primary Drinking Water Regulations. The remainder are derived from the Colorado Basic Surface Water Standards. These human health levels are set to protect the public from acute poisoning and from long-term "chronic" effects. The MCLs are also contained in the CPDWR. The limits for radioactive constituents; Cesium, Plutonium, Thorium and Tritium are those which would limit human exposure to four (4) millirems/year. Table 1 will be expanded as MCLs for additional parameters are developed under the National Primary Drinking Water Regulations. The numeric standards listed in Table 1 are applicable to ground waters classified "Domestic Use-Quality".

Table 2 contains additional numeric standards for "Domestic Use - Quality" ground waters. Much debate and discussion revolved around the need for these standards. These parameters are the National Secondary Drinking Water Standards and are instituted to maintain a ground water as a drinking water source requiring very little treatment. In the judgement of the USEPA Administrator, these limits are a requisite to protect the public welfare.

Contaminants (pollutants) contained in Table 2 are those which may adversely affect the aesthetic quality of a drinking water such as taste, odor, color, and appearance and which thereby may deter public acceptance of and confidence in that ground water source as a drinking water supply.

Numeric standards meant to protect a water source for agricultural uses are listed in Table 3. Table 3 numeric values were developed through Commission review of Water Quality Criteria in 1972, EPA/R/73/033 (March 1973). The value of the molybdenum was developed from information provided by AMAX and the Cottor Corporation. These values are set at levels to protect livestock and crops. All "Agricultural Use - Quality" ground waters must meet these standards when implemented by any agency.

Much public input and debate revolved around Table 4, "TDS Water Quality Standards." Some parties wanted less or no degradation of ground water, while other parties felt that more was warranted. The division proposed this version which allows for limited degradation.

The TDS numeric standard is implemented on a sliding scale and is applicable to all classes of ground water, except "Domestic Use - Quality" and "Limited Use and Quality" ground waters. TDS Table 4 values are applicable to "Agricultural Use - Quality", "Surface Water Quality Protection" and "Potentially Usable Quality" ground waters, because these three classes are not subject to Table 2 for sulfates and chlorides; a TDS limitation for these three classes assumes some level of anti-degradation.

By maintaining a TDS concentration within a range, an existing or potential use should not be impacted. The sliding scale allows for a twenty-five percent increase for all ground waters with a background TDS concentration greater than 500 mg/l. If the background concentration is less than 400 mg/l then the maximum allowable concentration of TDS is 500 mg/l. This value is the secondary drinking water standards and is instituted to maintain a high quality water. Total dissolved solids concentrations of less than 500 mg/l are not expected to impair any ground water use. The twenty-five percent allowable incremental increase for waters with a background between 500 and 10,000 mg/l would afford a greater degree of protection to ground water with lower TDS concentrations. Ground waters with TDS concentrations greater than 10,000 mg/l would not have a numeric limit.

The term "representative" contained within the definition for background level implies standard acceptable monitoring, sampling, and analytical procedures, which are available.

The criteria for determining background levels will be established by the Commission. It is important that the regulated entity work closely with the agency requiring the background level determination.

It is intended that the monitoring and sampling protocols shall be those procedures best capable for obtaining ground water samples which are representative of the water quality being monitored.

The following documents may provide useful guidance:

1. "Manual of Ground-Water Sampling Procedures", Scalf, M.R., et al., 1981. National Water Well Association, Worthington, Ohio.
2. "Procedures for the Collection and Preservation of Ground Water and Surface Water Samples and for the Installation of Monitoring Wells", U.S. Dept. of Energy, January, 1981. GJ/TMC-08, UC-70A.
3. "Practical Guide for Ground-Water Sampling", Barcelona, M.J., et al., EPA/600/2-85/104 September, 1985.

The analytical method selected for a parameter should be that which can measure the lowest detection limit for the parameter, unless a standard is within the range of another approved method. Approved analytical methods include those contained in the "Standard Methods for the Examination of Water and Wastewater," 16th or most recent edition, or "Methods for Chemical Analysis of Water and Wastes," EPA, Office of Technology Transfer, or 40 CFR "Guidelines Establishing Test Procedures for the analysis of Pollutants under the Clean Water Act (CWA)."

The owner/operator reporting the results of the laboratory studies shall identify the detection limit and method used for the analysis of each parameter.

POINT OF COMPLIANCE

The Commission intends to allow for flexibility in locating the point or points of compliance within the specified area. After the point or points of compliance are determined, applicable ground water quality standards are to be met at these locations.

Mining activities are recognized to occur within ground water bodies and that water quality within the disturbed area will obviously change. The point(s) of compliance established outside the area anticipated to be disturbed may protect the water body while allowing the mining activity.

The Commission envisions that future and/or amended regulations will specify the design criteria and/or monitoring requirements necessary at the point or points of compliance. Down-gradient ground water monitoring locations may correspond to the point of compliance for the regulated activity.

IMPLEMENTATION

The Commission has considered several approaches to implementation of these regulations. The proposed rule initially included a provision for automatic applicability, with appeals to the Commission for reclassification. The parties raised strong objections to this proposal based on due process and statutory grounds. In its deliberations the Commission deleted this approach and proposed to the delegate classification and standard setting authority to other state agencies. The Attorney General's office indicated that the approach would constitute an unlawful delegation of the Commission's statutory duties. Next the Commission proposed to include a procedure for appeals to the Commission, but the delegation issue continued to be raised by the Attorney General's office and at least one party. The implementation provisions adopted in this rule are a response to objections raised by parties and the Attorney General.

The Commission assumes full responsibility for classification and standard setting at this time. Ample opportunity for comment has been provided at each juncture in the process, and the Commission has afforded the parties two additional four day comment periods.

In the absence of some delegation of responsibility to other agencies, the Commission anticipates a potential workload beyond its capabilities to absorb. The final rule establishes a list of factors to be considered in acting upon petitions for rulemaking hearings, in recognition of the time and resource limitations placed upon the Commission.

Reconsideration of classifications and standards by the Commission is permissible in the final rule. However, the Commission has determined that C.R.S. 25-8-207 was intended to apply only to surface waters and is not applicable to ground water.

A variance provision has been included in the final rule. The burden of proof is on the proponent of a variance to demonstrate that Table Values need not be adopted in order to protect classified uses. Variances can be granted at the time that standards are initially adopted or in a proceeding under Section 3.11.7(D).

When the Commission has adopted classifications and standards, such regulations should be applied by the Commission, the Division and other state agencies in carrying out their ground water protection responsibilities. The Commission has favored the delegation of responsibilities to other agencies, but has eliminated that approach based upon the objections of the Attorney General. However, the Commission hopes that other agencies with the authority to do so will follow the classification and standards system established by the regulations even in the absence of rulemaking by the Commission to establish classifications and standards for a specified area.

Ground water in a specified area shall not be deemed classified under C.R.S. 25-8-203, and standards shall not be deemed to be set under C.R.S. 25-8-204, in the absence of rulemaking by the Commission.

FISCAL IMPACT STATEMENT FOR THE BASIC STANDARDS FOR GROUND WATER

The Colorado Water Quality Control Commission promulgates this regulation entitled "The Basic Standards for Ground Water" under the authority to classify waters of the state and to establish water quality standards to support those classifications, Section(s) 25-8-202, 203, and 204 CRS.

The regulation establishes a system for classifying ground water and describing those classifications by use and quality. The standards, when applied to specific classes of ground water, become the baseline by which one can establish if water quality has been degraded or water use has been impaired or precluded. At this point there is no economic impact with respect to these regulations, except the cost associated with adopting the regulations. As control or other regulations are proposed which will implement the classification and standards system, the actual costs and benefits for each such proposal will be developed and considered. These regulations as originally proposed would have been automatically applicable to all sources of ground water contamination. This concept has been eliminated in the final rule.

This statement discusses potential economic impacts from future regulations that may be adopted to implement this regulation. All statements regarding values and costs are subject to change during the future adoption of specific control regulations.

COSTS

The fiscal impacts may occur at two different points in the regulatory system. If the regulations are implemented through source controls, then the entities responsible for the source (activity) will bear the cost. In socio-economic terms, this is the most equitable way to pay for the cost of prevention. The responsible entity may either pass the costs on to their consumers and have a relatively small percent increase in costs of service over a large user base, or absorb the costs without changing the price of their goods or services.

If the regulations are implemented by pathway elimination (i.e., alternate water supplies or point-of-use water treatment), then the question is who bears the costs? If the owner or operator of the source (activity) pays for pathway elimination, then the cost remains spread over the users of the product. If the pathway is eliminated and the cost is borne by the ground water users who are not responsible for the source, then the cost may be borne by a larger but less appropriate user base.

Finally, if neither the source nor the pathway are controlled and contaminated ground water is delivered to its ultimate user, then the individual water user carries the burden associated with increased health costs and risks.

Treatment of waste prior to discharge as a result of a control regulation is a viable alternative but the burden is upon the facility to provide the treatment. The elimination or reduction of the discharge includes design criteria such as pond linings, leak collection and/or detection. These costs can be significant but are limited to the life of the facility plus some limited post closure period. Eliminating or reducing the discharge is already required under several state statutes for some facilities such as certain solid waste disposal facilities.

Treatment of waste prior to discharge is an effective option for controlling contamination but is capital-intensive in terms of initial costs. This is a cost of production, manufacturing or operation and is considered a cost of doing business. The treatment of waste prior to discharge is already required for facilities that discharge to surface water.

Treatment of water at the point of use is the most costly option because it requires recapturing a much larger volume of contaminated water and redistribution of the water as well as treatment and maintenance. When this is related to private water supplies and maintenance, the cost rises because the treatment is not centralized.

One example of point-of-use treatment costs is nitrate removal system for the McFarland Mutual Water Company water supply in McFarland, California. The capital cost in 1983 was \$900,000 for a one million gallon per day facility. Operating costs are twenty-four cents per 1,000 gallons.

In Colorado, provision of an alternate water supply could arguably be the most expensive option depending on the location of the contaminated resource. For example in the Denver area the cost to replace a water supply for South Adams County Water and Sanitation District (30,000 residents) is approximately \$20.9 million for water from the Metro Water Development Authority and \$34 million for water from the Burlington Ditch. This does not include the costs of treating the water. In rural areas, the replacement cost may not be as high as in the Denver area but alternate water supplies are not likely to be readily available.

Finally, the costs associated with cleanup of contaminated ground water tends to be the most expensive. Remedial cleanup is not always feasible, it is always costly. The costs associated with implementing these regulations as preventative measures are significantly less than the costs of implementing them as reactive or "cleanup" measures.

When used in the reactive sense, the costs of cleanup and contamination investigation have been described by Geraghty and Miller Ground Water Contamination , 1984, page 16. "Hydrogeologic investigations to define contamination problems can cost from \$25,000 to \$250,000. Litigation may lead to doubling of this price. The minimum costs of the ground water phase of a partial cleanup and containment project is \$500,000."

In Santa Clara, California, IBM has spent \$20 million and Fairchild has spent \$16 million to cleanup ground water contamination. California has had some nineteen sites put on the Superfund National Priorities List because the small companies which are responsible do not have the funds to pursue cleanup activities.

In Colorado, the costs estimated for the cleanup of the Rocky Mountain Arsenal are estimated in the billions of dollars. The time needed for such cleanup is estimated to be several decades. Indeed, there will be costs associated with these rules that are likely to be large. However, when compared to the benefits or elimination of risk to the public health, those costs are warranted.

In terms of monitoring requirements, the agencies that may have to consider these standards in their permitting actions already require specific monitoring and hydrogeologic analyses to be performed. Therefore, no new monitoring requirements or costs may be associated with these rules when implemented under existing regulatory controls unless frequency of sampling or the number of parameters is increased by the agency.

Monitoring requirements, when implemented under the Commission's future regulations, will be an additional cost to facilities which will be controlled by those regulations. The Colorado Mining Association has estimated that a new investigation designed to comply with monitoring requirements which may result from future control regulations, may cost \$500,000 the first year and \$68,000 for each additional year. Monitoring programs for other types of activities may be lesser or greater than these figures depending on the nature of the activity and the specific requirements of the future control regulations.

State agencies, including the Division, will incur costs to adopt the future classifications, standards and control regulations and to implement them. It is not now known the magnitude of such costs or whether they will be paid by the taxpayers of the state or by facility owners through cash funding mechanisms such as discharge permit fees.

BENEFITS

There are no specific benefits which can be attributed to this present Commission action since these regulations only set up a framework for additional future regulations and their implementation. Several potential benefits may be realized by such future action. The most obvious possible benefit would be the protection of human health. Prevention of ground water contamination which would otherwise result in long-term illness is a benefit. The prevention of the costs of remedial medical care for the sick, additional health insurance premiums and costs to business for long-term illnesses and the costs to society for caring for chronically ill patients, not to mention the reduction of human suffering, is a distinct benefit.

Possible environmental benefits are related to the preservation of a valuable resource in a water scarce state. In many areas of Colorado, ground water is the only source of water for agriculture. The prevention of contamination of ground water allows the agriculture use to continue through the irrigation of crops or watering of livestock. Such crops and livestock make up a significant segment of the Colorado economy, the protection of which is a benefit.

PARTIES TO THE PROCEEDINGS OF THE PUBLIC RULEMAKING HEARING FOR THE BASIC STANDARDS FOR GROUND WATER

1. CF&I Steel Corporation
2. The Colorado Water Congress
3. The Colorado Mining Association
4. Yuma County Ground Water Management Districts
5. Metropolitan Denver Sewage Disposal District
6. AMAX, Inc.
7. The City of Northglenn
8. The Colorado Association of Commerce & Industry
9. Committee on Oil Shale of the Rocky Mountain Oil and Gas Association
10. The City of Colorado Springs
11. The Adolph Coors Company
12. Cathedral Bluffs Shale Oil Company
13. The Special Districts Association
14. Colorado Petroleum Association
15. Gulf and Western, Inc.

41.13 STATEMENT OF BASIS, SPECIFIC STATUTORY AUTHORITY AND PURPOSE(1989 REVISIONS)

The provisions of section 25-8-202(1)(b), (2) and (7); and 25-8-204; C.R.S., provide the specific statutory authority for adoption of the attached regulatory amendments. The Commission also adopted, in compliance with section 24-4-103(4) C.R.S., the following statement of basis and purpose.

A. OVERVIEW

Since the Commission adopted The Basic Standards for Ground Water in 1987, no specific ground water quality classifications and standards have been adopted for any state ground waters. The purpose of the adoption of the statewide standards that are the subject of this action is to provide a statewide baseline of protection by establishing standards that will apply broadly to Colorado ground waters, for certain toxic organic pollutants and radioactive materials.

As a part of the same proceeding that led to the adoption of these ground water standards, the Commission has adopted similar statewide surface water standards for organic pollutants in section 3.1.11 of the Basic Standards and Methodologies for Surface Water, and deleted certain very general statewide ground water quality standards previously contained in that document. As explained more fully in the Statement of Basis and Purpose for those changes (section 3.1.22), the Commission has adopted an expanded set of numerical basic surface water standards for toxic organic pollutants in part due to requirements of the federal Clean Water Act. Although that Act does not contain any requirements for the adoption of ground water quality standards, the Commission believes that it is appropriate in this instance to provide consistent levels of protection for both surface and ground water resources. The principal difference between the two sets of standards is the lack of aquatic life standards for ground water, because ground water quality does not affect aquatic life unless it emerges at some point and becomes surface water (which is then subject to surface water standards).

Evidence has been submitted that on a site-specific basis some ground waters have become substantially contaminated with organic pollutants, e.g. as a result of past disposal practices. Although there is no information currently indicating that such contamination is widespread, the Commission believes that the best policy option is to adopt numerical standards now, to help assure that these pollutants do not become a more widespread problem.

The organic chemicals for which standards are being adopted generally are not naturally occurring water quality constituents. Therefore, the Commission has determined that a statewide approach to adoption of water quality standards for these substances is the most efficient and appropriate means of assuring human health and environmental protection in a timely manner. Where there may be naturally occurring levels of some specific pollutants for which standards are adopted, or where other site-specific factors warrant, the Commission has preserved the flexibility to adopt alternative, site-specific standards, as discussed further below.

In addition to the adoption of the new organic pollutant standards, the Commission also adopted new ground water quality standards for a limited list of radioactive materials. These standards are identical to those which have been and will continue in place for surface waters. The Commission rejected a proposal to adopt a new numerical uranium standard for ground water at this time, because the Commission believes that this issue warrants more specific analysis prior to such action. For example, the consistency with established surface water quality standards for uranium in several basins needs to be more fully considered.

Considering the desirability of having consistent levels of protection for surface and ground waters and the potentially serious adverse impacts from these pollutants, the Commission has determined that the record in this proceeding demonstrates the need for the adoption of these standards. Recently adopted legislation-Senate Bill 181 in the 1989 session-includes new provisions that apply when the Commission adopts "rules more stringent than corresponding enforceable federal requirements." Section 25-8-202(8)(a), C.R.S. The Commission interprets these provisions to be inapplicable to this rulemaking, since there are no "corresponding enforceable federal requirements" that establish ambient ground water quality standards. Section 303 (c)(2)(B) of the 1987 amendments to the federal Clean Water Act includes a directive that, whenever states revise surface water quality standards, they adopt standards for certain toxic pollutants. However, no federal standards—no enforceable federal requirements—are established for these pollutants, and the directive that states act applies only to surface water, not ground water.

Moreover, even if this section did apply, the Commission finds that the standards adopted are based on sound scientific and technical evidence in the record. This basis is demonstrated in part by the testimony submitted by witnesses for the Division and for EDF, including the underlying analyses and studies referenced therein. The Commission's evaluation of the available information, and its assessment of how this information should be reflected in the standards, is also addressed in the discussion of "Basis for Specific Standards" set forth below. Finally, these standards are necessary to protect the public health, beneficial uses of water, and the environment of the State-in part due to the fact that there are no corresponding enforceable federal requirements. As mentioned above, the Commission believes that the best policy to assure protection of these uses is to adopt uniform, preventive standards. Without such standards in place, waters that have not yet been affected by the discharge or presence of such toxic pollutants may be adversely affected in the future, and protection of their present and future uses would then not be assured. The approach adopted by the Commission attempts to assure protection of uses by initially applying the standards broadly, but at the same time assures economic reasonableness by providing flexibility to revise the standards on a site-specific basis and to take site-specific circumstances into account in determining the need to apply the standards in regulating individual entities. See, e.g., the discussion below regarding "Point of Compliance".

Finally, in addition to the revisions discussed in more detail below, the Commission has made relatively minor changes to sections 3.11.2 and 3.11.7 for consistency with the major changes being adopted.

B. RELATION OF STANDARDS TO CLASSIFICATIONS

In contrast to the approach the Commission has taken for the new surface water organic pollutant standards, applicability of the new ground water standards is not tied to the presence of corresponding ground water use classifications. For the reasons discussed above, and because it is likely to take several years to adopt site-specific ground water classifications throughout the State, the Commission has decided as a matter of policy that these standards now being adopted should apply statewide on an immediate basis.

During the course of the proceeding, other alternatives were considered. For example, one option discussed was applying the standards to (1) all nontributary ground water, (2) all tributary ground water that has been classified "domestic use-quality", (3) all tributary ground water located in aquifers that have been or are being used for domestic water supply purposes, and (4) all ground water that is tributary to streams or stream segments which are classified for domestic water supply. Alternatives such as this have the disadvantage of requiring potentially difficult factual determinations regarding precisely where the standards apply. While such issues could be resolved by the Division as they arise, this system would make it difficult for the public to know in advance where the standards apply.

The intent of such alternatives was to avoid unnecessarily stringent requirements that could result from applying the standards to ground water that does not warrant protection as an actual or potential drinking water supply. However, the Commission believes that this goal can be achieved by a simpler approach. Pursuant to recently adopted legislation (SB181), other state regulatory agencies with ground water quality protection responsibilities have the flexibility to determine appropriate points of compliance when implementing these standards. (See section 3.11.6(D) and the discussion under G., below.) Second, the Commission has included language in section 3.11.5(C)(5) to clarify that certain federal program regulatory determinations regarding ground water quality would not be superceded by the Commission's standards, where such programs dictate a contrary result. (See the discussion under F., below.) Finally, the Commission has preserved the option of establishing different site-specific standards to apply in place of the statewide standards, where determined appropriate following a rulemaking hearing before the Commission. (See section 3.11.5(D), and the discussion under D., below.)

The Commission believes that the combination of these provisions provides ample means of assuring that unnecessarily stringent regulation, based on the statewide standards, can be avoided.

C. BASIS FOR SPECIFIC STANDARDS

A wide range of approaches to setting standards for the organic pollutants were considered during the course of this proceeding. These ranged from setting “zero” standards for some pollutants (carcinogens), to setting standards only for chemicals for which maximum contaminant levels (MCLs) have been adopted, to setting standards based on practical quantitation limits (PQLs).

The standards adopted have been established as interim rather than permanent standards principally because it is clear to the Commission that the development of appropriate numerical criteria to protect various beneficial uses from organic pollutant impacts is a rapidly evolving area that is still very much in flux. For example, there are currently significant differences among the various criteria, advisories, and maximum contaminant levels available for a number of specific pollutants. As new information becomes available and potential conflicts among the various numerical levels are resolved, it may be appropriate in specific instances in the future to adopt permanent standards either more or less stringent than the interim standards being established at this time. However, given the importance of controlling toxic pollutants in the environment, the Commission believes that it is necessary to move forward with the adoption of interim statewide standards at this time, and that the interim standards adopted are reasonable based on the best currently available information.

The organic pollutant standards have been divided into two categories—Table A for carcinogens and Table B for non-carcinogens. For non-carcinogens, the interim standards are based on MCLs, or lifetime exposure levels derived from the “reference dose” for constituents for which no MCLs have been adopted. Non-MCL standards generally are based on EPA health advisories or integrated risk information system (IRIS) data. The Commission has determined that this is the best information currently available as to the appropriate criteria for protection of human health for non-carcinogens.

For the Table A carcinogens, the interim standards are again based on MCLs for constituents for which these limits have been developed. For non-MCLs, standards based on the 1×10^{-6} risk level have been adopted. Recognizing that there is no scientifically “correct” risk level, the Commission has selected this level as a matter of policy, because it believes this is an appropriately conservative and protective level for human health risks.

To determine which specific pollutants to list on Table A, any particular compound was considered to be carcinogenic if it has been classified by EPA as either a Group A (known human carcinogen) or Group B (probable human carcinogen) compound. Compounds classified as Group C (possible human carcinogen), Group D (information inadequate to assess), or Group E (not anticipated to be a carcinogen), were treated as non-carcinogenic and listed on Table B. A few specific compounds classified by EPA as Group B/C were considered carcinogens and included in Table A.

D. SITE-SPECIFIC STANDARDS

Section 3.11.5(D) clarifies the Commission's ability to adopt site-specific standards to apply in lieu of the statewide standards where appropriate. Rather than attempt to anticipate all potential factual justifications for different site-specific standards, the Commission has determined that it is most appropriate simply to refer to the standard statutory and regulatory criteria for such determinations.

The Commission believes that because these standards are being adopted without taking site-specific factual circumstances into account, any revised site-specific standards based on such a site-specific analysis should not be considered a downgrading. Rather, this would simply be a determination that different numerical standards are adequate to protect the uses in question. The fact that downgrading criteria would not apply to such circumstances is a material assumption upon which the Commission relies in adopting these statewide standards.

E. USE OF DETECTION LEVELS

Section 3.11.5(C)(4) explains how detection levels are to be used in implementing the new standards, in view of the fact that in many instances the standards are lower (more stringent) than common detection levels. The Commission believes that it is appropriate to recognize the limits of current detection technology by clarifying that specified detection levels will be used for purposes of establishing performance standards.

The specific detection levels to be used for these statewide standards are being specified in the regulation. Although this is not the Commission's normal practice, it has determined that this step is appropriate in this instance because the need to comply with very stringent standards for organic pollutants will be new to many regulated entities.

The Commission has decided to rely for now on detection levels based on practical quantitation limits (PQLs) associated with GC-MS laboratory analysis techniques, except where only a GC-based PQL exists. For those compounds which have an MCL as the standard, the corresponding detection method was adopted. The Commission has decided not to require detection to the generally more stringent GC-PQLs in all circumstances, in order to temper the economic impact of this new set of standards. Of course, as scientific knowledge and technology advance, this decision may be reconsidered in subsequent rulemaking hearings. In a few specific instances where national guidance is not available, PQLs have been established based on the Colorado Health Department Laboratory's best professional judgment.

F. RELATIONSHIP TO OTHER PROGRAMS

Concerns were raised during the hearing process regarding the relationship of these new statewide organic pollutant standards to environmental standards that might be established under federally-dictated environmental programs. The Commission does not intend to attempt to preempt such programs by the adoption of these standards. To address the programs where there appeared to be a potential for conflict, the Commission has added new subsection 3.11.5(C)(5), relating to the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), and Resource Conservation and Recovery Act (RCRA) Subtitle C and I programs. This section clarifies the Commission's intent that both a compliance level or performance standard, and a point of compliance that differ from those established in this regulation or in a site-specific hearing by the Commission can be utilized by the relevant agencies where authorized by those programs.

The Commission also notes that, in accordance with Senate Bill 181, for certain categories of activities these standards will be implemented initially by other state "implementing agencies." Section 25-8-202(7), C.R.S. The Commission believes that this system should be efficient and effective. Moreover, if at any time it appears that the other agencies are not taking adequate steps to assure compliance with the standards, the Commission is authorized by SB181 to step back in and take appropriate action.

G. POINT OF COMPLIANCE

The Commission has added significant new provisions to section 3.11.6, regarding points of compliance. In subsection (A) the Commission has now noted the integral relationship between numerical standards and points of compliance. In subsection (B), the Commission has specified points of compliance to apply for the new statewide organic pollutant and radioactive materials standards, unless a different site-specific point of compliance is later adopted by the Commission, or applied by another agency pursuant to its independent authorities.

For situations where significant ground water quality contamination has not yet occurred, the Commission believes that the downgradient limit of the area above which potentially polluting activities are located—the edge of the disturbed area—is a reasonable and environmentally protective point of compliance. However, for situations where contamination exists as of the effective date of these regulatory amendments, the Commission recognizes that it may not always be feasible to clean-up the ground water to the levels established by these statewide standards back to the edge of the disturbed area. Therefore, the alternative potential points of compliance listed in section 3.11.6(B)(1) have been established for such situations. This approach is being adopted to help assure the administrative practicality of applying the new statewide standards, to reduce the administrative burden of potentially numerous site-specific rulemaking hearings before the Commission, and the potential resulting delays in remediation of contaminated sites.

It was suggested during the course of the proceeding that subsection 3.11.6(B)(1) should make a further distinction between facilities at which control requirements have been established as of the effective date of these amendments, and facilities at which such requirements have not been established as of that date. The Commission has rejected this option for several reasons. First, significant factual and legal uncertainties could arise in determining which facilities are ones “at which control requirements have been established.” For example, have control requirements “been established” for a hazardous waste disposal facility operating without a permit?

Second, in order to achieve a preventive program, the Commission believes that activities and facilities that pollute ground water should be put on notice now that they may some day need to comply with these standards, even if they are not currently subject to specific regulatory requirements under an existing program. Section 3.11.6(B)(1) already allows an effective “grandfathering” of some pollution that has occurred prior to the effective date of these statewide standards. The Commission sees no reason to adopt a general grandfathering of future ground water pollution. If site-specific inequities would result from application of the statewide standards and points of compliance, that can be addressed in a site-specific hearing before the Commission (or, in some instances, by the implementing agency). Moreover, if new control regulations are proposed in the future, in a rulemaking proceeding to consider their adoption the Commission would consider whether application of the points of compliance established in this regulation would be appropriate in that new program. If such application would lead to unreasonable or inequitable results, the Commission could apply different provisions at the time, while still protecting the appropriate beneficial uses.

The Commission's overriding concern is that a point of compliance be established that is protective of human health and the environment. The Commission is adopting section 3.11.6(C) to provide further clarification of the approach that it intends to take to considering site-specific points of compliance. That section provides that when requested in a site-specific hearing, the Commission shall adopt a point of compliance closer to the existing source of contamination when the alternative points of compliance provided in section 3.11.6(B)(1) are not protective of human health and the environment. Conversely, section 3.11.6(C) also requires the Commission, when requested in a site-specific hearing, to establish a point of compliance further from the source of contamination than the alternatives provided in section 3.11.6(B) considering the enumerated factors, so long as the point of compliance remains protective of human health and the environment.

By establishing the alternative points of compliance in section 3.11.6(B)(1), for facilities with ground water contamination existing as of the effective date of these amendments, the Commission does not intend to supercede any more stringent ground water quality remediation requirements that may apply under other state or federal authorities. The Commission is attempting in section 3.11.6(B), as a matter of administrative necessity, to provide an initial baseline of protection, while avoiding potential unreasonably stringent results from the application of its statewide standards that are being adopted without taking site-specific conditions into account. Where a more stringent result is required or has been or is determined appropriate as a result of a site-specific analysis under another agency's program, such as RCRA or CERCLA, the Commission does not intend section 3.11.6(B)(1) to preempt that result. The alternative points of compliance established in section 3.11.6(B)(1) shall carry no presumptive weight in a site-specific standards hearing. In site-specific hearings, it is the Commission's intention to consistently apply the standards for establishing a point of compliance in similar circumstances at all remedial sites across the State.

Finally, the Commission has added a new subsection 3.11.6(D) to implement relevant portions of Senate Bill 181. In accordance with this Act, this subsection defers the initial authority to establish points of compliance to the appropriate "implementing agency." SB181 contemplates that implementing agencies will establish points of compliance for activities under their jurisdiction, in accordance with criteria established through rulemaking after public hearing and consultation with the Commission and Division, so as to protect present and future beneficial uses of water. Correspondingly, the ultimate authority of the Commission is retained to step back in and establish points of compliance if necessary to assure a consistent statewide water quality control program, in accordance with the specific provisions of SB181. The Commission intends to monitor the implementation of SB181 closely. In particular, the Commission intends to conduct an informal review of the implementation of these standards one year after their effective date. Hopefully, by that time other agencies will have had an opportunity to complete any required rulemaking and begin applying the standards where appropriate. If necessary, the Commission will at that time consider taking additional action of its own to assure that the standards are implemented in a timely and effective manner.

H. ECONOMIC REASONABLENESS

The new statewide standards for organic pollutants could have an adverse fiscal impact on any persons discharging such pollutants to state waters. It is impossible to quantify that impact at this time. Such impacts will depend to a large degree on the nature of any control regulations subsequently adopted by the Commission to implement these standards, as well as any potential future amendments to the discharge permit regulations to address discharges to ground water. The impacts will also depend on the requirements of other state agencies to implement or assure compliance with water quality standards adopted by the Commission. However, the Commission believes that in general the cost associated with compliance with the standards will be counter-balanced by the environmental benefits associated with protecting beneficial uses, although these benefits are also impossible to quantify at this time. Specifically with respect to future activities that may be subject to these standards, evidence was submitted indicating that preventing ground water contamination generally is less costly than after-the-fact clean-up or remediation.

The Commission has incorporated several elements into these amendments in an effort to make them as economically reasonable as possible, consistent with providing adequate protection of human health and the environment. Examples of these elements include:

1. Use of MCLs, which are set at levels that take technological feasibility into account, as standards for any pollutants for which these levels have been established;
2. Reliance on accepted detection levels as compliance thresholds where the actual standards are more stringent;
3. Establishment of more lenient points of compliance for situations with existing contamination;

41.14 STATEMENT OF BASIS, SPECIFIC STATUTORY AUTHORITY, AND PURPOSE (1990 REVISIONS)

4. Explicit deference to points of compliance established by certain state “implementing agencies;”
5. Provisions for adoption of site-specific standards and site-specific points of compliance to apply in lieu of the statewide provisions where appropriate; and
6. Explicit deference to certain federal regulatory programs which may apply different standards.

Each of these elements is discussed in more detail above, in earlier sections of this statement.

PARTIES TO THE PROCEEDINGS OF THE PUBLIC RULEMAKING HEARING FOR THE BASIC STANDARDS FOR GROUND WATER

1. Holme, Roberts & Owen
2. Vranesh & Raisch
3. Colorado Mining Association
4. City of Colorado Springs
5. North Front Range Regional Planning Agency
6. Homestake Mining Company
7. Rocky Mountain Oil & Gas Association
8. Amoco Production Company
9. Saunders, Snyder, Ross & Dickson
10. Welborn, Dufford, Brown & Tooley
11. Environmental Defense Fund

41.14 STATEMENT OF BASIS, SPECIFIC STATUTORY AUTHORITY, AND PURPOSE (1990 REVISIONS)

The provisions of sections 25-8-202(1)(a), (b), and (2); 25-8-203; and 25-8-204; C.R.S., provide the specific statutory authority for adoption of the attached regulatory amendments. The Commission also adopted, in compliance with section 24-4-103(4) C.R.S., the following Statement of Basis and Purpose.

A. POINT OF COMPLIANCE

The Commission has revised section 3.11.6 to eliminate the previous requirement that the Commission establish a point of compliance at the time of each ground water classification proceeding. The Commission determined that the former approach will often be inappropriate, where classifications are not being established to address a specific contamination source. At the time of a classification proceeding, the Commission may not be aware of all contamination sources within the specified area. In addition, the Commission has determined that establishment of points of compliance by the Division in the first instance is more consistent with the new framework established by Senate Bill 181, adopted in 1989. In this regulation the Commission is now establishing criteria to be taken into account by the Division in establishing such points of compliance. This structure is then parallel to that for other SB181 implementing agencies, who establish points of compliance in accordance with criteria adopted through rulemaking.

A definition of the term “point of compliance” has also been added by the regulatory amendments. The definition reflects the Commission’s view that it generally will be more practical to determine compliance with the standards at a vertical surface downgradient from the regulated activity (as opposed to a point directly below the activity). However, the Commission retains authority to designate a point of compliance other than a vertical surface on a case-by-case basis when a site-specific point of compliance is adopted under section 3.11.6 (E).

IMPLEMENTING AGENCY COORDINATION

In response to SB181, the Commission has amended the Basic Standards for Ground Water to clarify that a point of compliance for activities that are regulated by implementing agencies identified in that statute is not a part of this regulation. Consistent with the spirit of SB181, these other implementing agencies will have the first opportunity to assure that adequate water quality protection is provided by the facilities in question. The Commission anticipates that Memoranda of Agreement entered into between the Water Quality Control Commission and Division and appropriate other agencies will provide a mechanism to assure that the other agencies' programs provide protection that is comparable to that provided by this regulation. Pursuant to SB181, the ultimate authority of the Commission is retained to apply additional regulation to such facilities if necessary to ensure a consistent statewide water quality control program. The Commission intends to monitor the implementation of SB181 closely to assure that an acceptable overall water quality control program is maintained.

A question was raised during the hearing as to whether Commission oversight pursuant to SB 181 of other agencies' activities would be only programmatic, or might also address individual, site-specific actions by such agencies. The Commission anticipates that its oversight generally will be programmatic. However, the Commission has authority to act with respect to individual situations, if it believes its intervention is necessary to assure compliance with the intent of the Water Quality Control Act. Of course, even if the Commission did choose to act in such circumstances, it would be limited to acting through the adoption of control regulations or permit regulations.

WATER QUALITY CONTROL DIVISION IMPLEMENTATION

Section 3.11.6 (D) creates authority for the Water Quality Control Division to establish points of compliance whenever it has authority to do so pursuant to discharge permit regulations or control regulations. The Commission has scheduled a rulemaking hearing later this year to consider revisions to the discharge permit regulations, 6.1.0 (5 CCR 1002-2) to address discharges to ground water. At this time there are no control regulations governing ground water impacts, and no specific regulations of this type have been scheduled for consideration by the Commission. However, the Commission believes that it is advisable to have the point of compliance process in place, so that it should not be necessary to revise this regulation when new control regulations are adopted or the permit regulations are revised.

The Commission intends that determinations of a point of compliance within classified areas, as well as for statewide standards, by the Division will be appealable. The exact process for such appeals would be set forth in amendments to the permit regulations or any new control regulation.

WHERE THE STANDARD IS APPLIED

After standards, the most important issue regarding ground water protection is the physical point at which the standard should be applied. At what point in the aquifer does contamination constitute noncompliance? Among the points considered were the site boundary, the limit of existing contamination, or some specified distance from the contamination source.

It was determined that the site boundary should set the outer limit for a point of compliance (except for surface water discharges, as discussed below) because it distinguished areas that a responsible party controls from areas where the general public may be affected. For the inner limit we chose the edge of the activity or contamination source boundary to minimize the area affected. These limits are consistent with previous Commission rulings on the statewide standards.

For existing activities contamination may have, to some extent, merged with the immediate surroundings, making the contamination source boundary difficult and expensive to define. Where the standards might be exceeded only in the immediate vicinity of a source, the cost of remediation to avoid the exceedence might be unjustified in relation to the benefits of remediation. Therefore, for existing activities the regulation allows the Division to establish the point of compliance at a specified distance from the contamination source, taking into account site-specific facts in accordance with criteria spelled out in the regulation. Application of the standards at the specific activity boundary might not serve the intended purpose of avoiding large expenditures for very little gain, and yet setting some large arbitrary distance would be insufficiently protective. For those facilities who have conducted prior investigations to discover and map the extent of existing contamination, the option exists to set the point of compliance at the leading edge of the plume.

For new activities, new opportunities for site selection and preparation become available. For new sites we propose to apply the standards at the specific activity boundary. In effect, this is as protective as applying them at the specific contamination source (e.g., the point at the bottom of an impoundment at which a leak occurs), while allowing some benefit from sorption and dilution in immediately adjacent ground, in case small leaks occur.

HOW THE STANDARD IS APPLIED

The Commission recognized the difficulty of complying with a concentration limit standard at a fixed point in space, when operating within the temporal and spatial variations inherent in ground water flow.

The intent of any permit or control regulation should be to permit sampling frequency and interpretation that adequately reflects groundwater quality variation over time. Owners and operators should have latitude in this regard provided that an acceptable minimum number of samples are taken from each well annually. At the discretion of the owner/operator a shorter sampling interval may be employed to demonstrate that an exceedence of standards is due to temporal effects. This interval should be determined after evaluating the aquifer's effective porosity, hydraulic conductivity, and hydraulic gradient (which would govern rates of flow), and the fate and transport characteristics of the potential contaminants. This additional effort should help identify seasonal trends in the data and permit evaluation of the effects of seasonal variation or slugs of contamination if present in the samples. To better characterize spatial variability, an owner/operator may wish to install and sample from multiple background and compliance wells. If sufficient data is made available through these additional efforts, the owner/operator may employ statistical procedures such as moving averages and trend analysis to reduce seasonal and temporal effects. Utilization of site-specific characterizations to statistically evaluate an exceedence of standards requires detailed knowledge of the site. For owners/operators to use these methods they should be able to identify the uppermost aquifer, and aquifers hydraulically interconnected beneath the facility property, including groundwater flow direction and rate, and the basis for that identification.

In many situations it may benefit the owner/operator to install intermediate monitoring points. These monitoring points could be closer to the source or activity, or within the unsaturated zone. The monitoring points could function to alert the owner/operator to a potential contamination problem before it reaches the point of compliance.

“CONTAMINATION” DEFINITION

Because it is used several times in the point of compliance provisions, a definition of the term “contamination” has been added to the definitions section. This term is defined broadly, to provide a threshold determination of when non-naturally occurring pollution is present, and to help identify the appropriate locations for points of compliance. This definition does not determine who is responsible for cleaning up any specific contamination. It is not the Commission's intention by this broad definition to make individuals responsible for contamination caused by others. Nor is it the Commission's intention to adopt an antidegradation standard for ground water. The regulation does not state that all “contamination” must be avoided or cleaned up; rather, any adopted ground water standards remain the target for regulatory activities.

HYDROLOGICALLY DOWNGRADIENT LIMIT

Concern was expressed during the hearing regarding the use of the term “hydrologically downgradient limit.” This phrase is commonly used in the industry. Generally, it refers to the “downstream” edge of the ground water in question. For example, “the hydrologically downgradient limit of the area below the activity potentially impacting ground water quality” is located by a vertical plane at the immediate edge of the surface activity in question, on the side of the activity toward which the ground water is flowing.

SURFACE WATER DISCHARGES

The Commission has included in section 3.11.6 (D) language to address points of compliance for surface water discharges that may adversely impact ground water. Specifically, the Commission has added a cross-reference to the Discharge Permits System Regulations, where such points of compliance will be addressed. The Commission also added language to section 3.11.6 (D)(1)(b)(iii) and (D)(2)(b)(iii) to add the quality of water discharged to the factors to be considered by the Division in setting points of compliance.

B. OTHER REVISIONS

1. Table Corrections.

Other changes to the Basic Standards, first pointed out at the triennial review, involve corrections to table 1 and table A. In table 1 duplicative standards that are already established in the statewide standards for radioactive materials and organic pollutants have been deleted. In table A the detection level for the pesticides chlordane, DDT, and dieldrin were incorrectly listed in the GC/MS column. The corrected detection level of 0.1 ug/l is now under the GC column heading. These pesticides are part of a chemical group known as chlorinated organics and therefore should be tested by the GC method only. Concern was expressed at the hearing as to whether a second column confirmation would be conducted to achieve these practical quantitation limits. Dr. Sexton of the Health Department Laboratory testified that they routinely use such confirmations in accordance with the EPA methods.

2. Molybdenum Standard.

The Commission has agreed in response to a proposal by AMAX, Inc. to delete the previous molybdenum standard from Table 3, Agricultural Standards. The Commission has taken this action because it does not believe that the information submitted in the hearing was adequate to support any specific numerical standard at this time. The Commission has not made a determination that molybdenum poses no risk to potential beneficial uses of ground water, If better information is submitted at a later date regarding an appropriate numerical protection level for molybdenum, the Commission will reconsider the potential need for a standard at that time.

41.15 STATEMENT OF BASIS, SPECIFIC STATUTORY AUTHORITY, AND PURPOSE (1991 REVISIONS)

PARTIES TO THE PROCEEDINGS OF THE PUBLIC RULEMAKING HEARING FOR THE BASIC STANDARDS FOR GROUND WATER

1. Holme, Roberts & Owen
2. Vranesh & Raisch
3. Colorado Mining Association
4. City of Colorado Springs
5. North Front Range Regional Planning Agency
6. Homestake Mining Company
7. Rocky Mountain Oil & Gas Association
8. Amoco Production Company
9. Saunders, Snyder, Ross & Dickson
10. Welborn, Dufford, Brown & Tooley
11. Environmental Defense Fund

41.15 STATEMENT OF BASIS, SPECIFIC STATUTORY AUTHORITY, AND PURPOSE (1991 REVISIONS)

The provisions of section 25-8-202(1)(a),(b) and (2); 25-8-203; and 25-8-204; C.R.S., provide the specific statutory authority for adoption of the attached regulatory amendments. The Commission also adopted, in compliance with section 24-4-103(4) C.R.S., the following statement of basis and purpose.

STATEWIDE NUMERICAL STANDARDS

1. Organic Chemicals.

In 1989, the Commission adopted certain interim organic pollutant standards, applicable to ground water statewide. Several revisions and additions to those interim standards are now being adopted. In general, the primary purpose of these changes is to provide a more thorough system to assure protection of Colorado's water resources with respect to potential adverse impacts from organic chemicals. One change adopted is to combine previous Tables A and B into a single, consolidated Table A. The Commission believes that this format will be easier to read, and helps to assure elimination of potential inconsistencies between the separate tables.

a. Risk-based Water Supply Standards.

When the Commission adopted interim organic chemical standards in 1989, the Commission adopted standards based on maximum contaminant levels (MCLs) for all pollutants for which MCLs had been established under the Safe Drinking Water Act. The Commission has now reevaluated this policy and adopted health-based standards for these constituents instead of standards equal to the MCLs, whenever health-based criteria are available. Several considerations have led to this new approach.

The vast majority of the standards adopted in 1989 were already set equal to health-based criteria. MCLs generally are more lenient than health-based criteria, and have been developed taking into account laboratory detection limits and the economic ability of water suppliers to treat for removal of these constituents. The Commission already has attempted to temper the application of stringent health-based standards for non-MCLs organic pollutants by providing for the application of the practical quantitation limit (PQL) concept in determining compliance with the standards. Any dilution present prior to the point of compliance would further temper the application of these standards. Therefore, the Commission has determined that it is a more appropriate policy to base these water quality standards on health-based criteria, rather than MCLs. Revisions have been made to the standards, as now contained in the consolidated Table A.

b. Other Revisions.

Standards for a number of additional organic chemicals have been added to the Basic Standards for Organic Chemicals Table in the Basic Standards and Methodologies for Surface Water to help complete Colorado's compliance with section 303(c)(2)(B) of the federal Clean Water Act. The chemicals added are ones listed as priority toxic pollutants, and for which EPA has developed human health or aquatic life criteria under the Clean Water Act. The same additions have been made to the revised Table A in this regulation, for consistency between ground and surface water standards for organic chemicals.

The Commission decided not to include in the consolidated Table standards for total trihalomethanes or for polynuclear aromatic hydrocarbons (PAHs) as a class. The Commission believes that it is more practical to regulate individual chemicals in these groups. Some evidence was submitted indicating that not all PAHs should have the same standard. For now the Commission has adopted these standards based on the available EPA criteria, although if more specific evidence on this issue is brought to the Commission in the future, revisions can be considered.

Several minor clarifications have been adopted for Table A. A footnote has been added to the "standard" column to indicate that these are chronic water quality standards. The "detection levels" column has been relabeled "PQLs", to clarify that the values indicated are practical quantitation limits. In addition, the PQLs for a few parameters were revised to be consistent with the current information from the Colorado Department of Health laboratory.

PARTIES TO THE RULEMAKING HEARING FOR BASIC STANDARDS & METHODOLOGIES FOR SURFACE AND GROUND WATER

1. Adams Rib Recreational Area
2. EG&G Rocky Flats
3. Northwest Colorado Council of Governments
4. The Grand County Water & Sanitation District #1, Fraser Sanitation District and Winter Park Water and Sanitation District
5. The Metro Wastewater Reclamation District
6. Amax, Inc.
7. Kodak Colorado Division
8. Paramount Communications Inc.
9. Schlage Lock Company
10. The Colorado Water Congress
11. Chevron Shale Oil Company
12. Adolph Coors Company
13. Remedial Programs Section, Hazardous Materials & Waste Management Division, Colorado Department of Health
14. Umetco Minerals Corporation
15. Martin Marietta Corporation
16. Shell Oil Company
17. Cotter Corporation
18. Union Oil Company of California
19. Supervisory Committee of the Littleton-Englewood Bi-City Wastewater Treatment Plant
20. Arapahoe County Water and Wastewater Authority
21. City of Colorado Springs Wastewater Department
22. Colorado Wastewater Utility Council
23. Colorado Mining Association
24. Getty Oil Exploration Company and Texaco
25. Colorado River Water Conservation District
26. Exxon Company, USA
27. St. Vrain and Left Hand Conservancy District
28. Division of Wildlife
29. North Front Range Water Quality Planning Association

41.16 STATEMENT OF BASIS, SPECIFIC STATUTORY AUTHORITY, AND PURPOSE (1993 REVISIONS-DIMP STANDARD)

30. City of Westminster
31. City of Colorado Springs Water Department
32. Res-ASARCO
33. Three Lakes Water & Sanitation District
34. City of Arvada
35. Northern Colorado Water Conservancy District and the Municipal Subdistrict, Northern Colorado Water Conservancy District
37. Environmental Defense Fund
38. Cherokee Water and Sanitation District, Security Sanitation District, and the Fountain Sanitation District

41.16 STATEMENT OF BASIS, SPECIFIC STATUTORY AUTHORITY, AND PURPOSE (1993 REVISIONS-DIMP STANDARD)

The provisions of Colorado Revised Statutes (C.R.S.) Sections 25-8-202(1)(b), (2), and 25-8-204 provide the specific statutory authority for adoption of the attached regulatory amendment regarding a statewide ground water standard for diisopropylmethylphosphonate. In support of the regulatory amendment and in accordance with 24-4-103(4) C.R.S., the following statement of basis and purpose is provided.

I. Overview

a. Diisopropylmethylphosphonate (DIMP)

The purpose of this hearing was to consider the adoption of statewide water quality standards for diisopropylmethylphosphonate (DIMP). DIMP is a liquid chemical, a by-product from the manufacture and detoxification of a nerve agent, Sarin or GB (isopropylmethane fluorophosphonate), produced by the U.S. Army (Army) at the Rocky Mountain Arsenal in the 1950s. This is an area on the Front Range of the Rocky Mountains, just north of Denver. The Army disposed of DIMP, along with other chemicals, primarily in surface impoundments at the Rocky Mountain Arsenal where it leached into the underlying soils and ground water. The Water Quality Control Commission has heard testimony indicating that DIMP contamination has been detected in the surface and ground water within and outside the boundaries of the Rocky Mountain Arsenal, although ground water contamination exists in the greatest concentrations and is the most prevalent.

The Commission has heard evidence demonstrating that a significant quantity of ground water in the vicinity of the Rocky Mountain Arsenal is contaminated with DIMP. DIMP has been detected in certain drinking water wells located up to 5 miles downgradient of the Rocky Mountain Arsenal. In addition, the evidence indicates that DIMP-contaminated ground water near the Rocky Mountain Arsenal discharges to certain irrigation ditches and affects First Creek, a tributary to the South Platte River. For approximately the last three years, the State has been providing bottled water for consumption and cooking to residents and businesses whose wells were found to contain DIMP, although it is uncertain how long funds will be available to continue this program.

b. Scope of Evidence and Information

The Commission was presented with, and considered, a voluminous amount of evidence in this rulemaking. The majority of the evidence addressed the risk associated with exposure to DIMP and the toxicity of the chemical. The Commission heard approximately twenty-five hours of oral testimony from more than twenty witnesses for the Colorado Department of Health, the Army, the Shell Oil Company (Shell), the Arsenal Action Alliance, and the Environmental Protection Agency (EPA), as well as comments by members of the public and commentary by an expert advisory panel of toxicologists. The Commission received and considered literally thousands of pages of written testimony and exhibits from parties and the expert advisory panel. A Regulatory Analysis was prepared by Water Quality Control Division staff in response to a request by one of the parties. The Commission devoted a significantly greater amount of time in hearing testimony and considering written submissions, compared to the majority of water quality standard-setting proceedings it undertakes. Moreover, this hearing addressed the adoption of a water quality standard for a single contaminant, whereas most hearings address multiple pollutants and multiple segments.

Because of the importance of this proceeding, prior to the hearing the Commission took the unprecedented step of requesting that the parties and the Department of Health fund an independent expert advisory panel to provide testimony to the Commission on toxicology issues relating to DIMP. The expert advisory panel, which consisted of three toxicologists who were qualified to discuss risk assessment, assisted the Commission in objectively understanding the large volume of evidence regarding the toxicity of DIMP. The expert advisory panel provided a background educational briefing to the Commission, reviewed the written record, prepared a report for the Commission generally discussing the toxicity information and the different positions of the parties, attended the hearing and asked questions of witnesses, made an oral presentation to the Commission, and responded to questions from the Commission. The Commission found the explanation and clarification of the large amount of evidence by the expert advisory panel very helpful. In accordance with an agreement between the Department of Health, Shell and the Army, and upon advice by the Attorney General's Office, the panel did not advocate or offer a recommendation as to whether a water quality standard for DIMP should be adopted, or, if so, at what level.

Prior to these proceedings, there were no enforceable federal or state standards for DIMP. In 1989, the EPA's Office of Drinking Water issued a lifetime Health Advisory, which is not an enforceable standard, of 600 ug/l (micrograms per liter, also expressed as parts per billion) for DIMP. The EPA Health Advisory is based on a 1980 study of beagle dogs exposed to DIMP over a period of ninety days. 1

The Department of Health initiated these water quality proceedings by requesting that the Commission adopt a statewide standard for DIMP of 8 ug/l, based on its evaluation of the relevant toxicology studies and selection of the 1979 Aulerich mink study 2 as the critical study upon which to base the water quality standard. In the Aulerich study, a significant number of female mink died over the course of their one year exposure to DIMP. Based on this and a more recent study with mink 3, the Department of Health is concerned about the public health threat associated with DIMP exposure, particularly long-term or lifetime exposure, and derived its proposed standard to protect against these possible effects. In deriving its proposed standard of 8 ug/l for DIMP, the Department of Health followed EPA risk assessment methodology published in EPA's Integrated Risk Information System (IRIS) guidance. The Department of Health presented witnesses and exhibits supporting its recommended standard for DIMP of 8 ug/l. The State's consultant, Dr. Edward Calabrese, recommended a more stringent standard of 0.36 ug/l based on the Aulerich study, but employed certain factors in deriving that recommendation which the Department of Health, based on its professional judgment and the IRIS guidance, chose not to incorporate in its derivation of the recommended standard.

The EPA provided a witness who explained the toxicological basis for that agency's DIMP Health Advisory, and also discussed other issues related to the toxicity of DIMP. The Army and Shell offered witnesses and exhibits supporting the EPA Health Advisory of 600 ug/l on a site-specific basis, although one witness for Shell supported a standard of 500 ug/l later in the proceedings.

The Arsenal Action Alliance provided testimony and exhibits supporting its recommendation that a DIMP standard of 0 ug/l be adopted by the Commission. This position was based largely on that entity's general policy concerns regarding toxins and pollutants in the environment, although it referenced as support Dr. Calabrese's 1990 report regarding DIMP toxicity. The Commission also heard considerable testimony from the public regarding the significant health concerns raised by the presence of DIMP in domestic water supplies.

Accordingly, the toxicological testimony supporting the various recommended standards primarily involved three studies, the 1980 Hart dog study lasting ninety days, the 1992 Bucci study with mink lasting ninety days, and the 1979 Aulerich mink study lasting one year. As the expert advisory panel acknowledged, interpreting the toxicological data from these and the other relevant DIMP studies in the risk assessment context involves professional judgment, and there were differing opinions among the various experts on behalf of the parties regarding the results of these studies.

One question that arose near the conclusion of this process was whether a transcript of the Commission's deliberations regarding the issues raised in this rulemaking proceeding should be made a part of the hearing record. The Commission has decided not to include the deliberations transcript in the record, because it believes that to do so may result in confusion regarding the basis for the Commission's ultimate determination. During deliberations it is typical for many perspectives to be offered and many options advanced and "tested" by individual Commission members. However, it is ultimately only this Statement of Basis, Specific Statutory Authority, and Purpose that accurately reflects the final views of the full Commission. It is this document that sets forth the basis for the Commission's decision, not some or all of the individual comments made during the deliberative process.

c. Summary of Basis for Decision

Following consideration of the extensive information briefly summarized above, the Commission has decided to establish a statewide interim ground water quality standard for DIMP at 8.0 ug/l, with an accompanying practical quantitation limit (PQL) of 1.0 ug/l. The ultimate basis for this decision is a policy judgment regarding what level of DIMP is protective of public health and the beneficial uses of water, in the face of credible but differing scientific interpretation of the information regarding the toxicity of DIMP.

The Commission has experienced considerable frustration in coming to the realization that the extensive information and data presented in the record does not lead to the identification of one scientifically "correct" value for the toxicity of DIMP upon which all experts can agree. EPA, which issued a lifetime Health Advisory for DIMP, has indicated that it has "low confidence" in the standard it recommends. Based upon the information provided by the parties, the public, and the Department of Health staff, and the explanations and clarifications of this scientific evidence provided by the expert advisory panel, it is the Commission's judgment that it is ultimately faced with a range of scientifically supportable interpretations of the evidence regarding the toxicity of DIMP. The Commission acknowledges that each of these interpretations carries with it a degree of uncertainty. In the face of this uncertainty, the Commission must exercise its policy judgment. Even a decision to adopt no standard for DIMP would entail substantial uncertainty — uncertainty as to whether public health and the beneficial uses of water would be adequately protected until better information might become available in the future.

Fully cognizant of the existing scientific uncertainty, the Commission has determined that there is a need for the adoption of a statewide ground water quality standard for DIMP at the level of 8 ug/l, in view of the evidence submitted regarding the presence of DIMP in some waters of the State as described above and the evidence regarding the toxicological risk posed by DIMP (as discussed briefly above, and further discussed in section II of this Statement of Basis and Purpose). This standard is derived from the results of the 1979 Aulerich study. The Commission is concerned by the death of female mink observed at each dose level in that study, and cannot ignore these results. The Commission believes that the statewide standard of 8 ug/l is necessary to protect public health and the beneficial uses of waters of the State at this time, and that the standard is based on sound scientific and technical evidence in the record.

The Army and Shell have stated their belief that the Commission's selection of an 8 ug/l standard is based upon a public policy choice that "was not supported by the weight of the scientific evidence." This assertion is a misleading characterization of the basis for the Commission's action. The Commission finds that there is substantial and sufficient scientific and technical evidence in the record to support this standard. The fact that other standards could also be defended from a scientific and technical standpoint based upon the information submitted does not mean that there is no such basis for the standard selected.

This Statement of Basis, Specific Statutory Authority, and Purpose does set forth "an evaluation of the scientific or technological rationale justifying the rule," as required by the State Administrative Procedure Act. §24-4-103(4)(c). Indeed, in view of the importance of and controversy surrounding this determination, the Commission has taken pains to assure that this evaluation is substantially more extensive than that typically provided for the adoption of water quality standards. However, the Commission rejects the interpretation of the Administrative Procedure Act and Water Quality Control Act requirements implicit in the position advocated by the Army and Shell, which would appear to lead to the conclusion that whenever there is scientific disagreement or any remaining level of uncertainty regarding the appropriate standard to be adopted, the Commission is required to adopt the least stringent scientifically defensible standard. The Commission does not believe that this interpretation is mandated by law, and in fact believes that it would be contrary to the Commission's mission as set forth in the Water Quality Control Act.

The Commission previously considered the adoption of water quality standards for DIMP in January, 1991. The Commission eventually decided not to adopt any standards for DIMP as a result of that proceeding, in part based upon the representations of the Army that new DIMP toxicity studies then being conducted and scheduled for completion in 1992 would provide additional information that might address some of the uncertainty surrounding the interpretations of the studies completed prior to that time. It had been the Commission's hope that a new mink study of at least one year's duration, including at least one reproductive cycle for female mink, would be completed to essentially reassess the results of the 1979 Aulerich mink study, which was the focus of substantial debate in 1991 and again in this 1993 rulemaking hearing. Unfortunately, the additional studies conducted were not of a design or duration to provide this reassessment. Moreover, based upon the information presented in these proceedings it now appears unlikely that a new study of this scope, design and duration is likely to be completed in the foreseeable future. Therefore, the Commission believes that further delay or inaction on its part would be inappropriate. Accordingly, the Commission believes it must exercise its judgment based upon the information available now as presented in the 1993 rulemaking hearing, and adopt a standard to protect against the potential adverse health effects associated with DIMP exposure and to help ensure that DIMP does not become a more widespread threat to human health and the waters of the State.

This decision does not mean that the Commission is not open to reconsidering appropriate water quality standards for DIMP should additional relevant information become available in the future. Consistent with the Commission's practice for statewide standards for other organic chemicals, the DIMP standard is being adopted as an interim statewide standard. This standard is fully effective and enforceable once promulgated. However, the "interim" label recognizes the potential for future modifications should additional relevant information become available. In this regard, the Commission's statement concerning the adoption of interim statewide organic pollutant standards in 1989 applies here:

As new information becomes available and potential conflicts among the various numerical levels are resolved, it may be appropriate in specific instances in the future to adopt permanent standards either more or less stringent than the interim standards being established at this time. However, given the importance of controlling toxic pollutants in the environment, the Commission believes that it is necessary to move forward with the adoption of interim statewide standards at this time, and that the interim standards adopted are reasonable based on the best currently available information.

II. Selection of Numerical Level for Standard

a. Toxicological Basis

As briefly described above, the Water Quality Control Commission has heard and considered substantial testimony and scientific evidence regarding the toxicity of DIMP and the risk associated with DIMP exposure. The Commission believes that a statewide interim standard for DIMP of 8 ug/l is necessary and appropriate to protect the citizens of Colorado and the waters of the State, and is based on sound scientific evidence as presented by the Department of Health and the parties to the hearing. The Commission's determination follows EPA risk assessment methodology, as applied to the available information regarding DIMP toxicity. In summary form, the Commission's substantive basis for adopting the 8 ug/l statewide standard for DIMP in ground water is described below.

There are no studies of human exposure to DIMP that can be used in deriving a health-based drinking water standard. Of the most relevant animal studies regarding DIMP toxicity, the Commission has identified the 12 month mink study undertaken by Aulerich, as the critical animal study from which to derive a water quality standard. The Commission believes this is the critical study because none of the other species of animal used in other DIMP studies are proven to be of superior extrapolative relevance to humans; the 12 month mink study had the longest duration of all the animal studies; the 12 month study used a relatively large number of animals; and, the mink in the 12 month study proved to be the most sensitive of all the animals exposed to DIMP (exhibiting an increasing linear mortality relationship to their exposure to DIMP). This selection of the critical study comports with accepted risk assessment principles, including EPA's IRIS guidance.

The Commission recognizes the disagreement among scientific experts regarding the cause of death of mink in the 1979 Aulerich study and the issues surrounding background mortality for mink. However, the Commission agrees with the expert advisory panel's conclusion that the possibility that the mink deaths resulted from administration of DIMP could not be ruled out. The Aulerich 12 month mink study is the only study lasting one full year. Although experts debate over the significance of the results of the Aulerich study, the Commission recognizes that a dose-response relationship was exhibited during the study. This fact is troubling and cannot be ignored from a public health perspective, particularly because the end-point was mortality. No other studies to date have addressed female mink exposed before, during and through the reproductive cycle. The Commission also recognizes that adverse blood effects, among others, were observed in mink in the 90 day Bucci study, and that these effects were still increasing in severity when the study was completed at 90 days.

Given the Aulerich study's statistically significant mortality rate at the highest dose level, the statistically significant linear dose-response relationship across all doses, and the highly biologically significant endpoint, the Commission believes it is an appropriate scientific and policy decision to base the DIMP standard of 8 ug/l on the information available currently to the Commission regarding mortality in female mink. The Commission recognizes that there was a difference of opinion among experts in the hearing regarding the relevance of the linear regression (trend) analysis of mortality across the different dose levels to select a Lowest Observed Adverse Effect Level. One member of the expert advisory panel commented that such trend analysis could result in more false positive conclusions compared to other relevant statistical tests. Recognizing this concern as well as the advantages of trend analysis, the difference of opinion among experts, and that the end-point was mortality in female mink, the Commission has chosen to use this potentially more conservative approach as part of its analysis.

The Commission recognizes there was considerable debate in the testimony regarding whether to incorporate in the statistical analysis of the 1979 Aulerich DIMP study the female mink deaths observed in the control group of a parallel 1979 study with dicyclopentadiene (DCPD). The expert advisory panel discussed the results of the DCPD study and noted that, because of atypical circumstances, they “should be factored in the overall analysis” of the results of the Aulerich DIMP study. The Commission has considered this information, as well as countervailing evidence presented that it is unorthodox to use data from a different study to statistically evaluate the results of the primary study that is being considered, and that statistical comparison using the concurrent control group from the primary study is the norm. There was evidence both supporting and challenging the notion that the two studies were sufficiently similar to allow their respective results to be commingled. There is considerable professional judgment involved in evaluating the available data in risk assessment, and the Commission is concerned by the direct linear increase in female mink mortality observed between the control group and the successive treatment groups in the 1979 Aulerich DIMP study. Considering the above, the Commission has decided to follow scientific convention and use only the data from the 1979 Aulerich DIMP study to evaluate the death of female mink in that study.

With the selection of the Aulerich study as the critical study, following accepted risk assessment guidance, the Commission derives the recommended standard as follows:

- (1) The Lowest Observable Adverse Effect Level (LOAEL) 4 in the 12 month mink study was at the 11 mg/kg/day dose level (the lowest dose) because at this dose level the end-point of concern (female mink mortality) was both statistically and biologically significant. 5
- (2) In accordance with EPA methodology for risk assessment, the relevant Uncertainty Factors to be applied to the LOAEL of 11 mg/kg/day in the Aulerich study are: (i) interspecies variation, (10), (ii) intra-species variation (10), (iii) less than lifetime exposure (10), and (iv) conversion from LOAEL to NOAEL (10), for a total Uncertainty Factor of 10,000.
- (3) The Commission recognizes that the LOAEL identified in the critical study was for death in female mink. This critical effect level, therefore, is actually a Frank Effect level. 6 Given that the endpoint was a Frank Effect Level and not a subtle, reversible toxic effect, and that the critical study has not been replicated to verify the results or better characterize the biological response in that study, it is appropriate to consider the application of a Modifying Factor 7 . The Commission chooses to follow the professional judgment of the Department of Health that in this instance the appropriate Modifying Factor is 1 because of the overall protection provided by the four Uncertainty Factors adopted by the Commission, although it appears that the evidence could also support a larger Modifying Factor. Therefore, the total Uncertainty Factor of 10,000 will not change based on the Modifying Factor.
- (4) Deriving a safe human dose, commonly referred to as the Reference Dose (or RfD), the LOAEL is divided by the final total Uncertainty Factor of 10,000.

$$\frac{11 \text{ mg/kg/day}}{10,000} = 0.0011 \text{ mg/kg/day}$$

- (5) The water quality standard is derived using standard EPA methodology - multiplying the Reference Dose by (i) the average adult body weight of 70 kg and (ii) the relative source contribution from water of 20% (0.2), and then dividing this figure by (iii) the average drinking water consumption of 2 liters/day.

$$\frac{0.0011 \text{ mg/kg/day} \times 70 \text{ kg} \times 0.2}{2 \text{ l/day}} = 0.0077 \text{ mg/l.}$$

$$0.0077 \text{ mg/l} = 7.7 \text{ ug/l, which is rounded to } 8 \text{ ug/l.}$$

Based on the information available and evidence presented during these rulemaking proceedings, the Commission believes the statewide groundwater standard for DIMP of 8 ug/l is necessary, scientifically justified and supported by the record. Also, as described above, the Commission has fully considered the relevant evidence regarding the risk associated with the pollutant, and the extent of such pollution to be tolerated as a goal, in deciding to adopt the standard for DIMP of 8 ug/l.

b. Technological Basis

Based on evidence presented to the Commission in these proceedings, the Commission believes it is technically and economically feasible and practical to treat water contaminated with DIMP with granular activated carbon to achieve a DIMP effluent concentration in water of 8 ug/l or less. There is evidence in the record that other treatment technologies might also be practical and technically and economically feasible to achieve the adopted standard.

The Commission recognizes that the Army and Shell are currently undertaking ground water remediation at and near the Rocky Mountain Arsenal employing granular activated carbon; that their existing ground water treatment systems are treating ground water for DIMP prior to discharge and are capable of achieving the adopted DIMP standard of 8 ug/l; that the existing ground water treatment systems may have to be reconfigured or costs associated with those systems may be increased; and that, if adopted as an applicable or relevant and appropriate requirement under the federal Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) remediation process or applied as a standard pursuant to any other law, new or additional ground water treatment systems may be required of the Army and Shell in order to meet the adopted statewide ground water standard for DIMP. The Commission recognizes that costs may be associated with meeting the adopted standard if DIMP is discovered in ground water elsewhere in the State. It is the hope of the Commission that public health and the waters of the State can be protected in a cost-effective manner when the standards it adopts are applied in any regulatory or remedial context. However, the Commission finds that in general the costs associated with compliance with the adopted DIMP standard, wherever compliance may be required, will be counter-balanced by the public health and water quality benefits achieved.

c. Consideration of Statutory Requirements

As described in part above, in promulgating the statewide ground and surface water quality standards for DIMP, the Commission has considered the factors enumerated in Section 25-8-204(4), C.R.S. The Commission has considered evidence regarding the extent of DIMP contamination and the risk associated with DIMP exposure. The Commission is aware that DIMP is a non-naturally occurring pollutant and it is also a "continuous" pollutant in the ground water (versus "intermittent" or "seasonal") in the currently known affected area. The Commission has also considered the technical evidence regarding treatment, and has concluded that treatment techniques to achieve the statewide standard of 8 ug/l are available, practical, and technically and economically feasible. As discussed above, the Commission recognizes the potential economic impacts associated with the adopted standard for DIMP, but believes these potential impacts will be counter-balanced by the public health and water quality benefits achieved. No evidence was submitted indicating that treatment for DIMP would have a significant impact on water quantity. Based on all the evidence presented, as summarized above, the Commission believes that there is a strong need for a statewide standard for DIMP of 8 ug/l at this time to support the beneficial uses of State waters, including drinking water, and that the standard adopted is appropriate and scientifically supported by the record.

d. Senate Bill 181 Requirements

Colorado Senate Bill 181, adopted in the 1989 legislative session and codified in part in Section 25-8-202(8)(a), C.R.S., includes provisions that apply when the Commission adopts “rules more stringent than corresponding enforceable federal requirements.” In the 1989 revision to the Basic Standards for Ground Water 3.11.0 (5 CCR 1002-8), the Commission interpreted these provisions to be inapplicable to the rulemaking since there were no “corresponding enforceable federal requirements” that establish ambient ground water quality standards. Likewise, the provisions of C.R.S. Section 25-8-202(8)(a) are inapplicable to the proposed rulemaking on DIMP because, as stated above, there are no enforceable federal requirements for DIMP. Even if Section 25-8-202(8)(a) were applicable, the Commission finds that the standard adopted is based on sound scientific and technical evidence in the record.

III. Decision to Adopt a Statewide Standard

In establishing a statewide standard for DIMP the Commission has determined that DIMP should be controlled on a statewide basis, wherever it is found in the waters of the State, within or outside the Rocky Mountain Arsenal. While the present known contaminated area is limited, the Commission recognizes that the ultimate clean-up and remediation actions for the Rocky Mountain Arsenal may not be finally determined, or may not be put in place, for many years. In establishing a statewide standard, the Commission also intends to ensure that future disposal and handling practices associated with the clean-up and remediation do not adversely affect surface or ground water resources anywhere in the State, and that new contamination problems associated with DIMP do not arise elsewhere in the future.

Much of the rationale for the Commission's 1989 adoption of statewide standards for organic chemicals applies with respect to DIMP (see, Section 3.11.10; revised in 1991, Section 3.11.12). The Commission believes that as a matter of policy all potential beneficial uses of water should be protected on a statewide basis from potential contamination from non-naturally occurring organic chemicals. This policy was reflected in the Commission's 1989 adoption of statewide standards for surface and ground water for approximately 55 organic chemicals. The current adoption of the DIMP standard is a consistent extension of this policy. As with the other organic chemicals, DIMP is a non-naturally occurring pollutant for which a statewide standard is appropriate. Unlike certain other potential pollutants, there is no need to take natural background levels for DIMP into account on a site-specific basis in adopting standards. DIMP is a “continuous” pollutant in the ground water at and near the Rocky Mountain Arsenal, with an estimated half-life of over 500 years, so the adoption of a statewide standard that applies at all times, and that protects future water supplies, is appropriate. As Water Quality Control Division staff testified, there are other statewide standards for chemicals that exist in limited areas of the State, such as chlorobenzene, for example.

The Commission also intends to set a statewide standard in order to protect any state waters that are not yet known to have DIMP contamination, if any are found to exist. The Commission intends that the standard should be applied uniformly wherever DIMP may be a concern in the State, currently or in the future, and that the standard is generally applicable and legally enforceable throughout the State pursuant to statute and associated regulations.

41.17 STATEMENT OF BASIS, SPECIFIC STATUTORY AUTHORITY, AND PURPOSE (1993 REVISIONS)

The parties to the hearing have expressed differing opinions regarding the Commission's intent on how its statewide water quality standards will be used as cleanup standards in other statutory programs. In a letter to the Commission, Shell appears to interpret Sections 3.11.5(C)(5)(a) (regarding statewide ground water standards) and 3.1.11(5) (regarding statewide surface water standards), 5 C.C.R. 1002-8, of the Commission's regulations to mean that the Commission "did not intend" for its standards to be applicable or relevant and appropriate requirements (ARARs) under CERCLA (i.e., cleanup standards) or to be enforced as cleanup standards under other statutes. Shell interprets those sections to mean that the Commission believes "it is in the discretion of other agencies" to apply or ignore the statewide standards as cleanup standards, and that the Commission intended to "specifically defer to the discretion of other agencies in setting cleanup levels at Superfund sites." This is an inaccurate expression of the Commission's intent. Instead, the Commission intends for its standards to be used as cleanup requirements, including at CERCLA sites, except in the limited circumstances where "a determination is made that such a variation is authorized pursuant to the applicable provisions" of those federal statutes [§ 3.11.5(C)(5)(a); § 3.1.11(5)].

These cited sections were added to the Commission's regulations in 1989 as simple clarifying statements to address potential conflicts between the Commission's statewide standards and other remediation requirements under the federal programs. The Commission is simply stating that it does not attempt to preempt a federal law, such as CERCLA, by mandating the use of its specific water quality standards as cleanup standards in instances where the federal program is authorized to use a different standard, more or less stringent, and where such programs dictate that the different standard be applied. See e.g., § 3.11.10 (F). The Commission's regulations do not provide that any agency has open-ended discretion to choose to apply or disregard the Commission's standards as cleanup requirements. The Commission intends for its standards to be used as cleanup standards; the Commission understands that in certain federal programs, such as CERCLA, the federal agency can waive a state standard, but only if certain specific statutory requirements have been met. From the Commission's perspective, the standards cannot be waived based on the federal agency's mere discretion whether to use them or not.

IV. Selection of a Practical Quantitation Limit

The Commission has heard testimony from the Department of Health's Laboratory on its routine analytical capability and procedure for DIMP analysis, and has determined that the Practical Quantitation Limit (PQL) for DIMP should be set at 1.0 ug/l. The Commission credited the testimony that the Department of Health Laboratory has devised a reliable and effective methodology for analyzing DIMP. The Commission also considered the evidence that the Army has been reporting levels of DIMP above .392 ug/l since 1988, demonstrating that the Department of Health Laboratory's PQL could be reproduced by other laboratories. The basis for this PQL is consistent with that underlying PQLs for other statewide organic chemical standards. Because the adopted standard is higher than the PQL of 1.0 ug/l, this value should have little practical significance.

PARTIES TO THE RULEMAKING HEARING

1. Colorado Department of Health
2. United States Department of the Army
3. South Adams County Water and Sanitation District
4. Shell Oil Company
5. Arsenal Action Alliance

41.17 STATEMENT OF BASIS, SPECIFIC STATUTORY AUTHORITY, AND PURPOSE (1993 REVISIONS)

The provisions of section 25-8-202(1)(a), (b) and (2); 25-8-203; and 25-8-204; C.R.S., provide the specific statutory authority for adoption of the attached regulatory amendments. The Commission also adopted, in compliance with section 24-4-103(4) C.R.S., the following statement of basis and purpose.

ADDITIONAL ORGANIC CHEMICALS - TABLE A

In 1991, Table A, Ground Water Organic Chemical Standards, was updated to set health risk-based standards where MCLs had been established earlier. In this rulemaking, the same policy was followed for forty-five additional organic chemicals that have been promulgated by EPA in the National Primary Drinking Water Regulations as Maximum Contaminant Levels (MCLs), either in EPA's Phase II Rule (Fed. Reg. Jan. 30, 1991), or the Phase V Rule (Fed. Reg. July 17, 1992). Rather than establish the MCL as the standard, however, the Commission chose to continue with its policy to set a health risk-based standard at the 1:1,000,000 level using the same rationale as it did in 1991. That rationale is that MCLs are inappropriate as stream or ground water standards because they include economics and technical feasibility of removal in their development, whereas a standard is designed to fully protect the use of the water. Since dilution is present to temper the effect of applying the health-based standards to dischargers, along with the PQL, the net effect should not be overly burdensome on the regulated community. Where the necessary information in the integrated Risk Information System (IRIS) was not available to establish the health risk-based standard, the MCL was adopted as the standard. As more information becomes available over time, the Commission intends to convert all standards to the health risk-based level.

For benzene, the policy outlined above was not followed. At the informational hearing in February, 1993, the Commission heard considerable testimony concerning the implications that the health-based benzene standard of 1 ug/1 had been having on remedial activities associated with fuel contaminated areas. The MCL level of 5 ug/1 appears to provide sufficient health protection while recognizing the practical difficulties of removing benzene contamination to levels below that concentration.

The organic chemicals chlorophenol and phenol were moved from Table 1 (Human Health Standards) to Table 2 (Secondary Drinking Water Standards), and the proposed standards were set equal to the Ambient Water Quality Criteria for the chemicals. The reason for the change is that although the two chemicals pose a significant health risk at much higher concentrations, taste and odor considerations are a concern at lower concentrations.

PQL's for the organic chemicals proposed in this rulemaking were provided by the Colorado Department of Health Laboratory, and were calculated by multiplying the Method Detection Limit ("MDL"), Estimated Detection Limit ("EDL"), or other detectable level as published by EPA by a factor of ten (10).

It was determined during this rulemaking hearing that PQL's in the Basic Standards for Ground Water, and also in the Basic Standards and Methodologies for Surface Water, will receive further consideration by the Commission and the Division in the next year.

ADDITIONS TO TABLE 1

Four metals standards were added to Table 1 of the Basic Standards for Ground Water. The basis for the addition was the federal Phase V Rule, published in the Federal Register on July 17, 1992. All additional standards were set at the MCL level. Cyanide, one of the Phase V MCLs, was not changed since Table 1 already contained a cyanide standard at a level more stringent than the MCL.

During the rulemaking hearing, the Metro Wastewater Reclamation District pointed out that there is no laboratory test for free cyanide, and that the acid dissociable should be used. Since this proposal was not part of the public notice and was raised so late in the process, it was determined that the Division would address the issue in a rulemaking proposal during the next year.

41.18 STATEMENT OF BASIS, SPECIFIC STATUTORY AUTHORITY, AND PURPOSE (1994 REVISIONS)

CHANGES TO 3.11.5 (C)(5)(c)

The change in wording made in the section referenced above was necessary to update the statutory reference for the Storage Tank program in the Hazardous Materials and Waste Management Division. This change will allow a consistent regulatory approach by the Storage Tank program to ground water contamination caused by either underground or above-ground tanks.

CHANGES TO 3.11.6(A)

The change to 3.11.6(A) has been made for purposes of clarifying that the Division has existing authority to consider ground water standards when setting limits for surface water discharges which impact ground water.

A party to the proceeding is in a position where it has alluvial wells in close proximity to a proposed surface water discharge to a frequently dry stream. This party has raised the issue that the sole biological standard of total coliform bacteria may be inadequate to protect public health from direct or indirect discharges to ground water, and that this is particularly the case in instances where a surface discharge impacts ground water.

PARTIES TO THE DECEMBER, 1993 RULEMAKING HEARING

1. Shell Oil Company
2. The City of Colorado Springs
3. Arapahoe County Water and Wastewater Authority
4. Storage Tank Technology, Inc.
5. Martin Marietta Corporation
6. The Coors Brewing Company

41.18 STATEMENT OF BASIS, SPECIFIC STATUTORY AUTHORITY, AND PURPOSE (1994 REVISIONS)

The provisions of section 25-8-202(1)(a), (b) and (2); 25-8-203; and 25-8-204; C.R.S., provide the specific statutory authority for adoption. The Commission also adopted, in compliance with section 24-4-103(4) C.R.S., the following statement of basis and purpose of these amendments.

STATEMENT OF BASIS AND PURPOSE

During the December, 1993, hearing on the basic Standards for Ground Water, a number of parties and members of the public spoke and submitted evidence on the difficulties of implementing Practical Quantitation Limits (PQL's). It was determined at that time that the Division would consider the problem during this proceeding. A determination has been made that PQL's are more appropriately addressed within the Regulations for State Discharge Permit System, allowing more flexibility in applying the PQL's to regulated discharges. The PQL column in Table A has been removed, as have all footnotes to the Table A that pertained to PQL's. Note that the same modifications have been made to the Basic Standards and Methodologies for Surface Water (3.1.0).

Parties to this hearing also suggested that the Commission consider replacing the current bromodichloromethane, bromoform, chloroform, and dibromochloromethane standards with a total trihalomethanes (THMs) standard based on the current drinking water maximum contaminant level for total THMs, as was done in this hearing for surface water. The Commission has declined to do so, since one of the major factors applicable to the surface water situation—impact on dischargers—has not been demonstrated to apply with respect to ground water.

41.19 STATEMENT OF BASIS, SPECIFIC STATUTORY AUTHORITY, AND PURPOSE (1996 REVISIONS)

PARTIES TO THE JULY 11, 1994 HEARING

1. Sierra Club and Colorado Environmental Coalition
2. City of Colorado Springs
3. Conoco, Inc.
4. Shell Oil Co.
5. Metro Wastewater Reclamation District, the City of Fort Collins, the Silver Coalition, and the Cyprus Climax Metals Company
6. Coors Brewing Company
7. City of Pueblo
8. ASARCO, Inc.

41.19 STATEMENT OF BASIS, SPECIFIC STATUTORY AUTHORITY, AND PURPOSE (1996 REVISIONS)

The provisions of section 25-8-202(1)(a), (b) and (2); 25-8-203; and 25-8-204; C.R.S., provide the specific statutory authority for adoption. The Commission also adopted, in compliance with section 24-4-103(4) C.R.S., the following statement of basis and purpose.

BASIS AND PURPOSE:

This hearing was held to consider changes recommended in the triennial review informational hearing for the ground water standards and classifications regulations "The Basic Standards for Ground Water" 3.11.0, and "The Classifications and Water Quality Standards for Ground Water" 3.12.0. With a few exceptions, the majority of the changes proposed were of a "housekeeping" nature aimed at improving the clarity, organization, and useability of both sets of regulations.

The Commission has moved the statewide interim narrative standard for ground water from 3.12.0 to 3.11.0. This was done to consolidate all statewide standards in the basic standards regulation. This action was warranted due to the Commission's action, in December, 1994 to apply the interim narrative standard to all ground waters of the state. Note that the Statements of Basis and Purpose for the original adoption of the interim narrative standard and for applying it statewide are located in 3.12.11 and 3.12.13.

Changes to the Table 1 values for asbestos, barium, chromium and selenium were adopted for both 3.11.0 and 3.12.0 to reflect the current domestic use values found in the Colorado Primary Drinking Water Regulations . This change was particularly important for selenium as background levels in many areas of the state exceed the previous table value of 0.01 mg/l. Six changes were made to Table A in order to make these values reflect maximum contaminant levels (MCLs) found in the Safe Drinking Water Act, or the 10 -6 risk levels reported in EPA's IRIS System.

PARTIES TO THE RULEMAKING HEARING

1. Coors Brewing Company
2. CF&I Steel, L.P.
3. The United States Department of Energy
4. Cherry Creek Basin Water Quality Authority
5. City of Westminster
6. Kaiser-Hill Company, L.L.C.

41.20 STATEMENT OF BASIS, SPECIFIC STATUTORY AUTHORITY, AND PURPOSE (1996 REVISIONS)

The provisions of section 25-8-202(1)(a), (b) and (2); 25-8-203; and 25-8-204; C.R.S., provide the specific statutory authority for adoption. The Commission also adopted, in compliance with section 24-4-103(4) C.R.S., the following statement of basis and purpose.

BASIS AND PURPOSE

1. Summary

In this rulemaking proceeding, the Commission adopted a revised basic standard for ground water for plutonium (Pu) and established an additional basic standard for ground water for americium (Am).

2. Background

The Commission previously adopted a basic standard for plutonium of 15 pCi/L and had no basic standard for americium. A basic standard was considered in this hearing for americium because it is closely associated with plutonium and these two radionuclides generally occur together. The current basic standard of 15 pCi/L plutonium was calculated using methodologies in the 1976 National Interim Primary Drinking Water Regulations and was consistent with a goal of keeping exposures below 4 millirems per year. The Basis and Purpose indicated that it was necessary and important to restrict levels because of the difficulty of removing this radionuclide by conventional treatment procedures and because the potential adverse effect on human health suggests that extreme caution be exercised in its release to State waters. Since plutonium is predominantly an alpha emitter, the basic standard was made consistent with the 15 pCi/L alpha standard. (A site-specific standard, based on ambient conditions, was set in 1990. Note that this hearing also addressed site-specific standards, which are further discussed in section 3.8.48 of this Statement of Basis and Purpose.)

3. Basis for Commission Decision

Since the previous basic standard was set, several changes have occurred: 1) a new methodology for assessing carcinogens has become the standard practice, 2) new data have resulted in periodic updates to the slope factors used in this methodology, and 3) a more refined Commission policy on appropriate levels of protection for carcinogens has been developed. This latter risk-based policy also parallels a national trend towards risk-based approach to environmental cleanup standards.

The 15 pCi/L dose-based approach was calculated using a "reference-man" and considered exposure during his working life. It was an approach designed to address questions related to occupational exposure. It did not consider sex, age and organ-specific factors over a lifetime. In contrast, the new slope factor methodology, used in EPA's 1989 Risk Assessment Guidance for Superfund Sites, is more complete, more applicable to a general population and has become the standard practice for calculating risk.

The Commission adopted a basic standard of 0.15 pCi/L for plutonium and americium, calculated using a 1×10^{-6} risk level, based on residential use. This risk level is consistent with the Commission's policy for human health protection.

The Commission also considered a request by the Water Quality Control Division to annotate the new standards for plutonium and americium as total (unfiltered) water. The Commission heard disputed testimony on this issue and could not reach a consensus to require unfiltered samples in all circumstances. The Division will have discretion to consider appropriate sampling techniques in implementing the adopted standards.

PARTIES TO THE RULEMAKING

1. State of Colorado Division of Wildlife
2. U.S. Department of Energy
3. Kaiser-Hill Company, LLC
4. City of Broomfield
5. City of Westminster
6. U.S. EPA Region VIII

41.21 STATEMENT OF BASIS, SPECIFIC STATUTORY AUTHORITY AND PURPOSE; JULY, 1997
RULEMAKING

7. City of Thornton
8. City of Arvada
9. City of Northglenn

**41.21 STATEMENT OF BASIS, SPECIFIC STATUTORY AUTHORITY AND PURPOSE; JULY, 1997
RULEMAKING**

The provisions of sections 25-8-202 and 25-8-401, C.R.S., provide the specific statutory authority for adoption of the attached regulatory amendments. The Commission also adopted, in compliance with section 24-4-103(4) C.R.S., the following statement of basis and purpose.

BASIS AND PURPOSE

The Commission has adopted a revised numbering system for this regulation, as a part of an overall renumbering of all Water Quality Control Commission rules and regulations. The goals of the renumbering are: (1) to achieve a more logical organization and numbering of the regulations, with a system that provides flexibility for future modifications, and (2) to make the Commission's internal numbering system and that of the Colorado Code of Regulations (CCR) consistent. The CCR references for the regulations will also be revised as a result of this hearing.

**41.22 STATEMENT OF BASIS, SPECIFIC STATUTORY AUTHORITY AND PURPOSE; JANUARY,
1999 RULEMAKING**

The provisions of sections 25-8-202; 25-8-204; 25-8-402, C.R.S., provide the specific statutory authority for adoption. The Commission also adopted, in compliance with section 24-4-103(4) C.R.S., the following statement of basis and purpose.

BASIS AND PURPOSE

This revisions is to reconfirm the previous action taken by the Commission to include correct publication in the Colorado Code of Regulations Statement of Basis, Specific Statutory Authority and Purpose for the December, 1996 rulemaking hearing.

**41.23 STATEMENT OF BASIS, SPECIFIC STATUTORY AUTHORITY, AND PURPOSE (2001
REVISIONS)**

The provisions of section 25-8-202(1)(a), (b) and (2); 25-8-203; and 25-8-204; C.R.S., provide the specific statutory authority for adoption. The Commission also adopted, in compliance with section 24-4-103(4) C.R.S., the following statement of basis and purpose.

BASIS AND PURPOSE

This hearing was held to consider changes recommended in the triennial informational hearing for the ground water standards and classifications regulation "The Basic Standards for Ground Water" 41. Significant changes were made to Table A "Ground Water Organic Chemical Standards" with the addition of new chemical standards and changes to existing standards. The changes are in keeping with the Commission's Policy 96-2 to coordinate surface and ground water standards. The changes and additions to Table A reflect the changes to the surface water Human Health Based Water Supply Standards adopted by the Commission in the Basic Standards and Methodologies for Surface Water, Regulation 31, triennial review hearing July 10, 2000.

41.24 STATEMENT OF BASIS, SPECIFIC STATUTORY AUTHORITY AND PURPOSE; SEPTEMBER 2004 RULEMAKING

Many of the surface water standards are based upon EPA-established drinking water standards, under the Safe Drinking Water Act (SDWA), or water quality criteria developed pursuant or section 304(a) of the federal Clean Water Act. Since these standards and criteria are modified from time to time, it is necessary to review the existing Colorado standards in comparison to the latest available information. As a result of this review, the Commission adopted revisions to the standards to conform with the latest available information as to protective levels for the various chemicals.

In adopting these standards for ground water, 39 new organic chemical standards were added to Table A, 25 existing standards were changed, and two chemicals were renamed. Two organic Chemicals were renamed in Table A: Dichloromethane CAS No. 75-09-2 is now Methylene chloride C , and Di(2 ethylhexyl)phthalate C CAS No. 117-81-7 is now Ethylhexyl phthalate (BIS-2) C .

The Commission has adopted amendments to section 41.5.B to provide for the establishment of alternative standards to the site-specific water quality standards for the Domestic Use - Quality classification. Prior to this amendment this alternative was not possible because section 41.5.B.3.a provided that the human health standards (Table 1) and the secondary drinking water standards (Table 2) apply to ground water classified Domestic Use - Quality. No alternative standards to the Table 1 and 2 standards were provided for in the original regulation. The Commission believes that the option of site-specific standards should be allowed taking into account the factors set forth in §25-8-204(4) C.R.S. The language adopted by the Commission is similar to the language included in section 41.5.D.2 that allows the Commission to adopt sitespecific standards for radioactive materials and organic pollutants.

Additional changes proposed to Regulation 41 were of a “housekeeping” nature to update the regulation and to correct typographical errors.

PARTIES TO THE RULEMAKING

1. Climax Molybdenum Company

41.24 STATEMENT OF BASIS, SPECIFIC STATUTORY AUTHORITY AND PURPOSE; SEPTEMBER 2004 RULEMAKING

The provisions of sections 25-8-202; 25-8-204; 25-8-402, C.R.S., provide the specific statutory authority for adoption. The Commission also adopted, in compliance with section 24-4-103(4) C.R.S., the following statement of basis and purpose.

BASIS AND PURPOSE:

This hearing was held to consider changes recommended in an Informational Hearing for Regulation 41, The Basic Standards for Ground Water. The majority of the changes involved modifications to the organic chemical standards in Table A, as well as the addition of new standards for twenty-one carcinogenic organic chemicals. During this hearing the Commission also considered the organic chemical standards contained in Regulation 31, The Basic Standards and Methodologies for Surface Water. Other changes, for Regulation 41, included renaming Tables 1 and 2 to parallel the nomenclature used in Policy 96-2, the Commission’s policy on human-health based water quality criteria. Additionally, several footnotes for Tables 1 and 2 were updated to clarify and identify the source of the associated numeric standards. References to Practical Quantitation Limits (PQL) were modified to reflect the Commission’s decision to remove the determination of appropriate PQLs from the Rulemaking process. The Commission understands that the Water Quality Control Division is developing a PQL guidance document, which will contain those PQLs deemed acceptable to the Division. In addition, the Water Quality Control Division, or applicable implementing agency, may establish site-specific or discharge-specific PQLs. Finally, additional clarification was added to the table of Radioactive Standards to reflect the Commission’s decision to allow discretion in considering appropriate sampling techniques in implementing these standards.

In November 2000, EPA disapproved surface water standards for several Group C organic chemicals because the proposed standards were not based on carcinogenic risk. Group C carcinogens are typically classified, based on limited evidence, as possible human carcinogens. Historically, due to the lack of substantive carcinogenic evidence, the Commission has not established carcinogenic-based standards for Group C chemicals, but rather adopted standards based on toxicity.

Based on published human-health risk data there are three classes of Group C compounds, which include:

Those compounds with published toxicity (RfD) values, Those compounds with published cancer slope factors (q1*), and Those compounds with published RfD and q1* values.

Previously, the Commission has promulgated standards for the Group C compounds in the first and third class based on toxicity and for the second class based on carcinogenicity. However, this treatment of the class 3 Group C compounds resulted in EPA disapproving the standards.

In order to resolve this issue with EPA, during this hearing, the Commission adopted a standard for these Group C compounds based on toxicity, but with an additional margin of safety to account for any unknown carcinogenic effects. Using this method the standards for Group C compounds, with both RfD and q1* values, are based on toxicological data, and then adjusted downward using an uncertainty factor of 10. The Commission believes that this methodology is consistent with SDWA practices and will be protective of human health.

The Commission also decided to add numeric standards for twenty-one additional organic chemicals that are classified as either Group A, known human carcinogens, or Group B, probable human carcinogens.

One of the new standards that was the subject of extensive written and oral testimony in this hearing is a standard for 1,4-dioxane. Based upon the current status of the scientific evidence as disclosed at the hearing, with specific reference to the number for 1,4-dioxane found in EPA's IRIS database, the Commission adopted a standard of 6.1 ug/l to apply for a period of five years, with a standard of 3.2 ug/l becoming effective at the end of the five-year period. The Commission is aware of the fact that EPA is re-examining its criteria for 1,4-dioxane. However, that effort likely will take a number of years and the result is uncertain, and there is a current need to address this chemical in the water quality standards context. Because 6.1 ug/l is the value typically used to date for 1,4-dioxane remedial activities in Colorado, the adoption of this value as a water quality standard will provide a basic level of protection of human health while essentially preserving the status quo regarding clean-up requirements for the next five years. This standard provides protection within the same order of magnitude as the 3.2 ug/l standard that results from application of the Commission's generally accepted methodology for establishing health-based standards. The Commission sees no reason in this matter to deviate from its policy regarding the order of magnitude of risk used for the protection of human health.

If no further action is taken by the Commission, the 3.2 ug/l standard will go into effect after five years. If EPA's pending review of 1,4-dioxane results in a revision of the current IRIS value, the Commission can consider a corresponding revision of its water quality standards at that time.

The Commission notes that the adopted standards are consistent with the Department of Public Health and Environment's policy on the use of IRIS in setting standards. The Commission understands that remediation action levels applied by implementing agencies at currently contaminated sites may be set at a different, higher number based on a site-specific risk analysis as referenced in the CDPHE policy. The Commission also notes that it may adopt site-specific standards for 1,4-dioxane if warranted by a site-specific risk assessment. The Commission has adopted numerous site-specific standards for other chemicals where it was determined that such standards appropriately account for site-specific circumstances.

Further, to clarify the use of this standard in a regulatory context, the Commission requests that the Division promptly develop a practical quantitation limit (PQL) for 1,4-dioxane. Consistent with other provisions of this regulation, the PQL will be used as the compliance threshold for implementation of these standards. The Commission notes that it may be appropriate to establish a site-specific PQL for individual discharges, if warranted by the unique characteristics of a particular discharge.

In adopting standards for 1,4-dioxane, the Commission has considered the factors listed in section 25-8-204, C.R.S., as follows:

(a) The need for standards which regulate specified pollutants

1,4-dioxane is a Group B2, probable human carcinogen and has been found as a ground water contaminant in the State of Colorado. In addition, following treatment ground water contaminated with 1,4-dioxane is discharged to Colorado surface waters.

(b) Such information as may be available to the commission as to the degree to which any particular type of pollutant is subject to treatment; the availability, practicality, and technical and economic feasibility of treatment techniques; the impact of treatment requirements upon water quantity; and the extent to which the discharge to be controlled is significant

1,4-dioxane is most commonly treated with a combination of advanced oxidation processes (AOP) in combination with ultraviolet light (UV). This remediation technology, though relatively new, is rapidly becoming a more common technique. The AOP/UV treatment techniques will have minimal impact on water quantity. Evidence was submitted indicating that 1,4-dioxane treatment costs could be substantial in some circumstances, although there was conflicting evidence regarding treatment costs. Because the standard that will be in effect for the next five years is set at the level already most commonly used as a 1,4-dioxane remediation goal, the adopted standard will not have a major impact on treatment costs during this period. The Commission intends that discharge permits issued while the 6.1 ug/l standard is in effect will include effluent limits based on that standard until the expiration of the existing permit. Renewal permits will be subject to the standard in effect at the time of renewal. Moreover, to the extent that the adopted standards do result in increased treatment costs, the Commission believes that such costs must be weighed against the benefits of the protection of public health, including the preventative benefits of reducing the likelihood of future exposure to 1,4-dioxane.

As to the extent to which this pollutant is significant, since 1, 4-dioxane is primarily used as a solvent stabilizer, it will most likely be found in areas with known chlorinate solvent contamination. Chlorinated solvents have been in use since the 1960s, with more widespread use occurring in the late 1970s and early 1980s due to the increasing production of electronic circuits.

(c) The continuous, intermittent, or seasonal nature of the pollutant to be controlled

1,4-dioxane is characterized by a high solubility (infinitely soluble/miscible), moderate vapor pressure, and low Henry's Law Constant, all of which indicate that this chemical will be persistent within the aquatic environment. Additionally, the available data indicate that 1,4-dioxane will not readily degrade in the environment.

(d) The existing extent of pollution or the maximum extent of pollution to be tolerated as a goal

The Hazardous Materials and Waste Management Division reports that 1,4-dioxane has been found at 9 sites and is suspected at 19 others. The standards adopted by the Commission establish the maximum extent of 1,4-dioxane to be tolerated as a human health goal, for the reasons set forth in this Statement of Basis and Purpose.

(e) Whether the pollutant arises from natural sources

1,4-dioxane contamination does not arise from natural sources.

(f) Beneficial uses of water

The 1,4-dioxane standards are adopted to protect domestic water supply uses.

- (g) Such information as may be available to the Commission regarding the risk associated with the pollutants including its persistence, degradability, the usual or potential presence of the affected organisms in any waters, the importance of the affected organisms, and the nature and extent of the effect of the pollutant on such organisms

1,4-dioxane is a highly persistent contaminant. Very little degradation is observed in the ambient environment. The standards are being adopted to protect human health, so humans are the affected "organisms". 1,4-Dioxane is classified by EPA as a probable human carcinogen (Group B2). Conflicting evidence was submitted regarding the level at which 1,4-dioxane poses a human health risk. Some parties argued that a different toxicity model than that used to develop the current IRIS value for 1,4-dioxane should be used to characterize its toxicity. Some parties also argued that a 1,4-dioxane standard should be established based on a PQL for this chemical, but the Commission believes that the standard should be health-based. The Commission acknowledges that there are conflicting scientific interpretations of the available information and that further review and analysis of the toxicity of 1,4-dioxane is warranted. However, the outcome of that further review is uncertain and the Commission does not believe that there is sufficient evidence to invalidate the current EPA IRIS value at this time. The Commission believes that the record supports the scientific and technical validity of the standards that it is adopting. Moreover, in the face of conflicting scientific information, as a matter of policy the Commission has decided to err in the direction of protection of public health in approving the 6.1 ug/l and 3.2 ug/l standards for 1,4-dioxane.

Since the 1989 hearing, there has been debate about whether standards for parameters with MCLs should be based on the MCLs or purely health-based numbers. The arguments for MCLs focused on whether it is reasonable to require ground water remediation to a level below that required for drinking water. The arguments for health-based standards focused on maximizing human-health protection, putting the clean-up burden on pollution sources, and protection of ground water as a resource.

In this hearing, the Commission adopted a hybrid MCLG/MCL proposal that provides much of the benefits advocated for each of the above options. This hybrid approach allows for existing ground water contamination to be addressed at levels that are deemed safe for drinking water sources, but allow for the protection of ground water as a resource by implementing a more protective human-health health based standard for future contamination. The Commission decided that implementation of this range of standards should be based on the date of the discharge that subsequently caused contamination of the ground water. In some cases, especially where the ground water contamination may not be discovered immediately, the contamination will have subsequently migrated. In these instances, it is the Commission's intent that the original date of the release that caused the contamination, not the date of the identification or subsequent extent of any migration of that contamination, shall be used to determine the appropriate standard for the resulting contaminant plume.

Additionally, the hybrid MCLG/MCL proposal was concurrently considered for Regulation 31, The Basic Standards and Methodologies for Surface Water, and the adoption of this rule for ground water provides a consistent approach to addressing water quality for all waters of the State.

For existing aquifer storage and recovery facilities an issue, which was presented to the Commission regarding the MCLG/MCL proposal, was the potential impact this rule could have on existing aquifer storage and recovery, or artificial recharge projects. Cognizant of both the drought and the corresponding potential future implementation of the various forms of anthropogenic recharge, the Commission decided to adopt a total trihalomethanes (TTHM) standard. In order to assure that the ground water quality standards do not limit continued aquifer storage and recovery at these facilities using potable finished water, the Commission adopted a standard for TTHM. However, the Commission also elected to leave the existing standards for bromodichloromethane, bromoform, chloroform and dibromochloromethane in place in order to address ground water contamination due to other possible sources of these chemicals (e.g. from spills or industrial activity).

The applicability of Footnote 7 (allowing compliance with TTHMs rather than the separate standards for bromodichloromethane, bromoform, chloroform, and dibromochloromethane) to other sources of water and aquifers requires further evaluation. The Commission requests that the Division coordinate with stakeholders using and developing aquifer storage and recovery projects regarding these organic standards and their statewide applicability and provide a status report regarding whether modifications to the statewide organic standards for aquifer storage projects will likely be proposed.

The Commission is not aware of other instances where the ground water quality standards are likely to limit the ability to undertake such ground water recharge projects. If such circumstances should arise in the future the Commission can revisit other aspects of this regulation at that time. Alternatively, proponents of such projects could request site-specific ground water quality classifications and standards.

Tables 1 and 2 were renamed and revised to be more consistent with the description of the various standards in both Regulation 31 and Policy 96-2. Several footnotes were added or modified to further clarify the existing numeric standards.

A footnote was added to the radioactive standards table to reflect the Commission's decision in 1996 (41.20) to allow the Division latitude in requiring total or dissolved samples. In the 1996 hearing the Commission decided to allow the Division discretion to consider appropriate sampling techniques in implementing the radionuclide standards. Since that time there has been considerable interest in additional clarification of the implementation of these standards, and therefore the Commission elected to adopt additional footnotes clarifying the radioactive standards.

PARTIES TO THE RULEMAKING HEARING

1. Schlage Lock Company
2. Teck Cominco Limited
3. Raytheon Aircraft Company
4. City and County of Denver
5. Waste Management of Colorado
6. Lockheed Martin Space Systems Company
7. Barrick Gold Corporation
8. Shell Oil Company
9. Colorado Wastewater Utility Council
10. The City of Boulder
11. Emerson Electric Company
12. Colorado Association of Commerce and Industry
13. Metro Wastewater Reclamation District
14. Dover Industries, Inc.
15. Colorado Mining Association
16. The Board of County Commissioners of El Paso County
17. The JRW Family Limited Partnership
18. The South Adams County Water and Sanitation District
19. Colorado Department of Transportation
20. U.S. Environmental Protection Agency

21. Stephen A. Bain
22. U.S. Department of Energy, Rocky Flats Project Office
23. John D. Fognani & Suzanna K. Moran
24. Alliant Techsystems Inc.

41.25 STATEMENT OF BASIS, SPECIFIC STATUTORY AUTHORITY AND PURPOSE; DECEMBER 10, 2007 RULEMAKING; EFFECTIVE MAY 31, 2008

The provisions of sections 25-8-202(1)(b); 25-8-204; 25-8-402, C.R.S., provide the specific statutory authority for adoption. The Commission also adopted, in compliance with section 24-4-103(4) C.R.S., the following statement of basis and purpose.

BASIS AND PURPOSE:

1. Statewide Standards - Interim Organic Pollutant Standards

In this rulemaking, the Commission adopted revised and new organic chemical standards in section 41.5(C)(3). In an effort to keep ground water and surface water organic chemical standards consistent, the changes to section 41.5(C)(3) were considered during the same hearing that addressed changes to the statewide surface water organic chemical standards in Regulation No. 31 (Basic Standards and Methodologies for Surface Water).

In adopting these new and revised organic chemical standards, the Commission continued to rely on its past policy decisions and precedence documented in Commission Policy 96-2. Additionally, as per Departmental policy the Commission has relied on the United States Environmental Protection Agency's (EPA) Integrated Risk Information System (IRIS) as its first tier source of toxicological data. Review of the IRIS data that had been updated since the last revisions to 41.5(C)(3) indicated that the water quality standards for two organic chemicals, toluene and 1,2-dibromoethane, needed to be revised.

At the last hearing addressing section 41.5(C)(3), in September 2004, during which the Commission adopted water quality standards for several carcinogenic compounds, EPA had requested that a future rulemaking consider water quality standards for non-carcinogenic compounds. For this hearing the Commission reviewed several non-carcinogenic compounds that lacked water quality standards. This review identified four pesticides that the Commission elected to adopt water quality standards for: acetochlor, dicamba, metribuzin, and prometon. The Commission also corrected several typographical errors and added common synonyms for some of the organic chemicals.

2. Table Value Criteria – Tables 1 through 4

The Commission elected to adopt EPA's maximum contaminant level (MCL) for arsenic and uranium as Domestic Water Supply – Human Health Standards (Table 1). EPA promulgated a MCL of 30 µg/l for uranium in December of 2003, and a MCL of 10 µg/l for arsenic in January of 2006. The Commission has previously adopted these MCLs as surface water-water supply standards, and in an effort to keep the surface and ground water standards consistent, now adopts them as ground water standards.

The Commission received testimony regarding the association of molybdenum as a ground water contaminant in several uranium and vanadium processing and mining sites throughout the Colorado. During the 1990 hearing (q.v. section 41.14), the Commission had elected to delete the molybdenum standard until additional scientific data was available. In August of 1993, IRIS published additional findings and finalized an RfD for molybdenum. During this hearing the Commission elected to adopt a Domestic Water Supply – Human Health Standards (Table 1) for molybdenum based on this updated toxicological data, as well as testimony regarding both existing and planned uranium and vanadium mining and milling activities throughout the State.

The Water Quality Control Division submitted testimony regarding its efforts to update and issue new general ground water discharge permits, and during that process requested additional clarification regarding the existing fecal coliform standard. The Commission updated the fecal coliform standard to clarify both the averaging period and the allowable maximum over that same averaging period. In determining the appropriate maximum and averaging period the Commission relied on EPA's water reuse guidance (EPA/625/R-04/108) for unrestricted urban reuse.

During the Issues Formulation and Informational Hearing the Commission received testimony regarding the Agricultural Standards (Table 3) and the implementation of the manganese standard. The original agricultural manganese standard was derived from EPA's 1972 Water Quality Criteria ("Blue Book"), and addressed crop toxicity in acidic soils. In order to remain consistent with the 1972 criteria, as well as with Regulation No. 31, the Commission elected to add a footnote to specify that the agricultural manganese standard is only applicable in those areas where acidic soils exist.

3. Other Changes to the Regulation

During the Issues Formulation and Informational Hearing an issue was raised regarding activities that increase naturally occurring contamination, with the intent at that time being that revisions to section 41.5(A), the narrative standards, would address this issue. Additional investigation into the issue discovered that the narrative standards, as currently adopted in Regulation No. 41, are only implemented during a ground water classification hearing. The Commission believes that this poses two problems. First, as written, the narrative standards did not apply to all State waters which conflicts with the intention of the Colorado Water Quality Control Act (CWQCA). Second, the narrative standards have not been specifically adopted for all of the current ground water classifications.

One purpose of narrative standards is to provide general qualitative guidance for situations that lack quantifiable, or scientifically predicted, outcomes. Narrative standards define broad guidelines that are intended to meet general water quality goals. For these reasons, narrative standards are applicable when numeric criteria cannot be established, or applied, to a specific discharge or release. Additionally, narrative standards are critical for addressing emergency circumstances when the dynamics of the situation prevent timely scientific review or the normal Commission procedure.

For these reasons the Commission believes that applying the narrative standards to all ground water is appropriate and effectively solves the issues before them. By making the narrative standards statewide standards the Commission fulfills the intent of the CWQCA, implements the narrative standards for all existing ground water classifications, and addresses the issue of anthropogenic increases to naturally occurring ground water contamination.

The Commission revised the paragraph regarding "implementing agencies" to recognize the recent reorganization of the Division of Minerals and Geology into the Division of Reclamation, Mining, and Safety. The Commission also changed the reference to the agency responsible for the Resource Conservation and Recovery Act to recognize that both the Hazardous Materials and Waste Management Division and the Department of Labor and Employment implement different aspects of this statute.

In the 2004 hearing the Commission adopted footnote 7 which included a total trihalomethane (TTHM) standard applicable to existing aquifer storage and recovery (ASR) facilities that use potable finished water. The Commission's intention in doing so was to assure that the ground water organic chemical standards did not limit continued ASR at existing facilities. ASR has been identified by the Colorado General Assembly and the Colorado Water Conservation Board as a potential way to maximize use of aquifers through conjunctive use of surface and ground water resources. ASR has also been identified by the South Platte River Task Force as a potential tool to address water issues in the South Platte River Basin.

In order to assure that the ground water quality standards do not limit future use of ASR, the Commission adopted changes to footnote 7 deleting the reference to facilities that existed as of September 14, 2004, thereby applying the TTHM standard to all ASR facilities using finished potable water that meets all applicable federal and state drinking water requirements. In addition, the Commission adopted a new provision that applies the maximum containment level (MCL) as the standard for ground water that must be met by ASR facilities using finished potable water.

PARTIES TO THE RULEMAKING

1. Centennial Water and Sanitation District, Town of Castle Rock, Castle Pines Metropolitan District, Consolidated Mutual Water Company, Rangeview Metropolitan District
2. Metro Wastewater Reclamation District
3. Colorado Wastewater Utility Council
4. City of Boulder
5. City of Colorado Springs and Colorado Springs Utilities
6. City and County of Denver Department of Environmental Health
7. Climax Molybdenum Company
8. Information Network for Responsible Mining (INFORM), High Country Citizens' Alliance (HCCA), and Coloradans Against Resource Destruction (CARD)
9. United States Environmental Protection Agency, Region 8
10. U.S. Department of Energy (DOE) Office of Legacy Management
11. Upper Black Squirrel Creek Ground Water Management District

41.26 STATEMENT OF BASIS, SPECIFIC STATUTORY AUTHORITY AND PURPOSE; OCTOBER 13, 2009 RULEMAKING; EFFECTIVE NOVEMBER 30, 2009

The provisions of sections 25-8-202(1)(b); 25-8-204; 25-8-402, C.R.S., provide the specific statutory authority for adoption. The Commission also adopted, in compliance with section 24-4-103(4) C.R.S., the following statement of basis and purpose.

BASIS AND PURPOSE

During its September 2004 rulemaking, the Commission adopted two standards for 1,4 dioxane -- 6.1 ug/L to be effective through March 21, 2010; and 3.2 ug/L to become effective on March 22, 2010. The dual standard was adopted, in part, due to the uncertainty about the risks posed by 1,4 dioxane and the fact that EPA was in the process of updating the Integrated Risk Information System ("IRIS") database for that compound. At that time, the Commission adopted the 6.1 ug/L value (which had been typically used for remedial activities in Colorado) as a temporary standard in order to maintain the status quo for a period of five years to give EPA time to complete its IRIS update. The Commission determined that if EPA's pending review resulted in a change in the IRIS value, the Commission could consider a corresponding revision of its standards. As of this date, EPA has not completed the IRIS review.

In May 2009, EPA released an updated draft toxicological review on 1,4 dioxane for external peer review. According to the current schedule, final completion of the IRIS update should occur before the end of 2011.

41.27 STATEMENT OF BASIS, SPECIFIC STATUTORY AUTHORITY AND PURPOSE; AUGUST 13, 2012 RULEMAKING; FINAL ACTION SEPTEMBER 11, 2012; EFFECTIVE JANUARY 31, 2013

The provisions of sections 25-8-202(1)(b); 25-8-204; 25-8-402, C.R.S., provide the specific statutory authority for adoption. The Commission also adopted, in compliance with section 24-4-103(4) C.R.S., the following statement of basis and purpose.

BASIS AND PURPOSE

1. Statewide Standards - Interim Organic Pollutant Standards

In this rulemaking, the Commission adopted revised and new organic chemical standards in section 41.5(C)(3). In an effort to keep ground water and surface water organic chemical standards consistent, the changes to section 41.5(C)(3) were considered during the same hearing that addressed changes to the statewide surface water organic chemical standards in Regulation No. 31 (Basic Standards and Methodologies for Surface Water).

In adopting these new and revised organic chemical standards, the Commission continued to rely on its past policy decisions and precedence documented in Commission Policy 96-2. Additionally, as per Departmental policy, the Commission has relied on the United States Environmental Protection Agency's (EPA) Integrated Risk Information System (IRIS) as its first tier source of toxicological data. Review of the IRIS data that had been updated since the last revisions to 41.5(C)(3) indicated that the water quality standards for acrylamide, carbon tetrachloride, 1,2-cis dichloroethylene, 1,2-trans dichloroethylene, 1,4-dioxane, hexachloroethane, nitrobenzene, pentachlorophenol, tetrachloroethylene (PCE), and 1,1,1-trichloroethane, needed to be revised. This review also identified new compounds in the IRIS data that the Commission elected to adopt as water quality standards, these were: acetone, bromobenzene, chlordecone, 1,2-dibromoethane, dichloromethane, ethylene glycol monobutyl ether (EGBE) (2-Butoxyethanol), 2-hexanone, perchlorate, trichloroacetic acid, 1,2,3-trichloropropane.

The compounds acylamide, dichloromethane, and 1,2,3-trichloropropane are mutagenic compounds, and the resulting standards were calculated following EPA guidance on calculating drinking water supply standards for mutagenic compounds. Footnote 8 was added to indicate that these compounds were calculated using age dependent factors.

The EPA IRIS updates also included instances where the updated human health criteria is less stringent than the maximum contaminant level (MCL) promulgated under the federal Safe Drinking Water Act. In these instances, the Commission adopted two values shown as a range, with the updated human health criteria being the first number in the range and the federal MCL being the second number in the range. In such cases, the implementing agency must establish the protection level that is determined by the agency to be consistent with the current and future uses of the ground water. The compounds that have a range with the human health criteria being higher than the MCL are 1,2-trans dichloroethylene, tetrachloroethylene (PCE), and 1,1,1 trichloroethane (1,1,1-TCA). Footnote 6 to Table A was amended to clarify the standards implementation intent of the Commission when a human health based standard is a higher numeric value than the maximum contaminant level in a range between the human health based standard and the maximum contaminant level.

The Commission also corrected several typographical errors and added common synonyms for some of the organic chemicals.

The Commission heard testimony from several parties asserting that the revised standard adopted for 1,4 dioxane may not be attainable with economical treatment technologies and in some instances may be difficult to measure using current laboratory analytical techniques. Such technical and economic issues are often addressed by EPA in establishing a Maximum Contaminant Level (MCL) under the Safe Drinking Water Act, and the Commission has in the past established a range for a particular chemical, with the health-based standard being the minimum and the MCL the maximum, since EPA has determined that MCLs represent an acceptable level to provide in public drinking water. However, no MCL has been developed for 1,4 dioxane. The Commission therefore did not adopt a range and instead set the statewide standard for 1,4 dioxane at a level to protect human health, based on the currently available scientific information and applying the Commission's established risk-based policy approach. The Commission believes that the concerns raised are better addressed with respect to site-specific implementation issues and notes that there may be a need for site-specific standards for 1,4-dioxane and other regulated organic chemicals to address site-specific economic and/or technical treatment capabilities. The Division concurred with the parties' testimony regarding these concerns and expressed willingness to work with parties who propose site-specific solutions to the Commission.

2. Table Value Criteria – Tables 1 through 4

The Commission revised the Table 1 standard for molybdenum from 35 ug/l to 210 ug/l in an effort to keep the surface and ground water standards consistent. The Division presented evidence during the hearing that the total recoverable form of molybdenum can be translated to the dissolved form in a 1:1 ratio.

The Commission revised Table 1 standard for uranium to be a hyphenated value. The Commission retained the 30 µg/L value, the maximum contaminant level (MCL) from EPA's 2000 radionuclides rule under the Safe Drinking Water Act, and added a value of 16.8 µg/L. The 16.8 µg/L value is derived from use of the reference dose and relative source contribution from the 2000 radionuclides rule in Equation 1-1 of Policy 96-2. This equation and the resulting value are based purely upon the protection of human-health and do not take treatment or economic considerations into account as does the MCL. Footnote 2 to Tables 1-4 will be applied to the revised uranium value.

PARTIES TO THE RULEMAKING

1. Climax Molybdenum Company
2. Metro Wastewater Reclamation District
3. Lowry Environmental Protection/Cleanup Trust Fund
4. South Adams County Water and Sanitation District
5. Brown Group Retail, Inc.
6. International Risk Group, LLC
7. Environmental Protection Agency
8. City of Boulder

41.28 STATEMENT OF BASIS, SPECIFIC STATUTORY AUTHORITY AND PURPOSE; APRIL 11, 2016 RULEMAKING; FINAL ACTION MAY 9, 2016; EFFECTIVE DATE JUNE 30, 2016

The provisions of sections 25-8-202(1)(b); 25-8-204; 25-8-402, C.R.S., provide the specific statutory authority for adoption. The Commission also adopted, in compliance with section 24-4-103(4) C.R.S., the following statement of basis and purpose.

BASIS AND PURPOSE:

1. Statewide Standards - Interim Organic Pollutant Standards

The Commission adopted revised and new organic chemical standards in section 41.5(C)(3). In an effort to keep ground water and surface water organic chemical standards consistent, the changes to section 41.5(C)(3) were considered during the same hearing that addressed changes to the statewide surface water organic chemical standards in Regulation No. 31 (Basic Standards and Methodologies for Surface Water).

In adopting these new and revised organic chemical standards, the Commission continued to rely on its past policy decisions and precedence documented in Commission Policy 96-2. Additionally, as per Departmental policy, the Commission has relied on the United States Environmental Protection Agency's (EPA) Integrated Risk Information System (IRIS) as its first tier source of toxicological data. Review of the IRIS data that had been updated since the last revisions to 41.5(C)(3) indicated that the water quality standard for tetrachloroethylene (TCE), needed to be revised. EPA expressed concerns regarding the proposed hybrid standard approach for TCE. In light of the impact that a decision on the hybrid standard for TCE may have on other hybrid standards adopted by the WQCC, and because the human health risk of maintaining the current standard of 5 mg/L is not an order of magnitude above the risk for a standard of .76 mg/L, the Commission decided to not modify the TCE standard at this hearing. The Commission expects the broader issue of hybrid standards will be discussed with EPA and the stakeholders, and that the issue may be revisited at a future hearing. The IRIS review also identified new compounds in the IRIS data that the Commission elected to adopt as water quality standards, these were: biphenyl, methanol, and tetrahydrofuran.

2. Table A, Footnote 6

The Commission amended Footnote 6 to Table A in section 41.5(C)(3) to clarify the standards implementation intent of the Commission when a human health based standard is a higher numeric value than the maximum contaminant level in a range between the human health based standard and the maximum contaminant level.

The Commission deleted implementation language for organic chemicals that was deemed no longer necessary.

The Commission added to the footnote an explanation of its intent with how an implementing agency can establish a protection level when there is site-specific information that demonstrates that there is no current or reasonably anticipated future uses of groundwater.

3. Practical Quantification Limitations (PQLs)

The Commission heard testimony that it is no longer necessary for the Division to approve the Practical Quantification Limitations (PQLs) used by the groundwater standards implementing agencies. The groundwater implementing agencies have their own PQLs or PQL equivalents established under their own authorities. Therefore, section 41.5(C)(4) was amended to remove the requirement of the WQCD approving PQL's for the groundwater standards implementing agency.

PARTIES TO THE RULEMAKING

1. Environmental Protection Agency

41.29 STATEMENT OF BASIS, SPECIFIC STATUTORY AUTHORITY AND PURPOSE: AUGUST 8, 2016 RULEMAKING; FINAL ACTION NOVEMBER 14, 2016; EFFECTIVE DATE DECEMBER 30, 2016

The provisions of C.R.S. sections 25-8-202; 25-8-203; 25-8-204; 25-8-402, provide the specific statutory authority for adoption of this regulation. The Commission also adopted, in compliance with section 24-4-103(4) the following statement of basis and purpose.

BASIS AND PURPOSE

The Water Quality Control Commission amended Regulation 41.5(B)(6) to authorize the Commission to adopt site-specific standards in Regulation #42 for agricultural standards (listed in Tables 3 and 4) as well as domestic water supply standards (listed in Tables 1 and 2). The Commission determined that correcting the existing inconsistency between domestic and agricultural standards and expanding the Commission's authorization to adopt site-specific groundwater standards was consistent with the Commission's authority under the Water Quality Control Act, the overall policies of Regulations #41 and #42, and the Commission's 2001 discussion to allow consideration of site-specific standards for the agricultural standards in Tables 3 and 4.

PARTIES TO THE RULEMAKING

1. Cherokee Metropolitan District
 2. Upper Black Squirrel Ground Water Management District
 3. Wayne E. Booker Revocable Living Trust and Frances G. Booker Revocable Living Trust
 4. The Farmer Family
-

**Appendix D City and County of Denver – Guidance for Reuse of Soil
on City Projects**



DENVER
THE MILE HIGH CITY

Department of Environmental Health

Division of Environmental Quality
200 W 14th Ave, Suite 310
Denver, CO 80204
p: 720-913-1311
f: 720-865-5534
www.denvergov.org/deh

INTEROFFICE MEMORANDUM

TO: City and County of Denver Department Executive Directors

FROM: Bob McDonald, Executive Director

DATE: October 05, 2017

SUBJECT: Guidance for Reuse of Soil on City Projects

There is increasing demand in and around the City and County of Denver (City) for soil available for reuse. Such reuse offers several benefits to the City including reduced waste, hauling costs, disposal fees, and vehicle emissions.

As the local public health authority, the City's Department of Environmental Health (DEH) has determined that all reusable soil must be adequately characterized based on the intended reuse to ensure the protection of public health and the environment. If the soil is not suitable for reuse per these guidelines, it must be disposed at the City-owned Denver Arapahoe Disposal Site (DADS) in accordance with the City's Executive Order No. 115.

This guidance provides criteria by which City employees and/or third parties may, or may not, reuse soil from City projects at both City-owned properties and properties owned by others. DEH sign off will be required for any reuse options. As such, to promote safe and sustainable reuse, it is within DEH's purview to implement the following requirements for City soils to be reused:

1. For onsite reuse, City personnel are responsible for contacting DEH¹ when they want to reuse soil or receive a request to reuse soil. DEH is responsible for promptly informing the requestor of City sampling frequency and analysis requirements based on contaminants of concern from recognized environmental conditions, which are designed to promote safe and sustainable reuse.
2. For off-site reuse and/or material to be imported to a site, the person or entity requesting to reuse the soil must adequately characterize the soil by sampling at least every 500 cubic

¹ Diane DeLillio, 720-865-5448, diane.delillio@denvergov.org



DENVER
THE MILE HIGH CITY

Department of Environmental Health

Division of Environmental Quality

200 W 14th Ave, Suite 310

Denver, CO 80204

p: 720-913-1311

f: 720-865-5534

www.denvergov.org/deh

yards to be excavated (or alternative frequency as determined by DEH) and analyze those soil samples for, at a minimum:

- a. Volatile organic constituents;
 - b. Semi-volatile organic constituents;
 - c. Total petroleum hydrocarbons;
 - d. Pesticides;
 - e. Herbicides;
 - f. Polychlorinated biphenyls (PCBs);
 - g. Arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver; and
 - h. Asbestos – if debris is found and if suspect asbestos-containing material is found in the debris (e.g., transite, ash, brick mortar, asphalt shingles, etc.)
3. In general, the person or entity requesting to reuse the soil shall pay all costs associated with the sampling and analysis of the soil.
 4. Before the City will release the soil for reuse, the party requesting the excess soil must indicate the land use of the accepting site and demonstrate to DEH's satisfaction that the soil meets the criteria based on the designated land use of the receiving site. See Exhibit 1 for additional guidance.
 5. Maintain the documentation for sample collection, analytical results, and the environmental consultant's field notes and evaluation.
 6. Any third party will be required to sign a release to accept the soil from the City and to release the City from liability.

Attachments: Exhibit 1 – Soil Reuse Acceptance Criteria Guidance Table

Exhibit 2 - Draft Release for Third Party Acceptance

CC: Jessica Brody, CAO
Lee Zarzecki, CAO
Zachery Clayton, DEH
Gregg Thomas, DEH



DENVER
THE MILE HIGH CITY

Department of Environmental Health

Division of Environmental Quality

200 W 14th Ave, Suite 310

Denver, CO 80204

p: 720-913-1311

f: 720-865-5534

www.denvergov.org/deh

Exhibit 1 - Soil Reuse Acceptance Criteria Guidance Table

Land Use	Examples	Applicable Soil Reuse Acceptance Criteria*
Recreational	Parks, Open Space	All Contaminants except Arsenic (Residential) Arsenic Standard
Residential	Single Family, Multi-family, Mixed-use with residential component	All Contaminants except Arsenic (Residential) Arsenic Standard
Right of Ways (not inclusive of utilities)	Roads, sidewalks, bike paths	All Contaminants except Arsenic (Composite Worker) Arsenic Standard
Utility corridors (underground)	Storm water, Waste water,	All Contaminants except Arsenic (Composite Worker) Arsenic Standard
City-owned facilities	Maintenance garages, office buildings, safety buildings	All Contaminants except Arsenic (Composite Worker) Arsenic Standard

* Screening values presented in the Regional Screening Levels table are based on human health risk from the combined exposure of direct soil ingestion, dermal contact with soil and inhalation of vapors or particulates associated with soil. Other pathways, such as indoor air or groundwater protection, may need to be considered on a site-specific basis. Some sites in sensitive ecological settings may need to be evaluated for potential ecological risk. These screening levels may not be applicable to sites within and/or subject to other regulatory programs (i.e., RCRA Corrective Action, Leaking Underground Storage Tanks, Superfund Operable Unit, etc.)

In addition, the reuse of any regulated asbestos-containing soil (“RACS”) or suspect-RACS must be conducted in accordance with state regulations governing the management of RACS, 6 CCR 1007-2, § 5.5.

DEH is committed to assisting all agencies and projects to perform soil disturbing activities in a cost-effective and sustainable manner while ensuring protection of public health and the environment.



PRIVILEGED AND CONFIDENTIAL/ATTORNEY WORK PRODUCT

AGREEMENT AND RELEASE FOR EXCESS SOIL REUSE

This Agreement and Release (“Agreement”) is made by and between _____ (the “Accepting Party”) and the City and County of Denver (the “City”) (collectively, the “Parties”).

RECITALS

WHEREAS, the City has determined that it has excess soil available; and

WHEREAS, the Accepting Party has requested excess soil from the City for reuse at ___[address of reuse location]___; and

WHEREAS, the Accepting Party has sampled and analyzed the excess soil and determined it to be suitable for the intended reuse; and

NOW, THEREFORE, in consideration of the premises and agreements contained herein, the Parties agree as follows:

1. Recitals Binding. The Parties agree that the Recitals stated above are an integral part of the Agreement and are binding.
2. Conveyance of Ownership. The City agrees to convey to the Accepting Party ownership of up to ___[maximum volume]___ cubic yards of excess soil.
3. Acceptance “AS-IS”. The Accepting Party acknowledges that the City has made no representations or warranties regarding the environmental or geotechnical suitability of the excess soil. The Accepting Party acknowledges that it is assuming ownership of the excess soil based solely on its analysis of the soil. The Accepting Party accepts the excess soil “AS IS.”
4. Payment. The Accepting Party shall pay to the City good and valuable consideration in the amount of TEN DOLLARS (\$10.00), the sufficiency of which is hereby acknowledged.
5. Transportation to Receiving Site. The Accepting Party will transport, or arrange to transport, the excess soil from ___[address]___ to the reuse location at a time, place, and manner acceptable to the City.
6. Defense and Indemnification
 - a. The Accepting Party agrees to defend, indemnify, reimburse and hold harmless City, its appointed and elected officials, agents and employees for, from and against all liabilities, claims, judgments, suits or demands for damages to persons or property arising out of, resulting from, or relating to the reuse of the excess soil, unless such Claims have been specifically determined by the trier of fact to be the sole negligence or willful misconduct of the City.
 - b. Accepting Party’s duty to defend and indemnify City shall arise at the time written notice of the Claim is first provided to City regardless of whether Claimant has filed suit

PRIVILEGED AND CONFIDENTIAL/ATTORNEY WORK PRODUCT

on the Claim. Accepting Party's duty to defend and indemnify City shall arise even if City is the only party sued by claimant and/or claimant alleges that City's negligence or willful misconduct was the sole cause of claimant's damages.

c. Accepting Party shall defend any and all Claims which may be brought or threatened against City and shall pay on behalf of City any expenses incurred by reason of such Claims including, but not limited to, court costs and attorney fees incurred in defending and investigating such Claims or seeking to enforce this indemnity obligation. Such payments on behalf of City will be in addition to any other legal remedies available to City and will not be the City's exclusive remedy.

7. City Execution of Agreement. The Agreement will not be effective or binding on the City until it has been fully executed by all required signatories of the City and County of Denver, and if required by Charter, approved by the City Council.

8. Authority.

a. The Parties to this Agreement agree that each Party has authority to execute this Agreement.

b. The Parties to this Agreement have carefully read, and know and understand, the full contents of this Agreement and are voluntarily entering into this Agreement.

c. The Parties to this Agreement are competent to enter into this Agreement.

9. Governing Law and Venue. The Agreement will be construed and enforced in accordance with applicable federal law, the laws of the State of Colorado, and the Charter, Revised Municipal Code, ordinances, regulations and Executive Orders of the City and County of Denver, which are expressly incorporated into the Agreement. Unless otherwise specified, any reference to statutes, laws, regulations, charter or code provisions, ordinances, executive orders, or related memoranda, includes amendments or supplements to same. Venue for any legal action relating to the Agreement will be in the District Court of the State of Colorado, Second Judicial District (Denver District Court).

10. Entire Agreement: The Parties to this Agreement have not relied on any statement, representation, omission, inducement or promise of any other Party (or any officer, agent, employee, representative, or attorney for any other Party) in executing this Agreement, or in making the settlement provided for herein, except as expressly stated in this Agreement. The Agreement contains the entire understanding of the Parties relating to the subject matter of the Agreement. No promise, inducement or agreement which is not specifically provided in this Agreement has been made by any party to this Agreement, and no warranties, representations, or undertakings are made by the Parties hereto except as are expressly provided herein.

11. Electronic Signatures and Electronic Records. The Accepting Party consents to the use of electronic signatures by the City. The Agreement, and any other documents requiring a signature under the Agreement, may be signed electronically by the City in the manner specified by the City. The Parties agree not to deny the legal effect or enforceability of the Agreement solely because it is in electronic form or because an electronic record was used in its formation. The

PRIVILEGED AND CONFIDENTIAL/ATTORNEY WORK PRODUCT

Parties agree not to object to the admissibility of the Agreement in the form of an electronic record, or a paper copy of an electronic document, or a paper copy of a document bearing an electronic signature, on the ground that it is an electronic record or electronic signature or that it is not in its original form or is not an original.

[Remainder of the Page Intentionally Left Blank]

[Signature Pages Follow]

DRAFT

**Appendix E Remediation Activities Discharging to Surface Water
Permit Information**



DENVER

PUBLIC WORKS

Wastewater Capital Projects Management

Construction Dewatering Discharges Permit

For Asbury and Tejon Park

October 2018



**CERTIFICATION TO DISCHARGE UNDER CDPS GENERAL PERMIT COG070000
CONSTRUCTION DEWATERING DISCHARGES**

Certification Number: **COG076281**
This Certification to Discharge specifically authorizes:
Denver City and County
to discharge from the facility identified as

Tejon and Asbury Park
to: **South Platte River**

Facility Located at: Asbury Ave and Tejon St Intersection Denver, CO 80223, Denver County
Center Point Latitude 39.680535 Longitude -105.012128

Defined Discharge Outfall(s) to Surface Water	Outfall(s) Lat Long	Discharge Outfall(s) Description*	Receiving Stream
Outfall Number 001-A	39.679445, -105.011446	The construction dewatering effluent will be discharged to the storm sewer located at the southeast corner of Asbury & Tejon Park with flow to the South Platte River. Monitoring shall occur after the implementation of any best management practices and prior to discharge to the storm sewer.	South Platte River

*All discharges must comply with the lawful requirements of federal agencies municipalities, counties, drainage districts and other local agencies regarding any discharges to storm drain systems, conveyances, or other water courses under their jurisdiction.

Permit Limitations and Monitoring Requirements apply to 001-A as outlined in the Permit Part I.B and Part I.C

Parameter	Units	Discharge Limitations Maximum Concentrations			Monitoring Frequency	Sample Type
		30-Day Average	7-Day Average	Daily Max.		
APPLICABLE TO ALL DISCHARGES AS LISTED IN GENERAL PERMIT						
pH, (Minimum-Maximum) 00400	s.u.	NA	NA	6.5-9.0	Weekly	In-situ
Total Suspended Solids 00530	mg/l	30	45	NA	Weekly	Grab
Flow ¹ 50050	gpm	NA	NA	200	Weekly	Instantaneous or Continuous
Oil and Grease Visual 84066		NA	NA	NA	Weekly	Visual ²
Oil and Grease 03582	mg/l	NA	NA	10	Weekly	Grab ²
SITE SPECIFIC PARAMETERS						
Arsenic (Total Recoverable) 00978	µg/l	Report	NA	NA	Weekly	Grab

¹ The maximum flow limit will be equal to twice the maximum flow rate provided in the permit application or subsequent modifications.

² If a visible sheen is observed, a grab sample shall be collected and analyzed for oil and grease.



Certification is issued: 5/10/2018 Effective: 5/10/2018 Expiration Date: 8/31/2018

This certification under the permit requires that specific actions be performed at designated times. The certification holder is legally obligated to comply with all terms and conditions of the permit.

This certification was approved by:
Margo Griffin, Work Group Lead
Permits Section
Water Quality Control Division





David Huntsinger Dir
 Denver City and County
 201 W Colfax Ave Dept 601
 Denver, CO 80202

Memorandum

TO: Denver City and County

FROM: Mike Harris, Permit Writer 303-692-3598
 or (contacts) Debbie Jessop WGL 303-692-3590

DATE: 5/10/2018

RE: Certification, Colorado Discharge Permit System - Construction Dewatering Discharges
 Fact Sheet and Information for Permit Number COG070000 Certification Number: COG076281
 Permittee-Facility: Denver City and County - Tejon and Asbury Park

ATTACHMENTS:

Certification COG076281
 CDPS General Permit for Construction Dewatering Discharges

The Water Quality Control Division (the division) has reviewed the application submitted for the Tejon and Asbury Park facility and determined that it qualifies for coverage under the CDPS General Permit for **Construction Dewatering Discharges** (the permit).

Attached is your Certification to discharge under the CDPS General Permit for Construction Dewatering Discharges along with a copy of the general permit. This Certification authorizes you to discharge in accordance with the conditions of the general permit and provides site-specific monitoring requirements per Part I.B of the permit. You are required to comply with the requirements included in the general permit as well as the Certification.

Note: The DMR form for the permit requires permittees to report the number of days that discharges occurred. Permittees and/or DMR cognizant officials must enter the total number of days on which any effluent discharge occurred at the permitted outfall(s) during the reporting period. This requirement is made in accordance with Section II.B.2 of the permit, *Duty to Provide Information*.

FACT SHEET FOR CERTIFICATION COG076281 Denver City and County - Tejon and Asbury Park

I. DISCHARGE SPECIFIC INFORMATION

The discharge is to the storm sewer with flow to the South Platte River within Segment 14 of the Upper South Platte River Sub-basin, South Platte River Basin, found in the Classifications and Numeric Standards for the South Platte River Basin (Regulation No. 38) (**COSPUS14**). Segment 14 is Reviewable and is classified for the following beneficial uses: Aquatic Life, Class 1 Warm; Recreation Class E; Water Supply; and Agriculture. Applicable surface water standards are included in the permit certification.

II. BASIS FOR SITE SPECIFIC PARAMETERS

- The receiving water is on the 303(d) list as impaired for Arsenic. Since Arsenic has the potential to be in the dewatering discharge, sampling and reporting for Arsenic is required.
- There is a history of leaking underground storage tanks being found and removed within the vicinity of this project. A review of the data submitted with the application did not show concentrations of Benzene,



Toluene, Ethylbenzene, or Xylenes (BTEX) at detectable concentrations. Based on this data, ongoing monitoring for BTEX is not required at this time.

III. CHEMICAL USAGE

The permittee did not specify any chemicals for use in waters that may be discharged. On this basis, no chemicals are approved under this permit. Prior to use of any applicable chemical, the permittee must submit a request for approval which includes the most current Material Safety Data Sheet (MSDS) for that chemical. Until approved, use of a chemical in waters that may be discharged could result in discharge of pollutants not authorized under the permit.

GENERAL INFORMATION FOR CERTIFICATION COG076281: Denver City and County - Tejon and Asbury Park

I. FEE INFORMATION

An application fee of \$410 (50% of the annual fee) will be assessed for all new applications. In addition, all certifications that are active on July 1st of each year will be assessed an annual fee of \$820 [category 7, subcat II-G - Construction Low Complexity per CRS 25-8-502]. Permit certifications remain active until a complete "Termination Application" is received and processed by the division. Please do not pay fees until you receive an invoice from the division.

II. DISCHARGE MONITORING REPORTS (DMRs)

Discharge Monitoring Reports (DMRs) for Defined Discharge Locations: DMRs will be mailed to the permittee within the next month for each of the numbered defined discharge outfalls identified in the permit certification. DMRs for all outfalls must be submitted **monthly** as long as the certification is in effect. DMRs must be submitted for each outfall even if there was not a discharge from the outfall in a given month. For each outfall where no discharge occurs in a given month, the permittee shall mark 'No Discharge' on the DMR form(s). The permittee shall provide the division with any additional monitoring data on the permitted discharge collected for entities other than the division. If forms have not been received, please contact the division at 303-692-3517.

The division now has the ability to allow facilities to submit their DMRs electronically. Monitoring results shall be summarized for each calendar month via the division's NetDMR service unless a waiver is granted in compliance with 40 CFR 127. If a waiver is granted, monitoring results shall be reported on division approved discharge monitoring report (DMR) forms (EPA form 3320-1). For more information, please call the NetDMR team at 303-691-4046 or visit www.colorado.gov/cdphe/e-reporting-rule-discharge-monitoring-report-information.

III. CERTIFICATION RECORDS INFORMATION:

The following information is what the division records show for this certification. For any changes to Contacts - Legal, Local, Billing, or DMR - a "Notice of Change of Contacts form" must be submitted to the division. This form is also available on our web site and must be signed by the legal contact.

Facility: Tejon and Asbury Park

Activity Description: construction of the proposed water quality improvement project at Tejon and Asbury Park.

County: Denver

SIC Code: 1799

Legal Contact *Receives all legal documentation, pertaining to the permit certification. [including invoice; is contacted for any questions relating to the facility; and receives DMRs as appropriate*

David Huntsinger Dir
Denver City and County
201 W Colfax Ave Dept 601
Denver, CO 80202

Phone number: 720-913-8822
Email:
david.huntsinger@denvergov.org

Facility Contact *(contacted for general inquiries regarding the facility):*

Andy Stewart, Sr Engr Capital Projects Mgmt
Denver City and County
2000 W 3 Ave
Denver, CO 80223

Phone number: 303-446-3510
Email:
andy.stewart@denvergov.org



Billing Contact *(receives the invoice pertaining to the permit certification):*

Andy Stewart, Sr Engr Capital Projects Mgmt
Denver City and County
2000 W 3 Ave
Denver, CO 80223

Phone number: 303-446-3510
Email:
andy.stewart@denvergov.org

DMR Contact:

Andy Stewart, Sr Engr Capital Projects Mgmt
Denver City and County
2000 W 3 Ave
Denver, CO 80223

Phone number: 303-446-3510
Email:
andy.stewart@denvergov.org

For answers to common questions surrounding construction dewatering, please review the Construction Dewatering FAQ available on our website at: www.Coloradowaterpermits.com. Select Construction and Construction Compliance Assistance and Guidance.

DIVISION USE ONLY

G2B	Notices of Termination (NOTs)
G3A	DMRs: Regular Submission Frequency
G3C	DMRs: Regular Preparation Frequency - Retain Onsite





COLORADO
Department of Public
Health & Environment

Dedicated to protecting and improving the health and environment of the people of Colorado

David Huntsinger, Dir
Denver City and County
201 W Colfax Ave Dept 601
Denver, CO 80202

TO: Denver City and County
FROM: WQCD Permits Section 303-692-3517
DATE: 8/16/2018
RE: WQCD CDPS Permit Administrative Extension for COG076281

The Water Quality Control Division received an application from Denver City and County COG070000-Construction dewatering renewal on 5/8/2018. The application requests discharge authorization for Tejon and Asbury Park located at Asbury Ave and Tejon St Intersection Denver Facility SIC 1623. The assigned permit number is COG076281.

The application has been reviewed and is considered complete for the purposes of filing. The Division has not verified all of the information contained in your application and has relied upon your signed certification to determine that the information is true, accurate, and complete. No permit has been issued at this time.

In the event that the Division does not issue a renewal permit in advance of the permit expiration date, the expired permit shall be administratively extended and continue in force to the effective date of the new permit. This is official notice of your eligibility of administrative extension and the permit shall become administratively extended on the date following your permit expiration. The permits duration may be extended only through administrative extensions and not through interim modifications.

The General Permit will be scheduled for a permit writer to begin the renewal process in the near future. At that time the Division will contact you to inform you that permit renewal process has started. There may be outreach at that time to shareholders for input.

Based on the locational information provided in your application we have determined that your discharge would be to Segment: COSPUS14. This discharge designation is solely for permit tracking and work planning purposes. The Division may evaluate other waterbody segments, particularly downstream segment(s), as part of the permit development process.

If any of the information submitted in your application is no longer true, accurate, and complete please submit an application supplement using the form found on the Division's web site.

We have the following contacts on file, if any of this information changes from the date your application was submitted until we issue your permit, please send a revised application/change of contacts form

Permittee Contact the person authorized to sign and certify the permit application. This person receives all permit correspondences *[Including invoice; is contacted for any questions relating to the facility; and receives DMRs as appropriate]* and is the person responsible for ensuring compliance with the permit

David Huntsinger, Dir
Denver City and County
201 W Colfax Ave Dept 601
Denver, CO 80202
Phone number: 720-913-8822
Email: david.huntsinger@denvergov.org



Facility Contact (*contacted for general inquiries regarding the facility*):

Andy Stewart, Sr Engr Capital Projects Mgmt
Denver City and County
2000 W 3 Ave
Denver, CO 80223
Phone number: 303-446-3510
Email: andy.stewart@denvergov.org

Billing Contact (*receives the invoice pertaining to the permit certification*):

Andy Stewart, Sr Engr Capital Projects Mgmt
Denver City and County
2000 W 3 Ave
Denver, CO 80223
Phone number: 303-446-3510
Email: andy.stewart@denvergov.org

DMR Contact:

Andy Stewart, Sr Engr Capital Projects Mgmt
Denver City and County
2000 W 3 Ave
Denver, CO 80223
Phone number: 303-446-3510
Email: andy.stewart@denvergov.org

If you have any questions, feel free to contact the Permits Section and refer to the permit number COG076281. We have detailed email and telephone contact information available on the Division website at the "[Division Contacts](#)". You may also contact us by calling the permits line at 303-692-3517.

david.huntsinger@denvergov.org

andy.stewart@denvergov.org

andy.stewart@denvergov.org

andy.stewart@denvergov.org





CDPS GENERAL PERMIT

CONSTRUCTION DEWATERING DISCHARGES

TO DISCHARGE UNDER THE COLORADO DISCHARGE PERMIT SYSTEM

PERMIT NUMBER COG070000

Colorado Department
of Public Health
and Environment

In compliance with the provisions of the Colorado Water Quality Control Act, (25-8-101 et seq., CRS, 1973 as amended) and the Federal Water Pollution Control Act, as amended (33 U.S.C. 1251 et seq.; the "Act"), entities engaged in construction dewatering are authorized to discharge source water from authorized locations throughout the State of Colorado to specified waters of the State. Such discharges shall be in accordance with the conditions of this general permit.

This permit specifically authorizes the entity(s) listed on page 1 of this document (also known as the permit certification) to discharge process generated wastewaters, as of the effective dates stated on page 1 of the certification, in accordance with the permit requirements and conditions set forth in Parts I and II hereof. All discharges authorized herein shall be consistent with the terms and conditions of this permit.

The applicant may demand an adjudicatory hearing within thirty (30) days of the date of issuance of the final permit determination, per the Colorado Discharge Permit System Regulations, 61.7(1). Should the applicant choose to contest any of the effluent limitations, monitoring requirements or other conditions contained herein, the applicant must comply with Section 24-4-104 CRS and the Colorado Discharge Permit System Regulations. Failure to contest any such effluent limitation, monitoring requirement, or other condition, constitutes consent to the condition by the Applicant.

This permit and the authorization to discharge shall expire at midnight AUGUST 31, 2018

Modified and signed this 24th day of July, 2014.

COLORADO DEPARTMENT OF PUBLIC HEALTH AND ENVIRONMENT

Janet Kieler, Permits
Section Manager
WATER QUALITY CONTROL
DIVISION

Permit Action Summary:

Minor Modification #2 – Issued July 24, 2014, Effective July 24, 2014: Part I.C.1.b

Minor Modification #1—Issued May 16, 2014, Effective May 16, 2014: Part I.E.1; Table B.1

Originally Issued and Signed: July 22, 2013, Effective September 1, 2013

Table of Contents

PART I.....	5
A. COVERAGE UNDER THIS PERMIT.....	5
1. Activities Covered.....	5
2. Limitations on Coverage	5
3. Application Requirements.....	6
4. Terminating Coverage.....	7
5. Modifying Existing Permit Coverage.....	7
B. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS	7
1. Permitted Outfall(s).....	7
2. Numeric Effluent Limitations, Monitoring Frequencies, and Sample Types.....	7
C. TERMS AND CONDITIONS.....	11
1. Discharge Log	11
2. Practice Based Requirements	11
3. Practices for Discharges in Exceedance of Applicable Water Quality Standards.....	11
4. Chemical Additions.....	12
4. Discharge Point	12
5. Discharges to Conveyances.....	12
6. Mixing Zone.....	12
7. Discharges to Waters with Total Maximum Daily Loads (TMDLs).....	13
8. Discharges to 303(d) Listed Waters	13
D. DEFINITIONS OF TERMS.....	13
E. GENERAL MONITORING, SAMPLING AND REPORTING REQUIREMENTS	17
1. Routine Reporting of Data	17
2. Reporting for Undefined Outfalls.....	18
3. Representative Sampling.....	18
4. Analytical and Sampling Methods for Monitoring and Reporting.....	18
5. Records.....	20
6. Additional Monitoring by Permittee	21
7. Flow Measuring Device	21
8. Signatory and Certification Requirements	21
Part II.....	23
A. NOTIFICATIONREQUIREMNTS	23
1. Notification to Parties.....	23

2.	Change in Discharge or Wastewater Treatment	23
3.	Special Notifications Definitions	24
4.	Noncompliance Notification	24
5.	Other Notification Requirements	25
6.	Bypass Notification	25
7.	Upsets	26
8.	Discharge Point	26
9.	Proper Operation and Maintenance	26
10.	Minimization of Adverse Impact.....	26
11.	Removed Substances.....	27
12.	Submission of Incorrect or Incomplete Information	27
13.	Bypass	27
14.	Reduction, Loss, or Failure of Treatment Facility.....	27
B.	RESPONSIBILITIES	28
1.	Inspections and Right to Entry	28
2.	Duty to Provide Information	28
3.	Transfer of Ownership or Control.....	28
4.	Availability of Reports	29
5.	Modification, Suspension, Revocation, or Termination of Permits By the Division	29
6.	Oil and Hazardous Substance Liability.....	31
7.	State Laws	31
8.	Permit Violations.....	31
9.	Property Rights.....	32
10.	Severability.....	32
11.	Renewal Application	32
12.	Confidentiality.....	32
13.	Fees.....	32
14.	Duration of Permit.....	32
15.	Section 307 Toxics	32
16.	Effect of Permit Issuance	33

PART I

A. COVERAGE UNDER THIS PERMIT

1. Activities Covered

This permit authorizes the discharge of construction dewatering source water throughout the State of Colorado to waters of the state. Construction dewatering source water means groundwater, surface water, and stormwater that has mixed with the groundwater and/ or surface water (i.e. commingled stormwater runoff) that has come into contact with Construction Activities. This permit only authorizes discharges for which the source water is drawn from the specific area(s) identified in the application, or in subsequent notification(s) in accordance with Part II.A.2 and II.B.5 of the permit.

2. Limitations on Coverage

All effluent limitations for this permit are applied at the point of discharge. Dilution (i.e., mixing zone) considerations are not applicable in this permit.

A discharge that would meet any of the following conditions at the time of the effective date of the permit authorization are not eligible for coverage under this permit and must apply for coverage under another general permit or under an individual permit:

- a. The Division has determined that there is a reasonable potential for a pollutant to be present in the source water at a concentration that is greater than a numeric water quality standard of the receiving water. Note that a numeric water quality standard does not exist for Total Suspended Solids, and therefore permit coverage is available for discharges that require treatment to meet the Total Suspended Solid limitation in this permit. The Division's evaluation to identify potential pollutants will include, but is not limited to:
 - known areas of contamination at or near the facility (e.g., hazardous waste site, leaking underground storage tanks, or additional sources other than what is normally encountered at excavation and construction sites),
 - naturally occurring pollutants that potentially exist in the source water, and
 - pollutants that have the potential to be added to the source water prior to discharge.

An exception to this limitation will be allowed for discharges with a reasonable potential for Benzene, Toluene, Ethylbenzene, and Xylene to be present in the source water at a concentration that is greater than a numeric water quality standard of the receiving water when the applicant can demonstrate that the construction dewatering source water does not have concentrations of these parameters that are greater than the water quality standard of the receiving water.

A discharge subject to this limitation following the effective date of the permit authorization shall be determined to be inconsistent with the conditions of the permit and the Division shall require a new or revised permit application and shall follow the procedures specified in Sections 61.5 through 61.6, and 61.15 of the Colorado Discharge Permit System Regulations.

- b. The discharge(s) is to a receiving water designated as "outstanding waters."
- c. Discharges to ground water only cannot be covered under this general permit if subject to regulation by the EPA or by implementing agencies under Senate Bill 181. This exclusion does not apply to discharges to surface waters, including discharges to groundwater that are tributary to surface waters and for which the Division determines that the requirements of Regulation 61 applicable to surface waters apply.

Discharges that fall under the regulating authority of other agencies include:

- i. Discharges to Class V Injection Wells—Discharges to Class V Injection Wells within the state of Colorado are regulated by the Environmental Protection Agency (EPA), Region 8, through the Underground Injection Control (UIC) program. In accordance with of Colorado Discharge Permit System Regulations Section 61.14(1)(b)(vii), facilities operating under a permit issued pursuant to the UIC provisions are specifically exempt from coverage under the ground water discharge provisions of Regulation 61. A Class V Injection well is defined by EPA as any bored, drilled, or driven shaft, or dug hole that is deeper than its widest surface dimension, or an improved sinkhole, or a subsurface fluid distribution system.
- ii. Discharges to Surface Impoundments or Other Engineered Units—Facilities discharging wastewaters into surface impoundments and associated pipelines or other engineered units, even those designed for purposeful seepage (e.g. no liner or a seeping liner) shall be regulated by the Hazardous Materials Waste Management Division (HMWMD), Solid Waste Program.

3. Application Requirements

In order to apply for certification under this general permit, the applicant shall submit an application form as provided by the Division by mail or hand delivery **at least 30 days before the anticipated date of discharge**. The application in its entirety shall be submitted to:

Colorado Department of Public Health and Environment
Water Quality Control Division
Permits Section, WQCD-PCP-B2
4300 Cherry Creek Drive South
Denver, Colorado 80246-1530

Following review of the application, the Division may request additional information or deny the authorization to discharge under this general permit. If the Division determines that a new facility does not fall under the authority of the general permit, then the information received will be processed for an individual permit or the applicant may apply for coverage under an alternative general permit, and the applicant shall be notified of such a determination. If during the renewal process, the Division determines that a facility no longer qualifies for the general permit, then the certification may be revoked or the facility may be allowed to discharge under the general permit, with additional conditions in the amended certification, until an individual permit or alternative general permit is issued.

A permittee desiring continued coverage under the general permit must reapply **at least 180 days in advance of this permit expiration**. If this permit is not reissued or replaced prior to the expiration date, it will be administratively continued and remain in force and effect. If a permittee was authorized to discharge under this permit prior to the expiration date, any discharges authorized under this permit will automatically remain covered by this permit until the earliest of:

- a. Authorization for coverage under a reissued permit or a replacement of this permit following the timely and appropriate submittal of a complete application requesting authorization to discharge under the new permit and compliance with the requirements of the application;
- b. The issuance and effect of a termination issued by the Division;
- c. The issuance or denial of an individual permit for the facility's discharges;
- d. A formal permit decision by the Division not to reissue this general permit, at which time the Division will identify a reasonable time period for covered dischargers to seek coverage under an

alternative general permit or an individual permit. Coverage under this permit will cease when coverage under another permit is granted/authorized; or

e. The Division has informed the permittee that they are no longer covered under this permit.

4. **Terminating Coverage**

To terminate permit coverage, the legal permit applicant or duly authorized agent must submit a complete and accurate Notice of Termination Form, to the address listed in Part I.A.3. The authorization to discharge under this permit terminates at midnight of the day that the termination is effective as notified by the Division. The permittee is responsible for meeting the terms of this permit until the authorization is terminated. The Notice of Termination must be signed in accordance with Part I.E.8 of this permit.

5. **Modifying Existing Permit Coverage**

To modify an existing permit certification, the legal permit contact or duly authorized agent must submit a complete and accurate Modification Form, to the address listed in Part I.A.3. This form must be submitted to the Division at least 30 days prior to implementing any requested modifications that result in a discharge to state waters. The permittee is not authorized to discharge under the modified conditions until the modified certification is issued and effective. Modifications include but are not limited to: adding or removing discharge outfalls, adding new or additional chemicals to the treatment process or effluent, modifying treatment in a manner that would result in a new or altered discharge in terms of location or effluent quality, etc. The modification form must be signed in accordance with Part I.E.8 of this permit.

B. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

1. **Permitted Outfall(s)**

Beginning no earlier than the effective date listed on the permit certification and lasting through the expiration date of this permit, the permittee identified on the permit certification is authorized to discharge from the Outfall(s) listed on the permit certification in accordance with the conditions and limitations of this permit.

If requested in the permit application, the permit certification may identify an outfall as an undefined outfall, and the location of the discharge outfall will not be identified on the permit certification. For all undefined outfalls, the permittee must comply with the record keeping requirements in Part I.C.1.c (Discharge Log), reporting requirements in Part I.E.2 (Reporting for Undefined Outfalls), and the outfall location shall not be changed after a discharge has occurred except through a modification in accordance with Part I.A.5.

In order to keep permit certifications, discharge monitoring reports, and administration manageable, the Division is limiting the number of outfalls per permit certification to twenty (20). If the applicant has reason to request more than twenty outfall locations the Division may grant more outfalls on a case-by-case basis.

2. **Numeric Effluent Limitations, Monitoring Frequencies, and Sample Types**

In accordance with the Water Quality Control Commission Regulations for Effluent Limitations, Section 62.4, and the Colorado Discharge Permit System Regulations, Section 61.8(2), 5.C.C.R. 1002-61, the permitted discharge shall not contain effluent parameter concentrations that exceed the limitations specified in Table B.1 or B.2 below, as applicable to the outfall(s). For parameters for which the applicable note states that the analysis or monitoring will be included in the permit certification based on meeting specific

conditions, limitations and monitoring requirements are only applicable if identified in the permit certification for the specified outfall.

The permittee must monitor the effluent for all listed parameters at the frequency and sample types specified in Table B.1 or B.2 below, as applicable to the outfall(s).

Report only monitoring requirements for additional site-specific parameters may be included in the permit certification. Such additional monitoring may be required where this additional information will help the Division verify whether any anticipated changes or additional uncertainties reveal data that more accurately predicts actual effluent concentrations.

All required monitoring will begin immediately and last for the life of the permit unless otherwise noted. The results of such monitoring must be reported on the Discharge Monitoring Report (DMR) form (See Part I.E).

Table B.1, Numeric Effluent Limitations and Monitoring Requirements for all Discharges to Surface Water

ICIS Code	Parameter	Note (below)	Discharge Limitations			Monitoring Conditions	
			30-Day Average	7-Day Average	Daily Maximum	Monitoring Frequency	Sample Type
50050	Flow, gpm	1	---	---	Limitation in Certification	Weekly	Instantaneous or Continuous Recorder
00530	Total Suspended Solids, mg/l		30	45	---	Weekly	Grab
84066	Oil and Grease	2	---	----	---	Weekly	Visual
03582	Oil and Grease, mg/l	2	----	----	10	Weekly	Grab
00400	pH, s.u.		----	----	6.5-9.0	Weekly	In-situ or Grab
70295	Total Dissolved Solids, mg/l	3	Report	----	Report	Monthly	Grab
00665	Total Phosphorus, mg/l, as P	4	Report	----	Report	Monthly	Grab
51040	E. Coli bacteria, per 100 ml	5	Limit in Certification	Limit in Certification	----	Weekly	Grab
34030	Benzene, ug/l	6	Limit in Certification	----	Limit in Certification	Weekly	Grab
34010	Toluene, ug/l	6	Limit in Certification	----	Limit in Certification	Weekly	Grab
37371	Ethylbenzene, ug/l	6	Limit in Certification	----	Limit in Certification	Weekly	Grab
81551	Xylene, ug/l	6	Limit in Certification	----	Limit in Certification	Weekly	Grab
	Metals, Organics, Inorganics, Temperature, RADs	7	Report	----	Report	Weekly	Grab

Table B.2, Numeric Effluent Limitations and Monitoring Requirements for all Discharges to Ground Water

Parameter ICIS Code	Note (below)	Discharge Limitations			Monitoring Conditions	
		30-Day Average	7-Day Average	Daily Maximum	Monitoring Frequency	Sample Type
50050 Flow, gpm	1	----	----	Limitation in Certification	Weekly	Instantaneous or Continuous Recorder
84066 Oil and Grease	2	----	-----	-	Weekly	Visual
03582 Oil and Grease, mg/l	2	----	-----	10	Weekly	Grab
00400 pH, s.u.		----	-----	6.5-8.5	Weekly	In-situ or Grab
70295 Total Dissolved Solids, mg/l	8	Limit in Certification	-----	Limit in Certification	Monthly	Grab
00665 Total Phosphorus, mg/l, as P	4	Report	-----	Report	Monthly	Grab
74056 Total Coliform, per 100 ml	5	2.2		23	Weekly	Grab
34030 Benzene, ug/l	6	Limit in Certification	-----	Limit in Certification	Weekly	Grab
34010 Toluene, ug/l	6	Limit in Certification	-----	Limit in Certification	Weekly	Grab
37371 Ethylbenzene, ug/l	6	Limit in Certification	-----	Limit in Certification	Weekly	Grab
81551 Xylene, ug/l	6	Limit in Certification	-----	Limit in Certification	Weekly	Grab
Metals, Organics, Inorganics, Temperature, RADs	7	Report	-----	Report	Weekly	Grab

Notes for Tables B.1 and B.2:

Note 1: Flow Limit— The acute flow limit will be equal to twice the maximum flow rate provided in the permit application and will be stated on the certification. However, if the discharge flow rate exceeds the maximum flow rate identified in the application, the permittee shall notify the Division in accordance with Part II.A.2. of the Permit. The method for measuring flow rates authorizes estimates.

Note 2: Oil and Grease—A visual observation of the discharge for each permitted outfall must be made once a week. In the event an oil sheen or floating oil is observed, a composite sample shall be collected weekly, analyzed, and reported on the DMR. In addition, corrective action shall be taken immediately to mitigate the discharge of oil and grease. A description of the corrective action taken must be included with the DMR.

- Note 3: Total Dissolved Solids (TDS) – Surface Water Outfalls—Analysis for salinity, measured as TDS, will be included in the permit certification for all discharges in the Colorado River Basin. Following the submittal of the initial six sets of monthly data, the Division shall determine whether the permittee is required to submit a report addressing salt removal in accordance with the Colorado River Salinity Standards, Regulation No. (5CCR 1002-39). If the salinity report is required, the Division shall so advise the permittee by letter or through the inclusion of a compliance schedule and the report shall be submitted within 180 days.
- Note 4: Total Phosphorus—Analysis for Total Phosphorus, as P, will be included in the permit certification for all discharges to waters with a control regulation for P. In accordance with the Dillon Reservoir Control Regulation (Regulation 71), monitoring for Total Phosphorus is required. In accordance with the Cherry Creek Reservoir Control Regulation (Regulation 72), monitoring and compliance with the Total Phosphorus chronic numeric effluent limit of 0.05mg/l is required. In accordance with the Chatfield Reservoir Control Regulation (Regulation 73), monitoring and compliance with the Total Phosphorus chronic numeric effluent limit of 1.0 mg/l is required. In accordance with the Bear Creek Watershed Control Regulation (Regulation 74), monitoring for Total Phosphorus is required.
- Note 5: E Coli and Total Coliform—Analysis and limitations for E. Coli and Total Coliform will be included in the permit certification for discharges from construction dewatering operations that involve replacing or repairing existing sanitary sewer lines, are in proximity to septic disposal systems, or other sewage disposal conveyances or vessels, where the Division has made a qualitative reasonable potential determination that E. coli or Total Coliform may be present in the discharge. The E. coli effluent limitation will be applied for discharge to surface water and will reflect the Recreational Class of the receiving stream of the discharge (Class E at 126 per 100 ml, Class P at 205 per 100 ml, and Class N at 630 per 100ml). The Total Coliform effluent limitation will be applied if the discharge is to groundwater. If the construction dewatering operation is considered in-stream (for example, bank stabilization and discharges back to the same water body), monitoring and reporting, or monitoring and compliance with the numeric effluent limitation for E. coli or Total Coliform will not be required.
- Note 6: Benzene, Toluene, Ethylbenzene, and Xylene — Analysis and limitations for Benzene, Toluene, Ethylbenzene, and Xylene will be included in the permit certification for construction dewatering operations where the Division has made a qualitative reasonable potential determination that Benzene, Toluene, Ethylbenzene, or Xylene may be present in the discharge. See Part I A.2.a. of the permit regarding limitations of permit coverage associated with Benzene, Toluene, Ethylbenzene, and Xylene.
- If the construction dewatering operation is considered in-stream (for example bank stabilization and discharges back to the same water body), monitoring and compliance with the additional numeric effluent limitations will not be required.
- Note 7: Metals, Organics, Inorganics, Temperature, and RADS—Analysis for additional parameters may be added to the permit certification in accordance with Part I.B.2.
- If the construction dewatering operation is considered in-stream (for example bank stabilization and discharges back to the same water body), monitoring for the additional parameters will not be required.
- Note 8: Total Dissolved Solids (TDS) – Ground Water Outfalls—Analysis for salinity, measured as TDS, will be added to the permit certification for all discharges to a different aquifer from which the ground water was pulled. If the discharge is to the same aquifer from which it was pulled, sampling for TDS will not be required provided that the remediation activity is not contributing to TDS concentrations.

C. TERMS AND CONDITIONS

1. **Discharge Log**

The permittee shall maintain a documented Discharge Log identifying the following information for each permitted outfall:

- a. the dates and times when a discharge commences and ends,
- b. records for monitoring as required by Part I.E.5.
- c. prior to the start of any discharge from an undefined discharge outfall(s) (see Part I.B.1), the receiving water for the discharge and the location that the outfall will be located at, including the latitude and longitude to the nearest 15 seconds, , general description of the location, and a map showing the discharge locations.
- d. a description of the pollutant control practices used during construction dewatering, including:
 - i. for all filter devices- document the pollutant control filter maximum flow rate that will maintain compliance with the permit effluent limits and a drawing, sketch, and/or written description of the installation and implementation specifications.
 - ii. for all settling devices- document the residence time and maximum flow rate that will maintain compliance with the permit effluent limits and a drawing, sketch, and/or written description of the installation and implementation specifications..
 - iii. for all other techniques and methods implemented to remove pollutants prior to discharge, such as but not limited to pump in gravel-packs, sump conditions, and well screens- document the technique used and its intended purpose, the maximum flow rate for operation that will maintain compliance with the permit effluent limits, and a drawing, sketch, and/ or written description of the installation and implementation specifications.
 - iv. if no treatment has been determined necessary to remove pollutants prior to discharge in order to maintain compliance with the permit effluent limits- a statement identifying that no treatment will be provided.
- e. The method used to measure flow, in accordance with I.E.7.

The log must be updated within 72 hours of the occurrence of any activity requiring documentation in accordance with this subsection.

2. **Practice Based Requirements**

- a. **Pollutant Control Practices**: The permittee shall implement pollutant control practices to meet the effluent limitations contained in this permit. The pollutant control practices must be selected, designed, installed, implemented and maintained in accordance with good engineering, hydrologic, pollution control practices, and the manufacturer's specifications including installation and implementation specifications, where applicable. Practices may include treatment, schedules of activities, prohibitions of practices, maintenance procedures, monitoring practices used to document the capability of the treatment practices to remove pollutants, handling and disposal practices, and other management practices necessary to meet the effluent limitations contained in this permit.

3. **Practices for Discharges in Exceedance of Applicable Water Quality Standards**

The Division expects that compliance with the effluent limits in this permit will control discharges as necessary to meet applicable water quality standards. If at any time the permittee becomes aware that at the permitted outfall, pollutant concentrations for an effluent parameter **not** subject to an effluent limitation in Part I.B or the permit certification exceeds any applicable water quality standard for the receiving water, the permittee shall:

- a. Halt or reduce any activity if necessary to prevent the discharge of an effluent parameter(s), at the permitted outfall, in concentrations which exceed the applicable water quality standards for the receiving water; and
- b. Mail a written report to the Division containing all relevant monitoring data and the information consistent with that required for noncompliance in Part II.A.4 (a) within five (5) days after becoming aware of the exceedance.

Coverage under this general permit may be modified, suspended, or terminated by the Division if necessary to effectively implement protection of waters of the State. If the Division finds that such new or altered discharge might be inconsistent with the conditions of the permit, the Division shall require a new or revised permit application, or require coverage under an individual permit or alternative general permit, and shall follow the procedures specified in Sections 61.5 through 61.6, and 61.15 of the Colorado Discharge Permit System Regulations.

4. Chemical Additions

No chemicals are to be added that have the potential to be present in the permitted discharge, including, but not limited to, chemical additions at any point in the treatment process, unless the permittee provides advance notice to the Division of the planned changes in accordance with Part II.A.2 and the Division confirms that the new or altered discharge is appropriate for coverage under this permit. The permit applicant must submit a list of proposed chemicals, including dosage rates, used in the treatment process. Additionally, a MSDS for each chemical proposed for use must be provided to the Division. The addition of chemicals may require permitting under the Remediation Activities general permit that authorizes the discharge from remediation activities (e.g., the discharge requires treatments to remove pollutants resulting from the chemical addition).

Chemicals used in waters that will, or may be, discharged to waters of the State must be used in accordance with all state and federal regulations, and in strict accordance with the manufacturer's site-specific instructions.

4. Discharge Point

All waters shall be discharged in a manner to prevent erosion, scouring, or damage to stream banks, streambeds, or ditches.

5. Discharges to Conveyances

All dischargers must comply with the lawful requirements of counties; drainage districts and other state or local agencies regarding any discharges to storm drain systems or other watercourses under their jurisdiction.

6. Mixing Zone

For this general permit, all numeric effluent limitations are assigned as end of pipe limits based on the Water Quality Standards. Dilution (i.e. mixing zone) considerations are not applicable in this permit. Dischargers who want consideration of a mixing allowance should apply for an individual permit

7. Discharges to Waters with Total Maximum Daily Loads (TMDLs)

Discharges to State waters for which an approved or established TMDL has been developed may be authorized provided there are sufficient remaining waste load allocations in the approved or established TMDL. If sufficient remaining waste load allocations are not available, coverage under an Individual permit may be required. If additional effluent limitations or other terms and conditions not included in this permit are required for discharges to segments for which a TMDL has been completed, the discharge cannot be covered under this general permit and must apply for coverage under another general permit or under an individual permit. Factors that will be taken into consideration when making this determination include the plausibility that the pollutant for which the TMDL was developed will be in the discharge, and duration and frequency of the discharge.

8. Discharges to 303(d) Listed Waters

Sampling, monitoring and compliance with numeric effluent limitations may be required for discharges to 303(d) listed waters that are impaired for a specified pollutant(s), and that pollutant has the potential to be in the construction dewatering project discharge. If additional effluent limitations or other terms and conditions not included in this permit are required for discharges to 303(d), the discharge cannot be covered under this general permit and must apply for coverage under another general permit or under an individual permit. Factors that will be taken into consideration when making this determination include the plausibility that the pollutant listed on the 303(d) list will be in the discharge, and duration and frequency of the discharge.

D. DEFINITIONS OF TERMS

1. "**Construction Activities**" refers to ground surface disturbing activities, which include, but are not limited to, clearing, grading, excavation, demolition, installation of new or improved haul roads and access roads, staging areas, stockpiling of fill materials, and borrow areas.
2. "**Continuous**" measurement is a measurement obtained from an automatic recording device which continually measures provides measurements.
3. "**Daily Maximum limitation**" for all parameters except temperature, means the limitation for this parameter shall be applied as an instantaneous maximum (or, for pH or DO, instantaneous minimum) value. The instantaneous value is defined as the analytical result of any individual sample. DMRs shall include the maximum (and/or minimum) of all instantaneous values within the calendar month. Any instantaneous value beyond the noted daily maximum limitation for the indicated parameter shall be considered a violation of this permit.
4. "**Daily Maximum Temperature (DM)**" is defined in the Basic Standards and Methodologies for Surface Water 1002-31, as the highest two-hour average water temperature recorded during a given 24-hour period. This will be determined using a rolling 2-hour maximum temperature. If data is collected every 15 minutes, a 2-hour maximum can be determined on every data point after the initial 2 hours of collection. Note that the time periods that overlap days (Wednesday night to Thursday morning) do not matter as the reported value on the DMR is the greatest of all the 2-hour averages.

For example, data points collected at:

08:15, 08:30, 08:45, 09:00, 09:15, 09:30, 09:45, 10:00, would be averaged for a single 2 hour average data point

08:30, 08:45, 09:00, 09:15, 09:30, 09:45, 10:00, 10:15, would be averaged for a single 2-hour average data

point

08:45, 09:00, 09:15, 09:30, 09:45, 10:00, 10:15, 10:30, would be averaged for a single 2 hour average data point

This would continue throughout the course of a calendar day. The highest of these 2-hour averages over a month would be reported on the DMR as the daily maximum temperature. At the end/beginning of a month, the collected data should be used for the month that contains the greatest number of minutes in the 2-hour maximum.

Data from 11 pm to 12:59 am would fall in the previous day. Data collected from 11:01 pm to 1:00 am would fall in the new month.

5. "**Dissolved (D) metals fraction**" is defined in the Basic Standards and Methodologies for Surface Water 1002-31, as that portion of a water and suspended sediment sample which passed through a 0.40 or 0.45 UM (micron) membrane filter. Determinations of "dissolved" constituents are made using the filtrate. This may include some very small (colloidal) suspended particles which passed through the membrane filter as well as the amount of substance present in true chemical solution.
6. "**Geometric mean**" for *E. coli* bacteria concentrations, the thirty (30) day and seven (7) day averages shall be determined as the geometric mean of all samples collected in a thirty (30) day period and the geometric mean of all samples taken in a seven (7) consecutive day period respectively. The geometric mean may be calculated using two different methods. For the methods shown, a, b, c, d, etc. are individual sample results, and n is the total number of samples.

Method 1: Geometric Mean = $(a*b*c*d*...)^{(1/n)}$ "*" - means multiply

Method 2: Geometric Mean = antilog ([log(a)+log(b)+log(c)+log(d)+...]/n)

Graphical methods, even though they may also employ the use of logarithms, may introduce significant error and may not be used.

In calculating the geometric mean, for those individual sample results that are reported by the analytical laboratory to be "less than" a numeric value, a value of 1 should be used in the calculations. If all individual analytical results for the month are reported to be less than numeric values, then report "less than" the largest of those numeric values on the monthly DMR. Otherwise, report the calculated value.

For any individual analytical result of "too numerous to count" (TNTC), that analysis shall be considered to be invalid and another sample shall be promptly collected for analysis. If another sample cannot be collected within the same sampling period for which the invalid sample was collected (during the same month if monthly sampling is required, during the same week if weekly sampling is required, etc.), then the following procedures apply:

- i. A minimum of two samples shall be collected for coliform analysis within the next sampling period.
- ii. If the sampling frequency is monthly or less frequent: For the period with the invalid sample results, leave the spaces on the corresponding DMR for reporting coliform results empty and attach to the DMR a letter noting that a result of TNTC was obtained for that period, and explain why another sample for that period had not been collected.

If the sampling frequency is more frequent than monthly: Eliminate the result of TNTC from any further calculations, and use all the other results obtained within that month for reporting purposes. Attach a letter

noting that a result of TNTC was obtained, and list all individual analytical results and corresponding sampling dates for that month.

7. **“Good Engineering, Hydrologic and Pollution Control Practices:** means methods, procedures, and practices that a) are based on basic scientific fact(s); b) reflect best industry practices and standards; c) are appropriate for the conditions and pollutant sources; and d) provide appropriate solutions to meet the associated permit requirements, including all effluent limitations.
8. **"Grab"** sample, is a single "dip and take" sample so as to be representative of the parameter being monitored.
9. **“Groundwater”** means any water not visible on the surface of the ground under natural conditions.
10. **"In-situ"** measurement is defined as a single reading, observation or measurement taken in the field at the point of discharge.
11. **"Instantaneous"** measurement is a single reading, observation, or measurement performed on site using existing monitoring facilities.
11. To be considered an **“Intermittent Discharge”** one of the following must apply:
 - i. the maximum discharge frequency is less than 3 consecutive days (72 hours), and less than 3 days per 7 day period, and less than 10 days total per month
 - ii. the maximum discharge frequency is less than 5 consecutive days (120 hours) and less than 5 total days per month
 - iii. It can be shown that discharge frequency and duration is tied solely to precipitation events, where the discharge starts and stops shortly after the precipitation event starts/stops.
12. **"Maximum Weekly Average Temperature (MWAT)"** is defined in the Basic Standards and Methodologies for Surface Water 1002-31, as an implementation statistic that is calculated from field monitoring data. The MWAT is calculated as the largest mathematical mean of multiple, equally spaced, daily temperatures over a seven-day consecutive period, with a minimum of three data points spaced equally through the day. For lakes and reservoirs, the MWAT is assumed to be equivalent to the maximum WAT from at least three profiles distributed throughout the growing season (generally July-September).

The MWAT is calculated by averaging all temperature data points collected during a calendar day, and then averaging the daily average temperatures for 7 consecutive days. This 7 day averaging period is a rolling average, i.e. on the 8th day, the MWAT will be the averages of the daily averages of days 2-8. The value to be reported on the DMR is the highest of all the rolling 7-day averages throughout the month. For those days that are at the end/beginning of the month, the data shall be reported for the month that contains 4 of the 7 days.

Day 1: Average of all temperature data collected during the calendar day.

Day 2: Average of all temperature data collected during the calendar day.

Day 3: Average of all temperature data collected during the calendar day.

Day 4: Average of all temperature data collected during the calendar day.

Day 5: Average of all temperature data collected during the calendar day.

Day 6: Average of all temperature data collected during the calendar day.

Day 7: Average of all temperature data collected during the calendar day.

1st MWAT Calculation as average of previous 7 days

Day 8: Average of all temperature data collected during the calendar day.

2nd MWAT Calculation as average of previous 7 days

Day 9: Average of all temperature data collected during the calendar day.

3rd MWAT Calculation as average of previous 7 days

13. "**Potentially dissolved (PD) metals fraction**" is defined in the Basic Standards and Methodologies for Surface Water 1002-31, as that portion of a constituent measured from the filtrate of a water and suspended sediment sample that was first treated with nitric acid to a pH of 2 or less and let stand for 8 to 96 hours prior to sample filtration using a 0.40 or 0.45-UM (micron) membrane filter. Note the "potentially dissolved" method cannot be used where nitric acid will interfere with the analytical procedure used for the constituent measured.
14. "**Practical Quantification Limit (PQL)**" means the minimum concentration of an analyte (substance) that can be measured with a high degree of confidence that the analyte is present at or above that concentration. The use of PQL in this document may refer to those PQLs shown in Part I.D of this permit or the PQLs of an individual laboratory.
15. "**Quarterly measurement frequency**" means samples may be collected at any time during the calendar quarter if a continual discharge occurs. If the discharge is intermittent, then samples shall be collected anytime during the quarter that the discharge occurs. Calendar quarters are defined as January-March, April-June, July- September, and October-December.
16. "**Recorder**" requires the continuous operation of a chart and/or totalizer (or drinking water rotor meters or pump hour meters where previously approved.)
17. "**Seven (7) day average**" means, with the exception of fecal coliform or *E. coli* bacteria (see geometric mean), the arithmetic mean of all samples collected in a seven (7) consecutive day period. Such seven (7) day averages shall be calculated for all calendar weeks, which are defined as beginning on Sunday and ending on Saturday. If the calendar week overlaps two months (i.e. the Sunday is in one month and the Saturday in the following month), the seven (7) day average calculated for that calendar week shall be associated with the month that contains the Saturday. Samples may not be used for more than one (1) reporting period. (See the "**Analytical and Sampling Methods for Monitoring and Reporting Section in Part I.E.3 for guidance on calculating averages and reporting analytical results that are less than the PQL**").
18. "**State Waters**" means any and all surface or subsurface waters which are contained in or flow in or through this state, but does not include waters in sewage systems, waters in treatment works of disposal systems waters in potable water distribution systems, and all water withdrawn for use until use and treatment have been completed.
19. "**Stormwater**" means precipitation induced stormwater runoff, snow melt runoff, and surface runoff and drainage
20. "**Surface Water**" means all surface waters that meet the definition of "State Waters" but does not meet the definition of "stormwater runoff."
21. "**Thirty (30) day average**" means, except for fecal coliform or *E. coli* bacteria (see geometric mean), the arithmetic mean of all samples collected during a thirty (30) consecutive-day period. The permittee shall report the appropriate mean of all self-monitoring sample data collected during the calendar month on the Discharge Monitoring Reports. Samples shall not be used for more than one (1) reporting period. (See the "**Analytical and Sampling Methods for Monitoring and Reporting Section in Part I.E.3 for guidance on calculating averages and reporting analytical results that are less than the PQL**").

22. "**Total Metals**" means the concentration of metals determined on an unfiltered sample following vigorous digestion (Section 4.1.3), or the sum of the concentrations of metals in both the dissolved and suspended fractions, as described in Manual of Methods for Chemical Analysis of Water and Wastes, U.S. Environmental Protection Agency, March 1979, or its equivalent.
23. "**Total Recoverable Metals**" means that portion of a water and suspended sediment sample measured by the total recoverable analytical procedure described in Methods for Chemical Analysis of Water and Wastes, U.S. Environmental Protection Agency, March 1979 or its equivalent.
24. "**Visual**" observation is observing the discharge to check for the presence of a visible sheen or floating oil.
25. "**Water Quality Control Division**" or "Division" means the state Water Quality Control Division as established in 25-8-101 et al.)
26. "**Weekly measurement frequency**" means samples may be collected at any time during the week as defined as beginning on Sunday and ending on Saturday. If the discharge is intermittent, a sample must be collected for each week (as defined above) that the discharge occurs. A minimum of one sample must be collected for discharges lasting less than one week. For example, if an intermittent discharge begins on Wednesday, February 2nd and ends on Friday, February 4th, one sample must be collected on the 2nd, 3rd, or 4th. If the discharge resumes on Sunday, February 13 and is intermittent through Monday, February 14th an additional sample must be collected on the 13th or 14th.

E. GENERAL MONITORING, SAMPLING AND REPORTING REQUIREMENTS

1. Routine Reporting of Data

Reporting of data gathered in compliance with Part I.B.2 shall be on a **monthly** basis. Reporting of all data gathered shall comply with the requirements of Part I.E. (General Requirements). Monitoring results shall be summarized for each calendar month and reported on Division approved discharge monitoring report (DMR) forms (EPA form 3320-1).

The permittee must submit these forms either by mail, or by using the Division's Net-DMR services (when available). DMRs **must be** received by the Division no later than the 28th day of the month following the monitoring period (for example, the DMR for discharges occurring in January must be received by the Division by February 28th). If no discharge occurs during the reporting period, "No Discharge" shall be reported on the DMR.

If being mailed, the original signed copy of each discharge monitoring report (DMR) shall be submitted to the Division at the following address:

Colorado Department of Public Health and Environment
Water Quality Control Division
WQCD-P-B2
4300 Cherry Creek Drive South
Denver, Colorado 80246-1530

The Discharge Monitoring Report forms shall be filled out accurately and completely in accordance with requirements of this permit and the instructions on the forms. They shall be signed by an authorized person as identified in Part I.E.8.

2. **Reporting for Undefined Outfalls**

DMRs will be mailed to the permittee for each of the numbered undefined discharge outfalls identified in the permit certification.

Each outfall identified in the permit certification, and the associated DMR forms for that outfall shall only authorize and be used for reporting discharges at a single outfall at a specific location. The permittee shall establish and maintain records that identify, among other information, the exact place for each outfall for which monitoring has occurred in accordance with Part I. B. of the permit.

DMRs for all outfalls must be submitted monthly as long as the certification is in effect. DMRs must be submitted for each outfall even if there was not a discharge from the outfall in a given month. For each outfall where no discharge occurs in a given month, the permittee shall mark 'No Discharge' on the DMR form(s). The permittee shall provide the Division with any additional monitoring data on the permitted discharge collected for entities other than the Division. If forms have not been received, please contact the Division at 303-692-3517.

Sampling is required at the frequency established in the permit certification for each undefined discharge location. For multiple undefined discharge locations, as discharges occur chronologically, the data collected from the sampling event(s) in a given month from the first discharge location shall be summarized and reported on the pre-printed DMR for Discharge Number 001-AU. The data collected from the sampling event(s) in a given month from the second discharge location shall be summarized and reported on the pre-printed DMR for Discharge Number 002-AU; etc. If there is only one undefined outfall location requested in the permit application, the permit certification will only authorize one discharge location (outfall) to state water within the project boundary. The data collected from the sampling event(s) in a given month from the one authorized discharge location shall be summarized and reported on the pre-printed DMR for Discharge Number 001-AU.

3. **Representative Sampling**

Discharge points shall be designed or modified so that a sample of the effluent can be obtained at a point after the final treatment process and prior to discharge to state waters. Samples and measurements taken as required herein shall be representative of the volume and nature of the monitored discharge. All samples shall be taken at the monitoring points specified in this permit and, unless otherwise specified, before the effluent joins or is diluted by any other waste stream, body of water, or substance. Monitoring points shall not be changed without notification to and approval by the Division. The permittee shall provide access to the Division to sample the discharge at these points.

4. **Analytical and Sampling Methods for Monitoring and Reporting**

The permittee shall install, calibrate, use and maintain monitoring methods and equipment, including biological and indicated pollutant monitoring methods. All sampling shall be performed by the permittee according to specified methods in 40 C.F.R. Part 136; methods approved by EPA pursuant to 40 C.F.R. Part 136; or methods approved by the Division, in the absence of a method specified in or approved pursuant to 40 C.F.R. Part 136 (see text below for specifics on nonylphenol monitoring).

If the permit contains a numeric effluent limit for a parameter, the analytical method and PQL selected for all monitoring conducted in accordance with this permit for that parameter shall be the one that can measure at or below the numeric effluent limit. If all specified analytical methods and corresponding PQLs are greater than the numeric effluent limit, then the analytical method with the lowest PQL shall be used.

If the permit contains a report only requirement for a parameter, the analytical method and PQL chosen shall be one that can measure at or below the potential numeric effluent limit(s). If all analytical methods and corresponding PQLs are greater than the potential numeric effluent limit(s), then the analytical method with the lowest PQL shall be used.

If the permit contains an interim effluent limitation (a limit is report until such time as a numeric effluent limit becomes effective) for a parameter, the analytical method and PQL chosen for all monitoring conducted in accordance with this permit for the parameter shall be one that can measure to the final numeric effluent limit. If all analytical methods and corresponding PQLs are greater than the final numeric effluent limit(s), then the analytical method with the lowest PQL shall be used.

For parameters such as TIN, the analytical methods chosen shall be those that can measure to the potential or final numeric effluent limit, based on the sum of the PQLs for nitrate, nitrite and ammonia.

When the analytical method which complies with the above requirements has a PQL greater than the permit limit, and the permittee's analytical result is less than the PQL, the permittee shall report "BDL" on the DMR. Such reports will not be considered as violations of the permit limit, as long as the lowest available PQL is used for the analysis. When the analytical method which complies with the above requirements has a PQL that is equal to or less than the permit limitation, and the permittee's analytical result is less than the PQL, "< X" (where X = the actual PQL achieved by the laboratory) shall be reported on the DMR. For parameters that have a report only limitation, and the permittee's analytical result is less than the PQL, "< X" (where X = the actual PQL achieved by the laboratory) shall be reported on the DMR.

In the calculation of average concentrations (i.e. 7- day average, 30-day average, 2-year rolling average) any individual analytical result that is less than the PQL shall be considered to be zero for the calculation purposes. When reporting:

If all individual analytical results are less than the PQL, the permittee shall report either "BDL" or "<X" (where X = the actual PQL achieved by the laboratory), following the guidance above.

If one or more individual results is greater than the PQL, an average shall be calculated and reported. Note that it does not matter if the final calculated average is greater or less than the PQL, it must be reported as a value.

Note that when calculating T.I.N. for a single sampling event, any value less than the PQL (for total ammonia, total nitrite, or total nitrate) shall be treated as zero. The T.I.N. concentration for a single sampling event shall then be determined as the sum of the analytical results (zeros if applicable) of same day sampling for total ammonia and total nitrite and total nitrate. From these calculated T.I.N. concentrations, the daily maximum and thirty day average concentrations shall be calculated and must be reported as a value.

The present lowest PQLs for specific parameters, as determined by the State Laboratory (November 2008) are provided below. If the analytical method cannot achieve a PQL that is less than or equal to the permit limit, then the method, or a more precise method, must achieve a PQL that is less than or equal to the PQL in the table below. A listing of the PQLs for organic parameters that must meet the above requirement can be found in the Division's Practical Quantification Limitation Guidance Document, July 2008.

For nonylphenol, until such time as there is an EPA 40 CFR Part 136 method, the State is approving use of ASTM Methods D7065 and D7485. Until a statewide PQL has been developed, the permittee shall use

either the default PQLs listed in the table below, or develop their own site-specific PQL in accordance with the Practical Quantification Limitation Guidance Document (July 2008) for Organic Parameters. This document is available on the Division’s website at www.coloradowaterpermits.com. The delayed effective date for the monitoring requirement allows time for the permittee to develop a site-specific PQL.

For hexavalent chromium, samples must be unacidified so dissolved concentrations will be measured rather than potentially dissolved concentrations.

Parameter	Practical Quantification Limits,	Parameter	Practical Quantification Limits, µg/l
Aluminum	50 µg/l	Manganese	2 µg/l
Ammonia	1 mg/l	Mercury	0.1 µg/l
Arsenic	1 µg/l	Mercury (low-level)	0.003 µg/l
Barium	5 µg/l	Nickel	50 µg/l
Beryllium	1 µg/l	N-Ammonia	50 µg/l
BOD / CBOD	1 mg/l	N Nitrate/Nitrite	0.5 mg/l
Boron	50 µg/l	N-Nitrate	50 µg/l
Cadmium	1 µg/l	N-Nitrite	10 µg/l
Calcium	20 µg/l	Total Nitrogen	0.5 mg/l
Chloride	2 mg/l	Phenols	100 µg/l
Chlorine	0.1 mg/l	Phosphorus	10 µg/l
Total Residual Chlorine		Radium 226	1 pCi/l
- DPD colorimetric	0.10 mg/l	Radium 228	1 pCi/l
- Amperometric titration	0.05 mg/l	Selenium	1 µg/l
Chromium	20 µg/l	Silver	0.5 µg/l
Chromium, Hexavalent	20 µg/l	Sodium	0.2 mg/l
Copper	5 µg/l	Sulfate	5 mg/l
Cyanide (Direct / Distilled)	10 µg/l	Sulfide	0.2 mg/l
Cyanide, WAD+A47	5 µg/l	Total Dissolved Solids	10 mg/l
Fluoride	0.1 mg/l	Total Suspended Solids	10 mg/l
Iron	10 µg/l	Thallium	1 µg/l
Lead	1 µg/l	Uranium	1 µg/l
Magnesium	20 µg/l	Zinc	10 µg/l

5. Records

The permittee shall establish and maintain records. The records shall include the following:

- a. The date, type, exact location, and time of sampling or measurements;
- b. The individual(s) who performed the sampling or measurements;
- c. The date(s) the analyses were performed;
- d. The individual(s) who performed the analyses;
- e. The analytical techniques or methods used;
- f. The results of such analyses; and
- g. Any other observations which may result in an impact on the quality or quantity of the discharge as indicated in 40 CFR 122.44 (i)(1)(iii).

The permittee shall retain for the duration of permit coverage or a minimum of three (3) years (whichever is greater) records of all monitoring information, including all original strip chart recordings for continuous monitoring instrumentation, all calibration and maintenance records, laboratory data sheets, copies of all reports required by this permit and records of all data used to complete the application for this permit. This period of retention shall be extended during the course of any unresolved litigation regarding the discharge of pollutants by the permittee or when requested by the Division or EPA. These records must be retained at the facility during active treatment. Once active treatment is complete, the records shall be maintained and made available at the request of the Division.

6. Additional Monitoring by Permittee

If the permittee, using the approved analytical methods, monitors any parameter more frequently than required by this permit, then the results of such monitoring shall be included in the calculation and reporting of the values required in the Discharge Monitoring Report Form or other forms as required by the Division. Such increased frequency shall also be indicated.

7. Flow Measuring Device

Flow can be measured or determined from estimates based on volume of fill water, dimension of the pipeline, capacity of the pump, or other method documented in accordance with I.C.1.e (Discharge Log).

At the request of the Division, the permittee shall show proof of the accuracy of any flow-measuring device or method used in obtaining data submitted in the monitoring report. The flow-measuring device must indicate values within ten(10) percent of the actual flow being discharged from the facility.

8. Signatory and Certification Requirements

a. All applications must be signed and certified for accuracy as follows:

- (i) In the case of corporations, by a responsible corporate officer. For purposes of this section, the responsible corporate officer is responsible for the overall operation of the facility from which the discharge described in the form originates;
- (ii) In the case of partnership, by a general partner;
- (iii) In the case of a sole proprietorship, by the proprietor;
- (iv) In the case of a municipal, state, or other public facility, by either a principal executive officer or ranking elected official. For purposes of this section, a principal executive officer has responsibility for the overall operation of the facility from which the discharge originates.

b. All reports and other information required by the Division shall be signed and certified for accuracy by the permittee in accord with the following criteria:

- i) In the case of corporations, by a responsible corporate officer. For purposes of this section, the responsible corporate officer is responsible for the overall operation of the facility from which the discharge described in the form originates;
- ii) In the case of a partnership, by a general partner;
- iii) In the case of a sole proprietorship, by the proprietor;

- iv) In the case of a municipal, state, or other public facility, by either a principal executive officer, or ranking elected official. For purposes of this section, a principal executive officer has responsibility for the overall operation of the facility from which the discharge originates;
- v) By a duly authorized representative of a person described above, only if:
 - 1) The authorization is made in writing by a person described in i, ii, iii, or iv above;
 - 2) The authorization specifies either an individual or a position having responsibility for the overall operation of the regulated facility or activity such as the position of plant manager, operator of a well or a well field, superintendent, position of equivalent responsibility, or an individual or position having overall responsibility for environmental matters for the company. (A duly authorized representative may thus be either a named individual or any individual occupying a named position); and,
 - 3) The written authorization is submitted to the Division.
- c. If an authorization as described in this section is no longer accurate because a different individual or position has responsibility for the overall operation of the facility, a new authorization satisfying the requirements of this section must be submitted to the Division prior to or together with any reports, information, or applications to be signed by an authorized representative.

The permittee, or the duly authorized representative shall make and sign the following certification on all such documents:

"I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is to the best of my knowledge and belief, true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

Part II

A. NOTIFICATION REQUIREMENTS

1. Notification to Parties

All notification requirements under this section shall be directed as follows:

- a. Oral Notifications, during normal business hours shall be to:

Water Quality Protection Section - Industrial Compliance Program
Water Quality Control Division
Telephone: (303) 692-3500

- b. Written notification shall be to:

Water Quality Protection Section - Industrial Compliance Program
Water Quality Control Division
Colorado Department of Public Health and Environment
WQCD-WQP-B2
4300 Cherry Creek Drive South
Denver, CO 80246-1530

2. Change in Discharge or Wastewater Treatment

The permittee shall notify the Division in writing, of any planned physical alterations or additions to the permitted facility, this includes the treatment process. Notice is required when:

- a. The alteration or addition is likely to result in a new or altered discharge either in terms of location or effluent quality prior to the occurrence of the new or altered discharge, or;
- b. The alteration or addition results in a significant change in the permittee's sludge use or disposal practices, and such alteration, addition, or change may justify the application of permit conditions that are different from or absent in the existing permit, including notification of additional use or disposal sites not reported pursuant to an approved land application plan.

The permittee shall give advance notice to the Division of any planned changes in the permitted facility or activity which may result in noncompliance with permit requirements. For any pollutant for which monitoring requirements are not included in the permit certification, the permittee shall notify the Division as soon as it becomes aware that the pollutant(s) are present in the source water, influent, or effluent in concentrations greater than originally identified in the application.

Whenever notification of any planned physical alterations or additions to the permitted facility is required pursuant to this section, the permittee shall furnish the Division such plans and specifications which the Division deems reasonably necessary to evaluate the effect on the discharge, the stream, or ground water.

If the Division finds that such new or altered discharge might be inconsistent with the conditions of the permit, the Division shall require a new or revised permit application or a permit modification and shall follow the procedures specified in Sections 61.5 through 61.6, and 61.15 of the Colorado Discharge Permit System Regulations.

3. Special Notifications Definitions

- a. Bypass: The intentional diversion of waste streams from any portion of a treatment facility.
- b. Severe Property Damage: Substantial physical damage to property at the treatment facilities which causes them to become inoperable, or substantial and permanent loss of natural resources which can reasonably be expected to occur in the absence of a bypass. It does not mean economic loss caused by delays in production.
- c. Upset: An exceptional incident in which there is unintentional and temporary noncompliance with permit effluent limitations because of factors beyond the reasonable control of the permittee. An upset does not include noncompliance to the extent caused by operational error, improperly designed treatment facilities, inadequate treatment facilities, lack of preventative maintenance, or careless or improper operation.

4. Noncompliance Notification

- a. If, for any reason, the permittee does not comply with or will be unable to comply with any discharge limitations or standards specified in this permit, the permittee shall, at a minimum, provide the Division with the following information:
 - i) A description of the discharge and cause of noncompliance;
 - ii) The period of noncompliance, including exact dates and times and/or the anticipated time when the discharge will return to compliance; and
 - iii) Steps being taken to reduce, eliminate, and prevent recurrence of the noncomplying discharge.
- b. The permittee shall report the following circumstances **orally within twenty-four (24) hours** from the time the permittee becomes aware of the circumstances, and shall mail to the Division a written report containing the information requested in Part II.A.4 (a) **within five (5) days** after becoming aware of the following circumstances:
 - i) Circumstances leading to any noncompliance which may endanger health or the environment regardless of the cause of the incident;
 - ii) Circumstances leading to any unanticipated bypass which exceeds any effluent limitations in the permit;
 - iii) Circumstances leading to any upset which causes an exceedance of any effluent limitation in the permit;
 - iv) Daily maximum violations for any of the pollutants limited by Part I.A of this permit and specified as requiring 24-hour notification. This includes any toxic pollutant or hazardous substance or any pollutant specifically identified as the method to control any toxic pollutant or hazardous substance.
- c. Unless otherwise indicated in this permit, the permittee shall report instances of non-compliance which are not required to be reported within 24-hours at the time Discharge Monitoring Reports are submitted. The reports shall contain the information listed in sub-paragraph (a) of this section.

5. Other Notification Requirements

Reports of compliance or noncompliance with, or any progress reports on, interim and final requirements contained in any compliance schedule in the permit shall be submitted no later than fourteen (14) days following each scheduled date, unless otherwise provided by the Division.

The permittee shall notify the Division, in writing, thirty (30) days in advance of a proposed transfer of permit as provided in Part II.B.3.

The permittee's notification of all anticipated noncompliance does not stay any permit condition.

All existing manufacturing, commercial, mining, and silvicultural dischargers must notify the Division as soon as they know or have reason to believe:

- a. That any activity has occurred or will occur which would result in the discharge, on a routine or frequent basis, of any toxic pollutant which is not limited in the permit, if that discharge will exceed the highest of the following "notification levels":
 - i) One hundred micrograms per liter (100 µg/l);
 - ii) Two hundred micrograms per liter (200 µg/l) for acrolein and acrylonitrile; five hundred micrograms per liter (500 µg/l) for 2,4-dinitrophenol and 2-methyl-4,6-dinitrophenol; and one milligram per liter (1.0 mg/l) for antimony;
 - iii) Five (5) times the maximum concentration value reported for that pollutant in the permit application in accordance with Section 61.4(2)(g).
 - iv) The level established by the Division in accordance with 40 C.F.R. § 122.44(f).
- b. That any activity has occurred or will occur which would result in any discharge, on a non-routine or infrequent basis, of a toxic pollutant which is not limited in the permit, if that discharge will exceed the highest of the following "notification levels":
 - i) Five hundred micrograms per liter (500 µg/l);
 - ii) One milligram per liter (1 mg/l) for antimony; and
 - iii) Ten (10) times the maximum concentration value reported for that pollutant in the permit application
 - iv) The level established by the Division in accordance with 40 C.F.R. § 122.44(f).

6. Bypass Notification

If the permittee knows in advance of the need for a bypass, a notice shall be submitted, at least ten days before the date of the bypass, to the Division. The bypass shall be subject to Division approval and limitations imposed by the Division. Violations of requirements imposed by the Division will constitute a violation of this permit.

7. **Upsets**

a. **Effect of an Upset**

An upset constitutes an affirmative defense to an action brought for noncompliance with permit effluent limitations if the requirements of paragraph (b) of this section are met. No determination made during administrative review of claims that noncompliance was caused by upset, and before an action for noncompliance, is final administrative action subject to judicial review.

b. **Conditions Necessary for a Demonstration of Upset**

Permittee who wishes to establish the affirmative defense of upset shall demonstrate through properly signed contemporaneous operating logs, or other relevant evidence that:

- i) An upset occurred and that the permittee can identify the specific cause(s) of the upset; and
- ii) The permitted facility was at the time being properly operated and maintained; and
- iii) The permittee submitted proper notice of the upset as required in Part II.A.4. of this permit (24-hour notice); and
- iv) The permittee complied with any remedial measure necessary to minimize or prevent any discharge or sludge use or disposal in violation of this permit which has a reasonable likelihood of adversely affecting human health or the environment.

In addition to the demonstration required above, a permittee who wishes to establish the affirmative defense of upset for a violation of effluent limitations based upon water quality standards shall also demonstrate through monitoring, modeling or other methods that the relevant standards were achieved in the receiving water.

c. **Burden of Proof**

In any enforcement proceeding, the permittee seeking to establish the occurrence of an upset has the burden of proof.

8. **Discharge Point**

Any discharge to the waters of the State from a point source other than specifically authorized by this permit is prohibited.

9. **Proper Operation and Maintenance**

The permittee shall at all times properly operate and maintain all facilities and systems of treatment and control (and related appurtenances) which are installed or used by the permittee as necessary to achieve compliance with the conditions of this permit. Proper operation and maintenance includes effective performance and adequate laboratory and process controls, including appropriate quality assurance procedures (40 CFR 122.41(e)). This provision requires the operation of back-up or auxiliary facilities or similar systems which are installed by the permittee only when necessary to achieve compliance with the conditions of the permit.

10. **Minimization of Adverse Impact**

The permittee shall take all reasonable steps to minimize or prevent any discharge of sludge use or disposal in violation of this permit which has a reasonable likelihood of adversely affecting human health or the environment. As necessary, accelerated or additional monitoring to determine the nature and impact of the noncomplying discharge is required.

11. Removed Substances

Solids, sludges, or other pollutants removed in the course of treatment or control of wastewaters shall be disposed of in accordance with applicable state and federal regulations and in a manner that will prevent the removed pollutant(s) from entering waters of the State.

For all domestic wastewater treatment works, at industrial facilities, the permittee shall dispose of sludge in accordance with all State and Federal regulations.

12. Submission of Incorrect or Incomplete Information

Where the permittee failed to submit any relevant facts in a permit application, or submitted incorrect information in a permit application or report to the Division, the permittee shall promptly submit the relevant information which was not submitted or any additional information needed to correct any erroneous information previously submitted.

13. Bypass

- a. Bypasses are prohibited and the Division may take enforcement action against the permittee for bypass, unless:
 - i) The bypass is unavoidable to prevent loss of life, personal injury, or severe property damage;
 - ii) There were no feasible alternatives to bypass such as the use of auxiliary treatment facilities, retention of untreated wastes, or maintenance during normal periods of equipment downtime. This condition is not satisfied if adequate back-up equipment should have been installed in the exercise of reasonable engineering judgment to prevent a bypass which occurred during normal periods of equipment downtime or preventive maintenance; and
 - iii) Proper notices were submitted in compliance with Part II.A.4.
- b. "Severe property damage" as used in this Subsection means substantial physical damage to the treatment facilities which causes them to become inoperable, or substantial and permanent loss of natural resources which can reasonably be expected to occur in the absence of a bypass. Severe property damage does not mean economic loss caused by delays in production.
- c. The permittee may allow a bypass to occur which does not cause effluent limitations to be exceeded, but only if it also is for essential maintenance or to assure optimal operation. These bypasses are not subject to the provisions of paragraph (a) above.
- d. The Division may approve an anticipated bypass, after considering adverse effects, if the Division determines that the bypass will meet the conditions specified in paragraph (a) above.

14. Reduction, Loss, or Failure of Treatment Facility

The permittee has the duty to halt or reduce any activity if necessary to maintain compliance with the effluent limitations of the permit. Upon reduction, loss, or failure of the treatment facility, the permittee shall, to the extent necessary to maintain compliance with its permit, control production, control sources of wastewater, or all discharges, until the facility is restored or an alternative method of treatment is provided. This provision also applies to power failures, unless an alternative power source sufficient to operate the wastewater control facilities is provided.

It shall not be a defense for a permittee in an enforcement action that it would be necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this permit.

B. RESPONSIBILITIES

1. Inspections and Right to Entry

The permittee shall allow the Division and/or the authorized representative, upon the presentation of credentials:

- a. To enter upon the permittee's premises where a regulated facility or activity is located or in which any records are required to be kept under the terms and conditions of this permit;
- b. At reasonable times to have access to and copy any records required to be kept under the terms and conditions of this permit and to inspect any monitoring equipment or monitoring method required in the permit; and
- c. To enter upon the permittee's premises in a reasonable manner and at a reasonable time to inspect and/or investigate, any actual, suspected, or potential source of water pollution, or to ascertain compliance or non-compliance with the Colorado Water Quality Control Act or any other applicable state or federal statute or regulation or any order promulgated by the Division. The investigation may include, but is not limited to, the following: sampling of any discharge and/or process waters, the taking of photographs, interviewing of any person having knowledge related to the discharge permit or alleged violation, access to any and all facilities or areas within the permittee's premises that may have any affect on the discharge, permit, or alleged violation. Such entry is also authorized for the purpose of inspecting and copying records required to be kept concerning any effluent source.
- d. The permittee shall provide access to the Division to sample the discharge at a point after the final treatment process but prior to the discharge mixing with state waters upon presentation of proper credentials.

In the making of such inspections, investigations, and determinations, the Division, insofar as practicable, may designate as its authorized representatives any qualified personnel of the Department of Agriculture. The Division may also request assistance from any other state or local agency or institution.

2. Duty to Provide Information

The permittee shall furnish to the Division, within a reasonable time, any information which the Division may request to determine whether cause exists for modifying, revoking and reissuing, or terminating this permit, or to determine compliance with this permit. The permittee shall also furnish to the Division, upon request, copies of records required to be kept by this permit.

3. Transfer of Ownership or Control

- a. Except as provided in paragraph b. of this section, a permit may be transferred by a permittee only if the permit has been modified or revoked and reissued as provided in Section 61.8(8) of the Colorado Discharge Permit System Regulations, to identify the new permittee and to incorporate such other requirements as may be necessary under the Federal Act.
- b. A permit may be automatically transferred to a new permittee if:
 - i) The current permittee notifies the Division in writing 30 days in advance of the proposed transfer date; and
 - ii) The notice includes a written agreement between the existing and new permittee(s) containing a specific date for transfer of permit responsibility, coverage and liability between them; and
 - iii) The Division does not notify the existing permittee and the proposed new permittee of its intent to modify, or revoke and reissue the permit.

iv) Fee requirements of the Colorado Discharge Permit System Regulations, Section 61.15, have been met.

4. Availability of Reports

Except for data determined to be confidential under Section 308 of the Federal Clean Water Act and the Colorado Discharge Permit System Regulations 5 CCR 1002-61, Section 61.5(4), all reports prepared in accordance with the terms of this permit shall be available for public inspection at the offices of the Division and the Environmental Protection Agency.

The name and address of the permit applicant(s) and permittee(s), permit applications, permits and effluent data shall not be considered confidential. Knowingly making false statements on any such report may result in the imposition of criminal penalties as provided for in Section 309 of the Federal Clean Water Act, and Section 25-8-610 C.R.S.

5. Modification, Suspension, Revocation, or Termination of Permits By the Division

The filing of a request by the permittee for a permit modification, revocation and reissuance, termination or a notification of planned changes or anticipated noncompliance, does not stay any permit condition.

- a. A permit may be modified, suspended, or terminated in whole or in part during its term for reasons determined by the Division including, but not limited to, the following:
 - i) Violation of any terms or conditions of the permit;
 - ii) Obtaining a permit by misrepresentation or failing to disclose any fact which is material to the granting or denial of a permit or to the establishment of terms or conditions of the permit; or
 - iii) Materially false or inaccurate statements or information in the permit application or the permit.
 - iv) A determination that the permitted activity endangers human health or the classified or existing uses of state waters and can only be regulated to acceptable levels by permit modifications or termination.
- b. A permit may be modified in whole or in part for the following causes, provided that such modification complies with the provisions of Section 61.10 of the Colorado Discharge Permit System Regulations:
 - i) There are material and substantial alterations or additions to the permitted facility or activity which occurred after permit issuance which justify the application of permit conditions that are different or absent in the existing permit.
 - ii) The Division has received new information which was not available at the time of permit issuance (other than revised regulations, guidance, or test methods) and which would have justified the application of different permit conditions at the time of issuance. For permits issued to new sources or new dischargers, this cause includes information derived from effluent testing required under Section 61.4(7)(e) of the Colorado Discharge Permit System Regulations. This provision allows a modification of the permit to include conditions that are less stringent than the existing permit only to the extent allowed under Section 61.10 of the Colorado Discharge Permit System Regulations.
 - iii) The standards or regulations on which the permit was based have been changed by promulgation of amended standards or regulations or by judicial decision after the permit was issued. Permits may be modified during their terms for this cause only as follows:
 - (A) The permit condition requested to be modified was based on a promulgated effluent limitation guideline, EPA approved water quality standard, or an effluent limitation set forth in 5 CCR 1002-62, § 62 et seq.; and

- (B) EPA has revised, withdrawn, or modified that portion of the regulation or effluent limitation guideline on which the permit condition was based, or has approved a Commission action with respect to the water quality standard or effluent limitation on which the permit condition was based; and
 - (C) The permittee requests modification after the notice of final action by which the EPA effluent limitation guideline, water quality standard, or effluent limitation is revised, withdrawn, or modified; or
 - (D) For judicial decisions, a court of competent jurisdiction has remanded and stayed EPA promulgated regulations or effluent limitation guidelines, if the remand and stay concern that portion of the regulations or guidelines on which the permit condition was based and a request is filed by the permittee in accordance with this Regulation, within ninety (90) days of judicial remand.
- iv) The Division determines that good cause exists to modify a permit condition because of events over which the permittee has no control and for which there is no reasonable available remedy.
 - v) The permittee has received a variance.
 - vi) When required to incorporate applicable toxic effluent limitation or standards adopted pursuant to §307(a) of the Federal act.
 - vii) When required by the reopener conditions in the permit.
 - viii) As necessary under 40 C.F.R. 403.8(e), to include a compliance schedule for the development of a pretreatment program.
 - ix) When the level of discharge of any pollutant which is not limited in the permit exceeds the level which can be achieved by the technology-based treatment requirements appropriate to the permittee under Section 61.8(2) of the Colorado Discharge Permit System Regulations.
 - x) To establish a pollutant notification level required in Section 61.8(5) of the Colorado Discharge Permit System Regulations.
 - xi) To correct technical mistakes, such as errors in calculation, or mistaken interpretations of law made in determining permit conditions, to the extent allowed in Section 61.10 of the Colorado State Discharge Permit System Regulations.
 - xii) When required by a permit condition to incorporate a land application plan for beneficial reuse of sewage sludge, to revise an existing land application plan, or to add a land application plan.
 - xiii) For any other cause provided in Section 61.10 of the Colorado Discharge Permit System Regulations.
- c. At the request of a permittee, the Division may modify or terminate a permit and issue a new permit if the following conditions are met:
- i) The Regional Administrator has been notified of the proposed modification or termination and does not object in writing within thirty (30) days of receipt of notification,
 - ii) The Division finds that the permittee has shown reasonable grounds consistent with the Federal and State statutes and regulations for such modifications or termination;
 - iii) Requirements of Section 61.15 of the Colorado Discharge Permit System Regulations have been met, and
 - iv) Requirements of public notice have been met.

- d. Permit modification (except for minor modifications), termination or revocation and reissuance actions shall be subject to the requirements of Sections 61.5(2), 61.5(3), 61.6, 61.7 and 61.15 of the Colorado Discharge Permit System Regulations. The Division shall act on a permit modification request, other than minor modification requests, within 180 days of receipt thereof. Except for minor modifications, the terms of the existing permit govern and are enforceable until the newly issued permit is formally modified or revoked and reissued following public notice.
- e. Upon consent by the permittee, the Division may make minor permit modifications without following the requirements of Sections 61.5(2), 61.5(3), 61.7, and 61.15 of the Colorado Discharge Permit System Regulations. Minor modifications to permits are limited to:
 - i) Correcting typographical errors; or
 - ii) Increasing the frequency of monitoring or reporting by the permittee; or
 - iii) Changing an interim date in a schedule of compliance, provided the new date of compliance is not more than 120 days after the date specific in the existing permit and does not interfere with attainment of the final compliance date requirement; or
 - iv) Allowing for a transfer in ownership or operational control of a facility where the Division determines that no other change in the permit is necessary, provided that a written agreement containing a specific date for transfer of permit responsibility, coverage and liability between the current and new permittees has been submitted to the Division; or
 - v) Changing the construction schedule for a discharger which is a new source, but no such change shall affect a discharger's obligation to have all pollution control equipment installed and in operation prior to discharge; or
 - vi) Deleting a point source outfall when the discharge from that outfall is terminated and does not result in discharge of pollutants from other outfalls except in accordance with permit limits.
- f. When a permit is modified, only the conditions subject to modification are reopened. If a permit is revoked and reissued, the entire permit is reopened and subject to revision and the permit is reissued for a new term.
- g. The filing of a request by the permittee for a permit modification, revocation and reissuance or termination does not stay any permit condition.
- h. All permit modifications and reissuances are subject to the antibacksliding provisions set forth in 61.10(e) through (g).

6. **Oil and Hazardous Substance Liability**

Nothing in this permit shall be construed to preclude the institution of any legal action or relieve the permittee from any responsibilities, liabilities, or penalties to which the permittee is or may be subject to under Section 311 (Oil and Hazardous Substance Liability) of the Clean Water Act.

7. **State Laws**

Nothing in this permit shall be construed to preclude the institution of any legal action or relieve the permittee from any responsibilities, liabilities, or penalties established pursuant to any applicable State law or regulation under authority granted by Section 510 of the Clean Water Act. Nothing in this permit shall be construed to prevent or limit application of any emergency power of the division.

8. **Permit Violations**

Failure to comply with any terms and/or conditions of this permit shall be a violation of this permit. The discharge of any pollutant identified in this permit more frequently than or at a level in excess of that

authorized shall constitute a violation of the permit. Except as provided in Part I.E and Part II.A or B, nothing in this permit shall be construed to relieve the permittee from civil or criminal penalties for noncompliance (40 CFR 122.41(a)(1)).

9. Property Rights

The issuance of this permit does not convey any property or water rights in either real or personal property, or stream flows, or any exclusive privileges, nor does it authorize any injury to private property or any invasion of personal rights, nor any infringement of Federal, State or local laws or regulations.

10. Severability

The provisions of this permit are severable. If any provision of this permit, or the application of any provision of this permit to any circumstance, is held invalid, the application of such provision to other circumstances and the application of the remainder of this permit shall not be affected.

11. Renewal Application

If the permittee desires to continue to discharge, a permit renewal application shall be submitted at least one hundred eighty (180) days before this permit expires. If the permittee anticipates there will be no discharge after the expiration date of this permit, the Division should be promptly notified so that it can terminate the permit in accordance with Part II.B.5.

12. Confidentiality

Any information relating to any secret process, method of manufacture or production, or sales or marketing data which has been declared confidential by the permittee, and which may be acquired, ascertained, or discovered, whether in any sampling investigation, emergency investigation, or otherwise, shall not be publicly disclosed by any member, officer, or employee of the Commission or the Division, but shall be kept confidential. Any person seeking to invoke the protection of this Subsection (12) shall bear the burden of proving its applicability. This section shall never be interpreted as preventing full disclosure of effluent data.

13. Fees

The permittee is required to submit payment of an annual fee as set forth in the 2005 amendments to the Water Quality Control Act. Section 25-8-502 (l) (b), and the Colorado Discharge Permit System Regulations 5 CCR 1002-61, Section 61.15 as amended. Failure to submit the required fee when due and payable is a violation of the permit and will result in enforcement action pursuant to Section 25-8-601 et. seq., C.R.S. 1973 as amended.

14. Duration of Permit

The duration of a permit shall be for a fixed term and shall not exceed five (5) years. Filing of a timely and complete application shall cause the expired permit to continue in force to the effective date of the new permit. The permit's duration may be extended only through administrative extensions and not through interim modifications.

15. Section 307 Toxics

If a toxic effluent standard or prohibition, including any applicable schedule of compliance specified, is established by regulation pursuant to Section 307 of the Federal Act for a toxic pollutant which is present in the permittee's discharge and such standard or prohibition is more stringent than any limitation upon such pollutant in the discharge permit, the Division shall institute proceedings to modify or revoke and reissue the permit to conform to the toxic effluent standard or prohibition.

16. Effect of Permit Issuance

- a. The issuance of a permit does not convey any property rights or any exclusive privilege.
- b. The issuance of a permit does not authorize any injury to person or property or any invasion of personal rights, nor does it authorize the infringement of federal, state, or local laws or regulations.
- c. Except for any toxic effluent standard or prohibition imposed under Section 307 of the Federal act or any standard for sewage sludge use or disposal under Section 405(d) of the Federal act, compliance with a permit during its term constitutes compliance, for purposes of enforcement, with Sections 301, 302, 306, 318, 403, and 405(a) and (b) of the Federal act. However, a permit may be modified, revoked and reissued, or terminated during its term for cause as set forth in Section 61.8(8) of the Colorado Discharge Permit System Regulations.
- d. Compliance with a permit condition which implements a particular standard for sewage sludge use or disposal shall be an affirmative defense in any enforcement action brought for a violation of that standard for sewage sludge use or disposal.

**COLORADO DISCHARGE PERMIT SYSTEM (CDPS)
FACT SHEET TO PERMIT NUMBER COG070000
GENERAL PERMIT FOR
CONSTRUCTION DEWATERING DISCHARGES**

Table of Contents

I. TYPE OF PERMIT	1
II. SCOPE OF THE GENERAL PERMIT	1
III. RECEIVING STREAM	7
IV. SECTOR DESCRIPTION	7
V. COMPLIANCE HISTORY	8
VI. TERMS AND CONDITIONS OF PERMIT	8
VII REFERENCES	14
VIII PUBLIC NOTICE COMMENTS	15

I. TYPE OF PERMIT

Master General, NPDES, Surface Water and Groundwater, Sixth Renewal, Statewide.

II. SCOPE OF THE GENERAL PERMIT

A. SIC Code:

- 1799 Special Trade Contractors, Not Elsewhere Classified
- 1629 Heavy Construction, Not Elsewhere Classified

B. MAJOR CHANGES FROM LAST PERMIT VERSIONS

The current general permit, which expired on November 30, 2011 and has been administratively extended by the Water Quality Control Division (Division), provides coverage for approximately 300 facilities with Construction Dewatering. This renewed general permit is needed to continue to provide coverage for these established dischargers and for new construction dewatering discharges. The Division conducted a stakeholder process that included a Pre-Public Notice Meeting on May 1, 2013 and submittal of written input. The purpose of this stakeholder outreach was to increase awareness of the renewal process for the general permit, discuss the major areas of review, and obtain input for development of draft permit conditions. The Division considered the stakeholder input received during the meeting, and written input received after the meeting.

Major changes from last renewal include the following:

- Specifically authorizes the discharge of groundwater, surface water, and stormwater that has mixed with the groundwater and/ or surface water that has come into contact with Construction Activities.

- The permit only authorizes the discharge of the source water drawn from the specific area that is identified by the permittee in the application or subsequent notification to the Division.
- The number of undefined outfalls per permit certification will be twenty unless granted by the Division on a case-by case basis. This modification does not limit the number of outfalls that a facility can obtain permit authorization for, but limits the number under a single certification to help ensure that permit certifications, discharge monitoring reports, and administration is manageable
- Discharges cannot be authorized by the permit if there is a reasonable potential for a pollutant to be present in the source water at a concentration that is greater than a numeric water quality standard of the receiving water. An exception to this limitation is allowed for discharges with a reasonable potential for Benzene, Toluene, Ethylbenzene, and Xylene when the applicant can demonstrate that the construction dewatering source water does not have concentrations of Benzene, Toluene, Ethylbenzene, or Xylene that are greater than the water quality standard of the receiving water. The result of this exception is that a discharge can be authorized as long as it can be shown that treatment is not needed to meet the effluent limitations for Benzene, Toluene, Ethylbenzene, and Xylene.
- A flow limitation is included in the permit, as required by 5 CCR 61.8(2)(i). The acute flow limit will be equal to twice the maximum flow rate provided in the permit application. If the discharge flow rate exceeds the maximum flow rate requested in the application, the permittee is required to submit a notification. As required by 5 CCR 62.5(7), the flow-measuring device must indicate values within ten percent of the actual flow being measured. The method for measuring flow rates authorizes estimates. The method for determining flows must be documented in the discharge log.
- E. coli and Total Coliform limitation will be required for construction dewatering operations that involve replacing or repairing existing sanitary sewer lines, are in proximity to septic disposal systems, and or other sewage disposal conveyances or vessels and the Division has made a qualitative reasonable potential determination that E. coli or Total Coliform will be present in the discharge.
- The pollution control practices implemented to meet the effluent limitations contained in the permit must be selected, designed, installed, implemented and maintained in accordance with good engineering, hydrologic and pollution control practices and the manufacturer's specifications including installation and implementation specifications where applicable. The Division has determined that this new requirement is necessary to ensure compliance with the effluent limitations. The improper implementation of a control practice has the potential to result in failure or in exceedances of effluent limits that would not be identified until samples can be analyzed. For examples, the Division has observed construction dewatering filter bags at permitted facilities operated in excess of maximum flow rates or placed directly in water ways. Such operations would not meet the definition of good engineering, hydrologic and pollution control practices and could result in significant discharges of untreated pollutants do to failure or spills during maintenance.
- The permittee is required to maintain a documented discharge log that includes:
 - Dates and times of when the discharge commences and ends.
 - Prior to the start of any discharge from an undefined discharge outfall(s), the receiving water for the discharge and the location that the outfall will be located at, including the latitude and longitude to the nearest 15 seconds, , general description of the location, and a map showing the discharge locations.
 - A description of the pollutant control practices used during construction dewatering, including:
 - for all filter devices- document the pollutant control filter maximum flow rate that will maintain compliance with the permit effluent limits and a drawing, sketch, and/or written description of the installation and implementation specifications.

- for all settling devices- document the residence time and maximum flow rate that will maintain compliance with the permit effluent limits and a drawing, sketch, and/or written description of the installation and implementation specifications.
- for all other techniques and methods implemented to remove pollutants prior to discharge, such as but not limited to pump in gravel-packs, sump conditions, and well screens- document the technique used and its intended purpose, the maximum flow rate for operation that will maintain compliance with the permit effluent limits, and a drawing, sketch, and/ or written description of the installation and implementation specifications.
- if no treatment has been determined necessary to remove pollutants prior to discharge in order to maintain compliance with the permit effluent limits- a statement identifying that no treatment will be provided.
 - Undefined outfalls are only authorized and can be used for reporting discharges at a single outfall at a specific location.
 - The method for obtaining flow rates.

Discharges authorized by this permit often occur irregularly. This irregular nature can result in confusion for both the permittee and the Division in determining monitoring frequency and the application of both daily and averaged effluent limitations. A discharge monitoring log is therefore required. This requirement applies to all dischargers but is intended to not result in a significant tracking and record keeping burden for those discharges that are on-going. In addition, the Division has determined that documentation of basic information that identifies how treatment is implemented at a site is necessary to ensure compliance with the effluent limitations. Without documenting basic information such as maximum flow rate, there is no way for facility staff or Division inspectors to ensure they identify the proper implementation and maintenance of BMPs in a manner to prevent failure or in exceedances of effluent limits that would not be identified until samples can be analyzed. The information is also required to enable effective compliance oversight of the permitted facility.

C. Facilities Covered:

This general permit is to authorize discharges of construction dewatering source water associated with construction activities to waters of the State in Colorado. Construction dewatering source water can be groundwater, surface water, or stormwater that has commingled with the groundwater and/ or surface water. The permit only authorizes the discharge from the source water from the specific area(s) that has been identified in the permittee's application, or in subsequent notifications to the Division.

The following discussion outlines the differences between the Construction Dewatering Discharge Permit, the Remediation Activities General Permits, and the Low Risk Discharge Policy for Uncontaminated Groundwater Discharges to Ground. Additional information is included in the specific permit or low risk guidance.

- The Division has had a long standing practice of having a general permit available to provide coverage for Construction Dewatering discharges, as this general permit has been in place since 1983. This permit has and continues to provide administrative efficiencies by providing coverage for many activities across the state while shortening the application and issuance timeline that is needed in comparison to other types of general permits and individual permits. This streamlined approach and the scope of the general permit historically has been, and continues to be, targeted for areas where groundwater is not contaminated. Discharges that have been found to have groundwater

that is contaminated have been required to apply for coverage under another type of permit, either an individual permit or a general permit specifically allowing for coverage of treated contaminated groundwater.

In implementing this permit it has become important to be able to distinguish discharges that are contaminated from those that are not, and the terminology and information used to make that determination has evolved over time. The application for coverage under this general permit has always and continues to require information regarding the potential for groundwater contamination in the vicinity of the project. During the most recent term of the permit, the Division provided guidance regarding how this information can be obtained by the applicant. Recommended sources of information include published information regarding contaminated sites such as Brownfields Sites, leaking underground storage tanks, voluntary clean-up sites, and CERCLA and RCRA corrective action sites, Phase I or Phase II environmental site assessments routinely conducted to support a property transfer, and project specific groundwater monitoring. The general permit terminology used to describe discharges that are ineligible for coverage has evolved over time. For construction dewatering discharges that were evaluated early on in the process, the terminology used was to prohibit “process generated waste waters” and specifically identified sources such as sanitary waste and mine tailings dewatering wastes as ineligible for coverage. In the 1990s there was a focus on excluding sites associated with leaking underground storage tanks at commercial gas stations and the Division created a general permit specifically for remediation of those sources because of the increased frequency of encountering those sources either through construction associated with urban redevelopment and/or remediation of those sources. During the first five permit terms, the Construction Dewatering Permit required analysis of the water to be discharged as part of the permit application. In the current permit that is being renewed through this action, the requirement was refined and a chemical analysis is required on a case-by-case basis once the application is reviewed. The Division encourages data to be submitted with the application when available, and requires data to be submitted following the initial application review in cases where it is needed to finalize a reasonable potential determination.

More recently, the Division has had increased questions regarding naturally occurring pollutants, and whether they are or are not considered contaminants. To better align the general permit with the permitting framework defined through statutes and implementing regulations, this permit renewal defines discharges that are ineligible for coverage as discharges for which “the Division has determined that there is a reasonable potential for a pollutant to be present in the source water at a concentration that is greater than a numeric water quality standard of the receiving water”. Within the Clean Water Act framework, both anthropogenic and naturally occurring pollutants that may be present in a discharge are subject to effluent limitations as needed to protect water quality standards. If flexibility is appropriate due to factors such as limits of technology, ambient conditions, and economic impacts, relief can be considered under the water quality standards framework of the Clean Water Act (e.g., modifications or variances to stream standards), in contrast to being within the authority of a permit determination.

The Construction Dewatering Discharge Permit authorizes the discharge of construction dewatering to surface water and/ or groundwater. In general, the permit is intended to authorize discharges for which all pollutants discharged will meet stream standards and technology based requirements without the need of advanced treatment beyond basic filtering (e.g., filter bags), settling (e.g., tanks), or other systems designed to remove suspended solids. Coverage under this permit is not for discharges for which the Division has determined that there is a reasonable potential for a pollutant to be present in the source water at a concentration that is greater than a numeric water quality

standard of the receiving water.

The Division has determined it is appropriate and feasible to authorize discharges under this permit for which a limited set of specific contaminants (i.e., Benzene, Toluene, Ethylbenzene, Xylene, E. coli, and Total Coliform, as discussed below) have the reasonable potential to be present in the source water in excess of the receiving water standards, but for which treatment is not necessary to meet effluent limitations. This allowance expands the number of discharges eligible for coverage without overly complicating the permitting process and adding significant additional terms and conditions. For the remaining discharges that require additional evaluation during the authorization process and additional permit terms and conditions, general permit coverage is still available in most cases under the Remediation Activities Discharge General Permits. By having general permitting options, the Division is able to issue the majority of authorizations for dewatering discharges at construction sites under this permit in a more timely and efficient manner and with fewer terms and conditions.

In this permit renewal, the Division is specially stating that coverage is allowed in situations where the construction dewatering operation is in an area of potential contamination with Benzene, Toluene, Ethylbenzene, and Xylene (BTEX), and the applicant can demonstrate, through submission of data, that the construction dewatering discharge source water can meet the appropriate water quality standards, therefore not necessitating additional treatment for these pollutants, than the construction dewatering operation may be able to be covered under the Construction Dewatering Discharge Permit. The result is that the permit can authorize discharges where the source water has the reasonable potential to contain BTEX in excess of the receiving water standards, but for which the actual exceedance has not occurred. This scenario occurs for many permitted facilities due to the common occurrence of leaking underground storage tanks at commercial gas stations and other sources of petroleum pollution of soils and groundwater. When construction occurs in proximity to these locations of contamination, there is a potential that the contaminants can be drawn into the source water for a dewatering operation based on many variables that may be difficult to fully evaluate at the time of application, including the actual length of time of the discharge, location of the contaminated groundwater, and groundwater hydrology. By allowing the discharge to be covered under this permit for these reasonably common scenarios, the Division allows flexibility for the operator to simplify permitting under this permit, as compared to a Remediation Activities Discharge General Permit or individual permit. The permittee can make a determination based on their evaluation of the site at the time of the application regarding if they instead wish to seek permit coverage under a Remediation Activities Discharge General Permit which would allow the discharge to continue with treatment if BTEX exceeds the permit limitations.

A similar determination has also been made for E. coli and Total Coliform. The permit authorizes discharges where the source water has the reasonable potential to contain E. coli or Total Coliform (as appropriate for discharges to surface and groundwater respectively) in excess of the water quality standard, but for which the actual exceedance has not occurred. The Division will likely make a qualitative reasonable potential determination that E. coli or Total Coliform may exceed standards in the source water when the associated construction activity involves replacing or repairing existing sanitary sewer lines, are in proximity to septic disposal systems, and or other sewage disposal conveyances or vessels. In these cases, the potential is based on the possibility for leaks or spills either prior to or during construction. By authorizing discharges with such potential, the permit allows operator to comply with the permit limitations by avoiding sources of E. coli or Total Coliform.

- The Remediation Activities Discharge General Permits authorizes the discharge from Remediation

Activities (e.g., treatment and/or remedial activities of groundwater, alluvial water, stormwater, and/or surface water). The discharges are typically contaminated, or have the reasonable potential to be contaminated, from specific industrial sources that may include former dry cleaners, gasoline stations, industrial manufacturing facilities, or contaminated from an unknown sources. They may also have contamination from naturally occurring constituents at concentrations that trigger water quality based effluent limits for discharges to surface water based on a Reasonable Potential Analysis. The Remediation Activities Discharge General Permits requires influent screening of the groundwater to help the Division characterize the groundwater contamination associated with the discharge.

- The State of Colorado also has a Low Risk Discharge Policy for Uncontaminated Groundwater Discharges to Ground. The Low Risk Policy is intended for discharges of groundwater to land that are not expected to contain pollutants in concentrations that are toxic, or in concentrations that would cause or contribute to a violation of a water quality standard for groundwater. These types of discharges would not have pollutants or pollutant parameters above any water quality standard for the receiving groundwater.

If the construction dewatering operation covers large stretches of land, the applicant may break up the project into areas that may be authorized and permitted under the Construction Dewatering Discharge Permit, areas that can be authorized and permitted under the Remediation Activities Discharge General Permits, and areas that meet the intent of the Low Risk Policy of Uncontaminated Discharges to Land and can operate under the practices and procedures identified in the policy.

C. Limitations on Coverage

There are some discharges from Construction Dewatering operations that cannot be covered under this general permit and must apply for coverage under another general permit or an individual permit. These exclusions are listed in Part I.A.2 of the permit.

E. Application Requirements:

Construction Dewatering operations can apply for coverage under this general permit upon the issuance and effective date of the permit by submitting a complete and accurate application at least 30 days prior to the anticipated discharge. Following review of the application, the Division may request additional information. Upon receipt of the additional information, the Division shall have additional time to issue or deny the authorization to discharge.

Existing facilities with certifications under the administratively extended Construction Dewatering Discharge General Permit (COG-070000) that have submitted renewal applications and qualify for coverage under the new general permit will automatically be transferred. Coverage will be transferred to the new general permit without a lapse of coverage (i.e. discharging without a permit) and without loss of fee payments.

The CDPS general permit for Remediation Activities Discharging to Surface Water and CDPS general permit for Remediation Activities Discharging to Groundwater (COG-316000) authorizes discharges from similar activities as this general permit, but for which Remediation Activities may be conducted. As part of the Division's review of an application for coverage under COG-070000, or based on the availability of new information for facilities with existing coverage, the Division will assess the potential for various sources of contamination to be present in the discharge. Water quality based effluent limits may be required based on a

Reasonable Potential Analysis (see Part VI.A.2.g) due to the potential presence of contaminants in the source water. Coverage under COG-070000 will not be authorized by the Division if the discharge meets the limitations in Part I.A.2.a which could potential require that remediation activities be conducted for the discharge based on the need for water quality based effluent limits for the discharge. If the applicant wishes to obtain coverage under one of the Remediation Activities general permits for the discharge, the applicant must submit to the Division a statement requesting that the information received in the Construction Dewatering application be applied towards the Remediation Activities Permit application,

III. RECEIVING STREAM

The Division has identified the stream segments to which the facilities with current certifications under the general permit discharge. The Division expects to continue coverage for these facilities under this general permit since the stream standards and designations are consistent with the limitations on coverage in the permit ((i.e. none of the segments are designated as outstanding waters). The Division will also evaluate discharges to stream segments with established TMDLs, discharges to 303(d) listed waters, and other receiving water information as appropriate. Stream segments will be identified in the permit certification when issued under this permit.

IV. SECTOR DESCRIPTION

A. Industry Description

During construction activities, dewatering of excavation sites or other depressions is often necessary. The presence of water in areas of construction activities is normally the result of either groundwater or surface water intrusion or stormwater runoff from a precipitation event accumulating in the area. Removal of this water from the construction site is often necessary for construction activities to occur, including equipment operation and the integrity of the structure being constructed. Construction dewatering operations share common operational procedures, water treatment processes, and discharge effluent characteristics.

B. Chemical Usage

Construction dewatering operations covered under this general permit typically use passive treatment Best Management Practices to meet the Effluent Limitations and monitoring requirements outlined in the permit certification. Therefore, the use of chemicals is not expected at these facilities. However, for this general permit the Division has required applicants to submit a list of proposed chemicals, including dosage rates, used in the treatment process. Additionally, a MSDS for each chemical proposed for use must be provided so that the Division can determine the appropriate effluent limitations and conditions to include in the permit certification. If the chemicals proposed have constituents of concern, for which numeric permit effluent limitation included in Part I.2. Table B.1. and Table B.2. of the general permit are not sufficient to provide limitations to control the discharge of pollutants or pollutant parameters above any water quality standard for the receiving water, the Division may determine that coverage under the Construction Dewatering general permit is not appropriate. In most cases, coverage under one of the Remediation Activities general permits will likely be applicable for such discharges.

V. COMPLIANCE HISTORY

The Division reviewed DMR data for previously permitted Construction Dewatering operations between the years 2009 and November 2012. DMR data is available prior to this period, but was not entered into a database that would facilitate review and analysis of the data. During this time period, 1,489 sites had active dewatering permits. Of those sites, 1,375 sites had an active discharge and submitted sampling and monitoring data to the Division in the form of Discharge Monitoring Reports (DMR). Of those 1,375 sites, 956 sites were in urban areas (approximately 70%), while 416 sites were located in non-urbanized areas (approximately 30%). This review resulted in the following changes being made to the permit and Division practices.

During the period data was reviewed, the Division practice was to make qualitative reasonable potential determination to add BTEX limitations to a permit certification based on the location of the construction dewatering operation being in an urbanized area. Division DMR review indicated that there were few exceedances of the site-specific parameters (specifically, E.coli, Benzene, Toluene, Ethylbenzene, and Xylene (BTEX)) that were included in the permit certifications. Based on this information, the Division has revised its practice to no longer use the location within an Urbanized Area alone to make a qualitative reasonable potential determination for BTEX. However, the Division may still make a qualitative reasonable determination for BTEX based on site-specific information, such as the source water being from an area where contamination (at or near a hazardous waste site, leaking underground storage tank, or additional sources other than what is normally encountered at excavation and construction sites), naturally occurring pollutants potentially exist, or when there is otherwise a potential for pollutants to be added to the source water prior to discharge. These changes in practice are reflected in the permit requirements associated with monitoring and limitations for BTEX.

The Division was adding monitoring and reporting requirements to permit certifications under the previous Construction Dewatering permit for E. coli and Total Coliform if the discharge receiving water was on the 303(d) list as impaired for E. coli. DMR review did not indicate that there was correlation between the presence of E.Coli in the construction dewatering discharge and a stream impairment. The Division will no longer add E. coli or Total Coliform solely based on the construction dewatering discharging to state water that is impaired for E.Coli. However, the Division will add limitations if there is site specific determinations of reasonable potential, as discussed above (Part II.C).

VI. TERMS AND CONDITIONS OF PERMIT

A. Discussion of Effluent Limitations

1. Technology Based Limitations

- a. Federal Effluent Limitation Guidelines – There are no Federal Effluent Limitation Guidelines for this category of discharge.
- b. Regulation 62: Regulations for Effluent Limitations – These Regulations include effluent limitations that apply to all discharges of wastewater to State waters. These regulations are applicable to the discharge from Construction Dewatering.
 - i. Total Suspended Solids - The Division's current permit includes numeric technology-based limits for TSS based on Regulation 62. The Division has retained those more stringent requirements in this renewal permit for all dischargers as required by the anti-

backsliding provision in CWA § 402(o). These limitations are the same as those contained in the previous permit and are imposed upon the effective date of this permit.

- ii. Oil and Grease – The oil and grease limitations from the Regulations for Effluent Limitations are applied as they are the most stringent limitations. These limitations are the same as those contained in the previous permit and are imposed upon the effective date of this permit.
- iii. pH - The pH limitation specified in the Regulations for Effluent Limitations is not the most stringent and thus is not used. pH limitations for discharges to unclassified surface waters are generally 6.0-9.0, per Regulation 62. However, to maintain consistent effluent limitations under the general permit, the permit includes a pH limitation of 6.5-9.0 for all discharges to surface waters.

2. Water Quality Regulations, Policies, and Guidance Documents

- a. Antidegradation - As stated in The Basic Standards and Methodologies for Surface Water, Section 31.8, an antidegradation (AD) analysis is required for all discharges to waters designated “reviewable”, except in cases where the regulated activity will result in only temporary or short-term changes in water quality. Therefore, short-term and intermittent discharges will be considered a temporary impact and exempted from the AD review. Under this general permit the discharges are considered short term and intermittent and the discharges are exempt from AD review.
- b. Antibacksliding – The Division has retained the more stringent TSS numeric effluent limit in this renewal permit for all dischargers as required by the anti-backsliding provision in CWA § 402(o).
- b. Determination of Total Maximum Daily Loads (TMDLs) – Upon reissuance of the renewal certifications and for new construction dewatering permit applications under this revised general permit, the Division will assess whether or not any permitted facility discharges to segments for which a TMDL has been completed. The Division has included a provision in the general permit that authorizes the inclusion of additional effluent limits and other terms and conditions in a certification for discharges to segments for which a TMDL has been completed. The determination whether compliance with numeric effluent limitations will be required will be made on a case-by-case basis.
- c. Determination of Discharges to 303(d) Listed Waters— Upon reissuance of the renewal certifications and for new construction dewatering permit applications under this revised general permit, the Division will assess whether or not any permitted facility discharges to segments on the 303(d) list of impaired waters. The Division has included a provision in the general permit that authorizes the inclusion of additional effluent limits and other terms and conditions in a certification for discharges to segments that are on the 303(d) list of impaired waters. The determination whether compliance with numeric effluent limitations will be required will be made on a case-by-case basis.
- d. Colorado Mixing Zone Regulations – For this general permit, mixing zone regulations will not apply for discharges from Construction Dewatering Activities as all limitations are assigned as end of pipe limits based on the Water Quality Standards and Technology Based Limitations.

The rationale for not applying mixing zone regulations is due to Division resource limitations and the time required to conduct a thorough analysis of the receiving stream and its assimilative capacity. In addition, this level of analysis is more appropriate for the individual permit process in order to include public notice and comment opportunities. Not applying the mixing zone regulations is consistent with the previous iteration of the permit.

- e. Total Phosphorus – as noted in the general permit, the Division will implement effluent limitations and monitoring conditions in the certification in accordance Phosphorus Control Regulations (Regulations, 71, 72, 73, and 74).
- f. Reasonable Potential Analysis –An analysis must be performed to determine whether to include QBELs in the permit. This reasonable potential (RP) analysis is based on the Determination of the Requirement to Include Water Quality Standards-Based Limits in CDPS Permits Based on Reasonable Potential, dated December, 2002. This guidance document utilizes both quantitative and qualitative approaches to establish RP depending on the amount of available data.
- g. Intake Credits - –The Division has made the determination that there is not reasonable potential and effluent limitations do not need to be applied for discharges authorized under this permit where all of these conditions exist:
 - i. The source water (i.e., intake water) for a construction dewatering discharge is composed entirely of in-stream water. Based on the Division’s permitting experience, this condition is met when construction activities occur in-stream, and when construction activities occur on a stream bank where water is contiguous with in-stream water. It will not be the Division’s standard practice for intake credits to apply under this permit to intake water that is composed of alluvial groundwater that is hydrologically connected to the surface water body, as condition iv below may not be met. For example, the nature of alluvial groundwater dewatering, through the creation of cone of depression may increase soil pollutant delivery, regardless of whether a pollutant is present due to natural or anthropogenic causes. The act of transferring pollutants from dewatered alluvial groundwater to a stream can also change the rate (timing) and loading of the pollutant.
 - ii. An intake credit is necessary because a pollutant is present in the source water at a concentration that exceeds a water quality standard. For this permit, the Division qualitatively determines that this condition is met for all waterbodies identified as impaired (on the 303(d) list or category 4b) for numeric water quality criteria. The Division also makes this determination on a case-by-case basis where information is included in the permit application to document the pollutant concentration in the intake water.
 - iii. The proposed point of discharge is to the same waterbody segment as the source water.
 - iv. The discharge does not increase the pollutant loading or mass, including through introduction of pollutants to the discharge from the construction activities associated with the dewatering discharge. Intake credits do not apply to sediment for this permit, since construction activities can increase sediment loading in the intake water, and as such effluent limits are applied to construction dewatering discharges to limit the amount of sediment authorized in the discharge. Based on the Division’s permitting experience other parameters commonly found in the frequently used

control measures for construction dewatering, such as mechanical filtration and passive settling, do not increase pollutant concentrations (e.g., through evaporation). The scope of authorizations allowed under this general permit is limited to the source water and pollutants associated with the source water's contact with construction activities, and does not include other internal waste streams.

- v. This does not apply in situations where a TMDL wasteload allocation is applicable to the point source discharge

The Division's application of intake credits in these limited circumstances is consistent with EPA Region VIII policy regarding intake credits which is documented in a memo dated March 2, 1992 and the Division's past practice for these types of construction dewatering discharges. Pollutants for which intake credits are applied are expected to be present and are authorized in the point source discharge.

In addition, for discharges from dewatering projects for bank or in-stream construction activities, report only monitoring requirements will not be applied to the discharge. For these discharges, the Division does not anticipate that additional data obtained from report only monitoring will be needed to support future reasonable potential determinations.

This limited application of intake credits has been determined to be appropriate for discharges authorized under this permit, and is not intended to make a determination for the overall applicability and implementation of intake credits.

3. Pollutants Limited by Water Quality Standards –

- a. pH – This parameter is limited by the water quality standards of 6.5-9.0 s.u., as this range is more stringent than the range specified under the Regulations for Effluent Limitations. This limitation is the same as that contained in the previous permit and is imposed effective immediately.
- b. E. coli- The Division's Policy Concerning Escherichia coli versus Fecal Coliform establishes a maximum E. coli 30-day geometric mean limit of 2000 colonies/100 ml and also establishes the 7-day geometric mean limit for E. coli as two times the 30-day geometric mean limit; consequently, a 30-day geometric mean limit of 2000 colonies/100 ml and a 7-day geometric mean limit of 4000 colonies/100 ml have resulted.
- c. Temperature- The Division decided not to include monitoring for temperature on a permit-wide basis, as facilities generally do not add heat during their processes. However, a case-by-case determination will be made as to whether to include monitoring for temperature for facilities that containerize the effluent for extended periods of time causing the potential for temperature to be a pollutant of concern
- d. Metals—A case-by-case determination will be made as to whether or not metals are potential pollutants of concern that must be limited and/or monitored to protect the classified uses assigned to the receiving water. The case-by-case determination will be made based on the source water for the construction dewatering activity discharge, chemicals used in the remedial process, concentrations of naturally occurring metals, the potential for the characterization of the source water to change due to locations of contaminant plumes, and data supplied with the permit application used to characterize the potential source water. Concentrations of naturally

occurring metals, and data supplied with the permit application used to characterize the potential source water. The limitations for metals are based upon the water quality standards and will come directly from the basin regulations (Regulations 32-38) and the Basic Standards and Methodologies for Surface Water (Regulation 31). Standards for metals in the basin regulations that are shown as Table Value Standards (TVS) must be derived from equations that depend on the receiving stream hardness or species of fish present. These equations can be found in the basin regulations (Regulations 32-38).

- e. Volatile Organic Compounds (VOCs) and Semi-Volatile Organic Compounds (SVOCs)—A case-by-case determination will be made as to whether or not VOCs and/or SVOCs are potential pollutants of concern that must be limited and/or monitored to protect the classified uses assigned to the receiving water. The case-by-case determination will be made based on the chemicals used in the treatment process and data supplied with the permit application used to characterize the potential source water. The limitations for VOCs and SVOCs are based upon the water quality standards that come directly from the Basic Standards and Methodologies for Surface Water (Regulation 31). The numeric effluent limitations implemented are dependent on the beneficial use of the receiving stream.
5. Salinity Regulations – In compliance with the Colorado River Salinity Standards and the Colorado Discharge Permit System Regulations, the permittee shall monitor for total dissolved solids on a monthly basis.
6. Economic Reasonableness Evaluation – Section 25-8-503(8) of the revised (June 1985) Colorado Water Quality Control Act required the Division to "determine whether or not any or all of the water quality standard based effluent limitations are reasonably related to the economic, environmental, public health and energy impacts to the public and affected persons, and are in furtherance of the policies set forth in sections 25-8-192 and 25-8-104."

The Colorado Discharge Permit System Regulations, Regulation No. 61, further define this requirement under 61.11 and state: "Where economic, environmental, public health and energy impacts to the public and affected persons have been considered in the classifications and standards setting process, permits written to meet the standards may be presumed to have taken into consideration economic factors unless:

- a. A new permit is issued where the discharge was not in existence at the time of the classification and standards rulemaking, or
- b. In the case of a continuing discharge, additional information or factors have emerged that were not anticipated or considered at the time of the classification and standards rulemaking."

The evaluation for this permit shows that the Water Quality Control Commission, during their proceedings to adopt the basin regulations, considered economic reasonableness.

Furthermore, no new information has been presented regarding the classifications and standards. Therefore, the water quality standard-based effluent limitations of this permit are determined to be reasonably related to the economic, environmental, public health and energy impacts to the public and affected persons and are in furtherance of the policies set forth in Sections 25-8-102 and 104. If a party that desires coverage under this general permit disagrees with this finding, pursuant to

61.11(b) (ii) of the Colorado Discharge Permit System Regulations, they should submit all pertinent information to the Division during the public notice period.

B. Terms and Conditions Necessary to Assure Compliance

Regulation 61.8(3)(f) includes a requirement for permits to include such terms and conditions as the Division determines to be necessary to ensure compliance with applicable control regulations, water quality standards, and the state and federal Act. The Division has determined that the following conditions are necessary for discharges authorized by this permit.

- 1) Pollutant Control Practices, Materials Handling and Spill Prevention, and Discharge Log requirements have been added to the permit (Part I. C.1 and Part I C.2.).

C. Monitoring

Effluent monitoring will be required as shown in the general permit. Monitoring locations will be authorized in the permit certification. Facilities wanting to request a reduction in monitoring frequency must request so through the modification process. The Division will evaluate if a reduction in monitoring frequency can be made in accordance with the Monitoring Policy. Subsequently, upon permit renewal, facilities that have previously been granted a reduction in monitoring frequency will be re-evaluated against the criteria set forth in the Policy to determine if monitoring reductions can continue.

D. Reporting

- 1) Discharge Monitoring Report – Facilities authorized under this general permit must submit Discharge Monitoring Reports (DMRs) on a monthly basis to the Division. These reports should contain the required summarization of the test results for all parameters and monitoring frequencies shown in Part I.B of the permit. See the permit, Part I.B, C, D and/or E for details on such submission.
- 2) Special Reports – Special reports are required in the event of an upset, bypass, or other noncompliance. Please refer to Part II.A. of the permit for reporting requirements. Submittal of these reports to the US Environmental Protection Agency Region VIII is no longer required.

E. Spills

Spill requirements apply to materials spilled that result in their presence in the discharge authorized under this permit. Spills that may cause pollution of state waters that are not discharged through an outfall authorized under this general permit are not within the scope of this general permit and are required to be reported in accordance with the Colorado Water Quality Control Act 25-8-601(2), since the Division views these actions as not authorized under the scope of a discharge permit. Additional information regarding reporting of unauthorized spills is contained in the Divisions Guidance for Reporting Spills.

F. Compliance Schedules

Compliance schedules are authorized to be included in certifications as needed. All information and written reports required by a compliance schedule should be directed to the Permits Section for final review unless otherwise stated.

G. Additional Terms and Conditions

Signatory and Certification Requirements – Signatory and certification requirements for reports and submittals are discussed in Part I.E.7. of the permit.

Permit Writer
Maura McGovern
May 14, 2013

VII REFERENCES

- A. Colorado Department of Public Health and Environment, Water Quality Control Division Files, for CAAPFs currently authorized under this permit.
- B. Basic Standards and Methodologies for Surface Water, Regulation No. 31, Colorado Department of Public Health and Environment, Water Quality Control Commission, effective November 30, 2009.
- C. Colorado Discharge Permit System Regulations, Regulation No. 61, Colorado Department of Public Health and Environment, Water Quality Control Commission, effective September 30, 2009.
- D. Regulations for Effluent Limitations, Regulation No. 62, Colorado Department of Public Health and Environment, Water Quality Control Commission, effective March 30, 2008.
- E. Colorado River Salinity Standards, Regulation No. 39, Colorado Department of Public Health and Environment, Water Quality Control Commission, effective August 30, 1997.
- F. Antidegradation Significance Determination for New or Increased Water Quality Impacts, Procedural Guidance, Colorado Department of Public Health and Environment, Water Quality Control Division, effective December 2001.
- G. Memorandum Re: First Update to (Antidegradation) Guidance Version 1.0, Colorado Department of Public Health and Environment, Water Quality Control Division, effective April 23, 2002.
- H. Determination of the Requirement to Include Water Quality Standards-Based Limits in CDPS Permits Based on Reasonable Potential Procedural Guidance, Colorado Department of Public Health and Environment, Water Quality Control Division, effective December 2002.
- I. The Colorado Mixing Zone Implementation Guidance, Colorado Department of Public Health and Environment, Water Quality Control Division, effective April 2002.

- J. Baseline Monitoring Frequency, Sample Type, and Reduced Monitoring Frequency Policy for Domestic and Industrial Wastewater Treatment Facilities, Water Quality Control Division Policy WQP-20, May 1, 2007.
- K. Policy for Conducting Assessments for Implementation of Temperature Standards in Discharge Permits, Colorado Department Public Health and Environment, Water Quality Control Division Policy Number WQP-23, effective July 3, 2008.

VIII PUBLIC NOTICE COMMENTS

The draft general permit and associated fact sheet were noticed for public comment on May 17, 2013 and the 30 day comment period ended on June 17, 2013. Comments and questions were received from The City of Glendale, Southeast Metro Stormwater Authority (SEMSWA), Industrial Water Permitting and Recycling Consultants, LLC, Colorado Stormwater Council (CSC), City of Longmont, and Public Service Company of Colorado, PSCo (dba Xcel Energy) Summaries of these comments and questions and the Division's responses are provided below and organized by the permit and fact sheet section. The full comments and supporting documents are contained in the permit file and available upon request from the Division's Records Center. Some comments and questions received during the 30 day comment period were outside the scope of the general permit and the Division responded directly to the commenter.

General Comments

Comment 1, City of Longmont

Requested that the terms construction dewatering source water, source water, influent, effluent, discharge, and intake water be consistent throughout the documents, the location that the term is referencing should be clear, and the number of terms that refer to the same location should be minimized.

Response 1— Part I.A.1 was revised to better clarify references to source water.

Comment 2, City of Glendale and SEMSWA

Requested that the permit be consistent and complimentary with the State Engineer's Office regulations and that the Construction Dewatering Permit not result in heightened or additional requirements from another State agency

Response 2 —The Division is not aware of any conflict between the permit and the State Engineer's Office requirements.

Comment 3, Industrial Water Permitting and Recycling Consultants

Requested clarification on if dilution is considered basic treatment under this permit, assuming uncontaminated water is utilized in the dilution process? The assumption for this inclusion is that no chemicals are added to remove potential pollutants as part of treatment?

Response 3 — Dilution is a method of treatment and the notification, record keeping, and other permit requirements associated with treatment practices are applicable to this practice.

Comment 4, Industrial Water Permitting and Recycling Consultants

Requested clarification on if a construction firm or another entity obtain statewide coverage under this permit with one project area identified in the initial application and then modify the permit for subsequent projects? In support of this approach, could the outfalls be undefined in the certification, but recorded in the associated Discharge Log?

***Response 4**—Statewide coverage under this permit is not available. The permit only authorizes discharges for which the source water is drawn from the specific area(s) identified in the application. It is not feasible for the Division to determine if discharges that could occur for source water and receiving waters statewide would meet the limitations of this permit, and to identify the numeric effluent limitations and monitoring requirements required by 5 CCR 61 for the discharges. The permit does allow for a permittee to apply for undefined outfall locations for the area(s) identified in the application. Note that the number of undefined outfalls per permit certification will be twenty unless more are granted by the Division on a case-by case basis. All the potential receiving streams for the undefined outfall locations must be identified in the application in order for the Division to implement the most protective water quality standards of the potential receiving streams.*

Permit Part I.A.1 Activities Covered

Comment 1, City of Longmont and City of Glendale

Requested clarification on why surface water dewatering discharges are authorized by the general permit, when permit coverage would be applicable, and how 404 permitting relates to the discharge.

***Response 1**— The permit authorizes point source discharge that requires CDPS permit coverage in accordance with the 5 CCR 61, and the meet the requirements in I.A for coverage under the permit. This includes when dewatering water is removed from a surface water of the State (i.e., the source water) and then discharged back into any state water from a point source. Permitting of a discharge of dredge or fill material in accordance with section 404 of the Federal Clean Water Act may also be required for the same construction projects for which a point source discharge requiring CDPS permit coverage in accordance with 5 CCR 61 occurs.*

Comment 2, CSC

Commented that the language is more confusing than the current language in the permit and recommend maintaining the current permit language

***Response 2**—The intent of the new language is to clarify the types of construction dewatering discharges authorized under the permit. The Division has kept the language as proposed.*

Comment 3, City of Longmont

Requested clarification about what coming into “contact” with construction activity means. It appears that for situations where a stream is dewatered and work is only occurring on the banks that the discharge does not come into contact with “construction activity.”

***Response 3**— Regulation 5 CCR 61 defines point source discharges for which permit coverage is required, while the permit identifies the types of point source discharges eligible for coverage. Specifically, the permit authorizes point source discharges of pollutants where the potential source of the pollutants is from contact with construction activities and from the source water. If there is not a discharge of pollution requiring a*

permit in accordance with 5 CCR 61, CDPS permit coverage is not required. Permit coverage is not required for clean water diversions that do not introduce pollutants or otherwise create a point source discharge as defined in 5 CCR 61 (e.g., stream is dewatered and work is only occurring on the banks that the discharge does not come into contact with construction activities that can add pollutants).

Permit Part I.A.2 Limitations on Coverage

Comment 1, CSC

Requested clarification on how it is determined whether a discharge is covered under the Construction Dewatering Permit and who determines it?

***Response 1**—The Division would not cover a discharge under the Construction Dewatering Permit if it meets any of the conditions outlined in Part I.A.2 of the permit. The language provided in the permit and fact sheet is intended to help the applicant apply for appropriate permit coverage (Construction Dewatering, Remedial Activities, Low Risk Discharge Policy, or other implementing agency). The Division will determine if applications qualify for coverage under the Permit.*

Comment 2, CSC— Part I.A.2.a

Requested clarification on what permit is available for coverage if a discharge is ineligible for coverage under this permit?

***Response 2**— Part II.C of the Fact Sheet provides guidance on alternative options for discharges not eligible for coverage under the permit. Individual permits are drafted for a specific discharge(s) based on the application.*

Comment 3, CSC— Part I.A.2.a

Requested clarification on why Benzene, Toluene, Ethylbenzene, and Xylene (BTEX) are provided an exception, from the limitation when naturally occurring pollutants are not?

Comment 4, CSC and City of Longmont — Part I.A.2.a

Requested clarification on why Benzene, Toluene, Ethylbenzene, and Xylene (BTEX) are only contaminants called out specifically for an exemption from the limitation in I.A.2.a? Commented that dischargers should be eligible for this permit if they can show that any pollutant is not in the effluent, even if there is reasonable potential for it to be there.

***Response 3 and 4**—The limitations in Part I.A.2.a are intended to allow for a streamlined permitting approach for the majority of construction dewatering discharges. Coverage is not limited based on the reasonable potential for a pollutant to be present, but is limited if there is a reasonable potential for a pollutant to be present in the source water at a concentration that is greater than a numeric water quality standard of the receiving water. The Division general permits for Remediation Activities include additional application requirements, monitoring requirements, and effluent limitations determined necessary for discharges that do not qualify for coverage under this permit.*

The Division revised the fact sheet to better describe why the specific permit terms and conditions were used in this permit renewal. The fact sheet also explains that the BTEX limitations included in the permit and why the limitations on permit coverage differ for BTEX as compared to other pollutants (Part II.C)..

Comment 7, City of Longmont— Part I.A.2.a

Requested that permit coverage eligibility and limitations be based on exceedance of stream standards in the receiving water.

Response 7—The permit applies water quality standards at the end of pipe and does not account for dilution of pollutants by the receiving water, which would necessitate the calculation and inclusion of facility specific numeric effluent limitation(s) that incorporate mixing. The required data and calculation that would be needed for such an approach would also significantly extend the time to process applications, beyond the current 30 days identified for this permit. In addition, it is the Divisions’ determination that facility specific numeric effluent limitation(s) based on dilution should be subject to public notice and comment, and would be inconsistent with the regulations for issuing general permits in 5 CCR 61.9(2)(a)(ii). Facilities desiring such considerations may apply for coverage under an individual permit.

Comment 8, CSC— Part I.A.2.a

Requested additional explanation of "implementing agencies under Senate Bill 181."

Response 8—The implementing agencies are identified in 25-8-202(7), C.R.S.and 5 CCR 6113(2) and have the initial responsibility for implementation of water quality standards to protect ground water quality:

- a. Division of Reclamation, Mining and Safety;*
- b. State Engineer;*
- c. Oil and Gas Conservation Commission;*
- d. Hazardous Materials and Waste Management Division;*
- e. Division of Oil and Public Safety.*

Permit Part I.2. Numeric Effluent Limitations and Monitoring Requirements

Comment 1, Xcel Energy —Table B.1

Commented on the 30 day average limit for E.coli of 630 per 100 ml.

Response 1—The inclusion of 630 per 100 ml limitation was an error and the table has been updated to state “Limit in Certification.”

Comment 2, City of Longmont —Table B.2

Commented that pH monitoring (table B.1 and B.2) should not be limited to in-situ sampling when it can be performed according to EPA approved methods at a lab.

Response 2—Tables B.1 and B.2. have been updated to reflect the allowance of grab or in-situ sampling method for pH. The Permit requires that sampling is performed according to specified methods in 40 C.F.R. Part 136; methods approved by EPA pursuant to 40 C.F.R. Part 136; or methods approved by the Division, in the absence of a method specified in or approved pursuant to 40 C.F.R. Part 136. 40 CFR Part 136 Table II Sample Collection, Preservation Techniques, and Holding Times requires a maximum holding time for pH as “within fifteen minutes” and therefore in-situ will likely be the sampling method used.

Comment 3, City of Longmont and Xcel Energy —Tables B.1 and B.2

Requested clarification on the term “sewage conveyance” as discussed in Note 5 and the reference to the sanitary sewer collectors and how the Division will know whether the work is being done in close proximity to a “sewage conveyance” in order to make a reasonable potential determination?

Response 3—*The Division will make this determination based on the nature and location of the activity described in the permit application, and a qualitative determination of the reasonable potential for sewage to contribute pollutants to the discharge that results in the reasonable potential for E. coli or Total Coliform to be present in the source water at a concentration that is greater than a numeric water quality standard of the receiving water.*

Comment 4, CSC —Tables B.1 and B.2

Commented that the effluent limitation list has changed from the original permit and the frequency and number of tests has increased dramatically. Has the Division conducted a cost analysis?

Response 4—*The original permit required a measurement frequency of weekly for all parameters except Total Dissolved Solids and Total Phosphorus which were monthly and had the provision to add “site-specific” limitations on a case-by-case basis. This renewal permit also has a monitoring frequency of weekly for all parameters except Total Dissolved Solids and Total Phosphorus which again are monthly. Instead of referencing “site-specific” limitations the permit lists the specific possible parameters that may be added in the certification and therefore, the frequency and number of tests is not expected to differ for similar discharges under the renewed permit.*

The Division does strive to draft permits that include requirements that comply with regulations while not resulting in unnecessary costs for permittees. The Division has included numeric effluent limit in the permit in accordance with the requirements of 5 CCR 61.8(2), and the Division has determined that the monitoring and reporting requirements are “reasonably required,” in accordance with 5 CCR 61.8(4). Where public comment is provided that identifies specific requirements that may be unnecessary or inefficient, the Division will evaluate the comments and make changes to the permit as appropriate. However, the completion of a cost analysis is not required by state statute or regulation for this permit action. Note that in accordance with Colorado Senate Bill 12-073, upon request by an affected party, the Division will consider and give due weight to a cost-benefit that is provided to the Division during the public comment period, paid for by the affected party, and meets the additional conditions contained in the bill and incorporated into C.R.S 25-8-503.5.

Comment 5, Xcel Energy —Notes for Tables B.1 and B.2.

Commented on updating the “sample type” for flow to reflect the language described in the fact sheet.

Response 5—*The language in the Note 1 of the permit has been updated.*

Comment 6, City of Longmont —Notes for Tables B.1 and B.2.

Provide comment that groundwater is variable and actual flows will not be known until dewatering actually begins. If there is a limit on flow there might be overestimation at the time of application. Why would the Division double the maximum estimated flow for the certification and also want the permittee to notify the Division when maximum flow on the application is exceeded?

Response 6—*The permit limitation for flow is set at double the rate identified in the application to reduce the need for permit modifications resulting in variations in flow rate. However, notification is required by the permit when the rate identified in the application is exceeded since the Division's determinations for qualitative reasonable potential are based on that identified flow rate and may need to be reevaluated if the rate changes. This combination of a limitation and notification requirement provides for a reasonable limitation on the variation from the identified flow rate (i.e., double) without requiring a modification.*

Comment 7, City of Longmont

Commented that Selenium (Se) is a naturally occurring contaminant that has a state-wide potential for being in the source water and is very difficult and expensive to treat. What analysis has been done on the previous DMR data for Se? Please provide more detailed discussion about how Se will be evaluated for reasonable potential and also how it will be handled through permit limitations or requirements.

Response 7— *Discharges authorized by this permit may include report-only requirements for Selenium.*

This will typically only occur to facilitate the collection of additional data when a discharge is to a segment listed on the Division 303(d) list as impaired for selenium. Where there is a reasonable potential for Selenium to be present in the source water at a concentration that is greater than a numeric water quality standard of the receiving water, permit coverage is required under another general permit (i.e., a remediation activities general permit) or under an individual permit. The Division does consider the nature of the pollutant in making a reasonable potential determination. For example for pollutants like benzene that are not naturally occurring, the Division will make a qualitative determination of reasonable potential based on published groundwater contamination information that indicates a pollutant source is in the vicinity of the project, without requiring project specific groundwater sampling data to be submitted to confirm the determination. Additional information can be voluntarily submitted by the applicant to support a no RP decision as appropriate. For Selenium, reasonable potential will typically be evaluated based on site-specific data, or data from nearby facilities that are determined to be representative of the data and a yes RP decision is typically made only where more localized information confirm the presence of the pollutant. Under the previous permit the Division's practice for selenium where there was not site-specific data was to make a qualitative monitor only decision where the receiving water is impaired. The Division's review of this data has shown that selenium exceeded the receiving water quality in 23 of 61 facilities between 2009 and 2012. Although this shows that RP for selenium does occur in areas where the Division had only qualitative impairment information upon which to base the decision, it also shows that impairment alone does not correlate to an expectation that the discharge will exceed stream standards in the majority of the cases. Therefore, the Division drafted this master general permit with the expectation that effluent limits for selenium determinations would continue to be made based on local site specific data only. This is because there is known water quality problem, however given the nature of selenium, its presence in many ambient waters the and a monitor only decision is made where local data are not available to continue to inform future decisions. The Division acknowledges the challenges associated with treating for selenium; however discharges containing Selenium remain subject to the requirements of 5 CCR 61. requiring that effluent limitations must control all pollutants or pollutant parameters which the Division determines are or may be discharged at a level which will cause, have the reasonable potential to cause, or measurably contribute to an excursion above any water quality standard.

Comment 8, Industrial Water Permitting and Recycling Consultants, LLC —Permit Tables B.1 and B.2

Requested clarity on the "Limit in the Certification" language for BTEX in Tables B.1 and B.2. and how the limit will be developed. If these are the choices, why not enter them in the tables?

Response 8—*The limitations are based on the classification and beneficial uses of the receiving stream of the discharge. The appropriate numeric effluent limitations can be found in the Water Quality Control Commission Regulations and will vary based on the river basin, therefore "Limitation in Certification" is listed in the tables.*

Permit Part I.C. Terms and Conditions

Comment 1, City of Longmont —Part I.C.2

Commented that material handling and spill prevention should apply to activities that can have an impact on the permitted outfalls. If material handling and spill prevention is concern for entering State waters in general, the requirements should be handled in a different path; especially since dewatering permits will not cover all construction activities.

Response 1— The Division has removed the section requiring materials handling and spill prevention practices. The Division agrees that the control discharges not authorized by the permit are not appropriate to address in the permit. Due to the low risk of discharges from the permitted outfall being impacted by these practices, the Division has determined it is not necessary to include requirements in the permit.

Comment 2, City of Longmont, CSC, and City of Glendale —Part I.C.5

Commented that the permit should require that the permittee notify federal agencies, municipalities, counties, drainage districts, or other local agencies regarding any discharges to storm drain systems, conveyances, or other water courses under their jurisdiction.

Response 2— Requirements for such notifications would be in accordance with the applicable agencies requirements and not under the authority of the Division to require directly in the permit. In addition, not all such agencies require notification. The Division will advise permittees that such notification may be required in the permit application. The Division will evaluate the language referenced and used in other permits at the time of their renewals.

Comment 3, City of Longmont, —Part I.C.7

Asked if flow estimation methods, as discussed in Part I.C.7, comply with the requirements in the Analytical and Sampling Methods for Monitoring and Reporting section (Part I.E.4) or is an exemption needed in Part I.E.4?

Response 3— The requirements of Part I.E.4 are not applicable to flow limitations

Permit Part I.D. Definitions

Comment 1, City of Longmont— Part I.D.7

Commented on the definition of “Good Engineering, Hydrologic and Pollution Control Practices” (Part I.D.7) and that it should have been developed through discussions with other permit stakeholders like the MS4s, Non-Standards, and Construction Contractors. This definition applies to many more permits than just the construction dewatering permit. The definition should be removed until all appropriate stakeholders have been included and the definition has had adequate review for all applicable uses. At minimum, the criteria in the definition should be linked with “or” instead of “and.”

Response 1— The definition is only applicable to the terms and conditions of the permit, and therefore the public process for issuance of this permit was appropriate for seeking stakeholder comment. The Division does not agree that the criteria in the definition should be met when only one criterion is met. The criteria were drafted to be jointly applicable in order to set a standard that would result in appropriate control of pollutants.

Comment 2, Xcel Energy— Part I.D.26

Suggested changing the definition of “weekly measurement frequency” as follows: “means sample type may be collected at any time during a 7-day period”

Response 2— *This language is applied in all permits and has not been changed in order to maintain constancy with all Division permits.*

Permit Part II

Comment 1, City of Longmont— Part II.B.

Commented that language in Part II.B that is not directly applicable to discharges authorized by the permit should be removed.

Response 1— *This language is applied in all permits for constancy with 5 CCR 61 and between permits, and has not been removed*

Permit Part II.A. Notification Requirements

Comment 1, Xcel Energy —Part II.A.2

Commented that the last paragraph in this section indicates that the Division may require a new or revised permit application, but it seems that a permit modification may be appropriate as well.

Response 1—*The Division agrees with this comment and has added language to this section of the permit to include modification of an existing permit certification and submission of a Modification Form.*

Comment 2, City of Longmont —Part II.A.2

Commented that The Change in Discharge of Wastewater Treatment section (Part II.A.2) should be titled “Change in Discharge” and refer to changes in water quality of the dewatered discharges, not physical alterations or additions to a permitted facility or treatment process. The content should be similar to the language in the previous dewatering permit, which required notification of a change that is likely to result in a new or altered discharge.

Response 2— *This language is applied in all permits for consistency with 5 CCR 61 and between permits, and has not been removed. The limitations included in Part I.A.2 and requirements of Part I.C.3 of the permit were included to ensure permitting remains appropriate for additional changes in the water quality of the dewatering discharge.*

Comment 3, CSC— Part II.A.4.a

Requested clarification as to whom and where in the EPA this information should be submitted to?

Comment 4, Xcel Energy — Part II.A.4.a

Commented that it believes the inclusion of EPA is in error.

Response 3 and 4—*The Division agrees that the inclusion of EPA is in error and the requirement to provide notification to the EPA has been removed.*

Comment 5, City of Longmont— Part II.A.5

Commented that the section seems to apply to operation of a facility rather than dewatering activities and should not be included in this permit.

Response 5—*The section applies to the operation of a facility that has the potential to impact the discharge authorized in the permit certification.*

Comment 6, CSC— Part II.A.6

Asked if the Division is notified 10 days prior to the Bypass and the permittee hears no response from the Division, can the permittee can assume approval on the (11th) day?

Response 6—The Division requires notification if the permittee knows in advance of the need for a bypass. Bypasses are prohibited unless the conditions outlined in Part II.A.13. Paragraph (a) of the permit are met. No response from the Division does not mean approval of the Bypass.

Fact Sheet

Comment 1, Xcel Energy — Fact Sheet, Part II.B. 5TH Bullet

Commented that PSCo relies on pump capacity and visual observation to estimate construction dewatering flow rates. PSCo feels this method of estimating flow rates is fairly accurate but verification of the flow rate can be difficult to do. As such compliance with the required accuracy of flow measurement may be difficult to achieve

Response 1— The Division recognizes this issue, but has included the requirement in the permit in accordance with 5 CCR 62.5(7).

Comment 2, Xcel Energy — Fact Sheet, Intake Credits

Commented that the Division should not set policy or make assertions regarding intake credits through this permit action. The Division’s approach explained in the Fact Sheet would apply intake credits too narrowly. The Division proposes to require a demonstration that the intake water is “composed entirely of in-stream water,” and that the discharge “does not increase the pollutant loading or mass, including through introduction of pollutants to the discharge from the construction activities associated with the dewatering discharge.”

Response 2—The Division is not setting policy with the application of intake credits in this general permit. The Division is making a permit- specific determination for intake credits that is applicable only to discharges authorized by the permit. The approach to intake credits discussed in the fact sheet and implemented in the permit is not intended to define the overall applicability of intake credits by the Division. Note that it may be possible that a different application would occur for the same discharges if authorized under an individual permit. The Division believes the application of intake credits is an appropriate decision for this general permit and did not receive any comments regarding the actual permit language associated with intake credits. The Division has revised the Fact Sheet language to clarify that the scope of the decisions and assertions are limited to this permit.

Comment 3, Xcel Energy — Fact Sheet, Intake Credits

Commented that if there is no addition of a pollutant, there is no discharge, and therefore no discharge permit necessary. The U.S. Supreme Court affirmed that moving water containing no pollutants from on part of a water body to another part of a water body does not constitute "addition" of pollutants. The Division's application of intake credits would apply only where a permit is not necessary, rendering the intake credit provision meaningless.

Response 3—In addition to pollutants occurring in the surface water that is the source water for a discharge, discharges authorized by this permit have the potential to have pollutants added associated with construction activities such as total suspended solids. Therefore, the discharge authorized by this permit for which intake credits are applied would remain a point source discharge subject to the requirement to obtain permit coverage.

Comment 4, Xcel Energy — Fact Sheet, Intake Credits

Commented that the Division's support for its restrictive position of intake credits relies entirely on a Memo from EPA Region VIII dated March 2, 1992. The Division's reference to "Region VIII policy" exaggerates the meaning and effect of the Region VIII 1992 memorandum. Also, the rationale for the position promoted in the 1992 Region VIII memorandum is inconsistent with the current law regarding the definition of a "discharge."

Response 4—The cited memo is referenced in this fact sheet for additional information regarding EPA policy regarding intake credits and to eliminate any potential uncertainty about whether the decision in this permit would or would not be consistent with the EPA Region 8 policy. The Division decision regarding implementation of intake credits is discussed in the fact sheet and is intended to provide the basis for the decision in this case under this general permit. . The Division is making no assertion through this permit action of the applicability of the memo to intake credits applied outside of this permit and has provided additional clarification in the fact sheet.

Comment 5, Xcel Energy —Fact Sheet, Part VI.A.2.c

The paragraph referenced remediation activities; however it should reference construction dewatering activities.

Response 5—This reference has been updated.

Comment 6, Xcel Energy —Fact Sheet, Part VI.A.2.c

Commented that the determination of whether additional effluent limits and other terms and conditions are added to a certification if the discharge is to a segment on the 303 (d) list should be made on a case-by case basis. This section should be revised to include the noted language in Part VI.A.2.b

Response 6—This section has been updated to include the noted language.

Comment 7, Xcel Energy —Fact Sheet, Part VI.A.3.d

This section states that metals in the basin regulation that are TVS will be determined based on the hardness of the receiving stream or fish species present. How will these limitations be determined if that data is not available.

Response 7—If hardness data is not available for the receiving stream it is Division general practice to use the closest downstream hardness data that is available. In some cases the Division may use the hardness of a representative watershed.

Comment 8, Industrial Water Permitting and Recycling Consultants, LLC —Fact Sheet and General Permit

Commented that the permit is intended to offer coverage for dischargers to surface waters, including discharges to ground waters that are hydrologically connected to nearby surface waters. Other discharges to land, to impoundments, and to wells are under jurisdiction of other state or federal agencies. This statement should be provided in the permit (p5) with details in the Fact Sheet on discharges to land and groundwater under the authorities of separate agencies. The latter could include a fuller discussion of Senate Bill 181 and implementing agencies.

Response 8—The Division recognizes that some discharges to land, impoundments, and to wells are under jurisdiction of other state and federal agencies. Part I.A.2 of the permit is intended to address this.

**Permit Writer
Maura McGovern
July 22, 2013**

**COLORADO DISCHARGE PERMIT SYSTEM (CDPS)
FACT SHEET FOR MODIFICATION 2 to PERMIT NUMBER COG070000
GENERAL PERMIT FOR
CONSTRUCTION DEWATERING DISCHARGES**

Table of Contents

I. TYPE OF PERMIT	1
II. SCOPE OF THE GENERAL PERMIT	1

I. TYPE OF PERMIT

Master General, NPDES, Surface Water and Groundwater, Second Minor Modification , Statewide.

II. SCOPE OF THE GENERAL PERMIT

Modification #2

Division initiated minor change was made to the language in Part I.C.1.b to correct the reference from Part 1.E.4. to Part 1.E.5.



DENVER

PUBLIC WORKS

Wastewater Capital Projects Management

Example Carlsonator System from High Line Canal for Contractors Reference

For Asbury and Tejon Park

October 2018

DATE:	08/2018
DRAWING NAME:	HOLLY STREET CARLSONATOR
APPROVED BY:	DU
DESIGNED BY:	CC
DRAWN BY:	CC
SHEET NO.:	35

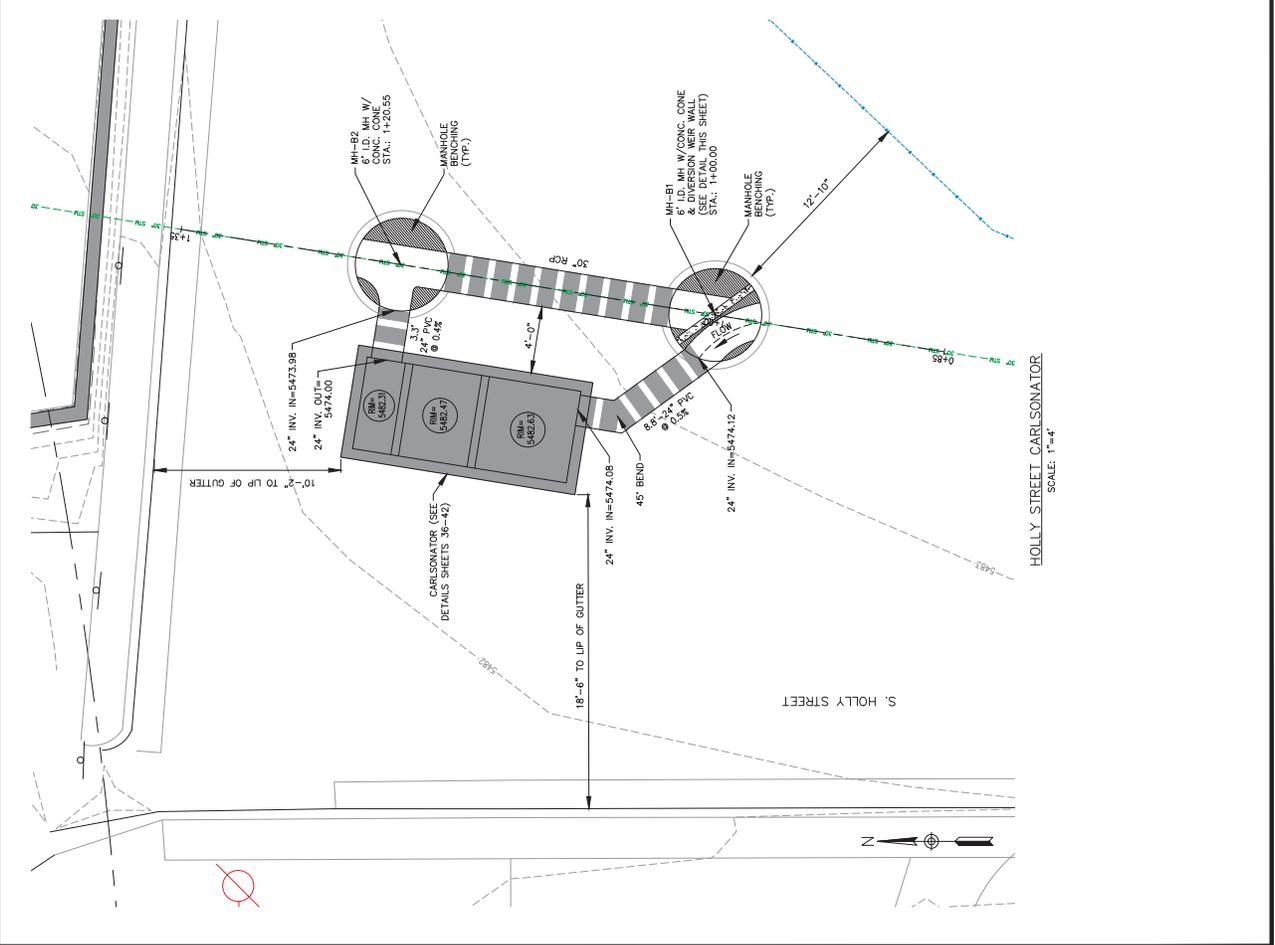
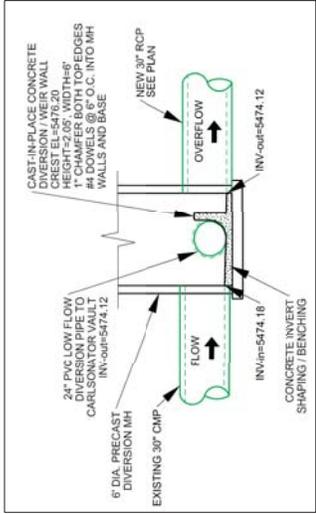
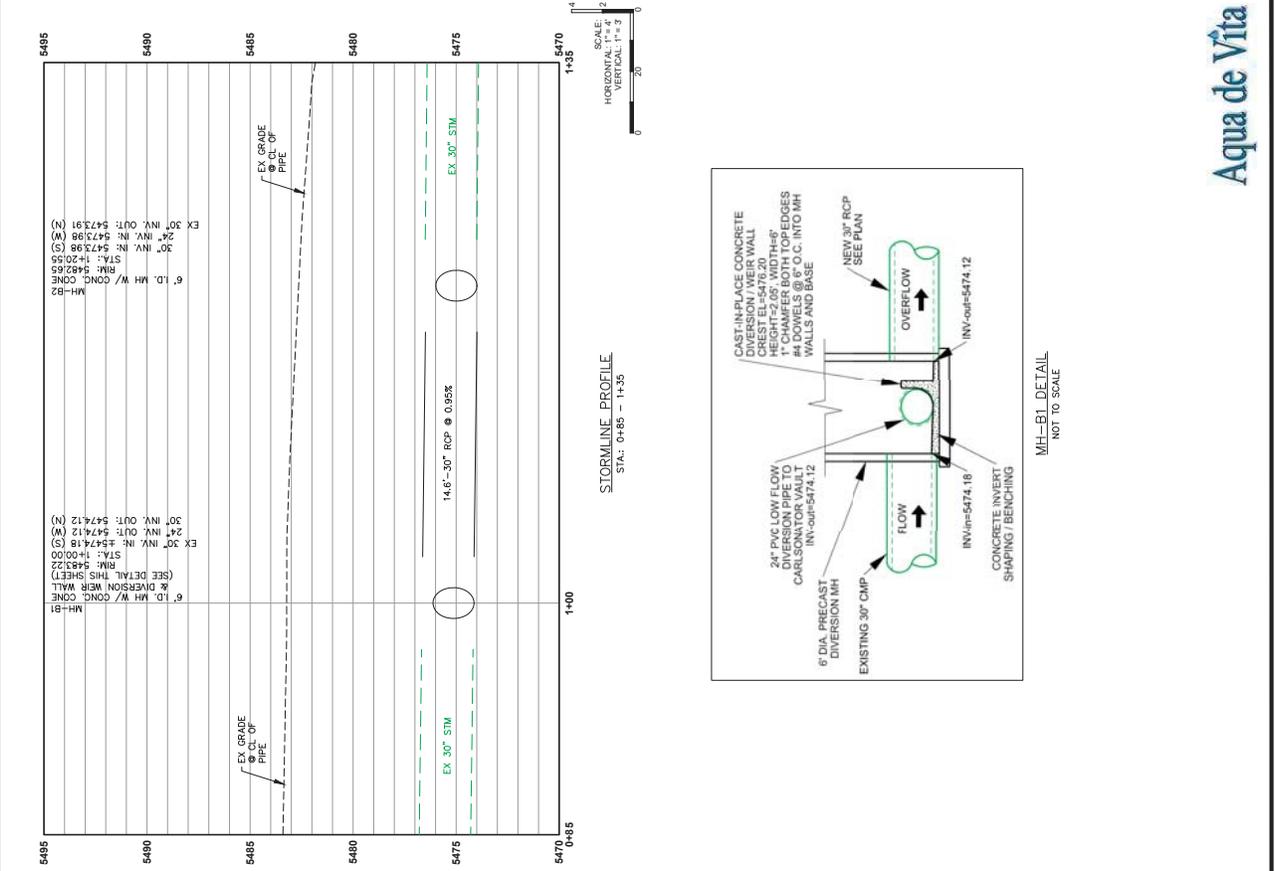
HIGHLINE CANAL
 WATER QUALITY FACILITY
 PCO TRACKING NO.: 2018-CIP-0000069
 PROJECT MASTER NO.: 2017-PROJMAST-0000022
 HOLLY CARLSONATOR SITE LAYOUT PLAN

CITY AND COUNTY OF DENVER
 DEPARTMENT OF PUBLIC WORKS
 CAPITAL PROJECTS MANAGEMENT
 2000 W. 3RD AVE. DENVER, CO 80223
 TEL: (303) 446-3617 FAX: (303) 446-3647

CALL UNCC
 BEFORE YOU DIG
 1-800-251-8882

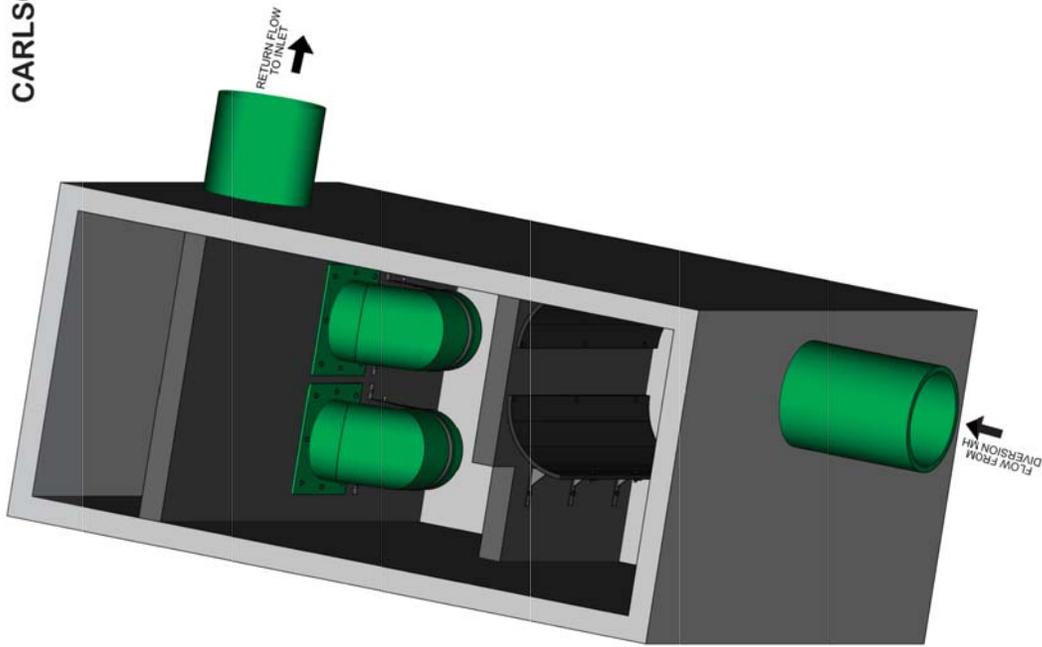


NO.	DESCRIPTION OF REVISIONS	DATE	BY

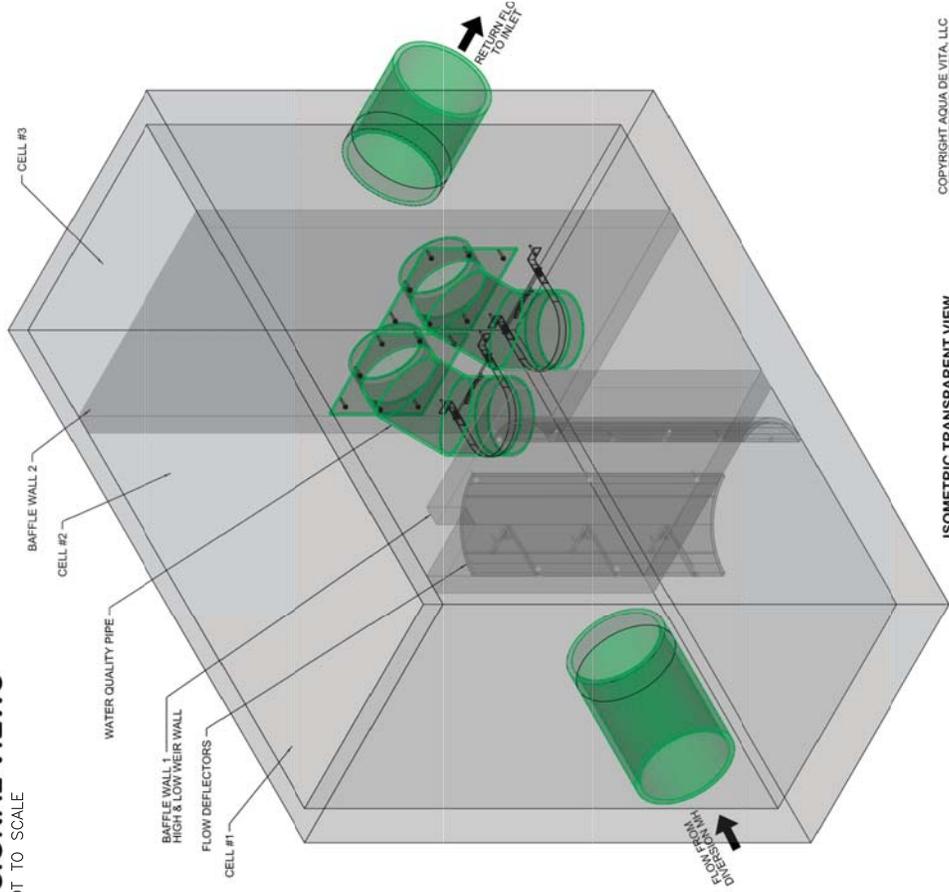


NO.	DESCRIPTION OF REVISIONS	DATE	BY

**CARLSONATOR WATER QUALITY VAULT
HOLLY STREET
3-DIMENSIONAL VIEWS**
NOT TO SCALE



FRONT TILT ILLUSTRATED VIEW



ISOMETRIC TRANSPARENT VIEW

COPYRIGHT AQUA DE VITA, LLC
NOT FOR REPRODUCTION

Aqua de Vita

Aqua de Vita

NO.	DESCRIPTION OF REVISIONS	DATE	BY

CALL UNCC
BEFORE YOU DIG
TWO WORKING DAYS
AHEAD
1-800-251-9887
UNCC
UNIVERSITY OF COLORADO
CONSTRUCTION



CITY AND COUNTY OF DENVER
DEPARTMENT OF PUBLIC WORKS
ENGINEERING DIVISION
CAPITAL PROJECTS MANAGEMENT
2000 W. 3RD AVE. DENVER, CO 80223
TEL: (303) 446-3617 FAX: (303) 446-3647

HIGHLINE CANAL
WATER QUALITY FACILITY
PROJECT MASTER NO.: 2018-CIP-0000069
PROJECT MASTER NO.: 2017-PROJMAST-0000022
HOLLY CARLSONATOR 3-D VIEWS

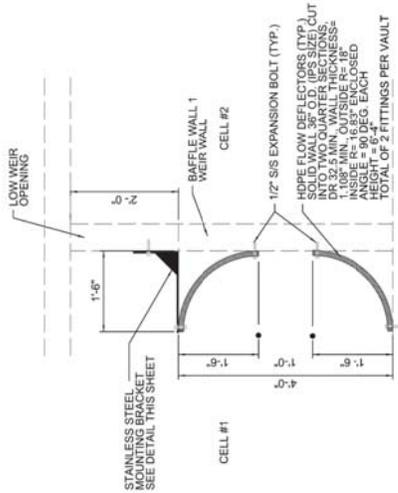
DESIGNED BY:	CC
APPROVED BY:	CC
DRAWING NAME:	DJ
DATE:	08.2018
SHEET NO.:	36

CARLSONATOR FLOW DEFLECTORS

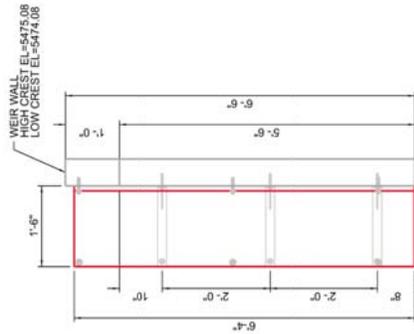
NOT TO SCALE

GENERAL NOTES

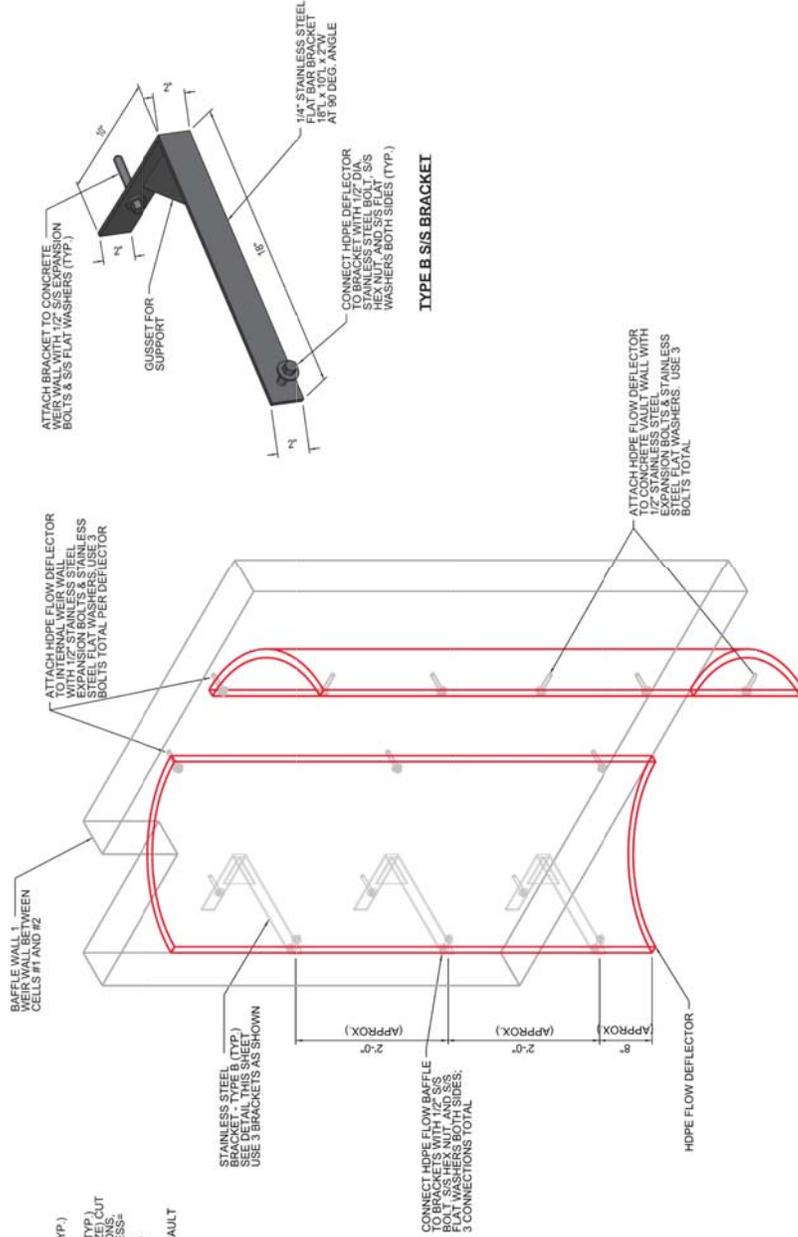
1. PROJECT: CITY & COUNTY OF DENVER, HOLLY STREET AT THE HIGH LINE CANAL
2. SEE ADDITIONAL DRAWINGS FOR WATER QUALITY PIPE FITTING DETAILS, PIPE CLAMP DETAILS, VAULT DESIGN DETAILS, ETC.



PLAN / TOP VIEW



FRONT VIEW



FLOW DEFLECTOR INSTALLATION - ISOMETRIC

NO.	DESCRIPTION OF REVISIONS	DATE	BY

CALL UNCC
BEFORE YOU DIG
1-800-251-1887
www.uncc.com

CITY AND COUNTY OF DENVER
DEPARTMENT OF PUBLIC WORKS
CAPITAL PROJECTS MANAGEMENT
2000 W. 3RD AVE. DENVER, CO 80223
TEL: (303) 446-3617 FAX: (303) 446-3647

HIGHLINE CANAL
WATER QUALITY FACILITY
PROJECT MASTER NO.: 2017-PROJMAST-0000022
PCO TRACKING NO.: 2018-CIP-0000069
HOLLY CARLSONATOR FLOW DEFLECTORS

DESIGNED BY:	CC
DRAWN BY:	CC
APPROVED BY:	DJ
DRAWING NAME:	
DATE:	08.2018
SHEET NO.:	39

COPYRIGHT AQUA DE VITA, LLC
NOT FOR REPRODUCTION



HDPE WATER QUALITY PIPE FITTINGS

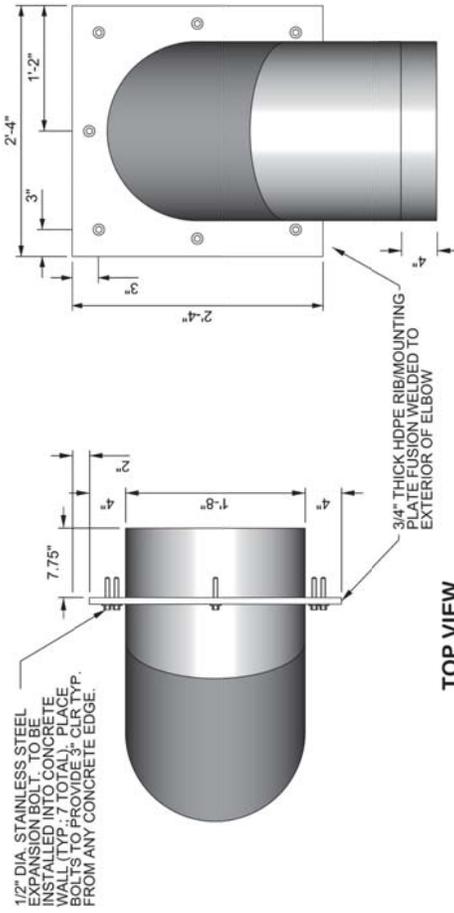
NOT TO SCALE

GENERAL NOTES

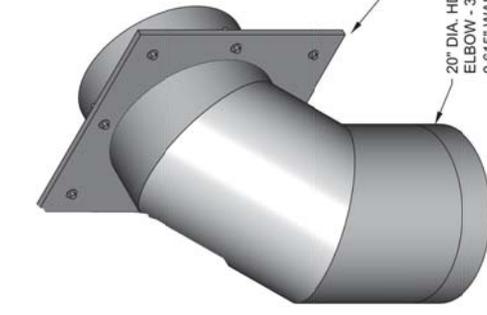
- TWO WATER QUALITY PIPE FITTINGS PER STRUCTURE
- PROJECT: CITY & COUNTY OF DENVER, HOLLY STREET AT THE HIGH LINE CANAL

INSTALLATION NOTES

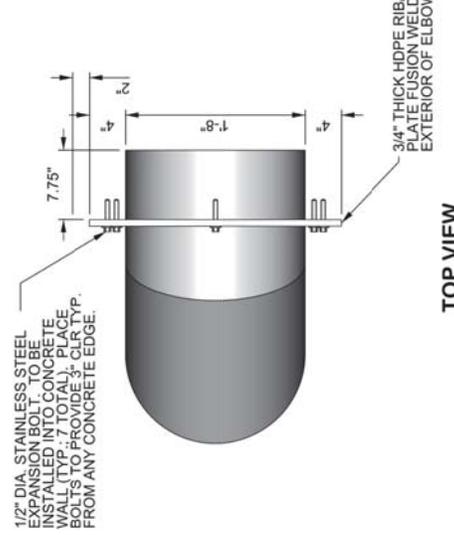
- MARK AND DRILL MOUNTING HOLES THROUGH HDPE RIBMOUNTING PLATE FOR 1/2" DIA. EXPANSION BOLTS.
- A NITRILE CAST-IN PUSH FIT PIPE CONNECTOR/GASKET WILL BE INSTALLED IN THE CONCRETE CELLWALL AT THE DESIGN ELEVATION.
- ENSURE FITTING END IS FREE FROM PHYSICAL DEFECTS OR BURRS. BEVEL THE FITTING END WITH AN ANGLE GRINDER TO REMOVE THE SHARP OUTSIDE EDGE SO THAT IT WON'T CATCH ON THE GASKET.
- CLEAN ANY LOOSE DEBRIS, DUST AND DIRT FROM THE GASKET CONNECTOR SURFACE AND FITTING O.D.
- THOROUGHLY LUBRICATE GASKET SURFACE AND O.D. OF FITTING UP TO THE RIB WITH SUITABLE GRADE OF TYLOX PIPE GASKET LUBRICANT. (HYDROCARBON BASED LUBRICANTS SHALL NOT BE USED - THEY WILL DAMAGE THE GASKET).
- INSTALL A SINGLE BEAD OF 3/8" ROUND EZ-STICK BUTYL JOINT SEALANT BY PRESS-SEAL WITH AT LEAST 4" OVERLAP ON THE ENDS BETWEEN THE HDPE RIBMOUNTING PLATE AND THE CONCRETE CELL WALL.
- INSERT END OF FITTING INTO THE GASKET UNTIL THE HDPE RIBMOUNTING PLATE IS FLUSH AGAINST THE CONCRETE BAFFLE WALL. FITTING MUST BE INSERTED STRAIGHT THROUGH THE GASKET.
- IF NECESSARY, TEMPORARILY BLOCK AND SUPPORT BOTTOM END OF FITTING TO HOLD IN PLACE FOR INSTALLATION.
- MARK BOLT HOLES IN CONCRETE CELL WALL, DRILL, AND INSTALL TAMP-IN LEAD ANCHORS.
 - DRILL 7/8" HOLE INTO WALL TO THE REQUIRED DEPTH (APPROX. 2" DEEP)
 - BLOW THE HOLE CLEAN OF CONCRETE DUST
 - INSERT THE ANCHOR INTO THE HOLE. NARROW END OF ANCHOR CONE MUST POINT OUT, LEAD SHIELD SLIDES OVER THE CONE.
 - POSITION A SETTING TOOL OR SOCKET AGAINST THE ANCHOR OUTER CONE. THE OUTER RIM OF THE TOOL OR SOCKET SHOULD SEAT ONTO THE LEAD SHIELD RIM.
 - SET THE ANCHOR BY DRIVING THE LEAD SLEEVE OVER THE CONE USING SEVERAL SHARP HAMMER BLOWS. BE SURE THE ANCHOR IS AT THE REQUIRED EMBEDMENT DEPTH (FLUSH OR SLIGHTLY BELOW FACE OF CONCRETE)
- ATTACH FITTING TO WALL USING 1/2" STAINLESS STEEL BOLTS AND 1/2" STAINLESS STEEL FLAT WASHERS. DO NOT OVERTIGHTEN; 10-15 LBS.
- INSTALL WATER QUALITY PIPE CLAMP. SEE THEIR DETAILS AND INSTALLATION NOTES.
- REPEAT PROCESS FOR EACH WQ PIPE FITTING.
- MATERIALS LIST (PER PIPE FITTING): (1) HDPE FABRICATED FITTING, (7) 1/2" EXPANSION BOLTS/ ANCHORS, (7) ANCHOR SHIELDS, (7) ANCHOR CONES, (7) 1/2" FLAT WASHERS



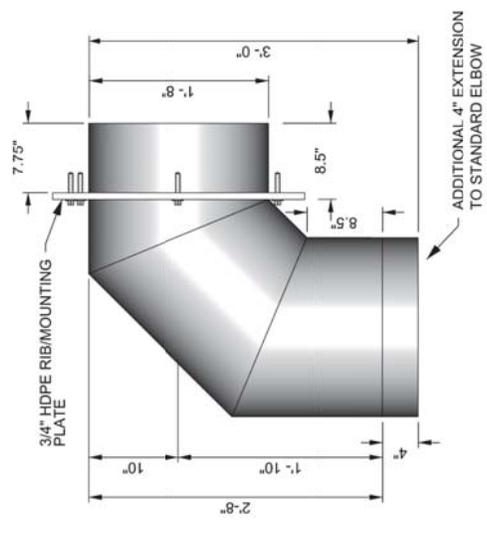
FRONT VIEW



ISOMETRIC VIEW



TOP VIEW



SIDE VIEW

CALL UNCC BEFORE YOU DIG 1-800-251-1887 1-800-251-1887			CITY AND COUNTY OF DENVER DEPARTMENT OF PUBLIC WORKS ENGINEERING MANAGEMENT CAPITAL PROJECTS MANAGEMENT 2000 W. 3RD AVE. DENVER, CO 80223 TEL.: (303) 446-3617 FAX: (303) 446-3647	HIGHLINE CANAL WATER QUALITY FACILITY PCO TRACKING NO.: 2018-CIP-0000069 PROJECT MASTER NO.: 2017-PROJMAST-0000022 HOLLY CARLSONATOR WATER QUALITY PIPE FITTINGS
NO.	DESCRIPTION OF REVISIONS	DATE	BY	

COPYRIGHT AQUA DE VITA, LLC
NOT FOR REPRODUCTION



CITY AND COUNTY OF DENVER
STATE OF COLORADO



DEPARTMENT OF PUBLIC WORKS

Plans/Drawings

Contract Number: 201845550



Asbury & Tejon Park

December 5, 2018



CITY AND COUNTY OF DENVER

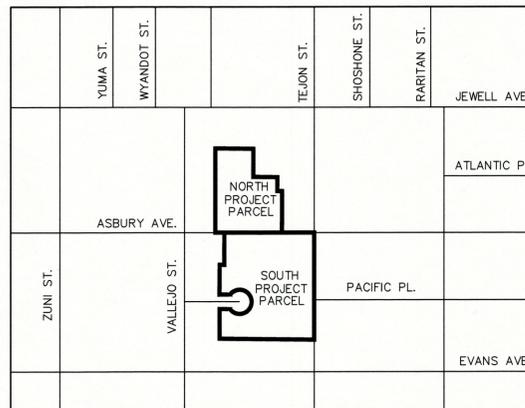
DEPARTMENT OF PUBLIC WORKS
ENGINEERING DIVISION

WASTEWATER CAPITAL PROJECTS MANAGEMENT

ASBURY & TEJON PARK RETROFIT DESIGN

PRO TRACKING NO : PWWW2017-004
PROJECT MASTER NO : 2017-PROJMSTR-0000150
CONTRACT CONTROL NO : _____

2140 W ASBURY AVENUE
SEC 28 T4S R68W



SHEET LIST

CS	COVER SHEET
G100	GENERAL NOTES AND ABBREVIATIONS
V100	SURVEY CONTROL PLAN
V101	EXISTING CONDITIONS
D100	DEMOLITION AND REMOVALS PLAN
D101	TREE PROTECTION PLAN
GR100	GRADING PLAN
GR101	GRADING PLAN
C108	CIVIL STORM PLAN
C109	CIVIL STORM AND SANITARY PROFILES
C110	NORTH POND SEDIMENT PAD
C200	CIVIL CHANNEL CENTERLINE PROFILE
C300	CIVIL CHANNEL SECTIONS
C500	CIVIL STORM STRUCTURE DETAILS
C501	CIVIL STORM STRUCTURE DETAILS
C502	CIVIL STORM STRUCTURE DETAILS
C503	CIVIL STORM STRUCTURE DETAILS

C504	CIVIL STORM STRUCTURE DETAILS
S500	STRUCTURAL NOTES AND TYPICAL DETAILS
S501	STRUCTURAL DETAILS
S502	STRUCTURAL DETAILS
S503	STRUCTURAL DETAILS
S504	STRUCTURAL DETAILS
S505	STRUCTURAL DETAILS
S506	STRUCTURAL DETAILS
S507	STRUCTURAL DETAILS
S508	STRUCTURAL DETAILS
S509	STRUCTURAL DETAILS
S510	STRUCTURAL DETAILS
L100	LANDSCAPE LAYOUT PLAN
L101	LANDSCAPE LAYOUT PLAN
L400	LANDSCAPE SITE ENLARGEMENT
L401	PLAYGROUND LAYOUT
L402	PLAYGROUND GRADING

L501	PLAYGROUND DETAILS
L502	PLAYGROUND DETAILS
L503	PLAYGROUND DETAILS
L504	PLAYGROUND DETAILS
L505	PLAYGROUND DETAILS
L506	PLAYGROUND DETAILS
L507	PLAYGROUND DETAILS
L508	PLAYGROUND DETAILS
I100	IRRIGATION SCHEDULE AND NOTES
I101	IRRIGATION PLAN
I102	IRRIGATION PLAN
I500	IRRIGATION DETAILS
I501	IRRIGATION DETAILS
I502	IRRIGATION DETAILS
LP100	PLANTING PLAN
LP101	PLANTING PLAN
LP600	PLANTING SCHEDULE, NOTES, AND DETAILS

BID DOCUMENTS

CITY OF COUNTY OF DENVER
DEPARTMENT OF PUBLIC WORKS

APPROVED BY:		
	EXECUTIVE DIRECTOR OF PUBLIC WORKS	9/24/18 DATE
	CITY ENGINEER	9/20/18 DATE
	DIRECTOR OF ENGINEERING CAPITAL PROJECTS	9/19/18 DATE
	CITY TRAFFIC ENGINEER	09/19/18 DATE

NO.	DESCRIPTION OF REVISIONS	DATE	BY

CALL UNCC
TWO WORKING DAYS
BEFORE YOU DIG
1-800-922-1987
UTILITY INFORMATION CENTER OF
DENVER

CITY AND COUNTY OF DENVER
DEPARTMENT OF PUBLIC WORKS
ENGINEERING DIVISION
CAPITAL PROJECTS MANAGEMENT
2000 W. 3RD AVE. DENVER, CO 80223
TEL.: (303) 446-3617 FAX: (303) 446-3647

ASBURY & TEJON PARK
RETROFIT DESIGN
PRO TRACKING NO: PWWW2017-004
PROJECT MASTER NO: 2017-PROJMSTR-0000150
COVER SHEET



DRAWN BY:
DESIGNED BY:
APPROVED BY:
DRAWING NAME: COVER SHEET
DATE: SEPTEMBER 2018
SHEET NO.: CS

Z:\CLIENT FOLDERS\ACTIVE PROJECTS\0271_LDRP ON CALL RESTORATION SERVICES\0271_CAD\015\GENERAL NOTES\0271_001_GCN-0105-00002.DWG

GENERAL NOTES:

- CONTRACTORS PERFORMING WORK ON ANY WASTEWATER FACILITY OR APPURTENANCE MUST BE PROPERLY LICENSED AND HAVE A LICENSED PLUMBER OR DRAINLAYER ON SITE DURING THE WORK. (GENERAL CONTRACT CONDITIONS (G.C.C.) 317.1).
- THE CURRENT EDITION OF THE WASTEWATER MANAGEMENT DIVISION STANDARD DETAILS SHALL APPLY TO ALL WORK AND WILL BE THE EDITION CURRENT AS OF THE ADVERTISEMENT DATE. THE CONTRACTOR MUST BE IN POSSESSION OF THE STANDARD CURRENT AT THE PRE-CONSTRUCTION CONFERENCE AND A COPY MUST REMAIN ON THE JOB SITE AT ALL TIMES DURING CONSTRUCTION. WASTEWATERMANAGEMENT DIVISION STANDARD DETAILS CAN BE OBTAINED AT WWW.DENVERGOV.ORG(SPECIAL CONTRACT CONDITIONS (SC-1), CONTRACT FORM - 8 (APPLICABLE LAWS)
- THE CONTRACT SPECIFIED EDITION OF THE CITY AND COUNTY OF DENVER'S TRANSPORTATION STANDARDS AND DETAILS FOR THE ENGINEERING DIVISION SHALL BE FOLLOWED FOR ALL ROADWAY WORK IN THE PLAN SET AND WILL BE THE EDITION CURRENT AS OF THE ADVERTISEMENT DATE. THESE STANDARDS AND DETAILS CAN BE OBTAINED AT WWW.DENVERGOV.ORG (SC-1, CONTRACT FORM - 8 (APPLICABLE LAWS))
- THE CONSTRUCTION ACTIVITIES STORMWATER DISCHARGE PERMITS (STATE AND LOCAL FLOODPLAIN PERMITS), STREET-CUT PERMIT, AND STREET OCCUPANCY PERMIT (INCLUDING THE ASSOCIATED TRAFFIC CONTROL PLANS) MAY BE REQUIRED AND IT IS THE CONTRACTOR'S RESPONSIBILITY TO OBTAIN ALL OF THESE PERMITS. APPROVED COPIES OF ALL REQUIRED PERMITS MUST BE SUBMITTED TO THE CITY CONSTRUCTION PROJECT MANAGER PRIOR TO THE START OF CONSTRUCTION. (G.C.C. 301.2, 317.1 & 317.2& 317.5; CONTRACT FORM - 8 (APPLICABLE LAWS))
- A PARKS PERMIT WILL BE REQUIRED FOR ANY WORK OR OCCUPANCY OF PARK LAND, THIS INCLUDES BUT IS NOT LIMITED TO: DESIGNATED CITY PARKS, PARKWAYS, OPEN SPACE, TRAILS AND BIKE PATHS. (G.C.C. 301.2, 317.1 & 317.2& 317.5; CONTRACT FORM - 8 (APPLICABLE LAWS)
- ALL DESIGN DRAWINGS PROVIDED AS PART OF THIS CONTRACT ARE FORMATTED FOR PRINTING FULL SIZE, ON STANDARD 22 X 34 INCH (ANSI D) PAPER SIZE AND TO HALF-SIZE (AND SCALE WHERE APPROPRIATE) ON STANDARD 11 X 17 PAPER SIZE. IT IS THE CONTRACTOR'S RESPONSIBILITY TO ENSURE THAT HARD COPIES OF PLANS UTILIZED FOR BIDDING OR CONSTRUCTION ARE PRINTED ON THE PROPER MEDIA SIZE AND THAT SCALES PROVIDED WITHIN THE DRAWINGS ARE CORRECTLY INTERPRETED.
- "RED-LINED" DRAWINGS AND PRINTS ARE TO BE MAINTAINED BY THE CONTRACTOR AND SUBMITTED TO THE CITY CONSTRUCTION PROJECT MANAGER AT THE COMPLETION OF THE PROJECT. ANY AND ALL FIELD CHANGES MADE DURING CONSTRUCTION MUST BE NOTED. THE DRAWINGS WILL STATE "RED LINES" IN LARGE BLOCK LETTERS. THE RED-LINED DRAWINGS MUST BE RECEIVED AND ACCEPTED BY THE CITY CONSTRUCTION PROJECT MANAGER PRIOR TO FINAL ACCEPTANCE AND SETTLEMENT.
- THE CONTRACTOR SHALL NOTIFY THE CITY CONSTRUCTION PROJECT MANAGER IMMEDIATELY OF "ANY" DISCREPANCIES OR VARIATIONS IN DRAWINGS & SPECIFICATIONS THAT EFFECT PRICING OR THAT COULD REQUIRE MODIFICATION TO THE DESIGN. (G.C.C.1103)
- THE CITY AND COUNTY OF DENVER ASSUMES NO RESPONSIBILITY FOR UTILITY LOCATIONS. THE UTILITIES SHOWN ON THESE DRAWINGS HAVE BEEN PLOTTED FROM THE BEST AVAILABLE INFORMATION. ALL UTILITIES MUST BE LOCATED BY THE CONTRACTOR. ALL COSTS ASSOCIATED WITH FIELD VERIFICATION OF LOCATION AND DEPTHS OF UTILITIES AND SHALL BE BORNE BY THE CONTRACTOR AND SHALL BE COMPLETED PRIOR TO THE COMMENCEMENT OF ANY CONSTRUCTION.(G.C.C. 701, 804)
- ALL RANGE POINTS OR OTHER SURVEY MONUMENTS WHICH MAY BE DAMAGED OR DESTROYED DURING CONSTRUCTION SHALL BE TIED OUT AND RESET BY THE PER CITY SURVEYING STANDARDS. (G.C.C. 318, 319)
- ALL ELEVATIONS SHOWN ARE NAVD88 DATUM, UNLESS OTHERWISE NOTED.
- INLETS AND MANHOLES ARE NOT SHOWN TO SCALE ON THE PLAN AND PROFILE SHEETS.
- INVERT ELEVATIONS AND CALCULATED PIPE SLOPES ON STORM AND SANITARY PROFILES ARE TO THE CENTER OF MANHOLE OR STRUCTURE. PIPE LENGTHS ARE TWO DIMENSIONAL LENGTHS AND ARE CENTER TO CENTER BETWEEN MANHOLES AND TO THE INSIDE EDGE OF INLETS.
- NORTHING AND EASTING CALLOUTS ON TYPE 16 AND TYPE 14 INLETS ARE TO THE CENTER OF THE STRUCTURE AT THE FLOWLINE. NORTHING AND EASTING CALLOUTS ON MANHOLES ARE TO THE CENTER OF THE MANHOLE.
- LOCATION OF INLETS AND/OR INLET CONNECTORS MAY BE ADJUSTED IN THE FIELD AT THE DIRECTION OF THE CITY CONSTRUCTION PROJECT MANAGER IN CONJUNCTION WITH DESIGN INTENTION. ALL INLET CONNECTIONS SHOWN IN PLAN AND PROFILE ARE APPROXIMATE LOCATIONS AND DEPTHS.
- DEPTHS OR BOTTOM OF STRUCTURE ELEVATIONS WILL NOT BE PROVIDED FOR INLETS WITHIN THE PROJECT SCOPE, AS THESE ARE REQUIRED TO BE DETERMINED BASED ON FIELD CONDITIONS IN ACCORDANCE WITH APPLICABLE STANDARD DETAIL DRAWINGS. IT SHALL BE THE RESPONSIBILITY OF THE GENERAL CONTRACTOR TO ESTABLISH INLET DEPTHS AND COMPLETE CONSTRUCTION IN CONFORMANCE WITH APPLICABLE STANDARD DETAIL DRAWINGS BASED ON CLEARANCES OF ADJACENT UTILITIES WHILE MAINTAINING MINIMUM REQUIRED GRADES ON LATERAL CONNECTIONS.
- ALL SEWER MANHOLES MUST BE MAINTAINED AND ACCESSIBLE DURING CONSTRUCTION.
- ALL SANITARY MANHOLES ARE 4' DIAMETER WITH "A" BASE AND CONCENTRIC CONE UNLESS NOTED OTHERWISE.
- ALL MANHOLES BUILT WITHIN THIS PROJECT SHALL INCLUDE EITHER A 4" OR 8" CAST IRON RISER WITH 3" STEEL ADJUSTING RINGS.

DENVER WATER

- IT SHALL BE THE CONTRACTOR'S RESPONSIBILITY TO TAKE WHATEVER STEPS NECESSARY TO PROTECT ALL WATER FACILITIES. IF ANY WATER FACILITIES CANNOT BE ADEQUATELY PROTECTED, THEN SAID WATER FACILITIES SHALL BE RELOCATED OR REMOVED IN ACCORDANCE WITH THE DENVER WATER DEPARTMENT REQUIREMENTS, BY A DENVER WATER PREQUALIFIED CONTRACTOR.
- CONSTRUCTION ACTIVITIES BY ANY PARTY THAT DISTURB, RELOCATE, SEVER, OR IN ANY OTHER WAY IMPACT A SERVICE LINE SHALL BE REQUIRED TO MEET CURRENT DENVER WATER REQUIREMENTS FOR SERVICE LINES AS SPECIFIED IN CHAPTER 3 OF THE LATEST DENVER WATER STANDARDS. IN THE EVENT LEAD WATER LINES ARE ENCOUNTERED, DO NOT DISTURB, IMMEDIATELY STOP WORK, AND NOTIFY THE CITY CONSTRUCTION PROJECT MANAGER.

TREE PROTECTION

- IF EXISTING TREES ARE TO BE REMOVED THEY MUST FIRST BE EVALUATED BY THE CITY AND COUNTY OF DENVER FORESTRY (PARKS) DEPARTMENT AND A PERMIT MUST BE OBTAINED. EXISTING TREES TO REMAIN MUST HAVE FORESTRY APPROVED TREE PROTECTION SET UP AROUND THEM DURING THE CONSTRUCTION AS SHOWN IN THE "INDIVIDUAL TREE PROTECTION DETAIL" IN THE DENVER PARKS DEPARTMENT STANDARD PLANS.THE CONTRACTOR MUST FOLLOW ALL OF THE CITY AND COUNTY OF DENVER TREE RETENTION AND PROTECTION GUIDELINES. REFER TO DENVER PARKS DEPARTMENT SPECIFICATION 01 56 39.

METRO WASTEWATER RECLAMATION DISTRICT

- METRO WASTEWATER RECLAMATION DISTRICT MUST BE NOTIFIED AT LEAST 48 HOURS PRIOR TO CONSTRUCTION ON METRO FACILITIES IN ORDER FOR A DISTRICT INSPECTOR TO BE PRESENT DURING CONSTRUCTION. CONTRACTOR MUST CONTACT METRO WASTEWATER RECLAMATION DISTRICT TO SCHEDULE THE INSPECTION 303-286-6000.

PROJECT SPECIFIC NOTES:

- A CERTIFIED ASBESTOS BUILDING INSPECTOR (CABI) WILL BE REQUIRED ONSITE DURING CONSTRUCTION ACTIVITIES.
- ALL CONTRACTORS WILL BE REQUIRED TO FOLLOW THE CDPHE SECTION 5.5 SOLID WASTE REGULATIONS - MANAGEMENT OF REGULATED ASBESTOS CONTAMINATED SOIL. THEREFORE, ANY PERSON WHO DISTURBS OR EXPOSES DEBRIS DURING A SOIL DISTURBING ACTIVITY SHALL CHARACTERIZE DEBRIS AND FOLLOW ANY NEEDED MITIGATION ACTIONS PER THIS REGULATION.
- CONTRACTOR SHALL NOT STAGE EQUIPMENT OR MATERIALS ON THE BASKETBALL COURT.

ENVIRONMENTAL NOTES:

- CONTRACTOR SHALL TAKE REASONABLE MEASURES TO PREVENT PARTICULATE MATTER FROM BECOMING AIRBORNE AND TO PREVENT THE VISIBLE DISCHARGE OF FUGITIVE PARTICULATE EMISSIONS BEYOND THE PROPERTY ON WHICH THE EMISSIONS ORIGINATE. THE MEASURES TAKEN MUST BE EFFECTIVE IN THE CONTROL OF FUGITIVE PARTICULATE EMISSIONS AT ALL TIMES ON THE SITE, INCLUDING PERIODS OF INACTIVITY SUCH AS EVENINGS, WEEKENDS, AND HOLIDAYS AS WELL AS ANY OTHER PERIOD OF INACTIVITY.
- DURING ANY SOIL DISTURBING ACTIVITIES, IF UNKNOWN/UNIDENTIFIED UNDERGROUND STORAGE TANKS, DRUMS, ODOROUS SOIL, STAINED SOIL, ASBESTOS-CEMENT PIPE (TRANSITE), BUILDING DEBRIS OR WASTE MATERIALS ARE ENCOUNTERED DURING THE PROJECT, CONTRACTOR SHALL IMMEDIATELY STOP WORK IN THE AREA OF THE DISCOVERY UNTIL DENVER ENVIRONMENTAL HEALTH (DEH) MAKES A DETERMINATION OF HOW TO PROCEED. CONTRACTOR SHALL IMMEDIATELY NOTIFY DEH OF THE DISCOVERY VIA THE PHONE NUMBER 720-460-1706.
- ANY FILL MATERIAL OR SOILS TO BE MOVED TO AND PLACED ON CCD-OWNED PROPERTY OR PLACED ON REAL PROPERTY TO BE TRANSFERRED TO THE CCD MUST BE FREE OF KNOWN CONTAMINATION (OBSERVED AND DOCUMENTED OR PREVIOUSLY DOCUMENTED) AND BE ACCEPTABLE FOR UNRESTRICTED RESIDENTIAL USE. CONTACT DAVE ERICKSON, DENVER ENVIRONMENTAL HEALTH (720-865-5433) FOR CLARIFICATION, IF NEEDED, REGARDING THIS CCD REQUIREMENT.
- THE CONTRACTOR SHALL DIRECT NON-RECYCLABLE, NON-HAZARDOUS WASTES FROM CCD-OWNED OR CONTROLLED PROPERTY OR FACILITIES TO THE DENVER ARAPAHOE DISPOSAL SITE (DADS) LANDFILL FOR DISPOSAL, FOLLOWING THE REQUIREMENT AND PROCEDURAL GUIDANCE OUTLINED IN CC EXECUTIVE ORDER 115.
- NOISE CONTROL. EXEMPTED HOURS FOR CONSTRUCTION IN THE CITY AND COUNTY OF DENVER ARE FROM 7 A.M. TO 9 P.M. MONDAY THROUGH FRIDAY AND 8 A.M. TO 5 P.M. ON SATURDAYS AND SUNDAYS PER SECTIONS 36-6.(B)(7) AND 36-7.(5)A, B. AND C. OF DENVER'S NOISE ORDINANCE, CHAPTER 36 "NOISE CONTROL," DENVER REVISED MUNICIPAL CODE. IF THERE IS A NEED TO WORK OUTSIDE OF THE EXEMPTED HOURS: 1) THE CONTRACTOR MUST REQUEST A NIGHTTIME NOISE VARIANCE, AND 2) THE VARIANCE PROCESS NEEDS TO BE STARTED A MINIMUM OF THREE MONTHS PRIOR TO THE DESIRED START DATE OF ANY WORK TO BE PERFORMED OUTSIDE OF EXEMPTED HOURS. ANY QUESTIONS SHOULD BE DIRECTED TO PAUL RIEDESEL, DEH COMMUNITY NOISE PROGRAM, (PHONE 720-865-5410)
- REGULATED ASBESTOS CONTAMINATED SOILS (RACS) MAY BE ENCOUNTERED IN BUILDING DEBRIS THROUGHOUT THE CITY DURING EXCAVATION. ALL RACS MUST BE MANAGED, DOCUMENTED, AND DISPOSED IN ACCORDANCE WITH STATE (CDPHE) REGULATIONS PERTAINING TO SOLID WASTE SITES AND FACILITIES, SECTION 5 - ASBESTOS WASTE MANAGEMENT. STATE REGULATIONS REQUIRE ANY DISTURBED DEBRIS BE CHARACTERIZED TO DETERMINE APPLICABILITY OF THE REGULATION. THE CONTRACTOR IS RESPONSIBLE FOR ENSURING COMPETENT TRAINED PERSONNEL CAPABLE OF IDENTIFYING RACS IN DEBRIS, AND FOR PROVIDING, OR HAVING ACCESS TO, AN ONSITE CERTIFIED ASBESTOS BUILDING INSPECTOR (CABI) IN CASE OF RACS DISCOVERY.

GRADING NOTES:

- CONTRACTOR SHALL PROTECT THE EXISTING SANITARY SEWER.
- CONTRACTOR SHALL CLEAN AND VIDEO INSPECT THE SANITARY SEWER PRIOR TO SEEDING/SODDING/PLANTING.
- CONTRACTOR SHALL PERFORM A TOPOGRAPHIC SURVEY BEFORE AND AFTER GRADING OPERATIONS TO DETERMINE GRADING VOLUME QUANTITIES.
- CONTRACTOR TO MEET WITH CONSTRUCTION PROJECT MANAGER AND DESIGN TEAM AFTER GRADING IS COMPLETE BUT PRIOR TO TOPSOIL PLACEMENT. THIS IS TO ENSURE PROPER SHAPING HAS OCCURRED.

GENERAL PERMIT FOR STORMWATER DISCHARGES ASSOCIATED WITH CONSTRUCTION ACTIVITY

- CONTRACTOR IS RESPONSIBLE FOR DEVELOPING A SITE STORMWATER MANAGEMENT PLAN (SWMP) FOR THE PROPOSED CONSTRUCTION. CONTRACTOR MUST COORDINATE WITH THE CITY AND COUNTY OF DENVER TO RECEIVE FINAL APPROVAL OF THE SWMP AND ASSOCIATED EROSION CONTROL PERMIT AND SEWER USE AND DRAINAGE PERMIT (SUDP).
- WHEN A PROJECT IS SUBJECT TO A STATE OF COLORADO OR FEDERAL STORMWATER DISCHARGE PERMIT, IT IS CONTRACTOR'S RESPONSIBILITY TO OBTAIN AND COMPLY WITH ALL THE CONDITIONS STATED IN SAID PERMIT(S). IF CONTRACTOR ANTICIPATES, OR IF CONSTRUCTION ACTIVITIES RESULT IN ANY CHANGE OR NONCOMPLIANCE WITH CONDITIONS STATED IN THE PERMIT(S), THEN CONTRACTOR SHALL DETAIL THE ANTICIPATED CHANGES OR NONCOMPLIANCE IN A WRITTEN REPORT TO OWNER. THE SUBMISSION OF THE REPORT WILL BE WITHIN FIVE (5) DAYS FROM THE TIME CONTRACTOR BECOMES AWARE OF CHANGE OR NONCOMPLIANCE. WITHIN TEN (10) DAYS AFTER RECEIPT OF THE REPORT, OWNER SHALL APPROVE OR DISAPPROVE THE REQUEST FOR CHANGE, OR DETAIL THE COURSE OF ACTION AFTER NONCOMPLIANCE.
- CONTRACTOR WILL BE HELD RESPONSIBLE AND LIABLE FOR ANY LEGAL ACTION TAKEN AGAINST CONTRACTOR OR OWNER DUE TO CONTRACTOR'S NONCOMPLIANCE WITH ANY OF THE CONDITIONS STATED IN THE STORMWATER DISCHARGE PERMIT(S). SUCH RESPONSIBILITY SHALL INCLUDE THE DEFENSE, INDEMNIFICATION AND HOLDING THE OWNER AND ALL OF ITS PROJECT PARTNERS HARMLESS IN REGARD TO SUCH NONCOMPLIANCE. CONTRACTOR SHALL BE SOLELY AND COMPLETELY LIABLE FOR ALL FINES, FEES AND ALL OTHER CHARGES THAT ARE ASSESSED AGAINST CONTRACTOR OR OWNER AND OWNER'S PROJECT PARTNERS AS A RESULT OF CONTRACTOR'S NONCOMPLIANCE WITH THE TERMS AND CONDITIONS OF THE STORMWATER DISCHARGE PERMIT(S).
- IF A MONETARY FINE IS ASSESSED AGAINST OWNER DUE TO CONTRACTOR'S NONCOMPLIANCE WITH ANY OF THE CONDITIONS STATED IN THE STORMWATER DISCHARGE PERMIT(S), THE FINE WILL BE SUBTRACTED FROM ANY MONEY DUE TO CONTRACTOR AS SET FORTH IN THE GENERAL CONDITIONS. IF SUCH FINE IS IN EXCESS OF ALL THE MONEY DUE TO CONTRACTOR, THEN CONTRACTOR SHALL BE LIABLE AND AGREES TO PAY TO OWNER THE AMOUNT OF SUCH EXCESS.

ABBREVIATIONS

- APPROX - APPROXIMATELY
- BEWF - BOTTOM OF ENGINEERED WOOD FIBER
- CL - CENTER LINE
- CCD - CITY AND COUNTY OF DENVER
- CFS - CUBIC FEET PER SECOND
- C & G - CURB AND GUTTER
- C G & SW - CURB, GUTTER, & SIDEWALK
- CH - CURB HEAD
- CIP- CORRUGATED IRON PIPE (WATER)
- CONC - CONCRETE
- CPM - CAPITAL PROJECTS MANAGEMENT
- DIA - DIAMETER
- DIP - DUCTILE IRON PIPE (WATER)
- DT-DECIDUOUS TREE
- DWD - DENVER WATER DEPARTMENT
- E - EAST
- EF - EACH FACE
- E.G.L. - ENERGY GRADE LINE
- EL - ELEVATION
- ELEV - ELEVATION
- EOA - EDGE OF ASPHALT
- ES - EACH SIDE
- EX- EXISTING
- EXST - EXISTING
- EW - EACH WAY
- EWf - ENGINEERED WOOD FIBER
- FG - FINAL/FINISH GRADE
- FL - FLOW LINE
- FO - FIBER OPTIC LINE
- G - GAS
- GB - GRADE BREAK
- H.G.L. - HYDRAULIC GRADE LINE
- HORIZ - HORIZONTAL
- HP - HIGH POINT
- I - INLET
- INV. - INVERT
- LF- LINEAR FEET
- LP - LOW POINT
- MAX - MAXIMUM
- MFR - MANUFACTURER
- MH - MANHOLE
- MIN - MINIMUM
- MJ- MECHANICAL JOINT
- MLG - MATCH LINE AND GRADE
- N - NORTH
- NTS - NOT TO SCALE
- OHE - OVERHEAD ELECTRIC LINE
- PL - PROPERTY LINE
- PR - PROPOSED
- PVC - POLY VINYL CHLORIDE
- q - DESIGN FLOW
- Qfull - FULL FLOW CAPACITY
- R - RADIUS
- RCBC - REINFORCED CONCRETE BOX CULVERT
- RCP - REINFORCED CONCRETE PIPE
- RE - REFER TO
- R.L. - RANGE LINE
- S - SOUTH
- STM - STORM SEWER
- SS - SANITARY SEWER
- SW - SIDEWALK
- TB - TOP OF BOULDER
- TC - TOP OF CURB
- TELE- TELEPHONE LINE
- TEWF - TOP OF ENGINEERED WOOD FIBER
- TL - TOP OF LOG
- TOC - TOP OF CONCRETE
- T.O.P. - TOP OF PIPE
- TP - TOP OF PAVEMENT
- TW - TOP OF WALL
- TYP. - TYPICAL
- UE - UNDERGROUND ELECTRIC LINE
- W - WEST
- WAT - WATER
- WMD - WASTEWATER MANAGEMENT DIVISION

SURVEY FEATURES LEGEND

- BENCHMARK
- CHISELED 'X'
- TRAVERSE POINT
- RANGE POINT
- LAND CORNER
- PIN & CAP
- REBAR
- EASEMENT LINE
- SECTION LINE
- PROPERTY LINE (NOT R.O.W.)
- RANGELINE
- R.O.W. LINE

EXISTING FEATURES LEGEND

- EXISTING STREET LIGHT
- EXISTING UTILITY/POWER POLE
- EXISTING GUY WIRE
- EXISTING TRAFFIC POLE
- EXISTING TRAFFIC CONTROL BOX
- EXISTING TRAFFIC CONTROL SWITCH BOX
- EXISTING ELECTRIC METER
- EXISTING ELECTRIC BOX
- EXISTING FIRE HYDRANT
- EXISTING WATER VALVE
- EXISTING WATER MH
- EXISTING WATER METER
- EXISTING GAS MANHOLE
- EXISTING WATER LINE
- EXISTING GAS LINE
- EXISTING STORM LINE W/MANHOLE
- EXISTING SANITARY LINE W/MANHOLE
- EXISTING UNDERGROUND TELEPHONE LINE
- EXISTING OVERHEAD TELEPHONE LINE
- EXISTING TRAFFIC CONTROL LINE
- EXISTING UNDERGROUND ELECTRIC
- EXISTING OVERHEAD ELECTRIC
- EXISTING FENCE WOOD
- EXISTING FENCE METAL
- EXISTING FENCE BARBED WIRE
- EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- EXISTING STORM INLETS
- EXISTING STREET SIGN
- EXISTING POST
- EXISTING TRASH RECEPTACLE
- EXISTING TRASH DUMPSTER
- EXISTING BUS BENCH
- EXISTING MAIL BOX
- EXISTING NEWSPAPER BOX
- EXISTING TELEPHONE MH
- EXISTING TELEPHONE BOX
- EXISTING TELEPHONE BOOTH
- EXISTING IRRIGATION BOX
- EXISTING TREE
- EXISTING SHRUB

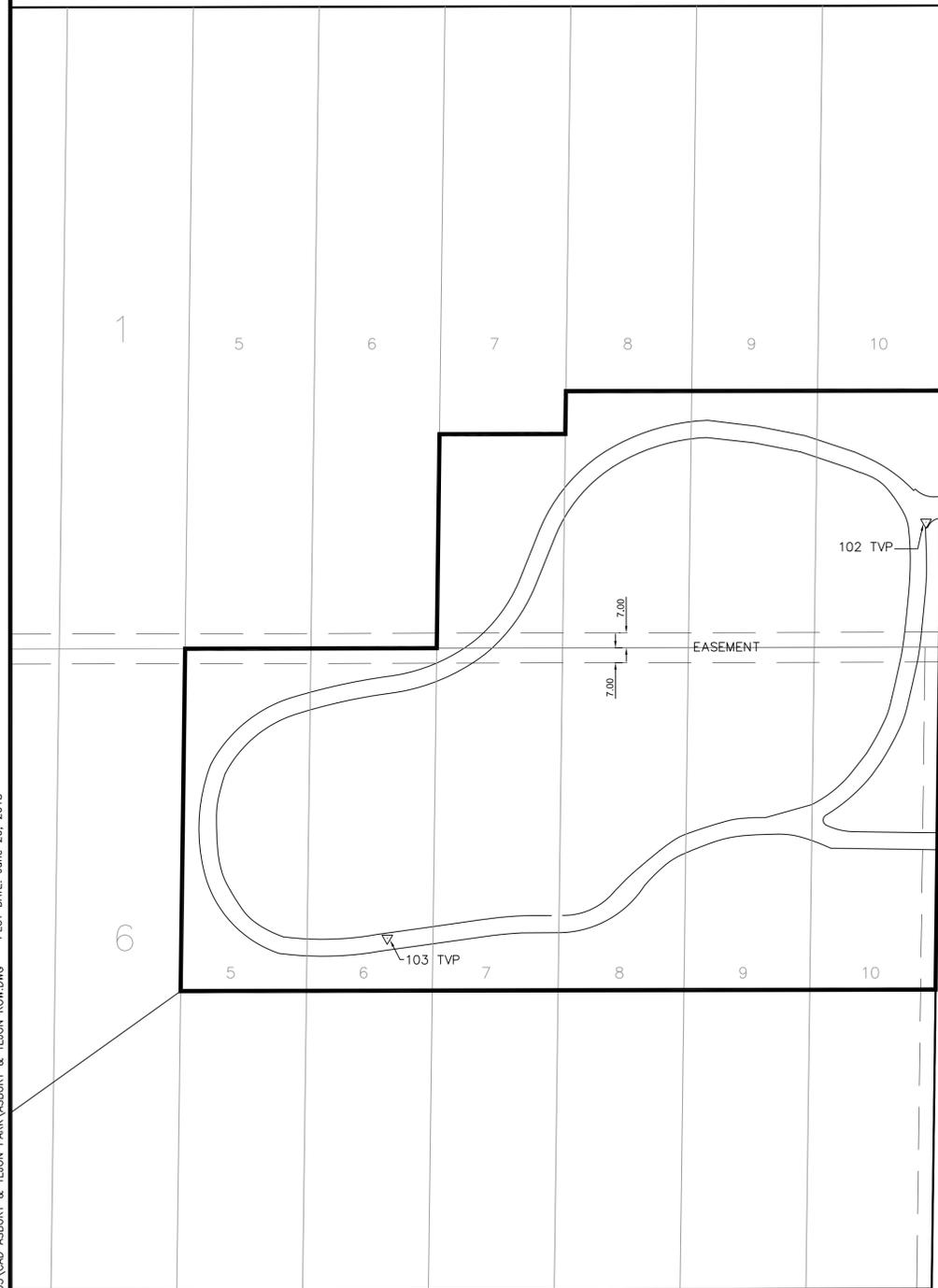
PROPOSED FEATURES LEGEND

- PROPOSED STORM INLET
- PROPOSED STORM SEWER W/MANHOLE
- PROPOSED SANITARY SEWER W/MANHOLE
- PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR
- PROPOSED CURB & GUTTER
- PROPOSED FH
- PROPOSED WATER
- PROPOSED WATER VALVE
- PROPOSED WATER REDUCER
- PROPOSED WATER BENDS AND/OR TEES
- PROPOSED GRASS AND/OR MULCH- REPLACE EXISTING LANDSCAPING MATERIAL
- PROPOSED CONCRETE UNLESS SPECIFIED OTHERWISE
- PROPOSED CURB RAMP
- PROPOSED DRAINAGE FLOW ARROW
- BORE/TEST HOLE LOCATION

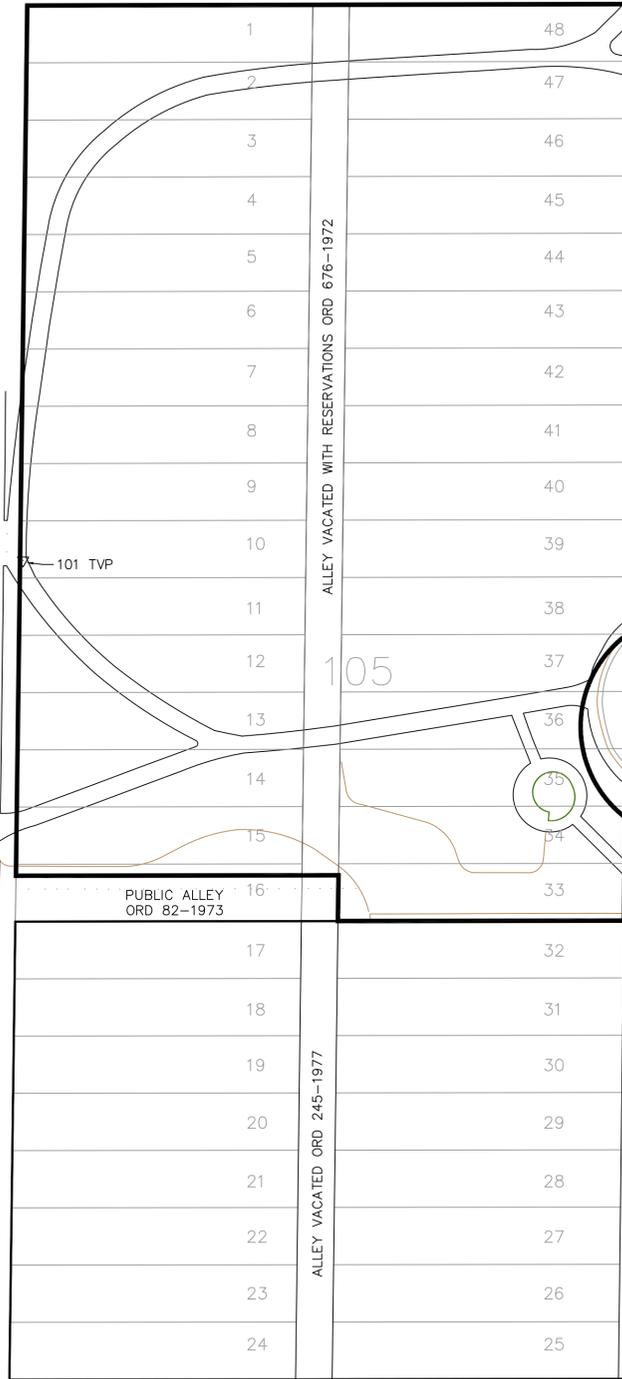
[NOTE: REFER TO INDIVIDUAL PLAN SHEETS FOR ADDITIONAL LEGENDS.]

NO.	DESCRIPTION OF REVISIONS	DATE	BY
CALL UNCC TWO WORKING DAYS BEFORE YOU DIG 1-800-922-1987 UTILITY SAFETY CENTER OF COLORADO			
			
CITY AND COUNTY OF DENVER DEPARTMENT OF PUBLIC WORKS AND DEPARTMENT OF PARKS AND RECREATION 201 WEST COLFAX AVE. DENVER, CO 80202 TEL.: (720) 913-1311			
ASBURY & TEJON PARK RETROFIT DESIGN PRO TRACKING NO: 2017-CIP-0000048 PROJECT MASTER NO: 2017-PROJMSTR-0000150 GENERAL NOTES AND ABBREVIATIONS			
DRAWN BY:		JC/CL	
DESIGNED BY:		CL	
APPROVED BY:		LG	
DRAWING NAME: GENERAL NOTES AND ABBREVIATIONS			
DATE: SEPTEMBER 2018			
SHEET NO.: G100			

SURVEY CONTROL DIAGRAM



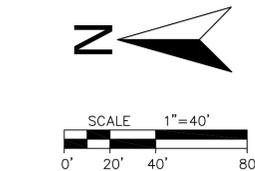
W. ASBURY AVE.



W. PACIFIC PL.

STREET VACATED WITH RESERVATIONS ORD 676-1972

S. VALLEJO ST.



Point Table				
Point #	Northing	Easting	Elevation	Raw Description
100	372347.79	568012.62	5346.20	TVP 100 SET CUT X
101	372753.13	567920.98	5344.62	TVP 101 SET CUT X
102	372821.77	567921.50	5343.55	TVP 102 SET CUT X
103	373074.10	567727.12	5351.77	TVP 103 SET CUT X
104	372301.47	568173.96	5336.96	TVP 104 SET CUT X
105	372301.95	567950.57	5340.60	TVP 105 SET CUT X
106	372294.73	567627.17	5345.38	TVP 106 SET CUT X
107	372409.56	567807.35	5346.46	TVP107 SS CUT X

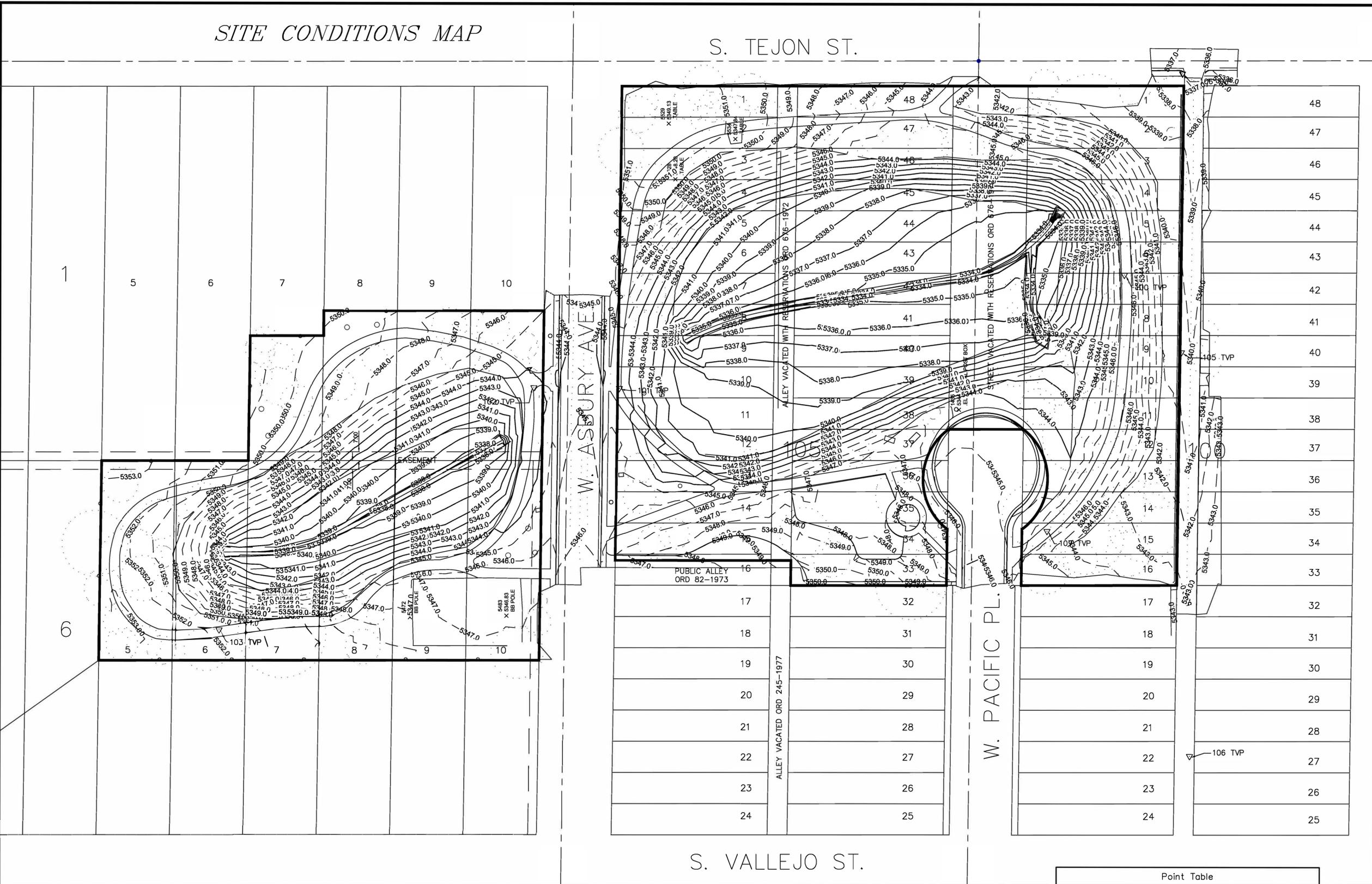


K:\PIQUES\SHARED\SURVEY\PROJECT FILES\2016-0005\CAD ASBURY & TEJON PARK\ASBURY & TEJON ROW.DWG PLOT DATE: June 20, 2018

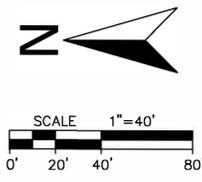
NO.	DESCRIPTION OF REVISIONS	DATE	BY
			
CALL UNCC TWO WORKING DAYS BEFORE YOU DIG 1-800-922-1987 UTILITY NOTIFICATION CENTER OF COLORADO			
CITY AND COUNTY OF DENVER DEPARTMENT OF PUBLIC WORKS AND DEPARTMENT OF PARKS AND RECREATION 201 WEST COLEFAX AVE. DENVER, CO 80202 TEL.: (720) 913-1311			
ASBURY & TEJON PARK RETROFIT DESIGN PRO TRACKING NO: 2017-CIP-0000048 PROJECT MASTER NO: 2017-PROJMSTR-0000150 SURVEY CONTROL DIAGRAM			
DRAWN BY:		WLR	
DESIGNED BY:		WLR	
APPROVED BY:		WLR	
DRAWING NAME:			
DATE:		02.09.2018	
SHEET NO.:		V100	

SITE CONDITIONS MAP

S. TEJON ST.



S. VALLEJO ST.



Point Table				
Point #	Northing	Easting	Elevation	Raw Description
100	372347.79	568012.62	5346.20	TVP 100 SET CUT X
101	372753.13	567920.98	5344.62	TVP 101 SET CUT X
102	372821.77	567921.50	5343.55	TVP 102 SET CUT X
103	373074.10	567727.12	5351.77	TVP 103 SET CUT X
104	372301.47	568173.96	5336.96	TVP 104 SET CUT X
105	372301.95	567950.57	5340.60	TVP 105 SET CUT X
106	372294.73	567627.17	5345.38	TVP 106 SET CUT X
107	372409.56	567807.35	5346.46	TVP107 SS CUT X

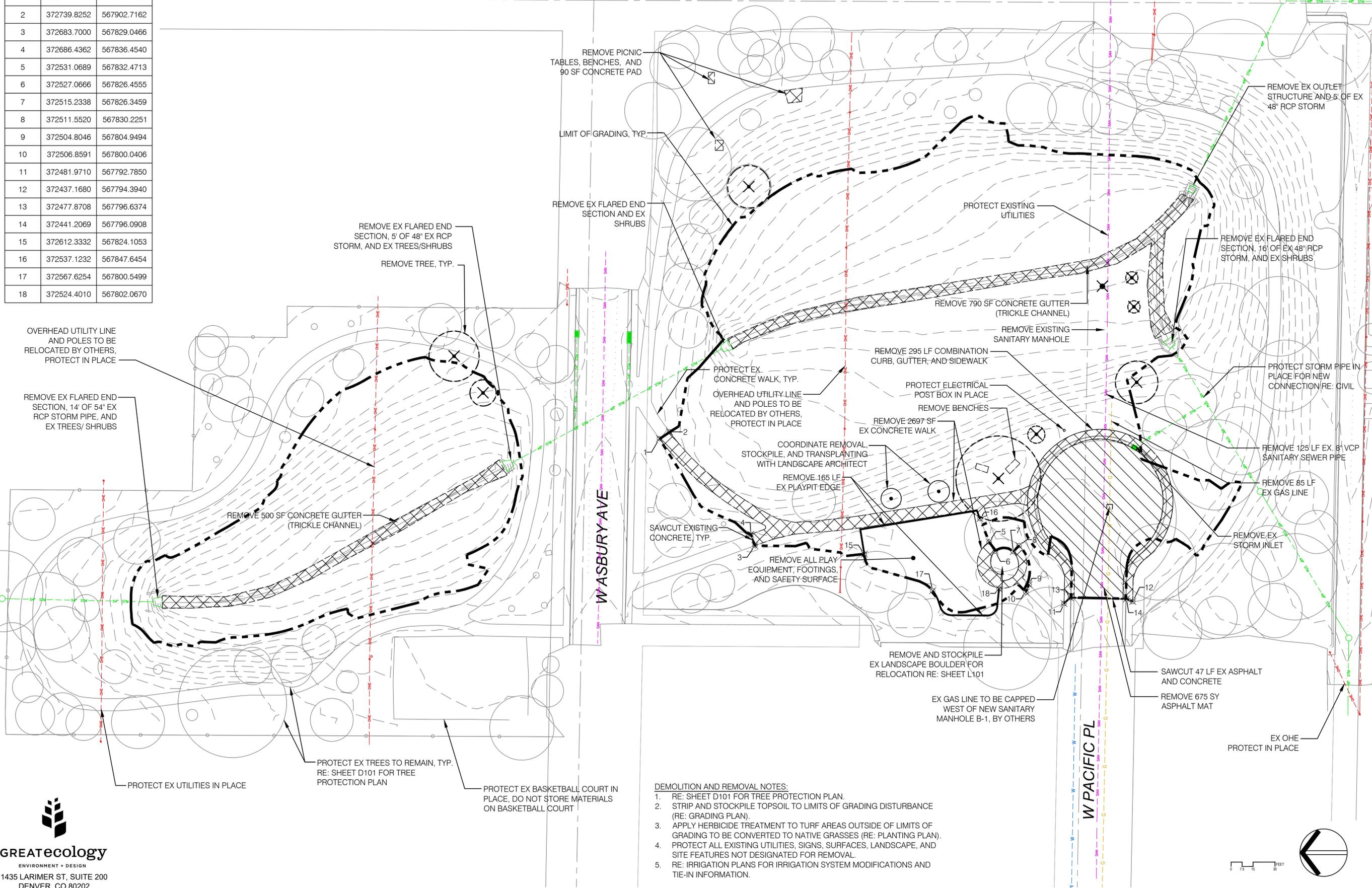
48
47
46
45
44
43
42
41
40
39
38
37
36
35
34
33
32
31
30
29
28
27
26
25

K:\PWDES\SHARED\SURVEY\PROJECT FILES\2016\0005\CAD ASBURY & TEJON PARK\ASBURY & TEJON ROW.DWG PLOT DATE: June 21, 2018

NO.	DESCRIPTION OF REVISIONS	DATE	BY
CALL UNCC TWO WORKING DAYS BEFORE YOU DIG 1-800-922-1987 UTILITY NOTIFICATION CENTER OF COLORADO			
CITY AND COUNTY OF DENVER DEPARTMENT OF PUBLIC WORKS AND DEPARTMENT OF PARKS AND RECREATION 201 WEST COLFAX AVE., DENVER, CO 80202 TEL.: (720) 913-1311			
ASBURY & TEJON PARK RETROFIT DESIGN PRO TRACKING NO.: 2017-CIP-0000048 PROJECT MASTER NO.: 2017-PROJMSTR-0000150 SITE CONDITIONS MAP			
DRAWN BY:		WLR	
DESIGNED BY:		WLR	
APPROVED BY:		WLR	
DRAWING NAME:			
DATE:		02.09.2018	
SHEET NO.:		V101	

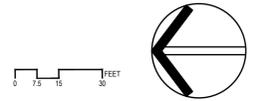
Point Table		
Point #	Northing	Easting
1	372746.4010	567898.1760
2	372739.8252	567902.7162
3	372683.7000	567829.0466
4	372686.4362	567836.4540
5	372531.0689	567832.4713
6	372527.0666	567826.4555
7	372515.2338	567826.3459
8	372511.5520	567830.2251
9	372504.8046	567804.9494
10	372506.8591	567800.0406
11	372481.9710	567792.7850
12	372437.1680	567794.3940
13	372477.8708	567796.6374
14	372441.2069	567796.0908
15	372612.3332	567824.1053
16	372537.1232	567847.6454
17	372567.6254	567800.5499
18	372524.4010	567802.0670

S TEJON ST



- DEMOLITION AND REMOVAL NOTES:**
1. RE: SHEET D101 FOR TREE PROTECTION PLAN.
 2. STRIP AND STOCKPILE TOPSOIL TO LIMITS OF GRADING DISTURBANCE (RE: GRADING PLAN).
 3. APPLY HERBICIDE TREATMENT TO TURF AREAS OUTSIDE OF LIMITS OF GRADING TO BE CONVERTED TO NATIVE GRASSES (RE: PLANTING PLAN).
 4. PROTECT ALL EXISTING UTILITIES, SIGNS, SURFACES, LANDSCAPE, AND SITE FEATURES NOT DESIGNATED FOR REMOVAL.
 5. RE: IRRIGATION PLANS FOR IRRIGATION SYSTEM MODIFICATIONS AND TIE-IN INFORMATION.

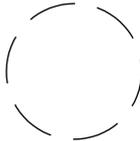
NO.	DESCRIPTION OF REVISIONS	DATE	BY
<p>CALL UNCC TWO WORKING DAYS BEFORE YOU DIG 1-800-922-1987 UTILITY SERVICES CENTER OF COLORADO</p>			
<p>CITY AND COUNTY OF DENVER DEPARTMENT OF PUBLIC WORKS AND DEPARTMENT OF PARKS AND RECREATION 201 WEST COLFAX AVE. DENVER, CO 80202 TEL.: (720) 913-1311</p>			
<p>ASBURY & TEJON PARK RETROFIT DESIGN</p> <p>PRO TRACKING NO: PWWW2017-004 PROJECT MASTER NO: 2017-PROJMSTR-0000150 DEMOLITION AND REMOVALS PLAN</p>			
<p>DRAWN BY: CL DESIGNED BY: CL APPROVED BY: LG</p>			
<p>DRAWING NAME: DEMOLITION AND REMOVALS PLAN DATE: SEPTEMBER 2018 SHEET NO.:</p>			
<p>D100</p>			



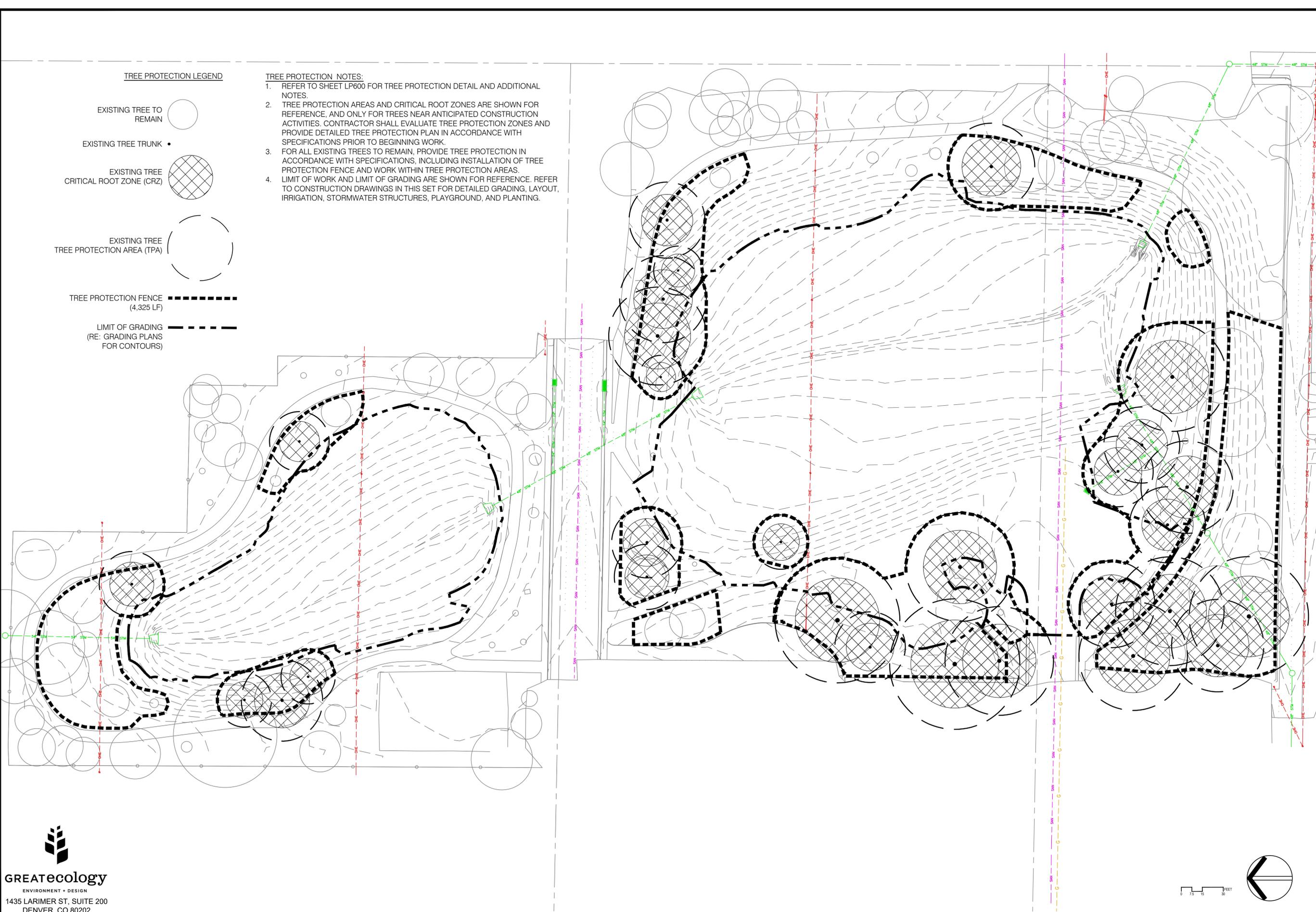
Z:\CLIENT FOLDERS\ACTIVE PROJECTS\0271_LDRP_ON_CALL RESTORATION SERVICES\0271_LDRP_ON_CALL RESTORATION SERVICES\ASBURY & TEJON PARK\02_CAD\PLANS\DEMOLITION\ASBURY & TEJON PARK\0271_001_DENVER.DWG

Z:\CLIENTS\FOLDERS\ACTIVE_PROJECTS\0271_LDPR_ON_CALL_RESTORATION_SERVICES\0271_LDPR_ON_CALL_RESTORATION_SERVICES\ASBURY & TEJON PARK\02_CAD\01\DESIGNS\ASBURY&TEJON\ASBURY&TEJON\0271_001_TREE_PROTECTION2.DWG

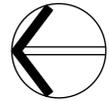
TREE PROTECTION LEGEND

- EXISTING TREE TO REMAIN 
- EXISTING TREE TRUNK 
- EXISTING TREE CRITICAL ROOT ZONE (CRZ) 
- EXISTING TREE TREE PROTECTION AREA (TPA) 
- TREE PROTECTION FENCE (4,325 LF) 
- LIMIT OF GRADING (RE: GRADING PLANS FOR CONTOURS) 

- TREE PROTECTION NOTES:**
- REFER TO SHEET LP600 FOR TREE PROTECTION DETAIL AND ADDITIONAL NOTES.
 - TREE PROTECTION AREAS AND CRITICAL ROOT ZONES ARE SHOWN FOR REFERENCE, AND ONLY FOR TREES NEAR ANTICIPATED CONSTRUCTION ACTIVITIES. CONTRACTOR SHALL EVALUATE TREE PROTECTION ZONES AND PROVIDE DETAILED TREE PROTECTION PLAN IN ACCORDANCE WITH SPECIFICATIONS PRIOR TO BEGINNING WORK.
 - FOR ALL EXISTING TREES TO REMAIN, PROVIDE TREE PROTECTION IN ACCORDANCE WITH SPECIFICATIONS, INCLUDING INSTALLATION OF TREE PROTECTION FENCE AND WORK WITHIN TREE PROTECTION AREAS.
 - LIMIT OF WORK AND LIMIT OF GRADING ARE SHOWN FOR REFERENCE. REFER TO CONSTRUCTION DRAWINGS IN THIS SET FOR DETAILED GRADING, LAYOUT, IRRIGATION, STORMWATER STRUCTURES, PLAYGROUND, AND PLANTING.



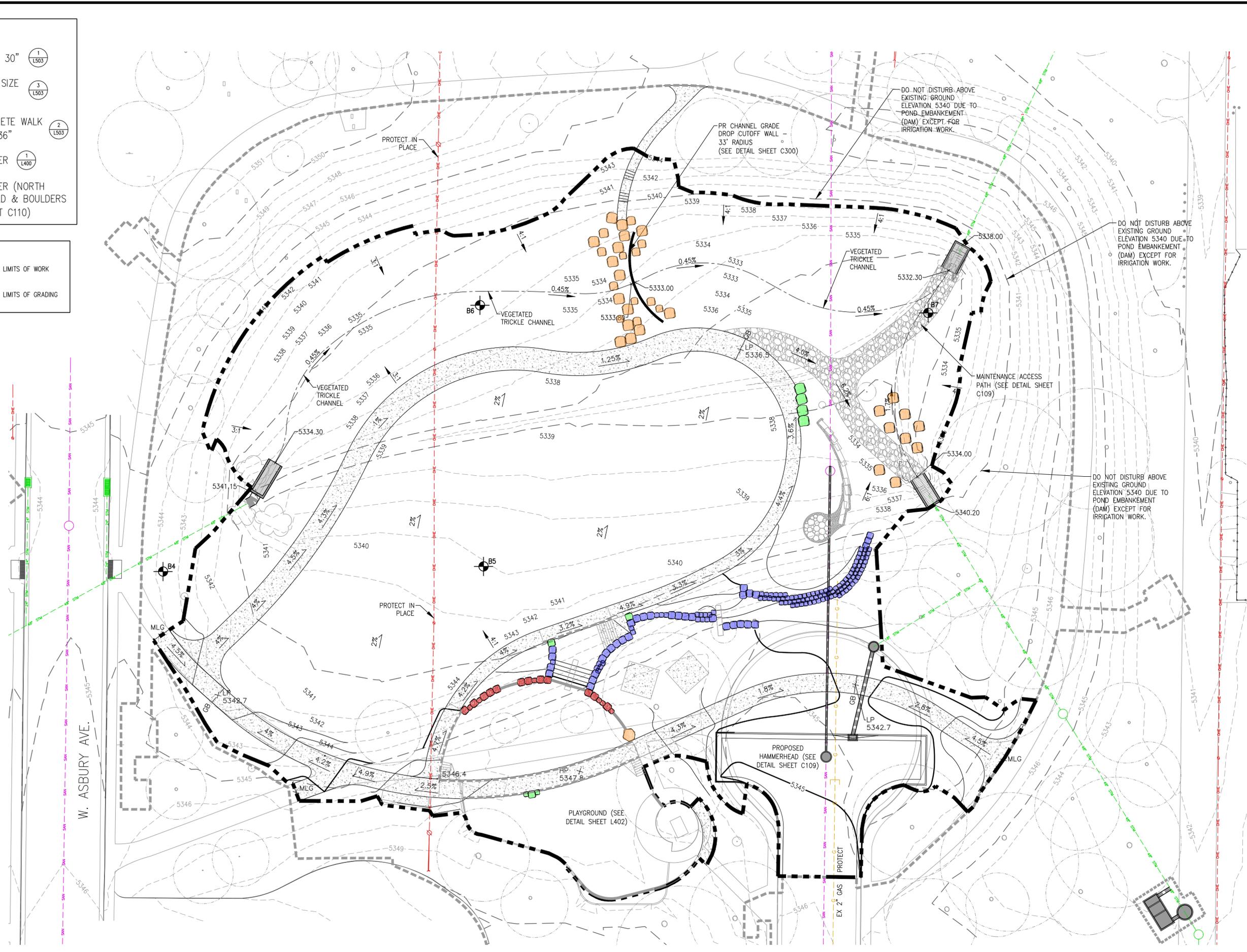
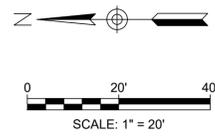

Greatecology
ENVIRONMENT + DESIGN
1435 LARIMER ST, SUITE 200
DENVER, CO 80202



NO.	DESCRIPTION OF REVISIONS	DATE	BY
<p>CALL UNCC TWO WORKING DAYS BEFORE YOU DIG 1-800-922-1987 UTILITY SERVICES CENTER OF COLORADO</p> 			
<p>CITY AND COUNTY OF DENVER DEPARTMENT OF PUBLIC WORKS AND DEPARTMENT OF PARKS AND RECREATION 201 WEST COLFAX AVE. DENVER, CO 80202 TEL.: (720) 913-1311</p>			
<p>ASBURY & TEJON PARK RETROFIT DESIGN</p> <p>PRO TRACKING NO: PWWW2017-004 PROJECT MASTER NO: 2017-PROJMSTR-0000150 TREE PROTECTION PLAN</p>			
DRAWN BY: CL			
DESIGNED BY: CL			
APPROVED BY: LG			
DRAWING NAME: TREE PROTECTION PLAN			
DATE: SEPTEMBER 2018			
SHEET NO.: D101			

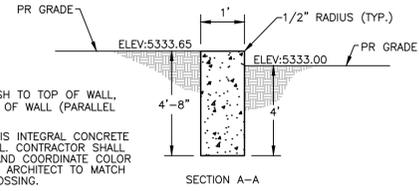
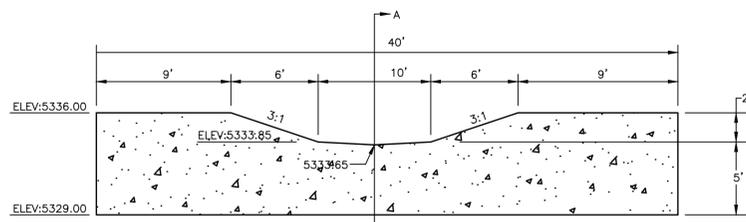
- BOULDER LEGEND**
-  STACKED BOULDER, 30" 1
L503
 -  BOULDER IN WALL, SIZE VARIES, 36"-42" 3
L503
 -  BOULDER IN CONCRETE WALK SIZE VARIES, 30"-36" 2
L503
 -  LANDSCAPE BOULDER 1
L400
 -  LANDSCAPE BOULDER (NORTH POND SEDIMENT PAD & BOULDERS -SEE DETAIL SHEET C110)

- LEGEND**
-  LIMITS OF WORK
 -  LIMITS OF GRADING



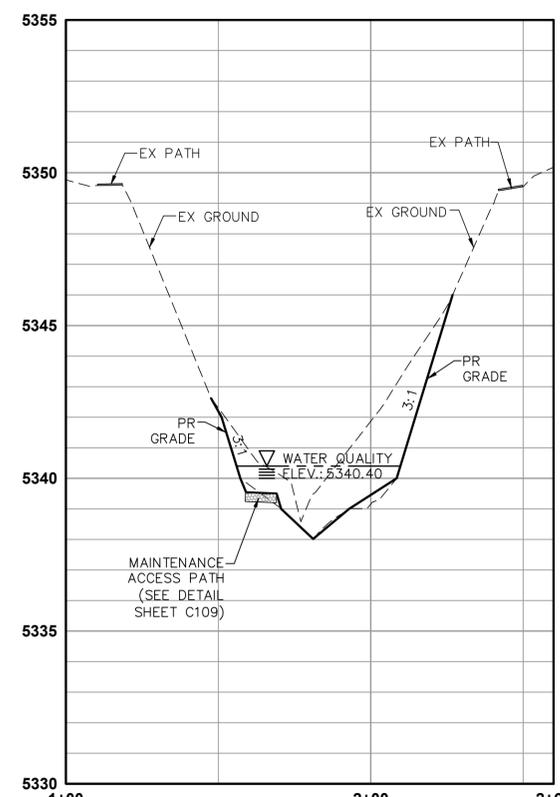
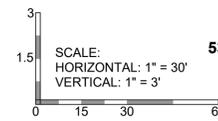
Enginuity
 ENGINUITY ENGINEERING SOLUTIONS
 10106 WEST SHAW AVENUE, SUITE 215
 LITTLETON, COLORADO 80127
 PH: 303-872-9112
 FX: 303-872-9104

NO.	DESCRIPTION OF REVISIONS
DATE	BY
<p>CALL UNCC TWO WORKING DAYS BEFORE YOU DIG 1-800-925-1987 UTILITY WORKFORCE CENTER OF COLORADO</p> 	
<p>CITY AND COUNTY OF DENVER DEPARTMENT OF PUBLIC WORKS AND DEPARTMENT OF PARKS AND RECREATION 201 WEST COLFAX AVE. DENVER, CO 80202 TEL.: (720) 913-1311</p>	
<p>ASBURY & TEJON PARK RETROFIT DESIGN</p> <p>PRO TRACKING NO.: PWWW2017-004 PROJECT MASTER NO.: 2017-PROJMSTR-0000150 SOUTH PARCEL GRADING PLAN</p>	
DRAWN BY:	JR
DESIGNED BY:	
APPROVED BY:	DJ
DRAWING NAME:	
DATE:	SEPTEMBER 2018
SHEET NO.:	GR101

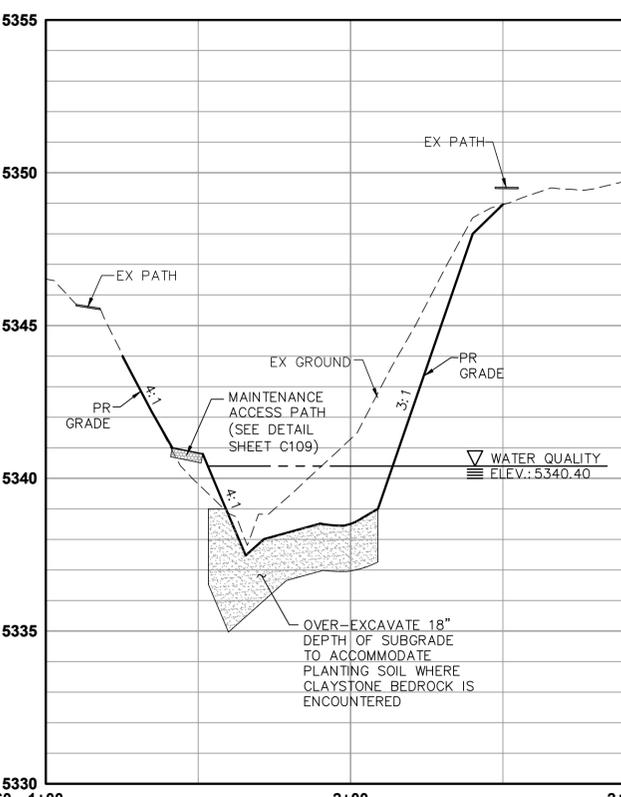


- NOTES:
1. APPLY MEDIUM BROOM FINISH TO TOP OF WALL, PERPENDICULAR TO LENGTH OF WALL (PARALLEL TO TOP WIDTH).
 2. WALL COLOR SHALL BE DAVIS INTEGRAL CONCRETE COLOR OR APPROVED EQUAL. CONTRACTOR SHALL PROVIDE COLOR SAMPLES AND COORDINATE COLOR SELECTION WITH LANDSCAPE ARCHITECT TO MATCH BOULDERS AT CHANNEL CROSSING.
 3. WALL HAS A RADIUS OF CURVATURE OF 33'.

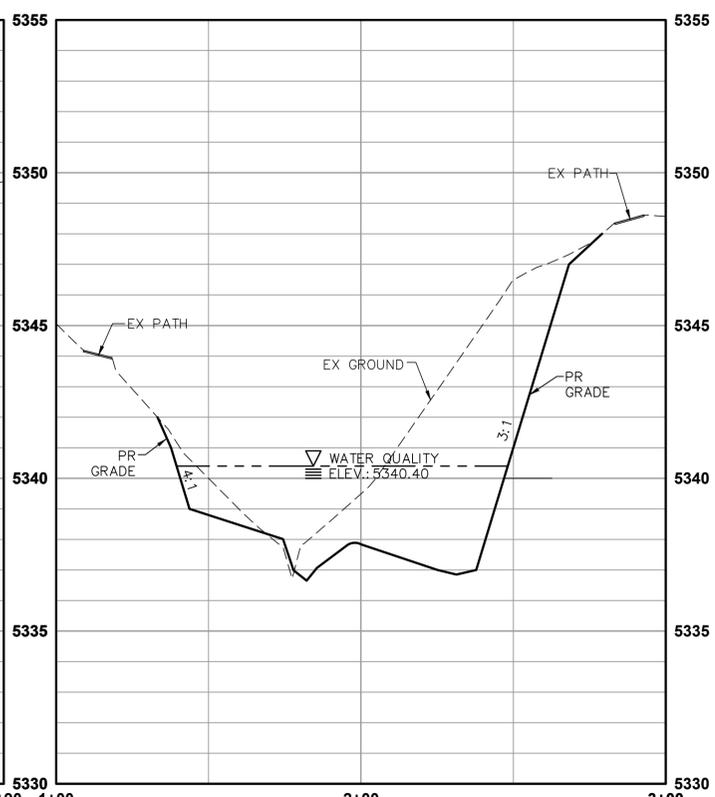
PR CHANNEL GRADE DROP CUTOFF WALL DETAIL
NOT TO SCALE



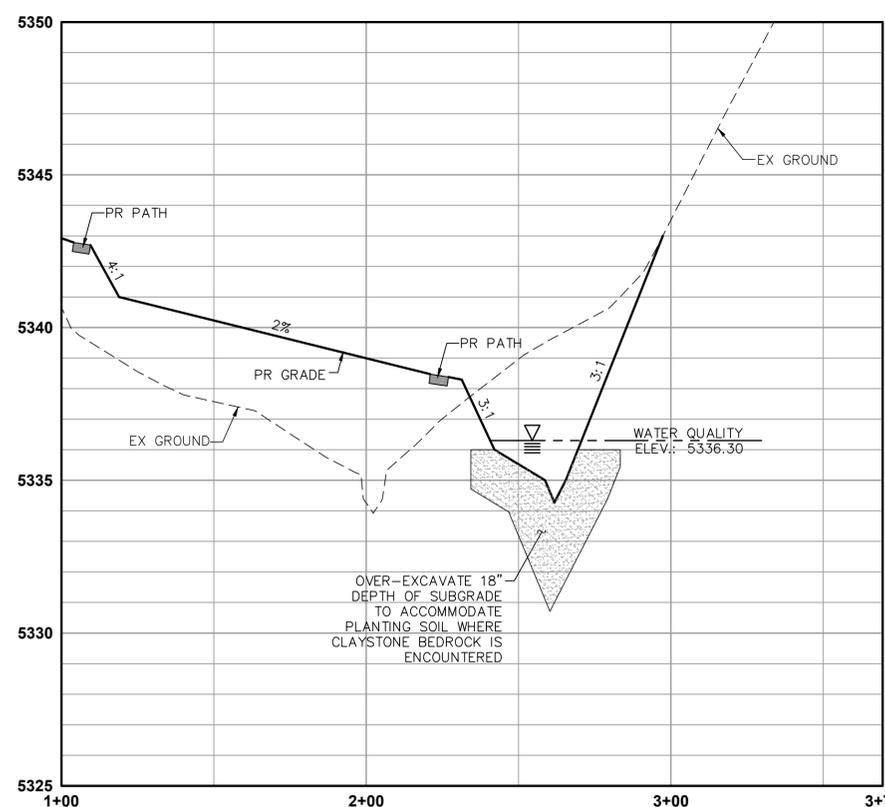
CROSS SECTION A-A



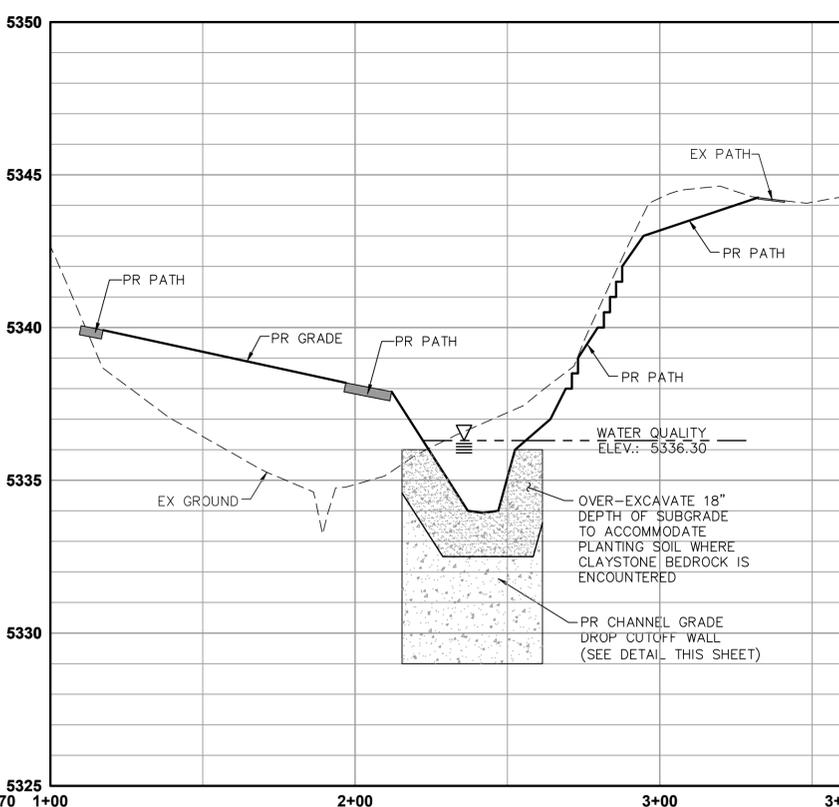
CROSS SECTION B-B



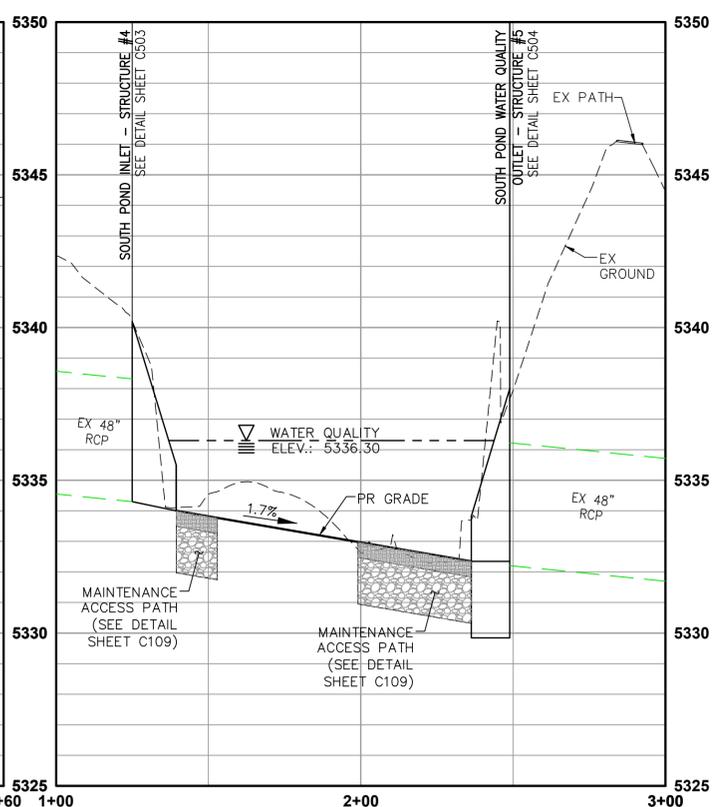
CROSS SECTION C-C



CROSS SECTION D-D



CROSS SECTION E-E



CROSS SECTION F-F

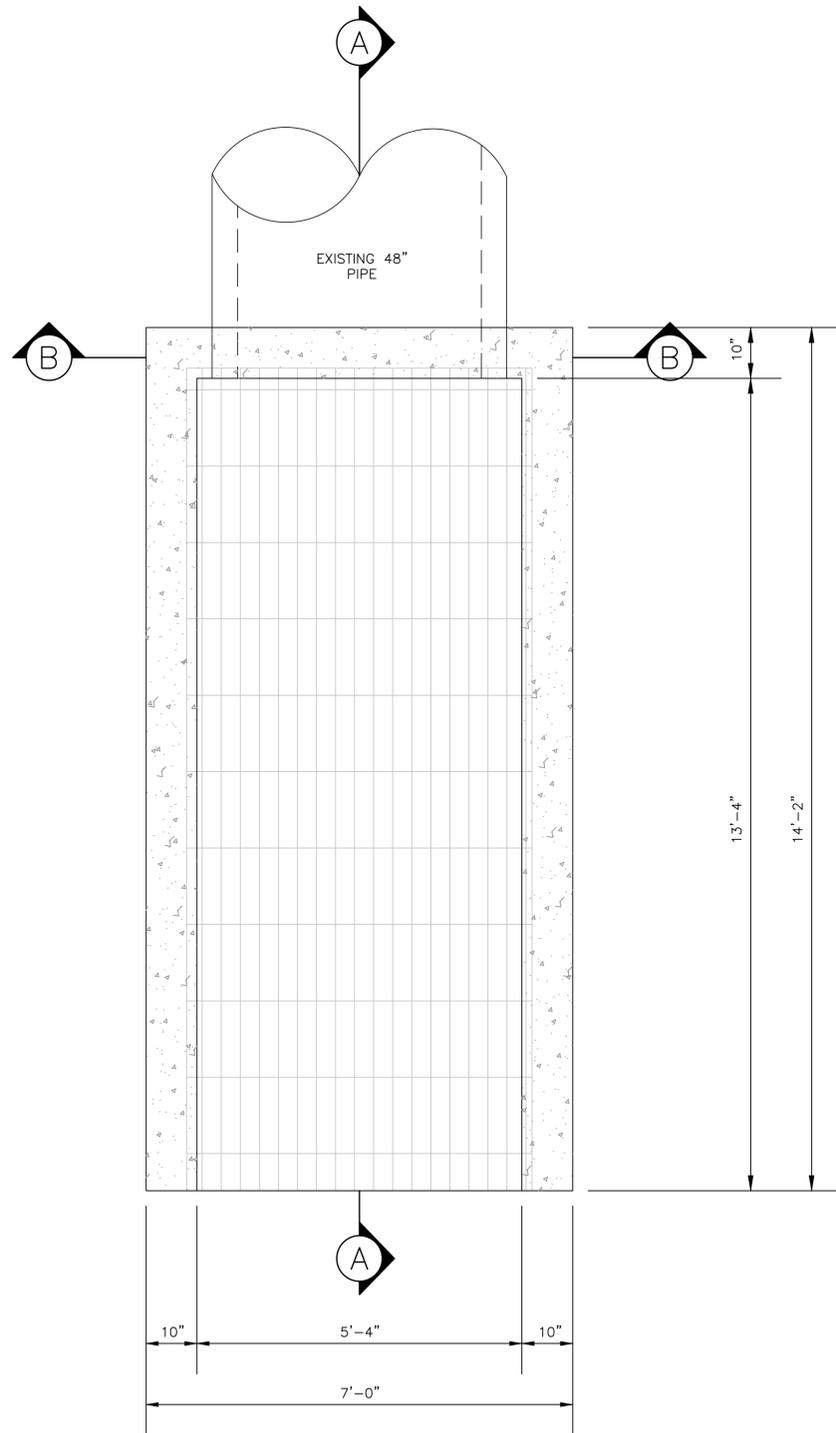
NO.	DESCRIPTION OF REVISIONS	DATE	BY



CITY AND COUNTY OF DENVER
DEPARTMENT OF PUBLIC WORKS
ENGINEERING DIVISION
CAPITAL PROJECTS MANAGEMENT
2000 W. 3RD AVE. DENVER, CO 80223
TEL.: (303) 446-3617 FAX: (303) 446-3647

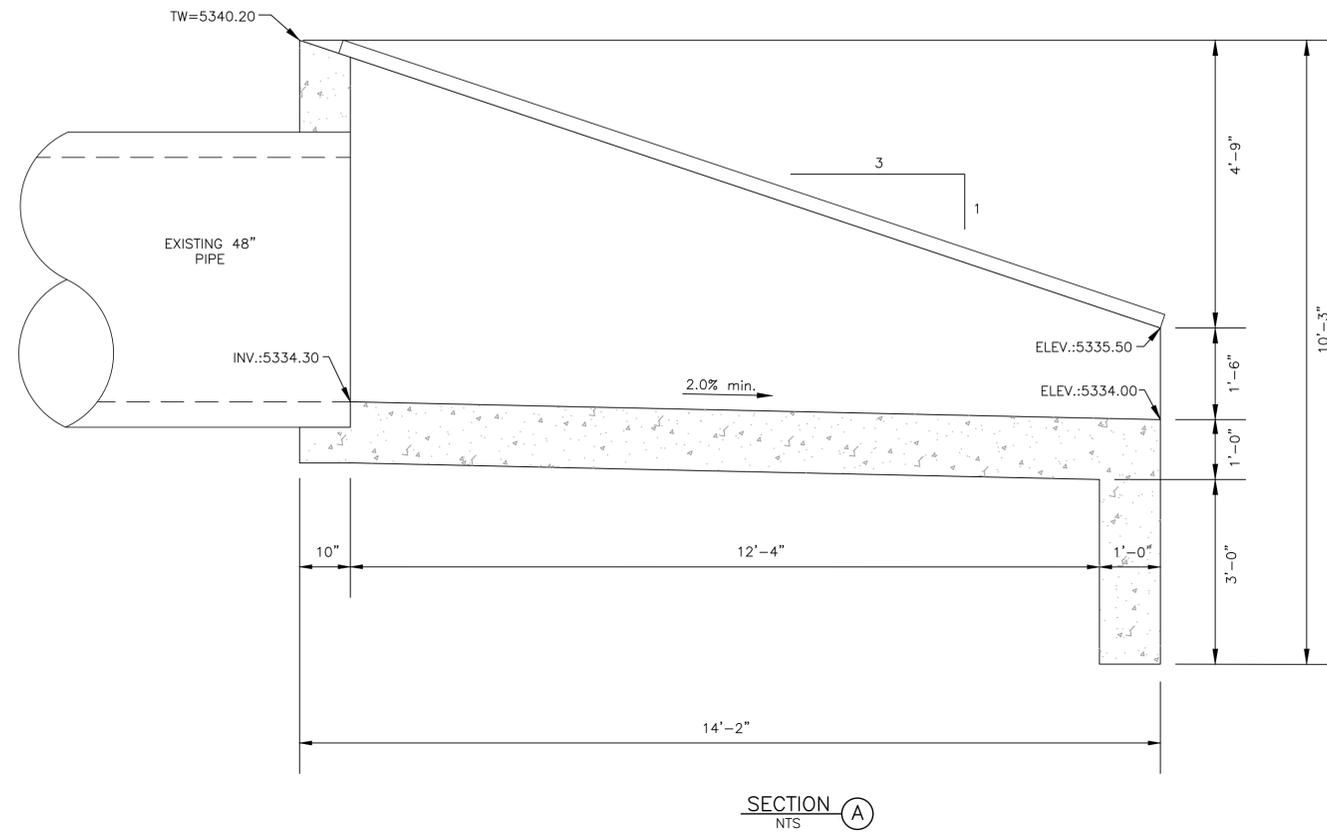
ASBURY & TEJON PARK
RETROFIT DESIGN
PRO TRACKING NO.: PWW2017-004
PROJECT MASTER NO.: 2017-PROJIMSTR-0000150
CIVIL CHANNEL SECTIONS

DRAWN BY:	JR
DESIGNED BY:	
APPROVED BY:	DJ
DRAWING NAME:	
DATE:	SEPTEMBER 2018
SHEET NO.:	C300

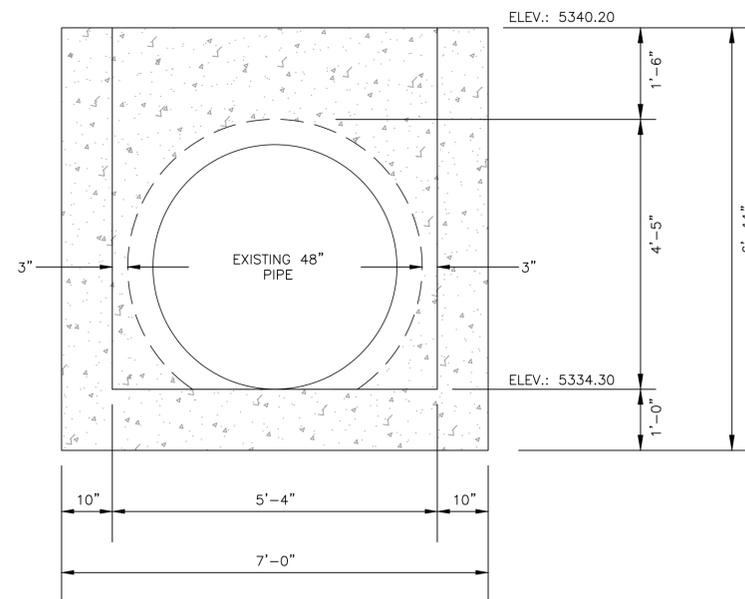


4 SOUTH POND INLET - STRUCTURE #4
 PLAN VIEW N.T.S.

REFER TO SHEETS S-507 & S-508
 FOR STRUCTURAL DETAILS



SECTION A
 NTS



SECTION B
 NTS

NO.	DESCRIPTION OF REVISIONS	DATE	BY

CALL UNCC
 TWO WORKING DAYS
 BEFORE YOU DIG
 1-800-922-1987
 UTILITY WORKER CENTER OF
 COLORADO

CITY AND COUNTY OF DENVER
 DEPARTMENT OF PUBLIC WORKS
 ENGINEERING DIVISION
 CAPITAL PROJECTS MANAGEMENT
 2000 W. 3RD AVE. DENVER, CO 80223
 TEL.: (303) 446-3617 FAX: (303) 446-3647

ASBURY & TEJON PARK
 RETROFIT DESIGN
 PRO TRACKING NO.: PWWW2017-004
 PROJECT MASTER NO.: 2017-PROJMSTR-0000150
 SOUTH POND INLET - STRUCTURE #4

DRAWN BY:	JR
DESIGNED BY:	
APPROVED BY:	DJ
DRAWING NAME:	
DATE:	SEPTEMBER 2018
SHEET NO.:	C503

GENERAL NOTES

ALL WORK SHALL BE DONE IN ACCORDANCE WITH CITY AND COUNTY OF DENVER (CCD) STANDARD CONSTRUCTION SPECIFICATIONS.

EXCEPT AS SHOWN IN THE PLANS, STRUCTURE EXCAVATION AND BACKFILL SHALL BE IN ACCORDANCE WITH M-206-2.

EXPANSION JOINT MATERIAL SHALL MEET AASHTO SPECIFICATION M-213.

GRADE 60 REINFORCING STEEL IS REQUIRED.

ALL REINFORCING STEEL SHALL BE NON-EPOXY COATED UNLESS OTHERWISE NOTED.

ⓔ DENOTES EPOXY COATED REINFORCING STEEL.

THE FOLLOWING TABLE GIVES THE MINIMUM CLASS B (STAGGERED) LAP SPLICE LENGTH FOR EPOXY COATED REINFORCING BARS PLACED IN ACCORDANCE WITH SUBSECTION 602.06. THESE SPLICE LENGTHS SHALL BE INCREASED BY 25% FOR BARS SPACED AT LESS THAN 6" ON CENTER, INCREASED BY 40% FOR HORIZONTAL BARS WITH MORE THAN 12" OF CONCRETE BELOW (TOP BARS), AND INCREASED BY 75% IF BOTH CONDITIONS EXIST. THE INCREASES ABOVE FOR #6 THRU #11 BARS MAY BE 25%, 13%, AND 42% RESPECTIVELY.

BAR SIZE	#4	#5	#6	#7	#8	#9	#10	#11
SPLICE LENGTH FOR CLASS D CONCRETE	1'-3"	1'-7"	2'-5"	2'-10"	3'-8"	4'-8"	5'-11"	7'-3"

WHEN THE CONTRACTOR ELECTS TO SUBSTITUTE EPOXY COATED REINFORCEMENT FOR BLACK REINFORCING BARS, THE MINIMUM LAP SPLICE SHALL BE AS DESCRIBED ABOVE.

THE FOLLOWING TABLE GIVES THE MINIMUM CLASS B (STAGGERED) LAP SPLICE LENGTH FOR BLACK REINFORCING BARS PLACED IN ACCORDANCE WITH SUBSECTION 602.06. THESE SPLICE LENGTHS SHALL BE INCREASED BY 25% FOR BARS SPACED AT LESS THAN 6" ON CENTER, INCREASED BY 40% FOR HORIZONTAL BARS WITH MORE THAN 12" OF CONCRETE BELOW (TOP BARS), AND INCREASED BY 75% IF BOTH CONDITIONS EXIST.

BAR SIZE	#4	#5	#6	#7	#8	#9	#10	#11
SPLICE LENGTH FOR CLASS D CONCRETE	1'-1"	1'-4"	1'-7"	1'-11"	2'-6"	3'-1"	3'-11"	4'-10"

THE ABOVE SPLICE LENGTHS SHALL BE INCREASED BY 30 PERCENT FOR NON-STAGGERED SPLICES.

THE ABOVE SPLICE LENGTHS SHALL BE INCREASED BY 20 PERCENT FOR 3 BAR BUNDLES AND 33 PERCENT FOR 4 BAR BUNDLES.

THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE STABILITY OF THE STRUCTURE DURING CONSTRUCTION.

E.F. = EACH FACE O.F. = OUTSIDE FACE
 F.F. = FAR FACE T.&B. = TOP AND BOTTOM
 N.F. = NEAR FACE T.F. = TOP FACE
 I.F. = INSIDE FACE B.F. = BOTTOM FACE

FOR STRUCTURE NUMBER INSTALLATION, SEE STANDARD S-614-12.

STATIONS, ELEVATIONS, AND DIMENSIONS CONTAINED IN THESE PLANS ARE CALCULATED FROM A RECENT FIELD SURVEY. THE CONTRACTOR SHALL VERIFY ALL DEPENDENT DIMENSIONS IN THE FIELD BEFORE ORDERING OR FABRICATING ANY MATERIAL.

THE INFORMATION SHOWN ON THESE PLANS CONCERNING THE TYPE AND LOCATION OF UNDERGROUND UTILITIES IS NOT GUARANTEED TO BE ACCURATE OR ALL INCLUSIVE. THE CONTRACTOR IS RESPONSIBLE FOR MAKING HIS OWN DETERMINATION AS TO THE TYPE AND LOCATION OF UNDERGROUND UTILITIES AS MAY BE NECESSARY TO AVOID DAMAGE THERETO. THE CONTRACTOR SHALL CONTACT THE UTILITY NOTIFICATION CENTER OF COLORADO AT 1-800-922-1987 AT LEAST 2 DAYS (NOT INCLUDING THE DAY OF NOTIFICATION) PRIOR TO ANY EXCAVATION OR OTHER EARTHWORK.

ALL CAST-IN-PLACE CONCRETE SHALL BE CLASS D UNLESS NOTED OTHERWISE.



SECTION OR DETAIL IDENTIFICATION
 CROSS-REFERENCE SHEET NUMBER (- = SAME SHEET)

DESIGN DATA

AASHTO, 7th EDITION LRFD

DESIGN METHOD: LOAD AND RESISTANCE FACTOR DESIGN.

LIVE LOAD: HL-93.

LATERAL EARTH PRESSURE: 60 P.C.F (AT-REST E.F.P.)

REINFORCED CONCRETE:
 CLASS D CONCRETE: $f_c = 4,500$ psi
 REINFORCING STEEL: $f_y = 60,000$ psi

ADDITIONAL REQUIREMENTS

1. ALL STRUCTURES SHALL BEAR ON UNDISTURBED SUBGRADE OR COMPACTED CLASS 6 GRAVEL BEDDING MATERIAL OVER UNDISTURBED SUBGRADE.

2. THE FOLLOWING MINIMUM COVER SHALL PROVIDED FOR REINFORCEMENT (UNLESS OTHERWISE NOTED):

CONCRETE CAST AGAINST AND PERMANENTLY EXPOSED TO EARTH: 3"

ALL OTHER CONCRETE LOCATIONS: 2"

3. REFER TO GEOTECHNICAL REPORT NO. 17-1-117 BY KUMAR & ASSOCIATES, INC. FOR ADDITIONAL REQUIREMENTS REGARDING EXCAVATION, AND BACKFILLING.

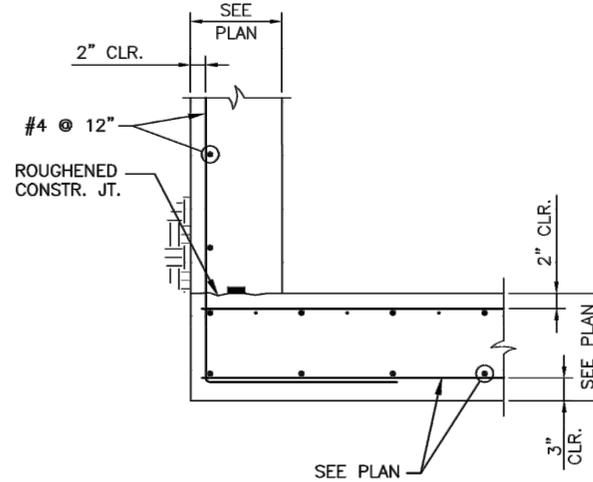
STRUCTURE DESCRIPTION

CAST-IN-PLACE REINFORCED CONCRETE OUTLET STRUCTURES

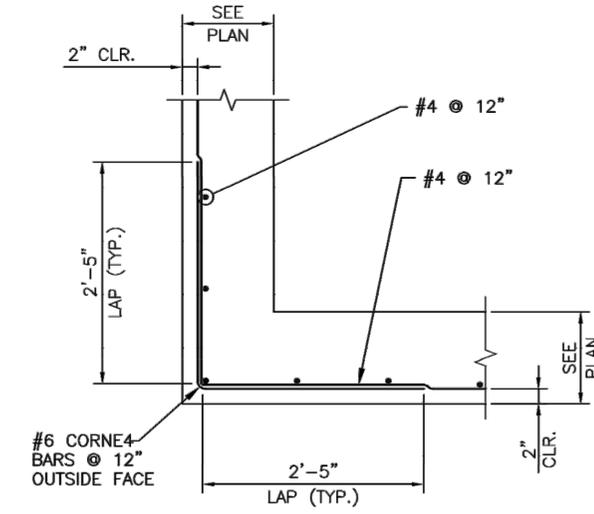
STRUCTURE DRAWING INDEX

- S500 GENERAL NOTES AND TYPICAL DETAILS
- S501 NORTH POND STILLING BASIN - STRUCTURE #1
- S502 NORTH POND STILLING BASIN - STRUCTURE #1 DETAILS
- S503 NORTH POND WATER QUALITY - STRUCTURE #2
- S504 NORTH POND WATER QUALITY - STRUCTURE #2 DETAILS
- S505 SOUTH POND OUTLET - STRUCTURE #3
- S506 SOUTH POND OUTLET - STRUCTURE #3 DETAILS
- S507 SOUTH POND STILLING BASIN - STRUCTURE #4
- S508 SOUTH POND STILLING BASIN - STRUCTURE #4 DETAILS
- S509 SOUTH POND WATER QUALITY - STRUCTURE #5
- S510 SOUTH POND WATER QUALITY - STRUCTURE #5 DETAILS

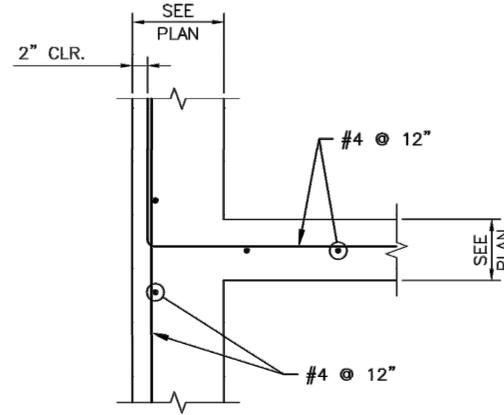
NOTE:
 USE CDOT 601.04 CLASS 2 SULFATE MITIGATION STRATEGIES, THUS NO CLASS C FLYASH IN ANY NEW CONCRETE IN CONTACT WITH SOILS (INLETS, PIPES, STRUCTURES), NOR IN CONTACT OR IN SPLASH ZONE OF STREET OR ROW, THUS CURB & GUTTER, SIDEWALKS, ADA RAMPS ETC.



1 TYPICAL BOTTOM OF WALL DETAIL



2 TYPICAL WALL CORNER DETAIL



3 TYPICAL WALL INTERSECTION DETAIL

NO.	DESCRIPTION OF REVISIONS	DATE	BY

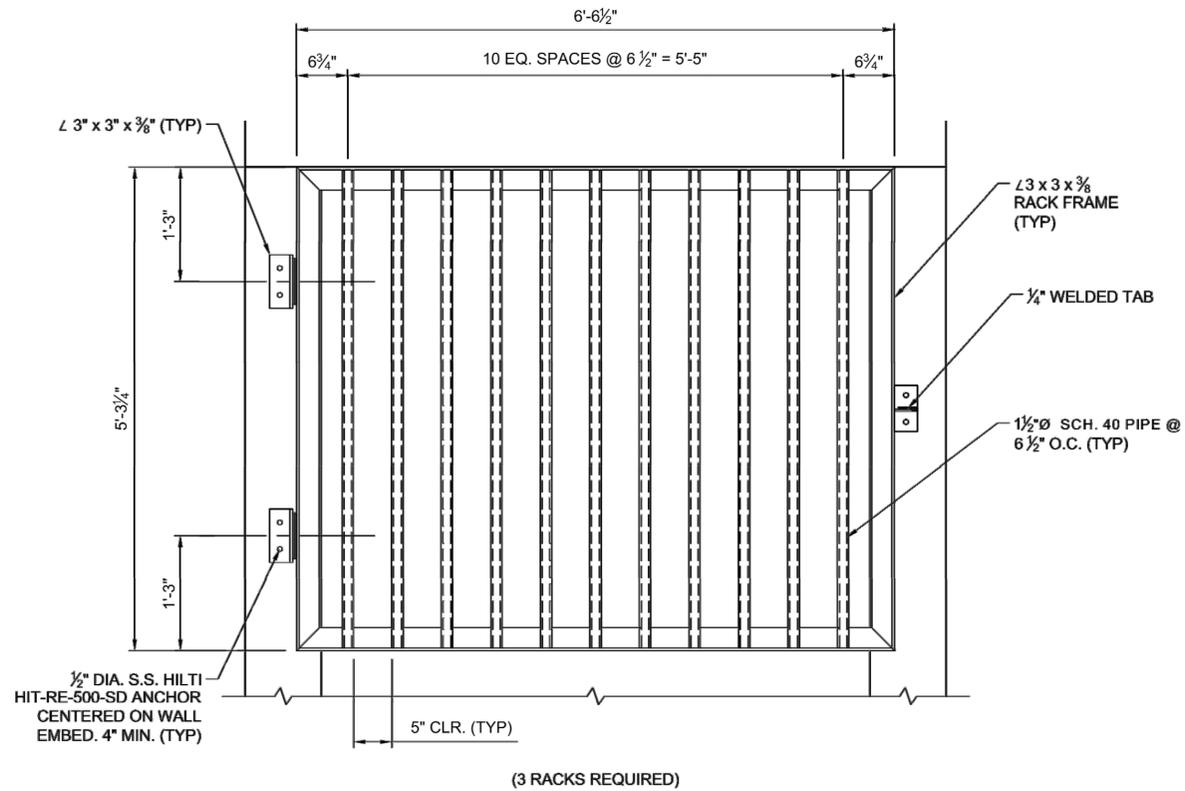
CALL UNCC
 TWO WORKING DAYS
 BEFORE YOU DIG
 1-800-922-1987
 UTILITY NOTIFICATION CENTER OF COLORADO

CITY AND COUNTY OF DENVER
 DEPARTMENT OF PUBLIC WORKS
 ENGINEERING DIVISION
 CAPITAL PROJECTS MANAGEMENT
 2000 W. 3RD AVE. DENVER, CO 80223
 TEL.: (303) 446-3617 FAX: (303) 446-3647

ASBURY & TEJON PARK
 RETROFIT DESIGN
 PRO TRACKING NO.: PWWW2017-004
 PROJECT MASTER NO.: 2017-PROJMSTR-0000150
 GENERAL NOTES AND TYPICAL DETAILS

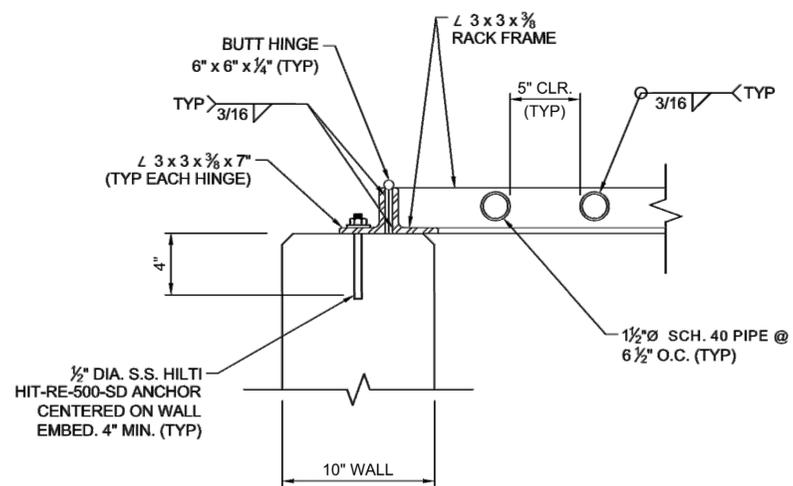
DRAWN BY:	KB
DESIGNED BY:	JMM
APPROVED BY:	JMM
DRAWING NAME:	
DATE:	SEPTEMBER 2018
SHEET NO.:	S500





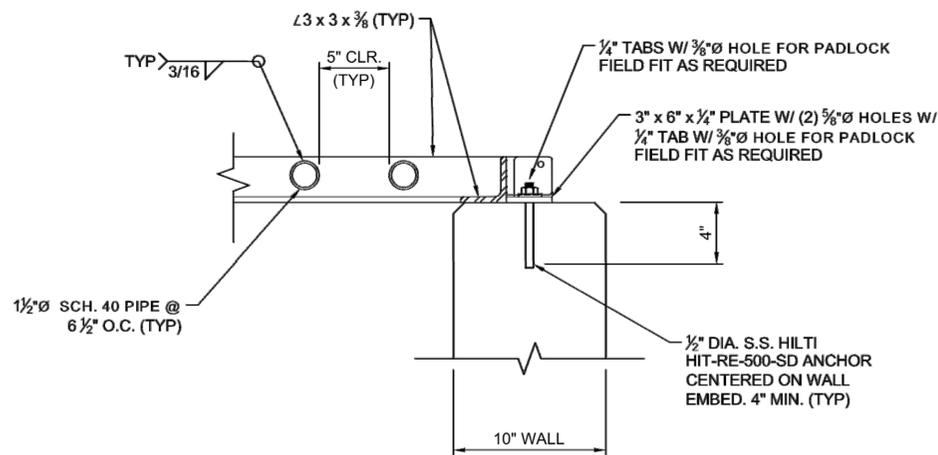
PLAN - NORTH POND INET - STRUCTURE #1 SAFETY GRATE

SCALE: 1" = 1'-0"



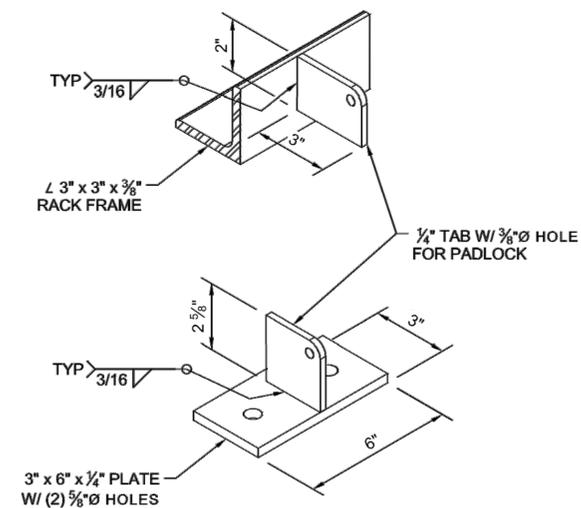
SECTION C - SLOPED RACK CONNECTION

SCALE: 2" = 1'-0"



SECTION D - SLOPED RACK SECURE CONNECTION

SCALE: 2" = 1'-0"



DETAIL - SLOPED RACK SECURE CONNECTION

SCALE: 1" = 1'-0"

SAFETY RACK NOTES

1. CONTRACTOR SHALL VERIFY ALL CONCRETE DIMENSIONS, LOCATIONS, AND ELEVATIONS PRIOR TO START OF RACK FABRICATION.
2. SHOP DRAWINGS FOR ALL STRUCTURAL STEEL FRAMING, GRATING, AND ATTACHMENTS SHALL BE SUBMITTED FOR APPROVAL PRIOR TO START OF FABRICATION.
3. THE SAFETY GRATES AND SECURE CONNECTION ASSEMBLY SHALL BE POWDER COATED "BLACK" FOLLOWING FABRICATION.
4. STRUCTURAL STEEL L SHAPES (ANGLES), AND STRUCTURAL PLATES, SHALL CONFORM TO ASTM A36.
5. STRUCTURAL TUBING MEMBERS SHALL CONFORM TO ASTM A500, GRADE B, AND PIPE ASTM A53, GRADE B.
6. ALL WELDING SHALL BE DONE USING E70XX ELECTRODES AND WELDING SHALL CONFORM TO AISC AND AWS D1.1. WHERE FILLET WELD SIZES ARE NOT SHOWN, PROVIDE THE MINIMUM SIZE PER TABLE J2.4 IN THE AISC "MANUAL OF STEEL CONSTRUCTION" 13TH EDITION.
7. HOLLOW STRUCTURAL STEEL TUBES SHALL BE FABRICATED WITH WEEP HOLES AT LOW ENDS FOR DRAINAGE.
8. HEAVY DUTY BUTT HINGES BY BATTALION, OR APPROVED EQUAL. BUTT HINGES SHALL BE MADE OF STEEL MATERIAL AND HAVE NON-REMOVABLE PINS.
9. POST-INSTALLED ANCHORS SHALL BE HILTI HIT-RE-500-SD ADHESIVE ANCHORS WITH HILTI HAS THREADED RODS AS MANUFACTURED BY HILTI NORTH AMERICA. ANCHORS IN EXTERIOR LOCATIONS SHALL BE STAINLESS STEEL HILTI HAS THREADED RODS. ADHESIVE ANCHORS SHALL BE FURNISHED AS A COMPLETE ASSEMBLY WITH ROD, NUTS, AND WASHER. EMBEDMENT OF ADHESIVE ANCHORS SHALL BE IN ACCORDANCE WITH MANUFACTURER'S SPECIFICATION FOR MINIMUM EMBEDMENT FOR ROD DIAMETER SHOWN ON DRAWINGS, UNLESS OTHERWISE SPECIFIED. ANCHORS SHALL BE INSTALLED IN ACCORDANCE WITH MANUFACTURER'S INSTRUCTIONS. OBSERVE MANUFACTURER RECOMMENDATIONS WITH RESPECT TO INSTALLATION TEMPERATURES FOR CARTRIDGE INJECTION ADHESIVE ANCHORS.

NO.	DESCRIPTION OF REVISIONS	DATE	BY

CALL UNCC
TWO WORKING DAYS
BEFORE YOU DIG
1-800-822-1987
UTILITY WORKING CENTER
OF COLORADO

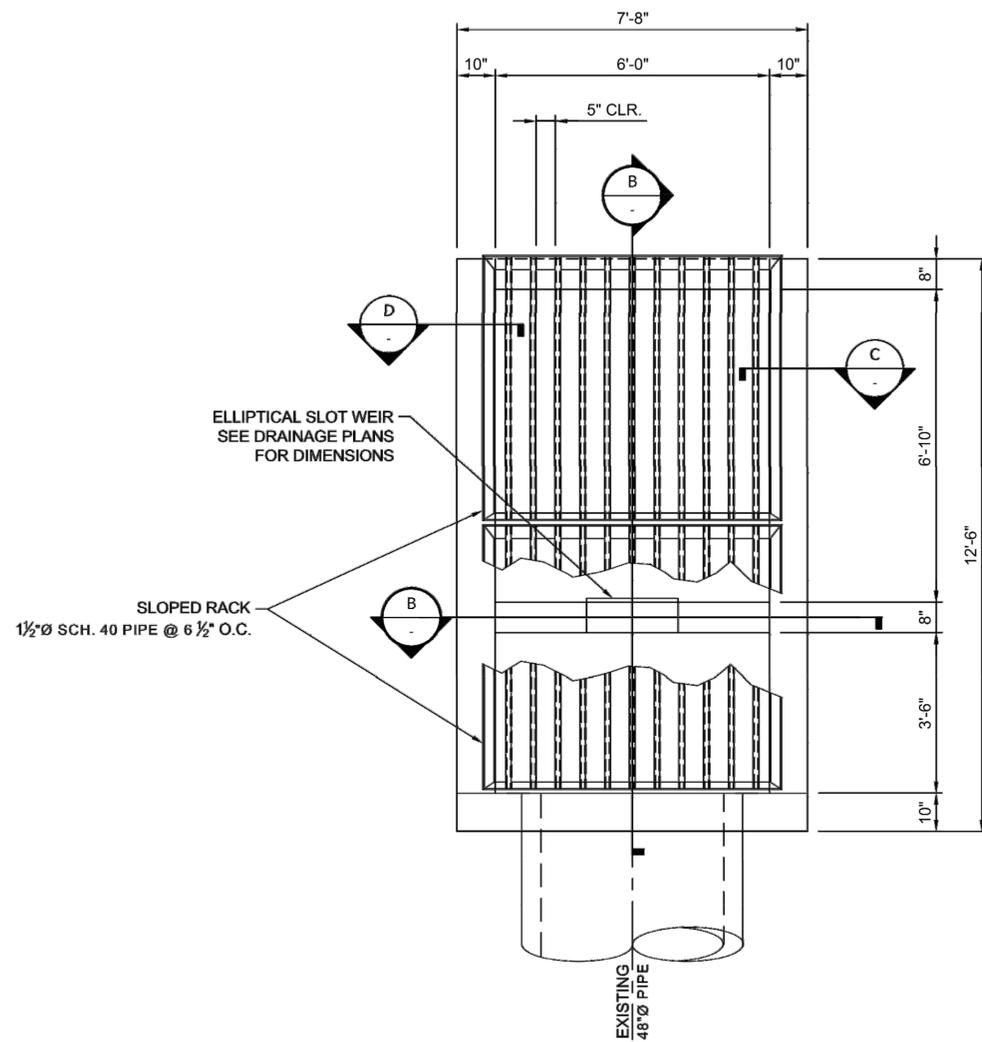
CITY AND COUNTY OF DENVER
DEPARTMENT OF PUBLIC WORKS
ENGINEERING DIVISION
CAPITAL PROJECTS MANAGEMENT
2000 W. 3RD AVE. DENVER, CO 80223
TEL.: (303) 446-3617 FAX: (303) 446-3647

ASBURY & TEJON PARK
RETROFIT DESIGN

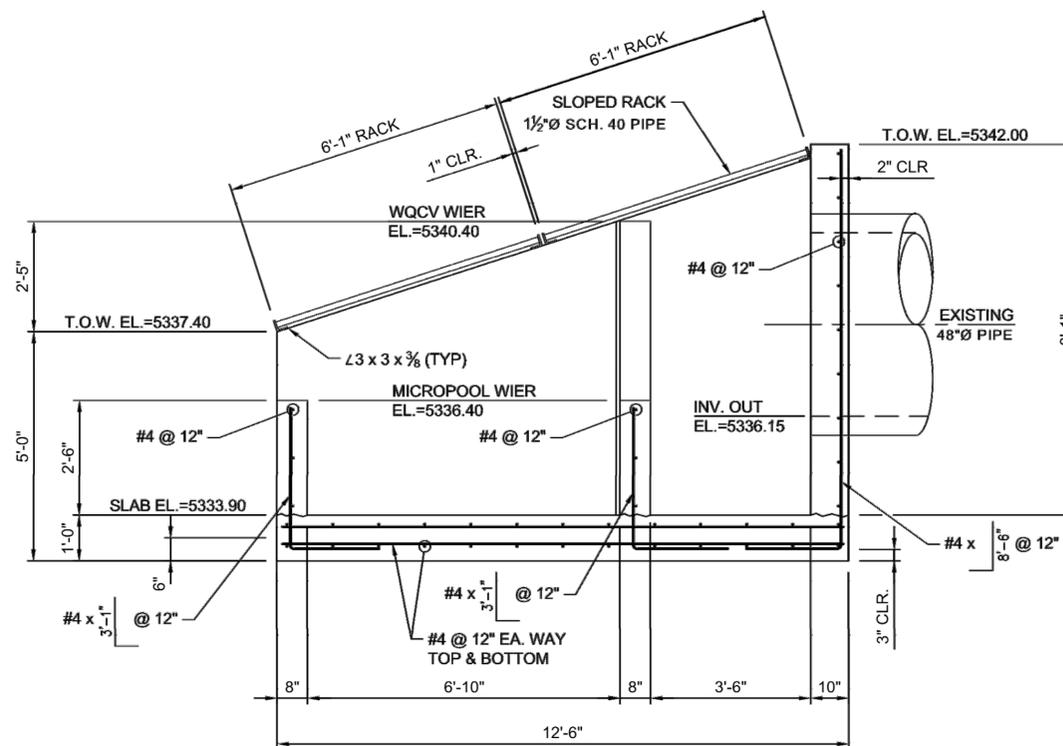
PRO TRACKING NO.: PWWW2017-004
PROJECT MASTER NO.: 2017-PROJIMSTR-0000150
NORTH POND INLET - STRUCTURE #1 DETAILS

DRAWN BY:	KB
DESIGNED BY:	JMM
APPROVED BY:	JMM
DRAWING NAME:	
DATE:	SEPTEMBER 2018
SHEET NO.:	S502

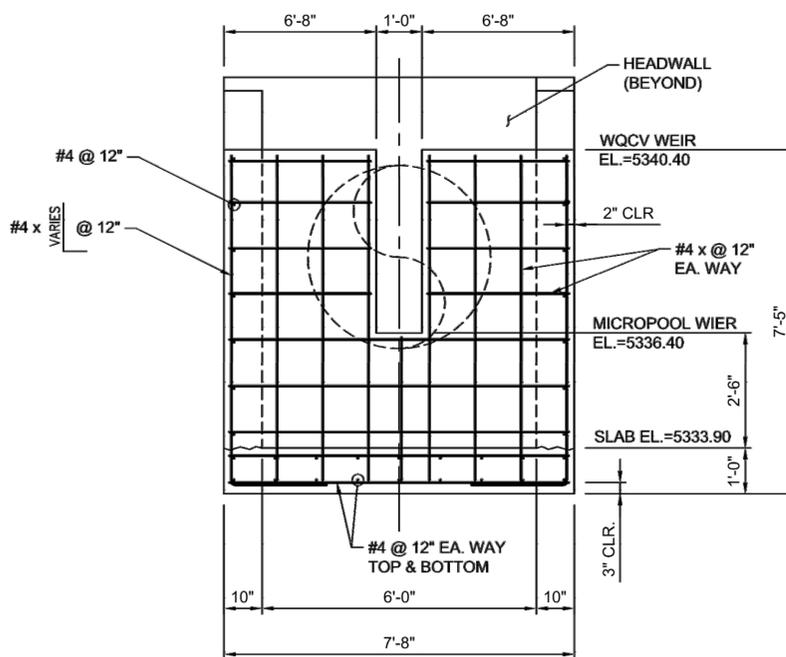




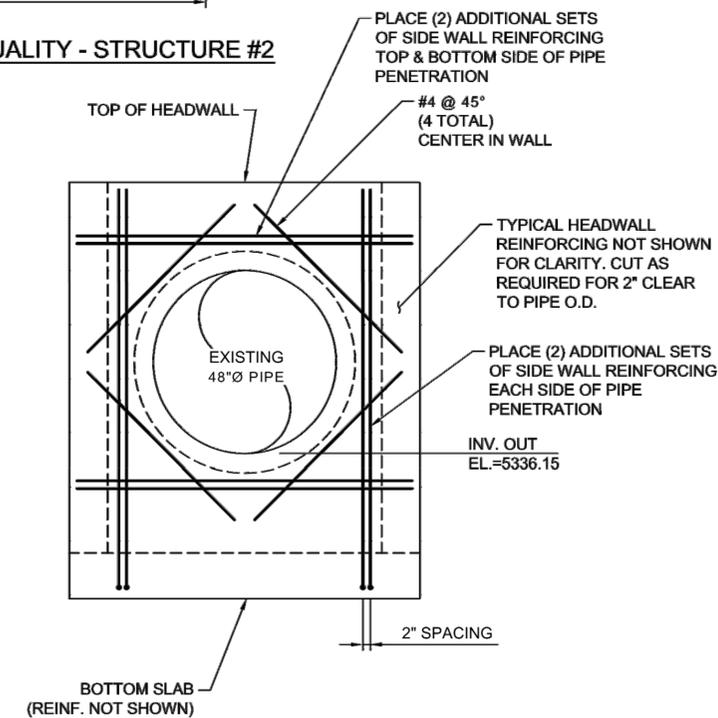
PLAN - NORTH POND WATER QUALITY - STRUCTURE #2
SCALE: 1/2" = 1'-0"



SECTION - NORTH POND WATER QUALITY - STRUCTURE #2
SCALE: 1/2" = 1'-0"



SECTION - NORTH POND WATER QUALITY - STRUCTURE #2
SCALE: 1/2" = 1'-0"



ELEVATION - HEADWALL REINFORCING
SCALE: 1/2" = 1'-0"

NO.	DESCRIPTION OF REVISIONS	DATE	BY

CALL UNCC
TWO WORKING DAYS
BEFORE YOU DIG
1-800-925-9877
UTILITY WARNING CENTER OF
COLORADO

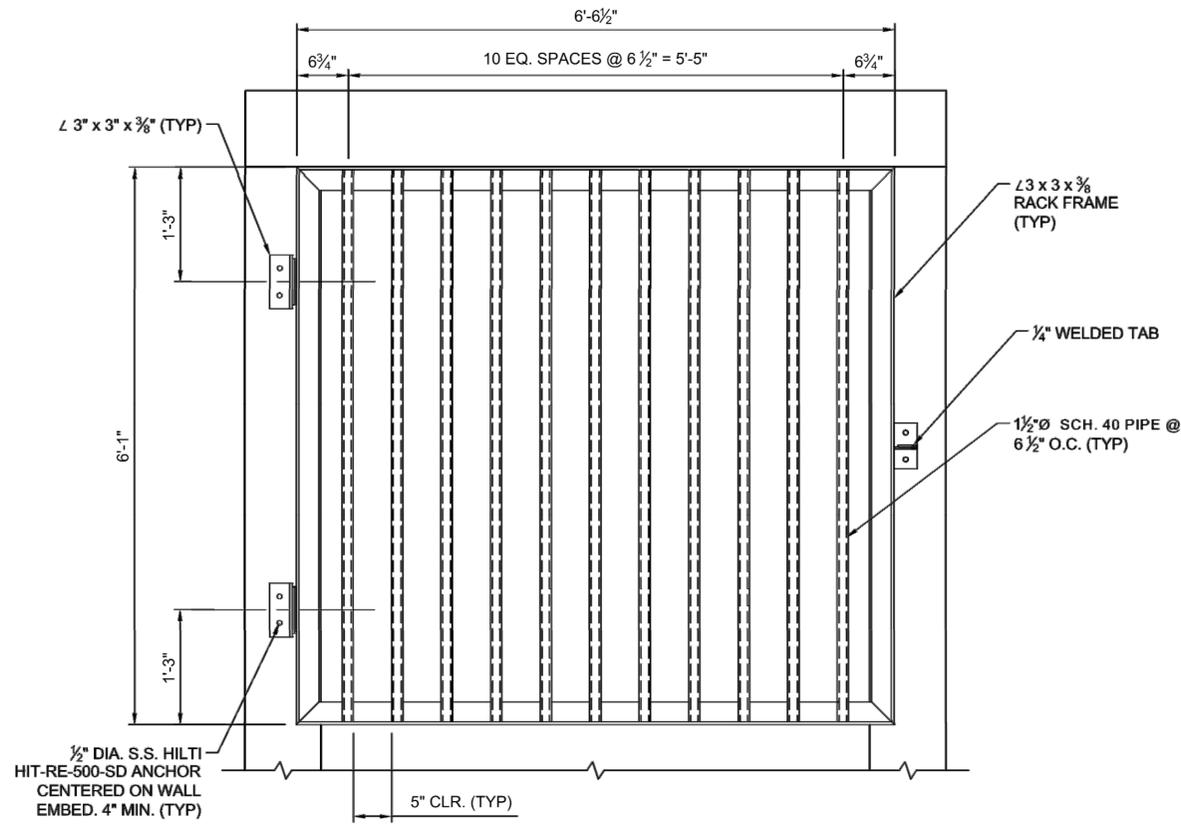
CITY AND COUNTY OF DENVER
DEPARTMENT OF PUBLIC WORKS
ENGINEERING DIVISION
CAPITAL PROJECTS MANAGEMENT
2000 W. 3RD AVE. DENVER, CO 80223
TEL.: (303) 446-3617 FAX: (303) 446-3647

ASBURY & TEJON PARK
RETROFIT DESIGN

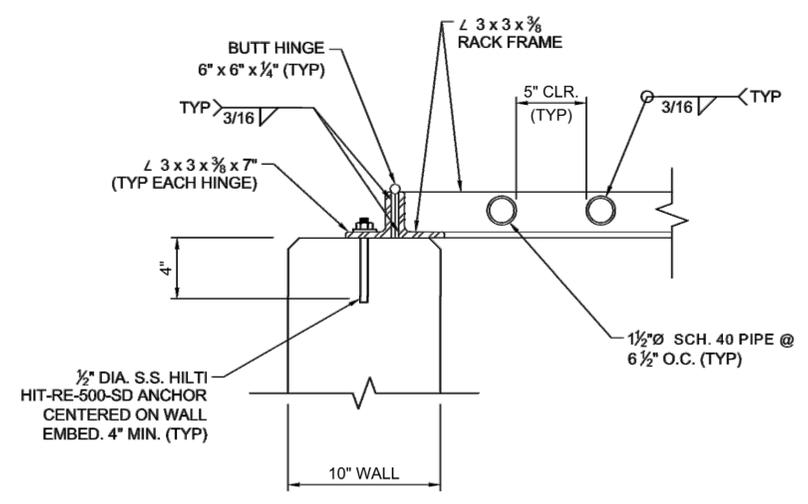
PRO TRACKING NO.: PWWW2017-004
PROJECT MASTER NO.: 2017-PROJMSTR-0000150
NORTH POND WATER QUALITY - STRUCTURE #2

DRAWN BY: KB
DESIGNED BY: JMM
APPROVED BY: JMM
DRAWING NAME:
DATE: SEPTEMBER 2018
SHEET NO.: S503

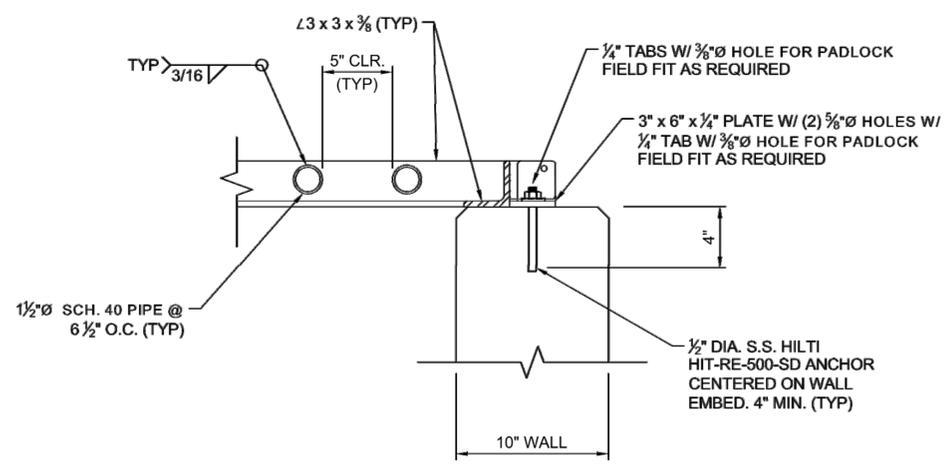




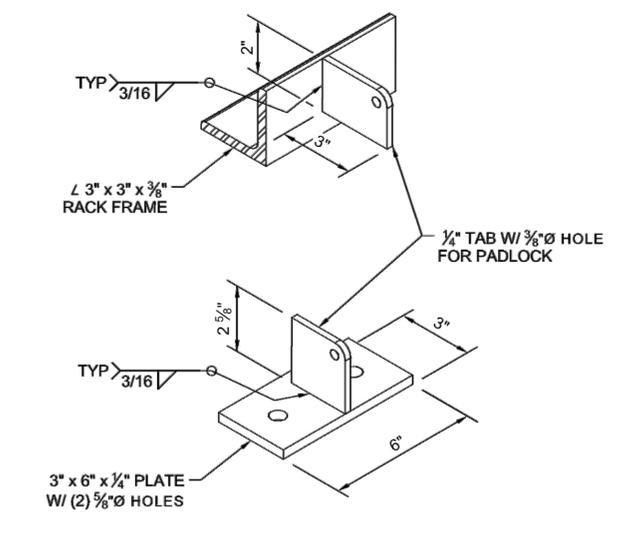
PLAN - NORTH POND WATER QUALITY - STRUCTURE #2 SAFETY GRATE
SCALE: 1" = 1'-0"



C SECTION - SLOPED RACK CONNECTION
SCALE: 2" = 1'-0"



D SECTION - SLOPED RACK SECURE CONNECTION
SCALE: 2" = 1'-0"



DETAIL - SLOPED RACK SECURE CONNECTION
SCALE: 1" = 1'-0"

SAFETY RACK NOTES

- CONTRACTOR SHALL VERIFY ALL CONCRETE DIMENSIONS, LOCATIONS, AND ELEVATIONS PRIOR TO START OF RACK FABRICATION.
- SHOP DRAWINGS FOR ALL STRUCTURAL STEEL FRAMING, GRATING, AND ATTACHMENTS SHALL BE SUBMITTED FOR APPROVAL PRIOR TO START OF FABRICATION.
- THE SAFETY GRATES AND SECURE CONNECTION ASSEMBLY SHALL BE POWDER COATED "BLACK" FOLLOWING FABRICATION.
- STRUCTURAL STEEL L SHAPES (ANGLES), AND STRUCTURAL PLATES, SHALL CONFORM TO ASTM A36.
- STRUCTURAL TUBING MEMBERS SHALL CONFORM TO ASTM A500, GRADE B, AND PIPE ASTM A53, GRADE B.
- ALL WELDING SHALL BE DONE USING E70XX ELECTRODES AND WELDING SHALL CONFORM TO AISC AND AWS D1.1. WHERE FILLET WELD SIZES ARE NOT SHOWN, PROVIDE THE MINIMUM SIZE PER TABLE J2.4 IN THE AISC "MANUAL OF STEEL CONSTRUCTION" 13TH EDITION.
- HOLLOW STRUCTURAL STEEL TUBES SHALL BE FABRICATED WITH WEEP HOLES AT LOW ENDS FOR DRAINAGE.
- HEAVY DUTY BUTT HINGES BY BATTALION, OR APPROVED EQUAL. BUTT HINGES SHALL BE MADE OF STEEL MATERIAL AND HAVE NON-REMOVABLE PINS.
- POST-INSTALLED ANCHORS SHALL BE HILTI HIT-RE-500-SD ADHESIVE ANCHORS WITH HILTI HAS THREADED RODS AS MANUFACTURED BY HILTI NORTH AMERICA. ANCHORS IN EXTERIOR LOCATIONS SHALL BE STAINLESS STEEL HILTI HAS THREADED RODS. ADHESIVE ANCHORS SHALL BE FURNISHED AS A COMPLETE ASSEMBLY WITH ROD, NUTS, AND WASHER. EMBEDMENT OF ADHESIVE ANCHORS SHALL BE IN ACCORDANCE WITH MANUFACTURER'S SPECIFICATION FOR MINIMUM EMBEDMENT FOR ROD DIAMETER SHOWN ON DRAWINGS, UNLESS OTHERWISE SPECIFIED. ANCHORS SHALL BE INSTALLED IN ACCORDANCE WITH MANUFACTURER'S INSTRUCTIONS. OBSERVE MANUFACTURER RECOMMENDATIONS WITH RESPECT TO INSTALLATION TEMPERATURES FOR CARTRIDGE INJECTION ADHESIVE ANCHORS.

NO.	DESCRIPTION OF REVISIONS	DATE	BY

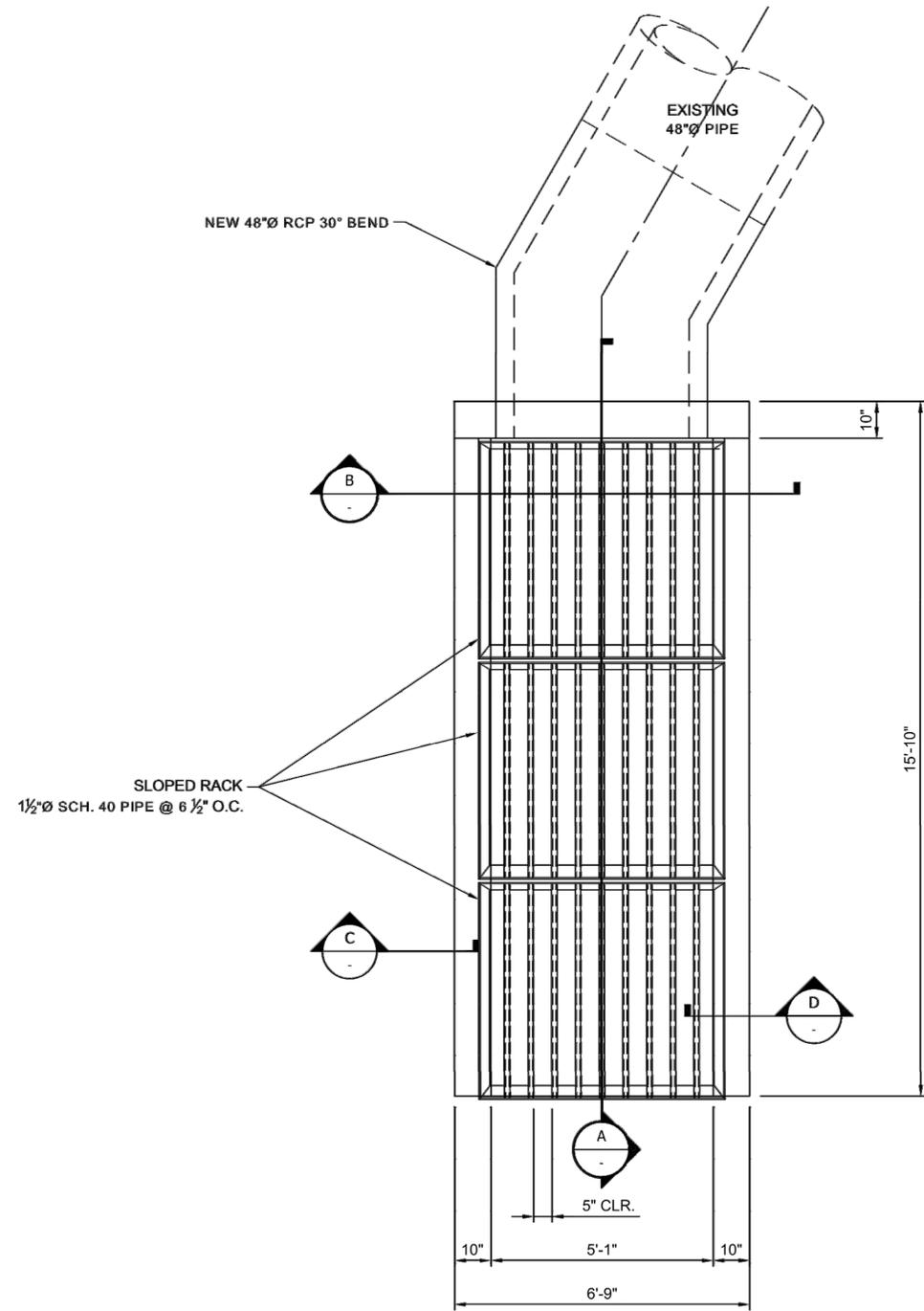
CALL UNCC
TWO WORKING DAYS
BEFORE YOU DIG
1-800-823-1987
UTILITY WARNING CENTER
OF COLORADO

CITY AND COUNTY OF DENVER
DEPARTMENT OF PUBLIC WORKS
ENGINEERING DIVISION
CAPITAL PROJECTS MANAGEMENT
2000 W. 3RD AVE. DENVER, CO 80223
TEL.: (303) 446-3617 FAX: (303) 446-3647

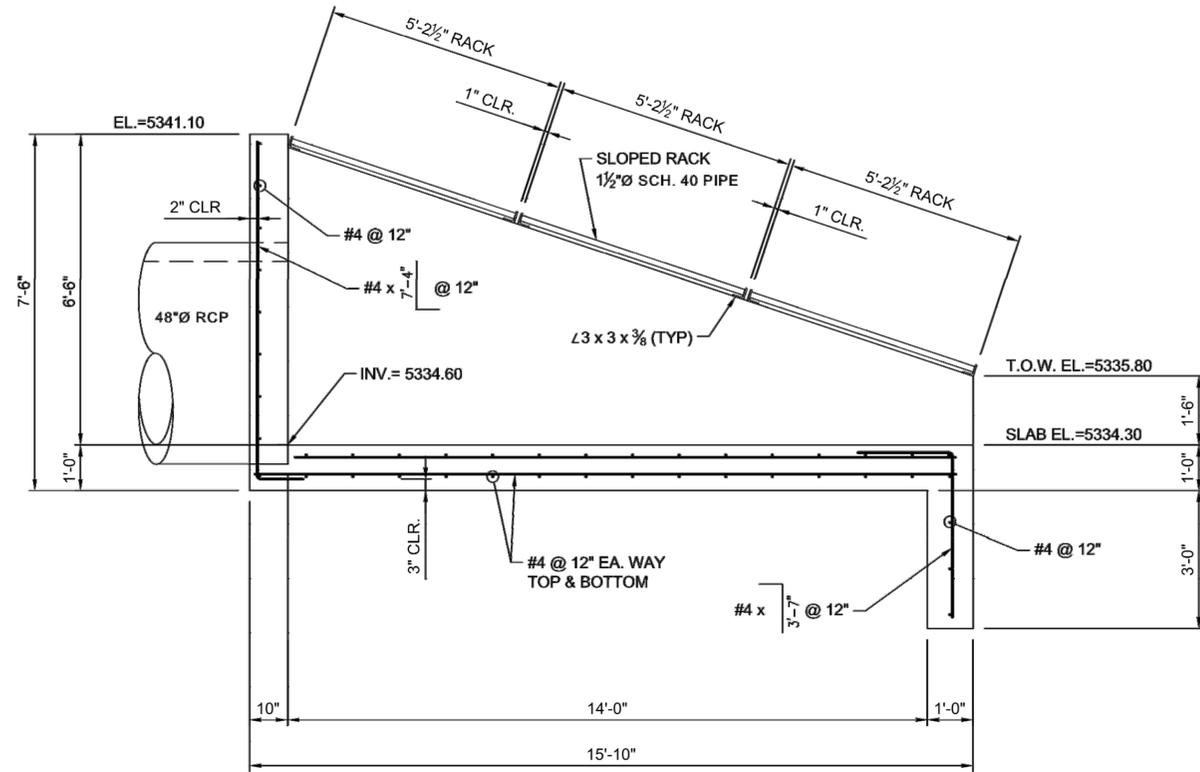
ASBURY & TEJON PARK
RETROFIT DESIGN
PRO TRACKING NO.: PWWW2017-004
PROJECT MASTER NO.: 2017-PROJMSTR-0000150
NORTH POND WATER QUALITY - STRUCTURE #2 DETAILS

DRAWN BY:	KB
DESIGNED BY:	JMM
APPROVED BY:	JMM
DRAWING NAME:	
DATE:	SEPTEMBER 2018
SHEET NO.:	S504

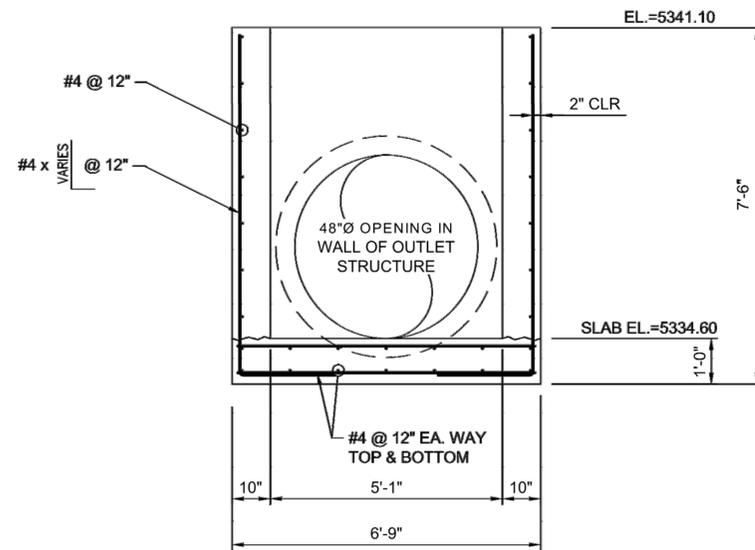




PLAN - SOUTH POND INLET - STRUCTURE #3
SCALE: 1/2" = 1'-0"



SECTION - SOUTH POND INLET - STRUCTURE #3
SCALE: 1/2" = 1'-0"



SECTION - SOUTH POND INLET - STRUCTURE #3
SCALE: 1/2" = 1'-0"

NO.	DESCRIPTION OF REVISIONS	DATE	BY

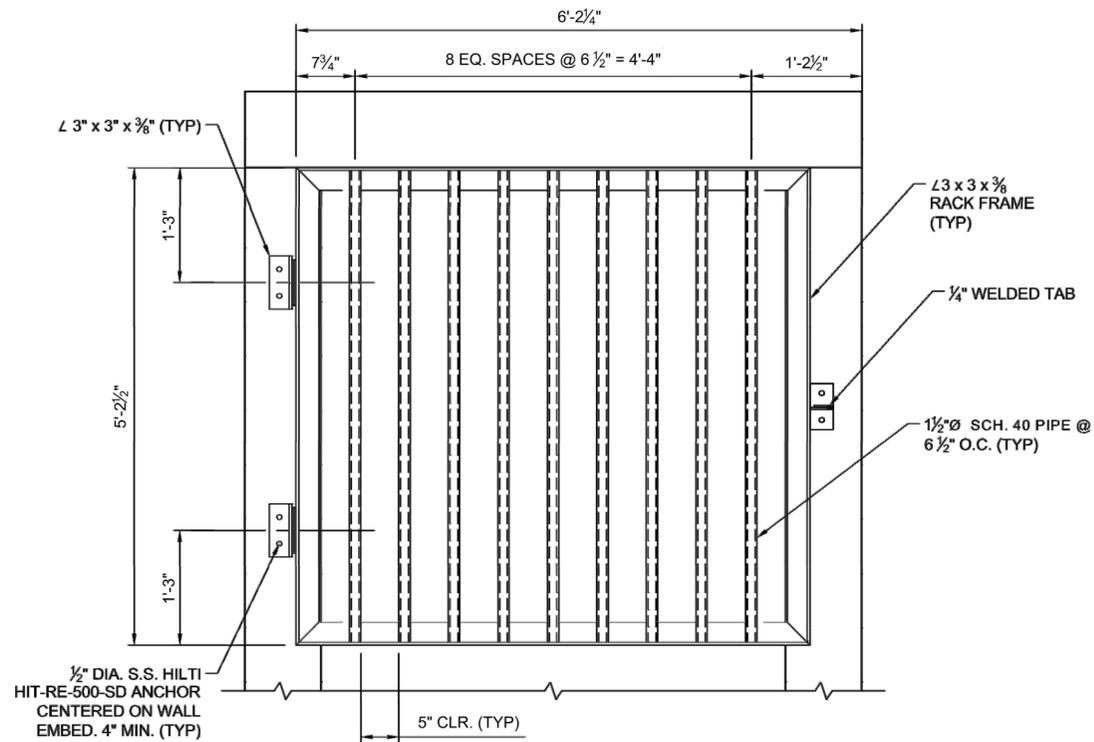
CALL UNCC
TWO WORKING DAYS
BEFORE YOU DIG
1-800-922-1987
UTILITY WORKING CENTER OF
COLORADO

CITY AND COUNTY OF DENVER
DEPARTMENT OF PUBLIC WORKS
ENGINEERING DIVISION
CAPITAL PROJECTS MANAGEMENT
2000 W. 3RD AVE. DENVER, CO 80223
TEL.: (303) 446-3617 FAX: (303) 446-3647

ASBURY & TEJON PARK
RETROFIT DESIGN
PRO TRACKING NO.: PWWW2017-004
PROJECT MASTER NO.: 2017-PROJMSTR-0000150
SOUTH POND INLET - STRUCTURE #3

DRAWN BY:	KB
DESIGNED BY:	JMM
APPROVED BY:	JMM
DRAWING NAME:	
DATE:	SEPTEMBER 2018
SHEET NO.:	S505

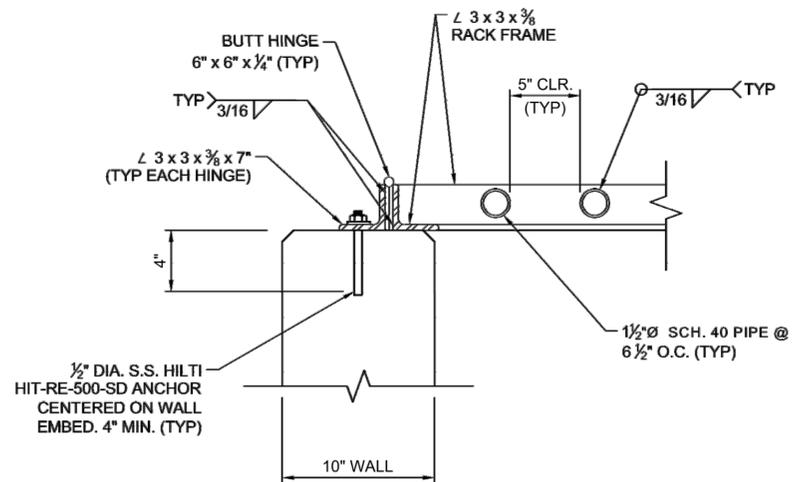




(3 RACKS REQUIRED)

PLAN - SOUTH POND INLET - STRUCTURE #3 SAFETY GRATE

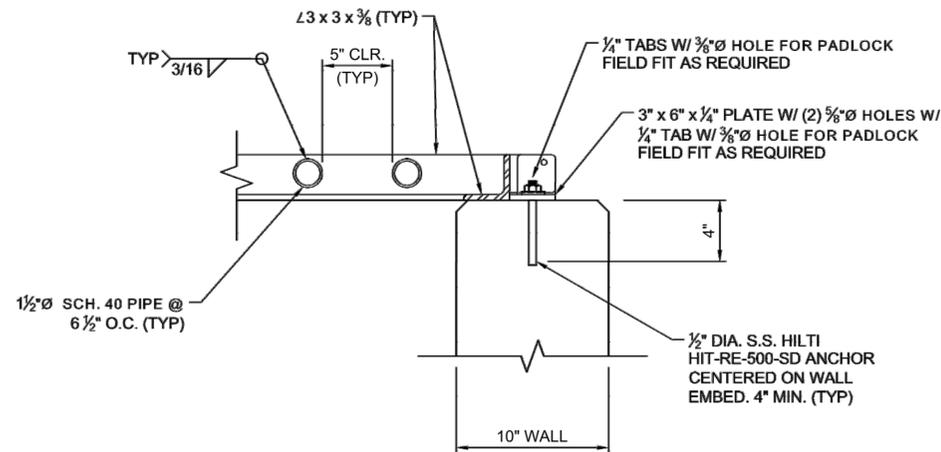
SCALE: 1" = 1'-0"



C SECTION - SLOPED RACK CONNECTION

SCALE: 2" = 1'-0"

S5500



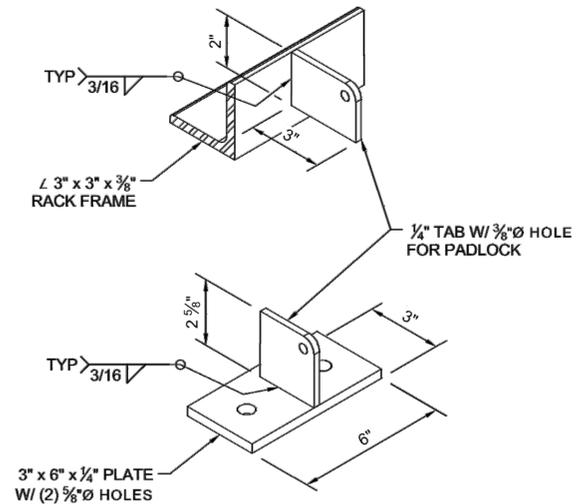
D SECTION - SLOPED RACK SECURE CONNECTION

SCALE: 2" = 1'-0"

S5500

SAFETY RACK NOTES

1. CONTRACTOR SHALL VERIFY ALL CONCRETE DIMENSIONS, LOCATIONS, AND ELEVATIONS PRIOR TO START OF RACK FABRICATION.
2. SHOP DRAWINGS FOR ALL STRUCTURAL STEEL FRAMING, GRATING, AND ATTACHMENTS SHALL BE SUBMITTED FOR APPROVAL PRIOR TO START OF FABRICATION.
3. THE SAFETY GRATES AND SECURE CONNECTION ASSEMBLY SHALL BE POWDER COATED "BLACK" FOLLOWING FABRICATION.
4. STRUCTURAL STEEL L SHAPES (ANGLES), AND STRUCTURAL PLATES, SHALL CONFORM TO ASTM A36.
5. STRUCTURAL TUBING MEMBERS SHALL CONFORM TO ASTM A500, GRADE B, AND PIPE ASTM A53, GRADE B.
6. ALL WELDING SHALL BE DONE USING E70XX ELECTRODES AND WELDING SHALL CONFORM TO AISC AND AWS D1.1. WHERE FILLET WELD SIZES ARE NOT SHOWN, PROVIDE THE MINIMUM SIZE PER TABLE J2.4 IN THE AISC "MANUAL OF STEEL CONSTRUCTION" 13TH EDITION.
7. HOLLOW STRUCTURAL STEEL TUBES SHALL BE FABRICATED WITH WEEP HOLES AT LOW ENDS FOR DRAINAGE.
8. HEAVY DUTY BUTT HINGES BY BATTALION, OR APPROVED EQUAL. BUTT HINGES SHALL BE MADE OF STEEL MATERIAL AND HAVE NON-REMOVABLE PINS.
9. POST-INSTALLED ANCHORS SHALL BE HILTI HIT-RE-500-SD ADHESIVE ANCHORS WITH HILTI HAS THREADED RODS AS MANUFACTURED BY HILTI NORTH AMERICA. ANCHORS IN EXTERIOR LOCATIONS SHALL BE STAINLESS STEEL HILTI HAS THREADED RODS. ADHESIVE ANCHORS SHALL BE FURNISHED AS A COMPLETE ASSEMBLY WITH ROD, NUTS, AND WASHER. EMBEDMENT OF ADHESIVE ANCHORS SHALL BE IN ACCORDANCE WITH MANUFACTURER'S SPECIFICATION FOR MINIMUM EMBEDMENT FOR ROD DIAMETER SHOWN ON DRAWINGS, UNLESS OTHERWISE SPECIFIED. ANCHORS SHALL BE INSTALLED IN ACCORDANCE WITH MANUFACTURER'S INSTRUCTIONS. OBSERVE MANUFACTURER RECOMMENDATIONS WITH RESPECT TO INSTALLATION TEMPERATURES FOR CARTRIDGE INJECTION ADHESIVE ANCHORS.



DETAIL - SLOPED RACK SECURE CONNECTION

SCALE: 1" = 1'-0"

NO.	DESCRIPTION OF REVISIONS	DATE	BY

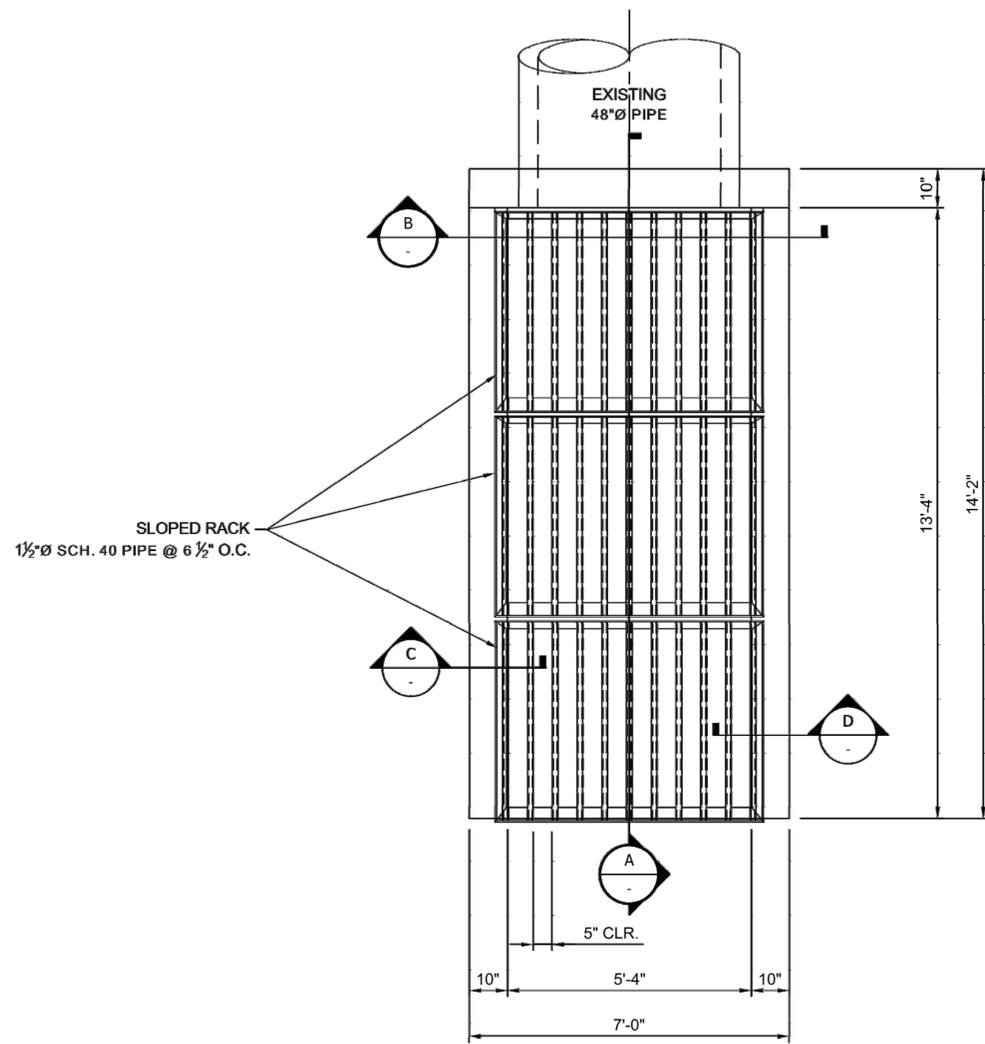
CALL UNCC
TWO WORKING DAYS
BEFORE YOU DIG
1-800-922-1987
UNCC.COM



CITY AND COUNTY OF DENVER
DEPARTMENT OF PUBLIC WORKS
ENGINEERING DIVISION
CAPITAL PROJECTS MANAGEMENT
2000 W. 3RD AVE. DENVER, CO 80223
TEL.: (303) 446-3617 FAX: (303) 446-3647

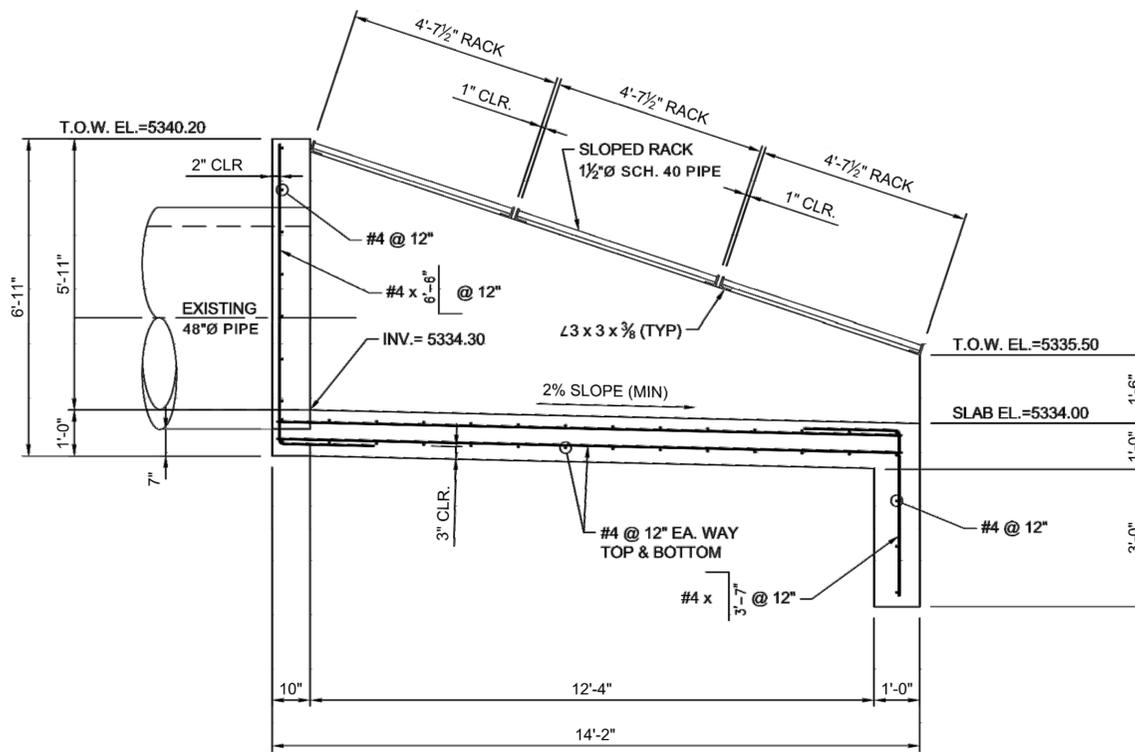
ASBURY & TEJON PARK
RETROFIT DESIGN
PRO TRACKING NO.: PWWW2017-004
PROJECT MASTER NO.: 2017-PROJMSTR-0000150
SOUTH POND INLET - STRUCTURE #3 DETAILS

DRAWN BY: KB
DESIGNED BY: JMM
APPROVED BY: JMM
DRAWING NAME:
DATE: SEPTEMBER 2018
SHEET NO.: S506



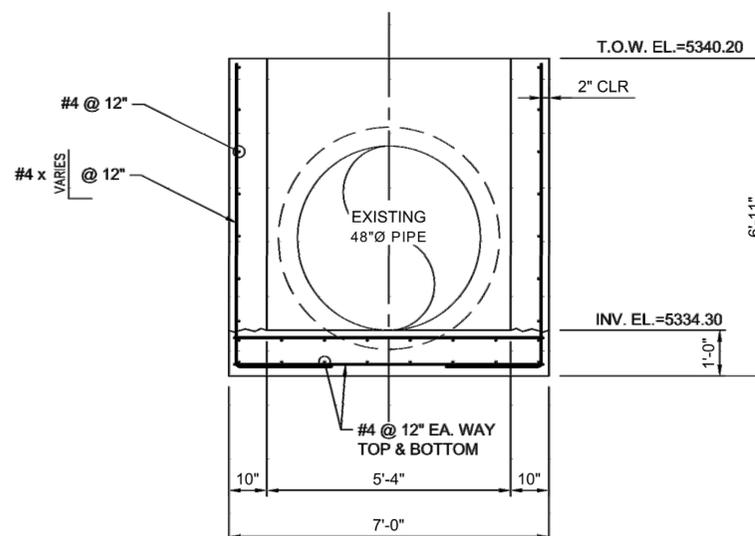
PLAN - SOUTH POND INLET - STRUCTURE #4

SCALE: 1/2" = 1'-0"



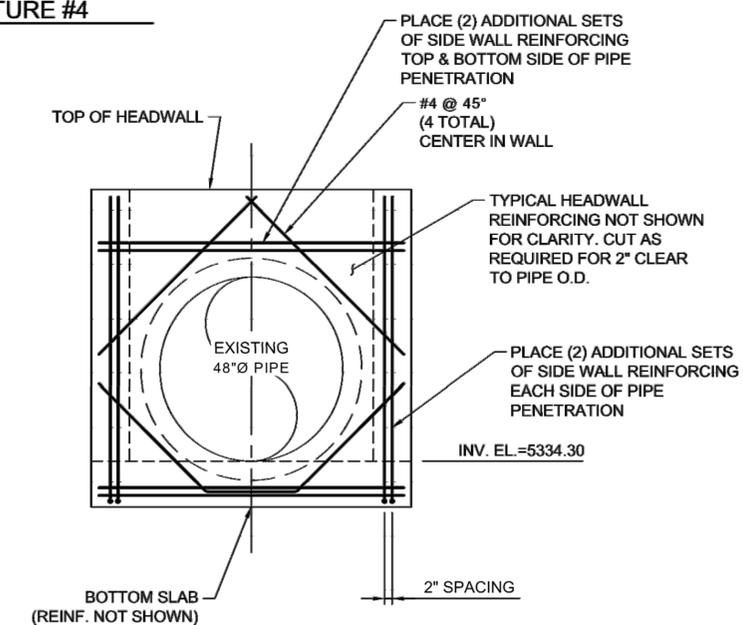
SECTION - SOUTH POND INLET - STRUCTURE #4

SCALE: 1/2" = 1'-0"



SECTION - SOUTH POND INLET - STRUCTURE #4

SCALE: 1/2" = 1'-0"



ELEVATION - HEADWALL REINFORCING

SCALE: 1/2" = 1'-0"

NO.	DESCRIPTION OF REVISIONS	DATE	BY

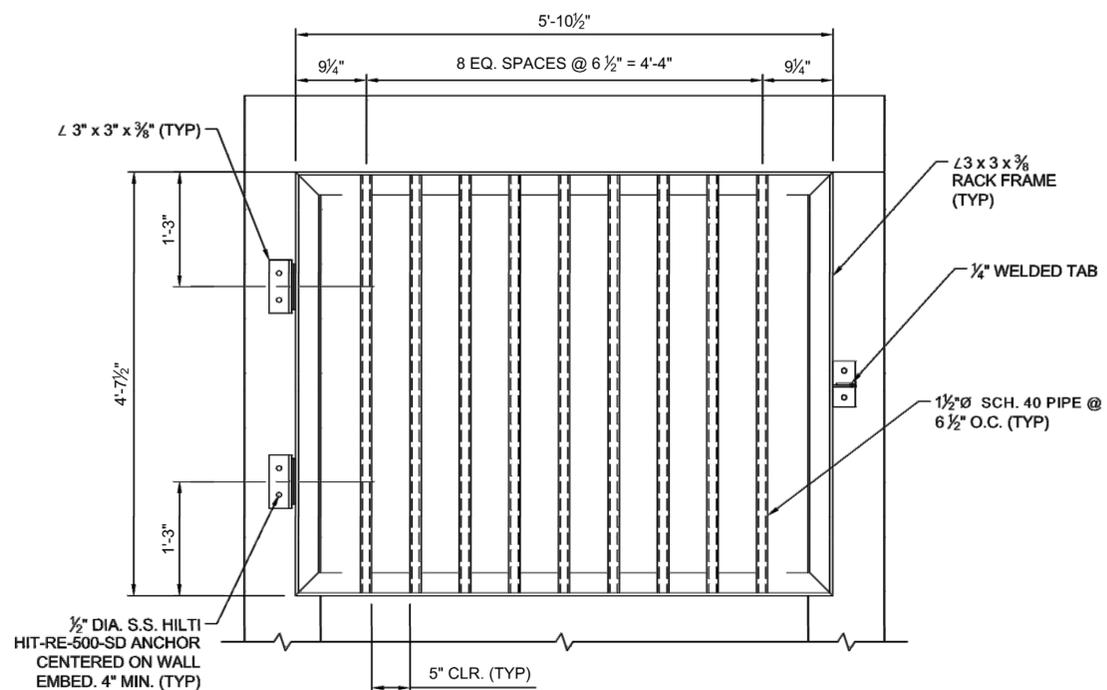
CALL UNCC
TWO WORKING DAYS
BEFORE YOU DIG
1-800-922-1987
UTILITY WORKERS UNION

CITY AND COUNTY OF DENVER
DEPARTMENT OF PUBLIC WORKS
ENGINEERING DIVISION
CAPITAL PROJECTS MANAGEMENT
2000 W. 3RD AVE. DENVER, CO 80223
TEL.: (303) 446-3617 FAX: (303) 446-3647

ASBURY & TEJON PARK
RETROFIT DESIGN
PRO TRACKING NO.: PWWW2017-004
PROJECT MASTER NO.: 2017-PROJMSTR-0000150
SOUTH POND INLET - STRUCTURE #4

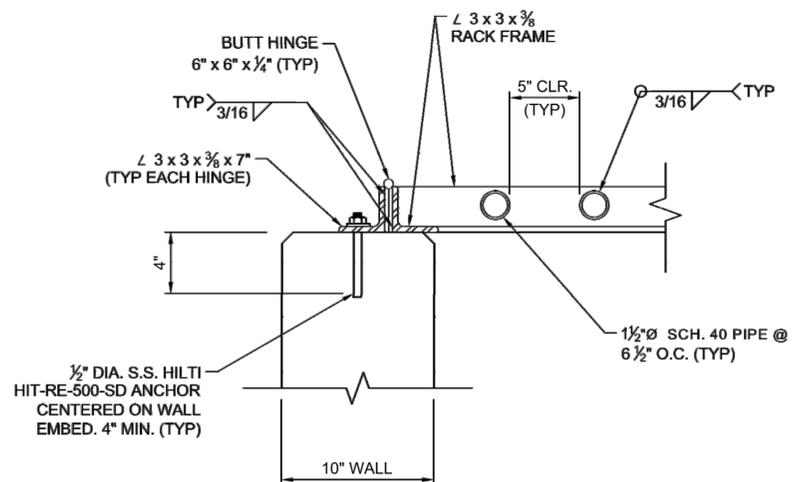
DRAWN BY:	KB
DESIGNED BY:	JMM
APPROVED BY:	JMM
DRAWING NAME:	
DATE:	SEPTEMBER 2018
SHEET NO.:	S507





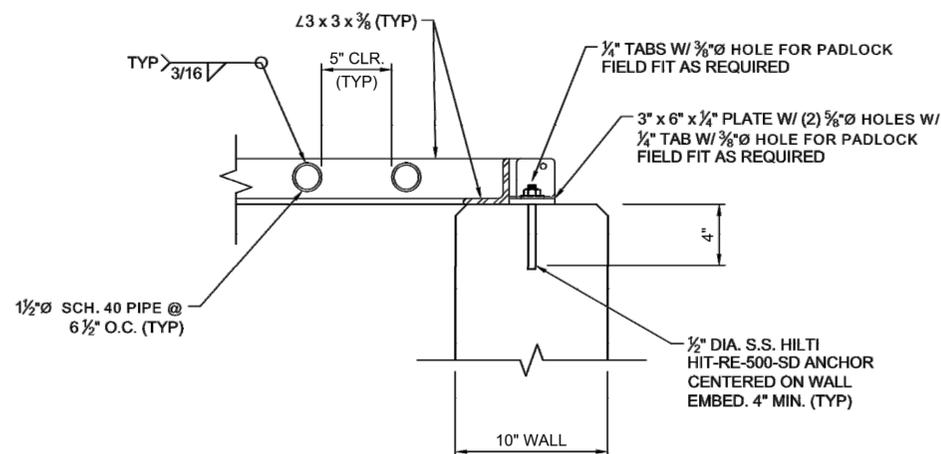
PLAN - SOUTH POND INLET - STRUCTURE #4 SAFETY GRATE

SCALE: 1" = 1'-0"



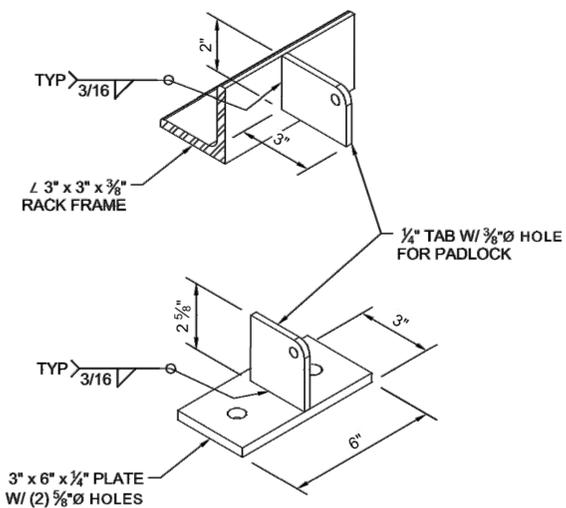
SECTION C - SLOPED RACK CONNECTION

SCALE: 2" = 1'-0"



SECTION D - SLOPED RACK SECURE CONNECTION

SCALE: 2" = 1'-0"



DETAIL - SLOPED RACK SECURE CONNECTION

SCALE: 1" = 1'-0"

SAFETY RACK NOTES

1. CONTRACTOR SHALL VERIFY ALL CONCRETE DIMENSIONS, LOCATIONS, AND ELEVATIONS PRIOR TO START OF RACK FABRICATION.
2. SHOP DRAWINGS FOR ALL STRUCTURAL STEEL FRAMING, GRATING, AND ATTACHMENTS SHALL BE SUBMITTED FOR APPROVAL PRIOR TO START OF FABRICATION.
3. THE SAFETY GRATES AND SECURE CONNECTION ASSEMBLY SHALL BE POWDER COATED "BLACK" FOLLOWING FABRICATION.
4. STRUCTURAL STEEL L SHAPES (ANGLES), AND STRUCTURAL PLATES, SHALL CONFORM TO ASTM A36.
5. STRUCTURAL TUBING MEMBERS SHALL CONFORM TO ASTM A500, GRADE B, AND PIPE ASTM A53, GRADE B.
6. ALL WELDING SHALL BE DONE USING E70XX ELECTRODES AND WELDING SHALL CONFORM TO AISC AND AWS D1.1. WHERE FILLET WELD SIZES ARE NOT SHOWN, PROVIDE THE MINIMUM SIZE PER TABLE J2.4 IN THE AISC "MANUAL OF STEEL CONSTRUCTION" 13TH EDITION.
7. HOLLOW STRUCTURAL STEEL TUBES SHALL BE FABRICATED WITH WEEP HOLES AT LOW ENDS FOR DRAINAGE.
8. HEAVY DUTY BUTT HINGES BY BATTALION, OR APPROVED EQUAL. BUTT HINGES SHALL BE MADE OF STEEL MATERIAL AND HAVE NON-REMOVABLE PINS.
9. POST-INSTALLED ANCHORS SHALL BE HILTI HIT-RE-500-SD ADHESIVE ANCHORS WITH HILTI HAS THREADED RODS AS MANUFACTURED BY HILTI NORTH AMERICA. ANCHORS IN EXTERIOR LOCATIONS SHALL BE STAINLESS STEEL HILTI HAS THREADED RODS. ADHESIVE ANCHORS SHALL BE FURNISHED AS A COMPLETE ASSEMBLY WITH ROD, NUTS, AND WASHER. EMBEDMENT OF ADHESIVE ANCHORS SHALL BE IN ACCORDANCE WITH MANUFACTURER'S SPECIFICATION FOR MINIMUM EMBEDMENT FOR ROD DIAMETER SHOWN ON DRAWINGS, UNLESS OTHERWISE SPECIFIED. ANCHORS SHALL BE INSTALLED IN ACCORDANCE WITH MANUFACTURER'S INSTRUCTIONS. OBSERVE MANUFACTURER RECOMMENDATIONS WITH RESPECT TO INSTALLATION TEMPERATURES FOR CARTRIDGE INJECTION ADHESIVE ANCHORS.

NO.	DISCUSSION OF REVISIONS	DATE	BY

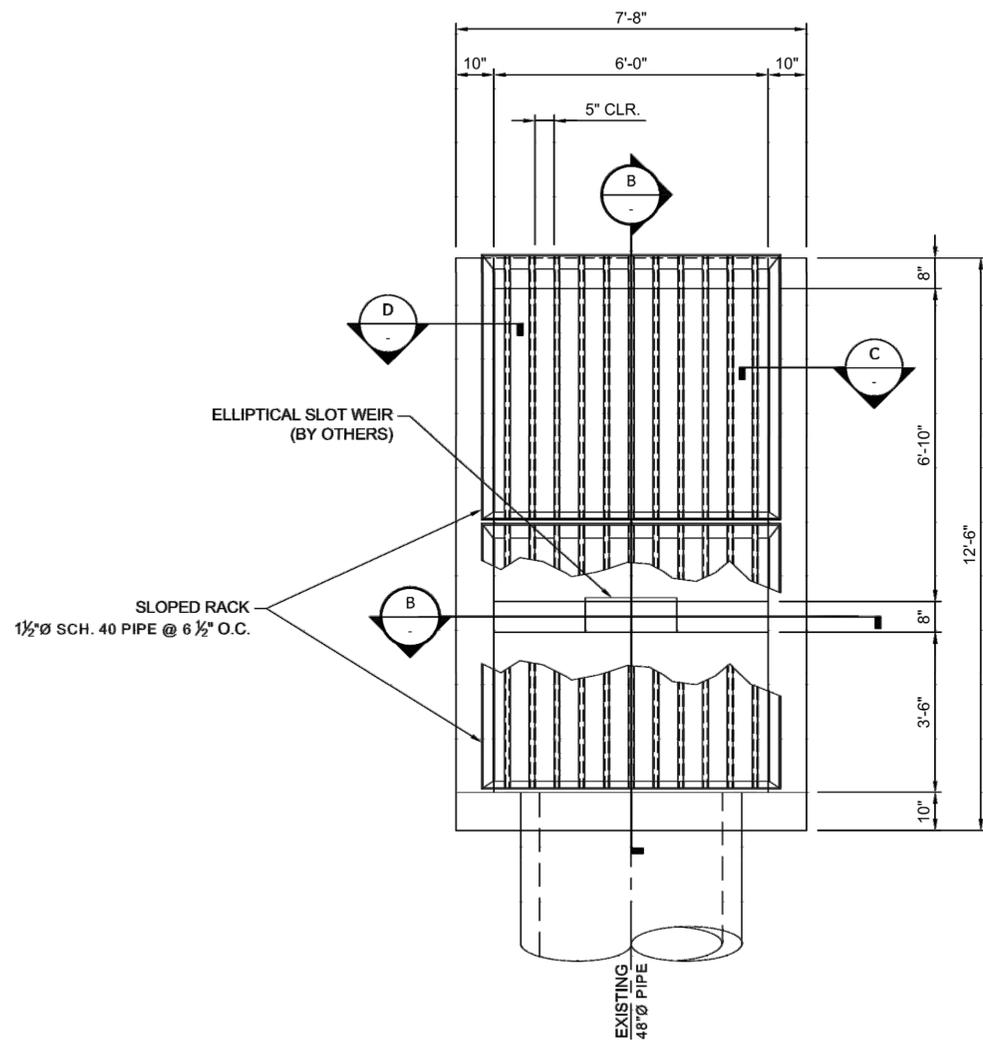
CALL UNCC
TWO WORKING DAYS
BEFORE YOU DIG
1-800-922-1987
UNCC.COM

CITY AND COUNTY OF DENVER
DEPARTMENT OF PUBLIC WORKS
ENGINEERING DIVISION
CAPITAL PROJECTS MANAGEMENT
2000 W. 3RD AVE. DENVER, CO 80223
TEL.: (303) 446-3617 FAX: (303) 446-3647

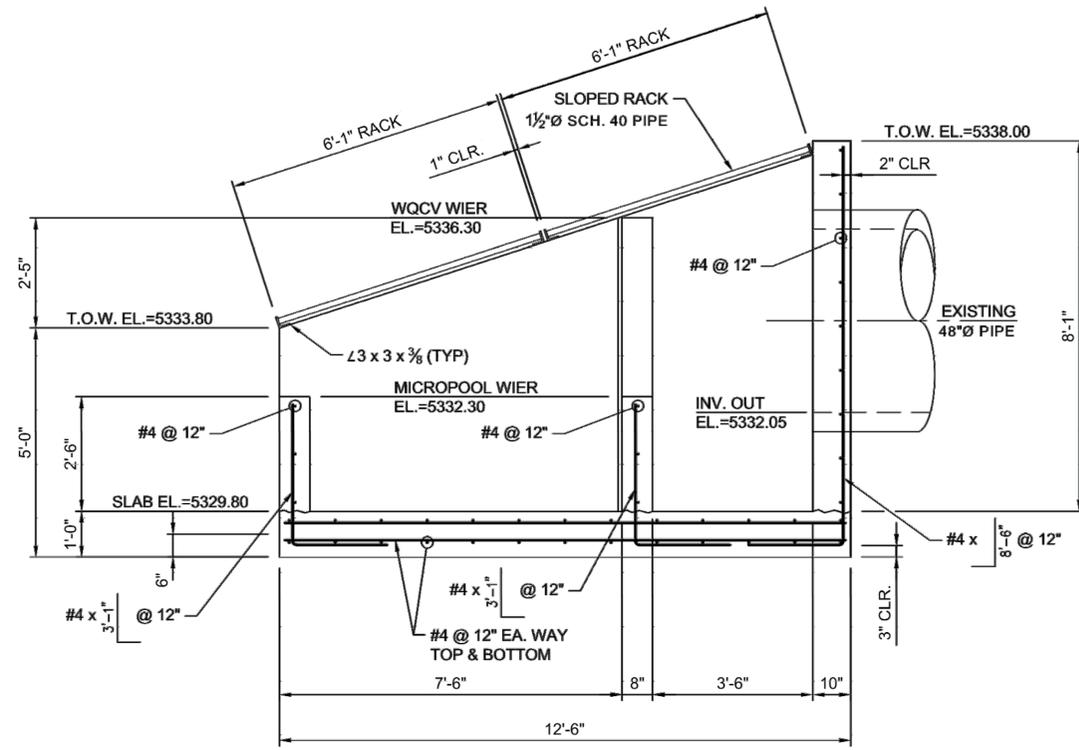
ASBURY & TEJON PARK
RETROFIT DESIGN
PRO TRACKING NO.: PWWW2017-004
PROJECT MASTER NO.: 2017-PROJMSTR-0000150
SOUTH POND INLET - STRUCTURE #4 DETAILS

DRAWN BY: KB
DESIGNED BY: JMM
APPROVED BY: JMM
DRAWING NAME:
DATE: SEPTEMBER 2018
SHEET NO.: S508

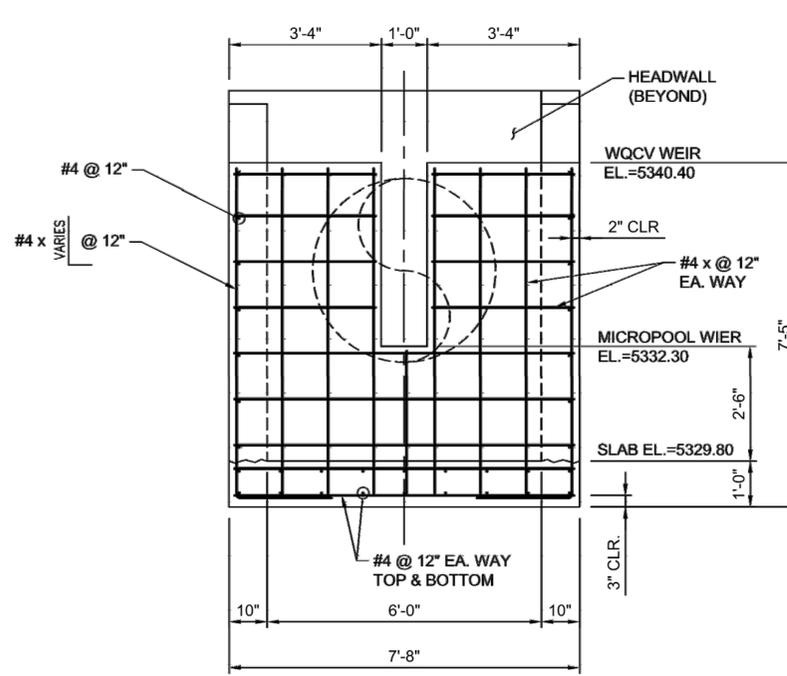




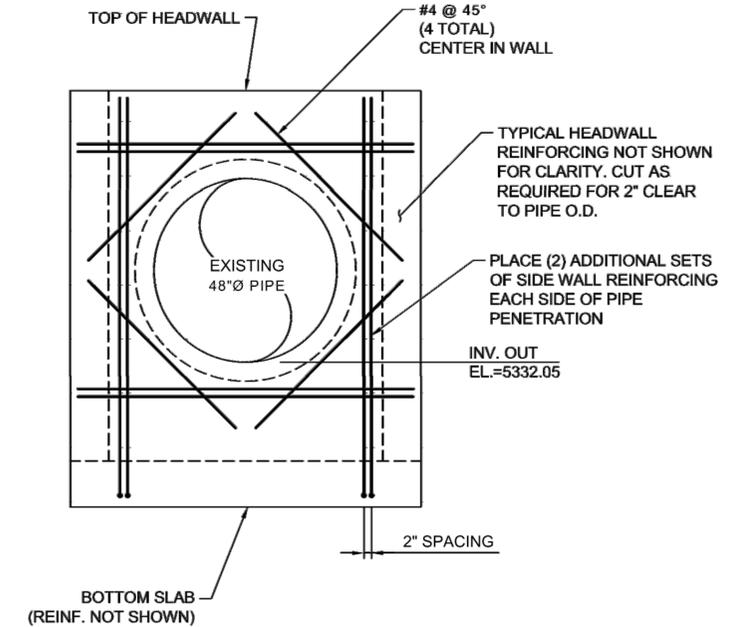
PLAN - SOUTH POND WATER QUALITY - STRUCTURE #5
SCALE: 1/2" = 1'-0"



SECTION - SOUTH POND WATER QUALITY - STRUCTURE #5
SCALE: 1/2" = 1'-0"



SECTION - SOUTH POND WATER QUALITY - STRUCTURE #5
SCALE: 1/2" = 1'-0"



ELEVATION - HEADWALL REINFORCING
SCALE: 1/2" = 1'-0"

NO.	DISCUSSION OF REVISIONS	DATE	BY

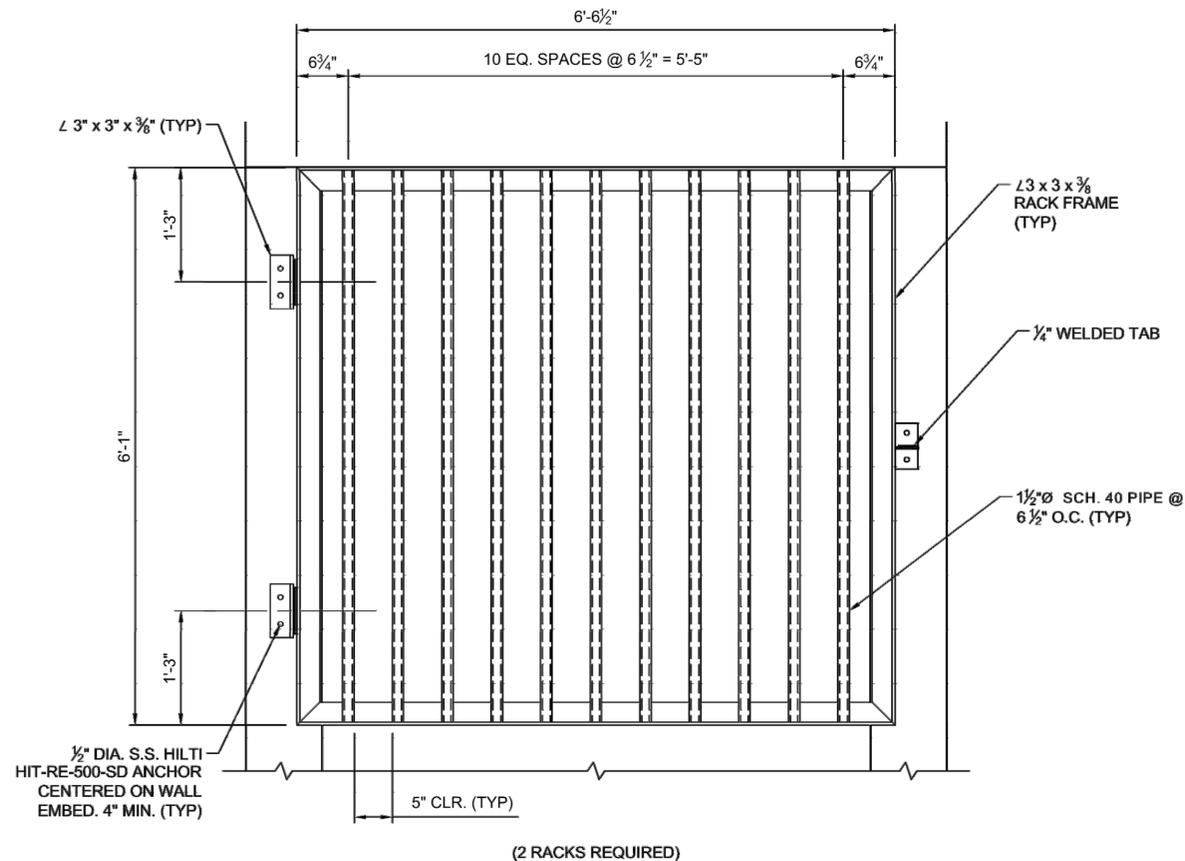
CALL UNCC
TWO WORKING DAYS
BEFORE YOU DIG
1-800-922-1987
UNCC QUALITY ASSURANCE

CITY AND COUNTY OF DENVER
DEPARTMENT OF PUBLIC WORKS
ENGINEERING DIVISION
CAPITAL PROJECTS MANAGEMENT
2000 W. 3RD AVE. DENVER, CO 80223
TEL.: (303) 446-3617 FAX: (303) 446-3647

**ASBURY & TEJON PARK
RETROFIT DESIGN**
PRO TRACKING NO.: PWWW2017-004
PROJECT MASTER NO.: 2017-PROJMSTR-0000150
SOUTH POND WATER QUALITY - STRUCTURE #5

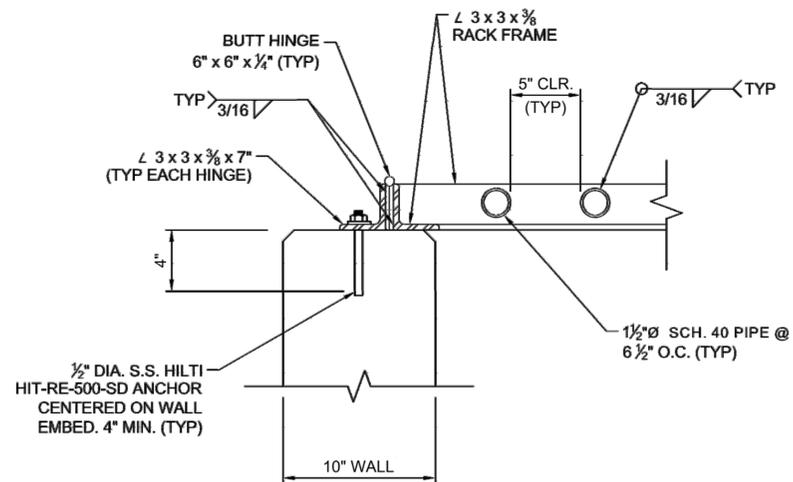
DRAWN BY:	KB
DESIGNED BY:	JMM
APPROVED BY:	JMM
DRAWING NAME:	
DATE:	SEPTEMBER 2018
SHEET NO.:	S509





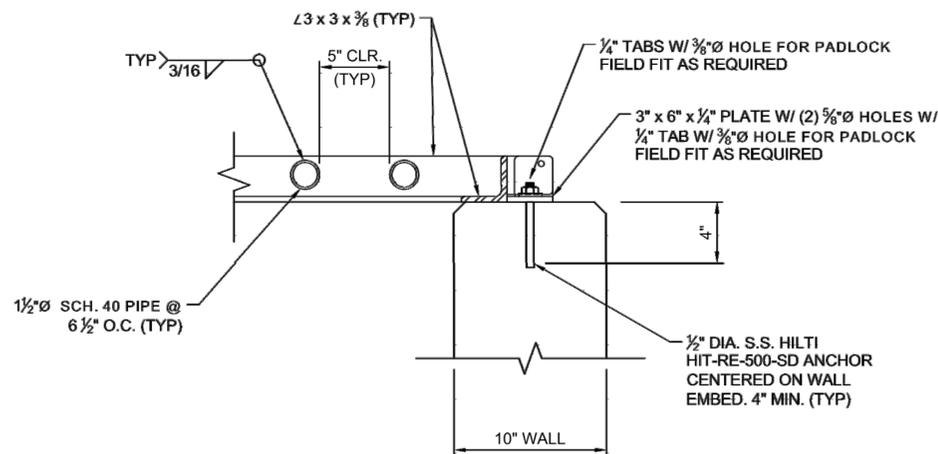
PLAN - SOUTH POND WATER QUALITY - STRUCTURE #5 SAFETY GRATE

SCALE: 1" = 1'-0"



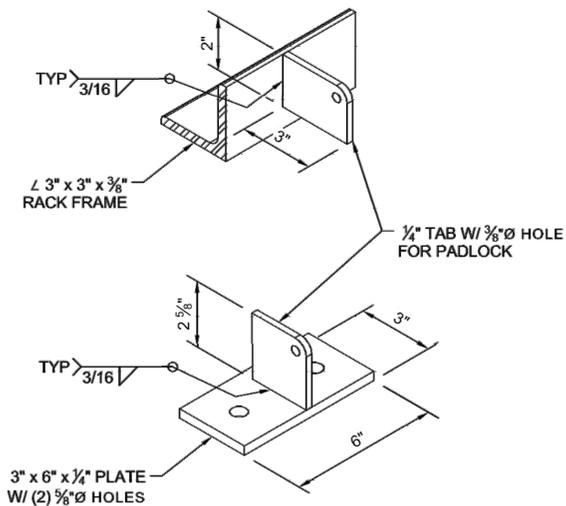
C SECTION - SLOPED RACK CONNECTION

S5500 SCALE: 2" = 1'-0"



D SECTION - SLOPED RACK SECURE CONNECTION

S5500 SCALE: 2" = 1'-0"



DETAIL - SLOPED RACK SECURE CONNECTION

SCALE: 1" = 1'-0"

SAFETY RACK NOTES

1. CONTRACTOR SHALL VERIFY ALL CONCRETE DIMENSIONS, LOCATIONS, AND ELEVATIONS PRIOR TO START OF RACK FABRICATION.
2. SHOP DRAWINGS FOR ALL STRUCTURAL STEEL FRAMING, GRATING, AND ATTACHMENTS SHALL BE SUBMITTED FOR APPROVAL PRIOR TO START OF FABRICATION.
3. THE SAFETY GRATES AND SECURE CONNECTION ASSEMBLY SHALL BE POWDER COATED "BLACK" FOLLOWING FABRICATION.
4. STRUCTURAL STEEL L SHAPES (ANGLES), AND STRUCTURAL PLATES, SHALL CONFORM TO ASTM A36.
5. STRUCTURAL TUBING MEMBERS SHALL CONFORM TO ASTM A500, GRADE B, AND PIPE ASTM A53, GRADE B.
6. ALL WELDING SHALL BE DONE USING E70XX ELECTRODES AND WELDING SHALL CONFORM TO AISC AND AWS D1.1. WHERE FILLET WELD SIZES ARE NOT SHOWN, PROVIDE THE MINIMUM SIZE PER TABLE J2.4 IN THE AISC "MANUAL OF STEEL CONSTRUCTION" 13TH EDITION.
7. HOLLOW STRUCTURAL STEEL TUBES SHALL BE FABRICATED WITH WEEP HOLES AT LOW ENDS FOR DRAINAGE.
8. HEAVY DUTY BUTT HINGES BY BATTALION, OR APPROVED EQUAL. BUTT HINGES SHALL BE MADE OF STEEL MATERIAL AND HAVE NON-REMOVABLE PINS.
9. POST-INSTALLED ANCHORS SHALL BE HILTI HIT-RE-500-SD ADHESIVE ANCHORS WITH HILTI HAS THREADED RODS AS MANUFACTURED BY HILTI NORTH AMERICA. ANCHORS IN EXTERIOR LOCATIONS SHALL BE STAINLESS STEEL HILTI HAS THREADED RODS. ADHESIVE ANCHORS SHALL BE FURNISHED AS A COMPLETE ASSEMBLY WITH ROD, NUTS, AND WASHER. EMBEDMENT OF ADHESIVE ANCHORS SHALL BE IN ACCORDANCE WITH MANUFACTURER'S SPECIFICATION FOR MINIMUM EMBEDMENT FOR ROD DIAMETER SHOWN ON DRAWINGS, UNLESS OTHERWISE SPECIFIED. ANCHORS SHALL BE INSTALLED IN ACCORDANCE WITH MANUFACTURER'S INSTRUCTIONS. OBSERVE MANUFACTURER RECOMMENDATIONS WITH RESPECT TO INSTALLATION TEMPERATURES FOR CARTRIDGE INJECTION ADHESIVE ANCHORS.

NO.	DESCRIPTION OF REVISIONS	DATE	BY

CALL UNCC
TWO WORKING DAYS
BEFORE YOU DIG
1-800-922-1987
UNCC.COM



CITY AND COUNTY OF DENVER
DEPARTMENT OF PUBLIC WORKS
ENGINEERING DIVISION
CAPITAL PROJECTS MANAGEMENT
2000 W. 3RD AVE. DENVER, CO 80223
TEL.: (303) 446-3617 FAX: (303) 446-3647

ASBURY & TEJON PARK
RETROFIT DESIGN
PRO TRACKING NO.: PWWW2017-004
PROJECT MASTER NO.: 2017-PROJMSTR-0000150
SOUTH POND WATER QUALITY - STRUCTURE #5 DETAILS

DRAWN BY:	KB
DESIGNED BY:	JMM
APPROVED BY:	JMM
DRAWING NAME:	
DATE:	SEPTEMBER 2018
SHEET NO.:	S510

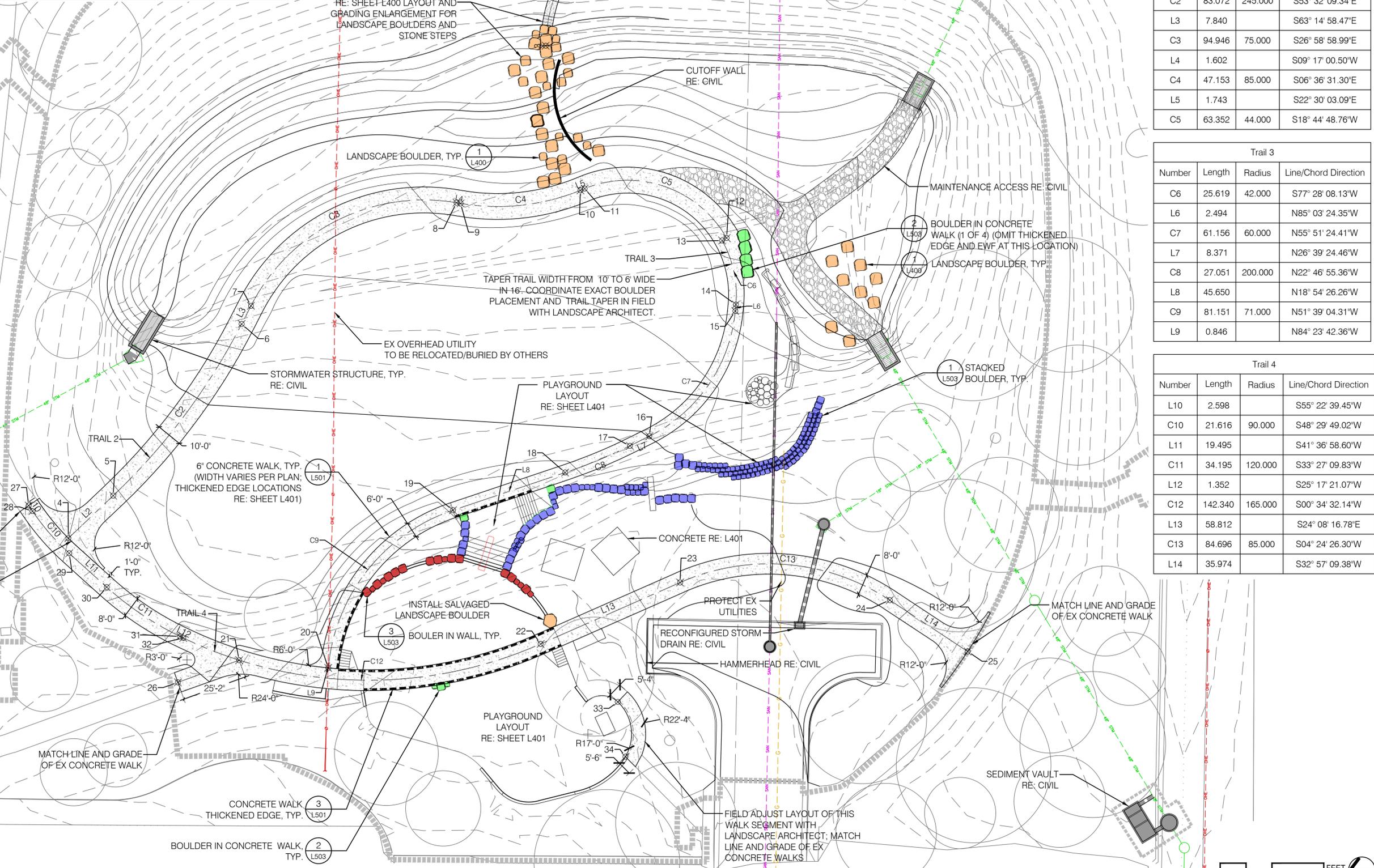


Z:\CLIENT FOLDERS\ACTIVE PROJECTS\0271-LDPR ON CALL RESTORATION SERVICES\02 ASBURY & TEJON PARK\07-CAD\PLANS\ASBURY\01-LAND LAYOUT-L100.DWG

Point #	Northing	Easting
1	372511.8542	568136.3802
2	372527.7193	568120.1306
3	372544.7840	568078.9186
4	372727.7187	567887.9657
5	372710.5310	567904.4610
6	372661.3958	567970.9505
7	372657.8669	567977.9516
8	372578.7948	568018.2114
9	372577.2135	568017.9530
10	372530.9721	568023.3104
11	372529.3615	568023.9776
12	372474.4197	568005.3307
13	372476.1517	568004.3305
14	372470.6790	567979.7080
15	372470.8939	567977.2238
16	372503.7520	567928.7713
17	372511.2332	567925.0157
18	372536.1547	567914.5489
19	372579.3412	567899.7567
20	372627.0777	567838.6805
21	372661.4748	567841.4200
22	372545.1593	567848.4583
23	372491.4894	567872.5088
24	372410.4945	567866.2662
25	372380.3076	567846.6981
26	372685.0578	567832.7222
27	372743.1168	567900.4435
28	372741.6408	567898.3057
29	372727.3510	567882.1557
30	372712.7765	567869.2085
31	372684.3423	567850.4220
32	372683.1196	567849.8443
33	372515.2338	567826.3459
34	372512.1420	567805.2552

BOULDER LEGEND

- STACKED BOULDER, 30" 1
L503
- BOULDER IN WALL, SIZE VARIES, 36"-42" 3
L503
- BOULDER IN CONCRETE WALK, SIZE VARIES, 30"-36" 2
L503
- LANDSCAPE BOULDER, SIZE VARIES 24"-48" 1
L400



LINE AND CURVE TABLES

Trail 1			
Number	Length	Radius	Line/Chord Direction
L1	22.710		N45° 41' 09.25"W
C1	45.702	60.000	N67° 30' 25.44"W

Trail 2			
Number	Length	Radius	Line/Chord Direction
L2	23.822		S43° 49' 20.22"E
C2	83.072	245.000	S53° 32' 09.34"E
L3	7.840		S63° 14' 58.47"E
C3	94.946	75.000	S26° 58' 58.99"E
L4	1.602		S09° 17' 00.50"W
C4	47.153	85.000	S06° 36' 31.30"E
L5	1.743		S22° 30' 03.09"E
C5	63.352	44.000	S18° 44' 48.76"W

Trail 3			
Number	Length	Radius	Line/Chord Direction
C6	25.619	42.000	S77° 28' 08.13"W
L6	2.494		N85° 03' 24.35"W
C7	61.156	60.000	N55° 51' 24.41"W
L7	8.371		N26° 39' 24.46"W
C8	27.051	200.000	N22° 46' 55.36"W
L8	45.650		N18° 54' 26.26"W
C9	81.151	71.000	N51° 39' 04.31"W
L9	0.846		N84° 23' 42.36"W

Trail 4			
Number	Length	Radius	Line/Chord Direction
L10	2.598		S55° 22' 39.45"W
C10	21.616	90.000	S48° 29' 49.02"W
L11	19.495		S41° 36' 58.60"W
C11	34.195	120.000	S33° 27' 09.83"W
L12	1.352		S25° 17' 21.07"W
C12	142.340	165.000	S00° 34' 32.14"W
L13	58.812		S24° 08' 16.78"E
C13	84.696	85.000	S04° 24' 26.30"W
L14	35.974		S32° 57' 09.38"W

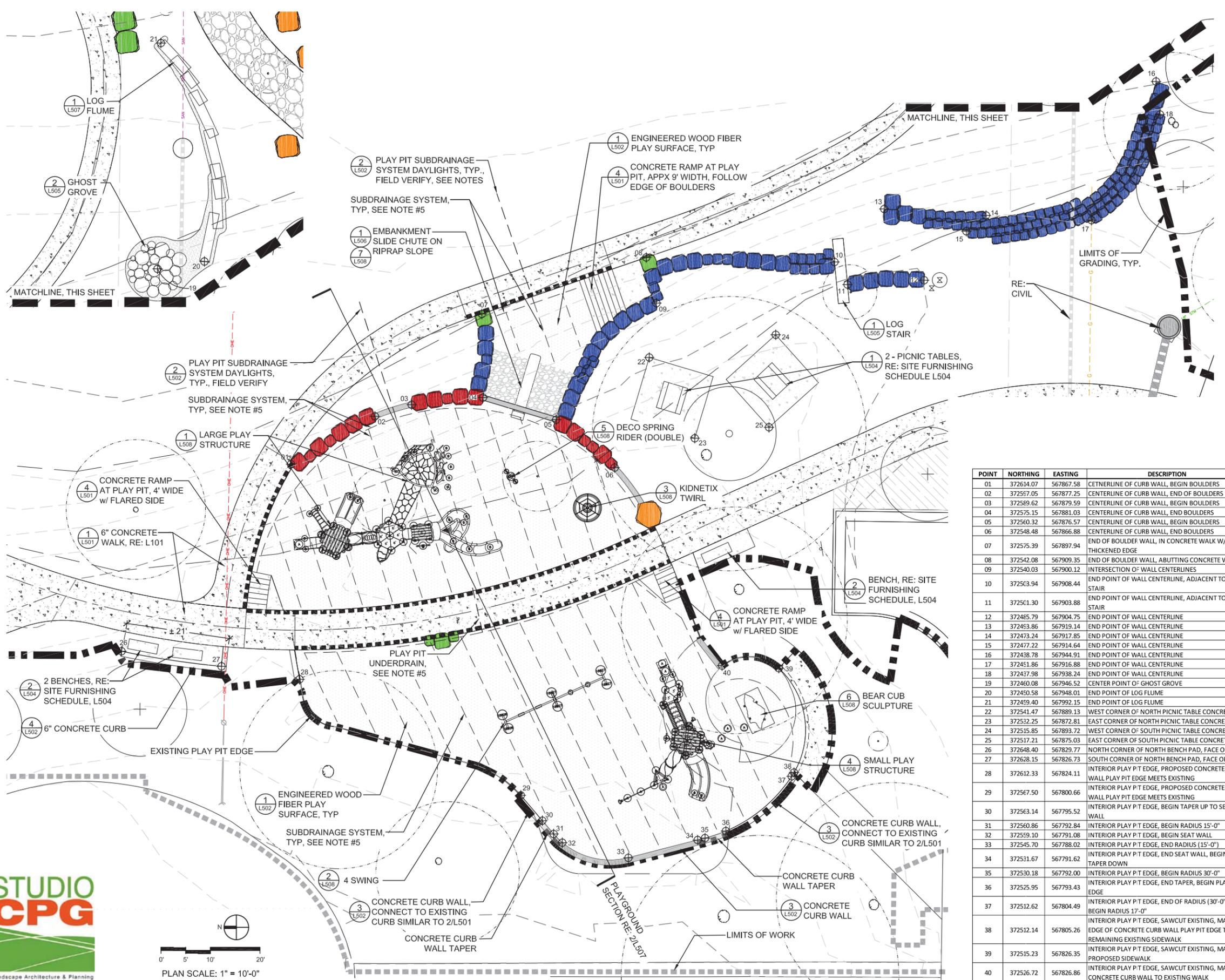
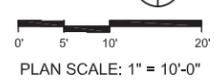
DATE		BY	
DESCRIPTION OF REVISIONS			
NO.			
CALL UNCC TWO WORKING DAYS BEFORE YOU DIG 1-800-922-1987 UTILITY SERVICES CENTER OF COLORADO			
CITY AND COUNTY OF DENVER DEPARTMENT OF PUBLIC WORKS AND DEPARTMENT OF PARKS AND RECREATION 201 WEST COLFAX AVE. DENVER, CO 80202 TEL.: (720) 913-1311			
ASBURY & TEJON PARK RETROFIT DESIGN PRO TRACKING NO: PWWW2017-004 PROJECT MASTER NO: 2017-PROJUMSTR-0000150 TRAIL LAYOUT PLAN			
DRAWN BY:		MK/CL	
DESIGNED BY:		CL	
APPROVED BY:		LG	
DRAWING NAME:		TRAIL LAYOUT PLAN	
DATE:		SEPTEMBER 2018	
SHEET NO.:		L101	

WASBURY AVE

ENVIRONMENT • DESIGN
 1435 LARIMER ST, SUITE 200
 DENVER, CO 80202



\\SERVER\CPG_PROJECTS\ASBURY TEJON\CAD\ASBURY & TEJON - L0.DWG
 PLOT DATE: September 19, 2018



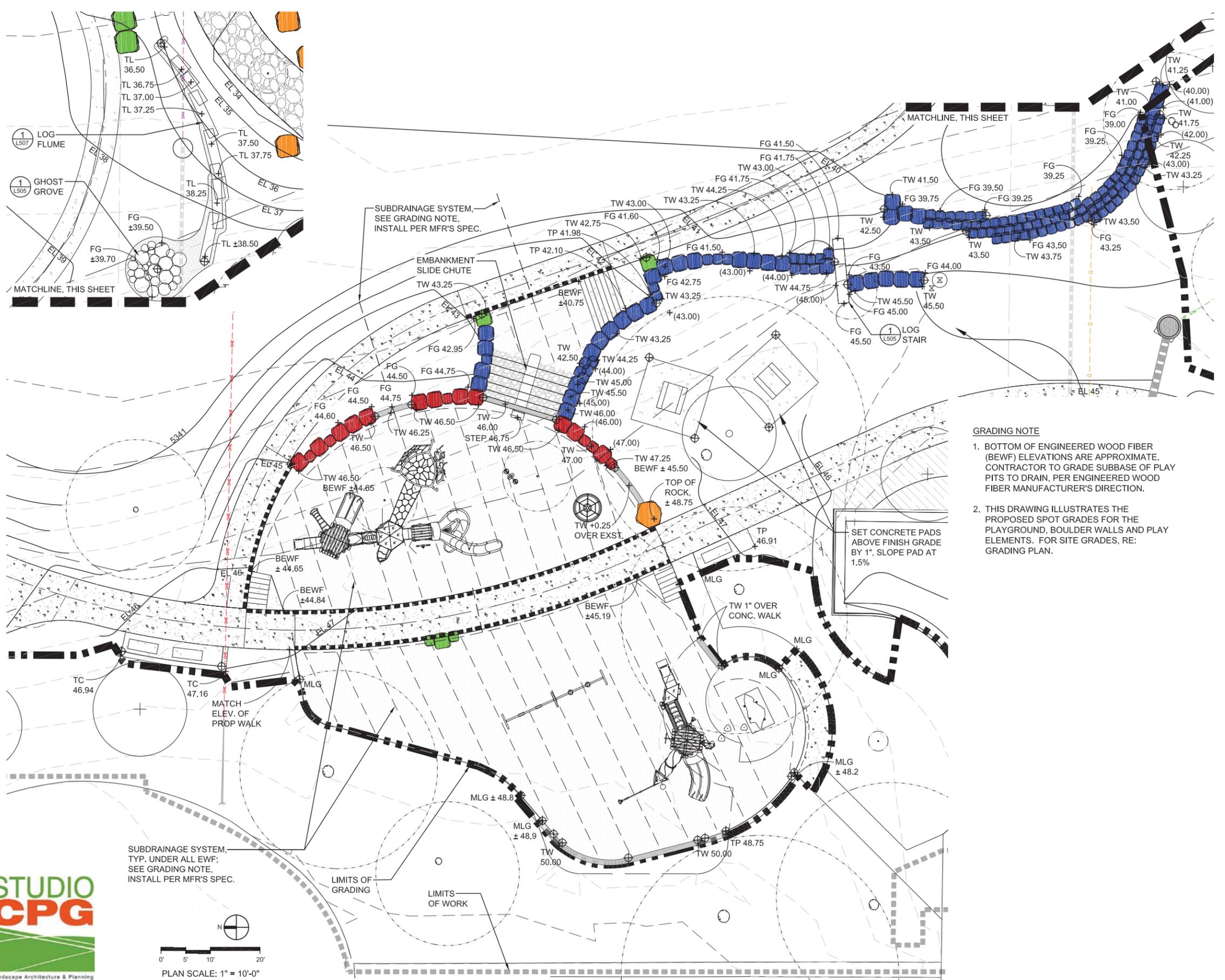
- PLANTING LEGEND**
RE: PLANTING PLAN
- PROPOSED DECIDUOUS TREE
 - PROPOSED SHRUBS
 - EXISTING TREE DRIP LINE
 - LIMITS OF WORK
 - LIMITS OF GRADING
- MATERIAL LEGEND**
- CONCRETE PAVING RE: LANDSCAPE (L502)
 - ENGINEERED WOOD FIBER (L502)
 - CONCRETE CURB WALL (L502)
 - CONCRETE WALK WITH ONE THICKENED EDGE (L501)
 - CONCRETE WALK WITH TWO THICKENED EDGES (L501)
 - RIPRAP SLOPE
 - SUBDRAINAGE SYSTEM, SEE NOTE #5
- BOULDER LEGEND**
- STACKED BOULDER, 30" (L503)
 - BOULDER IN WALL SIZE VARIES, 36" - 42" (L503)
 - BOULDER IN CONCRETE WALK SIZE VARIES, 30" - 36" (L503)
 - LANDSCAPE BOULDER (L400)
 - LANDSCAPE BOULDER (NORTH POND SEDIMENT PAD - SEE DETAIL SHEET C110)

POINT	NORTHING	EASTING	DESCRIPTION
01	372614.07	567867.58	CENTERLINE OF CURB WALL, BEGIN BOULDERS
02	372557.05	567877.25	CENTERLINE OF CURB WALL, END OF BOULDERS
03	372569.62	567879.59	CENTERLINE OF CURB WALL, BEGIN BOULDERS
04	372575.15	567881.03	CENTERLINE OF CURB WALL, END BOULDERS
05	372560.32	567876.57	CENTERLINE OF CURB WALL, BEGIN BOULDERS
06	372548.48	567866.88	CENTERLINE OF CURB WALL, END BOULDERS
07	372575.39	567897.94	END OF BOULDER WALL, IN CONCRETE WALK w/ THICKENED EDGE
08	372542.08	567909.35	END OF BOULDER WALL, ABUTTING CONCRETE WALK
09	372540.03	567900.12	INTERSECTION OF WALL CENTERLINES
10	372533.94	567908.44	END POINT OF WALL CENTERLINE, ADJACENT TO LOG STAIR
11	372531.30	567903.88	END POINT OF WALL CENTERLINE, ADJACENT TO LOG STAIR
12	372485.79	567904.75	END POINT OF WALL CENTERLINE
13	372453.86	567919.14	END POINT OF WALL CENTERLINE
14	372473.24	567917.85	END POINT OF WALL CENTERLINE
15	372477.22	567914.64	END POINT OF WALL CENTERLINE
16	372438.78	567944.91	END POINT OF WALL CENTERLINE
17	372451.86	567916.88	END POINT OF WALL CENTERLINE
18	372437.98	567938.24	END POINT OF WALL CENTERLINE
19	372460.08	567946.52	CENTER POINT OF GHOST GROVE
20	372450.58	567948.01	END POINT OF LOG FLUME
21	372459.40	567992.15	END POINT OF LOG FLUME
22	372541.47	567889.13	WEST CORNER OF NORTH PICNIC TABLE CONCRETE PAD
23	372532.25	567872.81	EAST CORNER OF NORTH PICNIC TABLE CONCRETE PAD
24	372515.85	567893.72	WEST CORNER OF SOUTH PICNIC TABLE CONCRETE PAD
25	372517.21	567875.03	EAST CORNER OF SOUTH PICNIC TABLE CONCRETE PAD
26	372648.40	567829.77	NORTH CORNER OF NORTH BENCH PAD, FACE OF CURB
27	372628.15	567826.73	SOUTH CORNER OF NORTH BENCH PAD, FACE OF CURB
28	372612.33	567824.11	INTERIOR PLAY PIT EDGE, PROPOSED CONCRETE CURB WALL PLAY PIT EDGE MEETS EXISTING
29	372567.50	567800.66	INTERIOR PLAY PIT EDGE, PROPOSED CONCRETE CURB WALL PLAY PIT EDGE MEETS EXISTING
30	372563.14	567795.52	INTERIOR PLAY PIT EDGE, BEGIN TAPER UP TO SEAT WALL
31	372560.86	567792.84	INTERIOR PLAY PIT EDGE, BEGIN RADIUS 15'-0"
32	372559.10	567791.08	INTERIOR PLAY PIT EDGE, BEGIN SEAT WALL
33	372545.70	567788.02	INTERIOR PLAY PIT EDGE, END RADIUS (15'-0")
34	372531.67	567791.62	INTERIOR PLAY PIT EDGE, END SEAT WALL, BEGIN TAPER DOWN
35	372530.18	567792.00	INTERIOR PLAY PIT EDGE, BEGIN RADIUS 30'-0"
36	372525.95	567793.43	INTERIOR PLAY PIT EDGE, END TAPER, BEGIN PLAY PIT EDGE
37	372512.62	567804.49	INTERIOR PLAY PIT EDGE, END OF RADIUS (30'-0"), BEGIN RADIUS 17'-0"
38	372512.14	567805.26	INTERIOR PLAY PIT EDGE, SAWCUT EXISTING, MATCH EDGE OF CONCRETE CURB WALL PLAY PIT EDGE TO REMAINING EXISTING SIDEWALK
39	372515.23	567826.35	INTERIOR PLAY PIT EDGE, SAWCUT EXISTING, MATCH PROPOSED SIDEWALK
40	372526.72	567826.86	INTERIOR PLAY PIT EDGE, SAWCUT EXISTING, MATCH CONCRETE CURB WALL TO EXISTING WALK

- LAYOUT NOTES:**
- SEE CIVIL PLANS FOR ADDITIONAL INFORMATION.
 - SEE SHEET L.101 FOR BOULDER CALL-OUTS. SEE L.501 AND L.503 FOR ADDITIONAL BOULDER INFORMATION AND DETAIL.
 - FIELD VERIFY EXISTING CONDITIONS. NOTIFY PROJECT MANAGER WHEN DISCREPANCIES EXIST.
 - REFER TO LANDSCAPE LAYOUT AND GRADING PLANS FOR ADDITIONAL INFORMATION.
 - QUALIFIED PLAY EQUIPMENT INSTALLER TO PROVIDE SHOP DRAWINGS OF AS-BUILT PLAY PIT, INCLUDING DIMENSIONS, ON PLAYGROUND LAYOUT PLAN, RE: SPECIFICATIONS.
 - PLAY PIT SUBDRAINAGE SYSTEM TO BE INSTALLED PER MANUFACTURER SPECIFICATION.

CITY AND COUNTY OF DENVER DEPARTMENT OF PUBLIC WORKS AND DEPARTMENT OF PARKS AND RECREATION 201 WEST COLFAX AVE. DENVER, CO 80202 TEL.: (720) 913-1311	CALL UNCC TWO WORKING DAYS BEFORE YOU DIG 1-800-952-1987 UTILITY WARNING CENTER OF
ASBURY & TEJON PARK RETROFIT DESIGN PRO TRACKING NO: PWWW 2017 - 004 PROJECT MASTER NO: 2017-PROJ.MSTR-0000150 PLAYGROUND LAYOUT	DRAWN BY: BP DESIGNED BY: BG APPROVED BY: IMF DRAWING NAME: PLAYGROUND LAYOUT DATE: SEPTEMBER 2018 SHEET NO.: L401

\\SERVER\CPG_PROJECTS\ASBURY TEJON\CAD\ASBURY & TEJON - LO.DWG PLOT DATE: September 21, 2018



- GRADING LEGEND**
- XX.XX PROPOSED GRADE
 - (XX.XX) EXISTING GRADE
 - MLG MATCH EXISTING LINE & GRADE
 - FG FINISH GRADE
 - TC TOP OF CURB
 - TL TOP OF LOG
 - TP TOP OF PAVEMENT
 - TW TOP OF WALL
 - BEWF BOTTOM OF ENG. WOOD FIBER
 - LIMITS OF WORK
 - LIMITS OF GRADING

- MATERIAL LEGEND**
- CONCRETE PAVING RE: LANDSCAPE
 - ENGINEERED WOOD FIBER (1 L502)
 - CONCRETE CURB WALL (3 L502)
 - CONCRETE WALK WITH ONE THICKENED EDGE (3 L501)
 - CONCRETE WALK WITH TWO THICKENED EDGES (3 L501)
 - RIPRAP SLOPE
 - SUBDRAINAGE SYSTEM, SEE NOTE #5

- GRADING NOTE**
1. BOTTOM OF ENGINEERED WOOD FIBER (BEWF) ELEVATIONS ARE APPROXIMATE. CONTRACTOR TO GRADE SUBBASE OF PLAY PITS TO DRAIN, PER ENGINEERED WOOD FIBER MANUFACTURER'S DIRECTION.
 2. THIS DRAWING ILLUSTRATES THE PROPOSED SPOT GRADES FOR THE PLAYGROUND, BOULDER WALLS AND PLAY ELEMENTS. FOR SITE GRADES, RE: GRADING PLAN.

- BOULDER LEGEND**
- STACKED BOULDER, 30" (1 L503)
 - BOULDER IN WALL SIZE VARIES, 36" - 42" (3 L503)
 - BOULDER IN CONCRETE WALK SIZE VARIES, 30" - 36" (2 L503)
 - LANDSCAPE BOULDER (1 L400)
 - LANDSCAPE BOULDER (NORTH POND SEDIMENT PAD - SEE DETAIL SHEET C110)

SUBDRAINAGE SYSTEM, TYP. UNDER ALL EWF; SEE GRADING NOTE, INSTALL PER MFR'S SPEC.



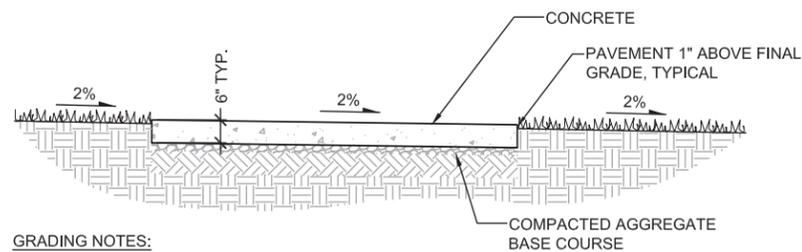
NO.	DESCRIPTION OF REVISIONS	DATE	BY

CALL UNCC TWO WORKING DAYS BEFORE YOU DIG
1-800-922-1987
UTILITY WORK CENTER OF DENVER

CITY AND COUNTY OF DENVER
DEPARTMENT OF PUBLIC WORKS AND DEPARTMENT OF PARKS AND RECREATION
201 WEST COLFAX AVE. DENVER, CO 80202
TEL.: (720) 913-1311

ASBURY & TEJON PARK
RETROFIT DESIGN
PRO TRACKING NO: PWWW 2017 - 004
PROJECT MASTER NO: 2017-PROJMASTER-0000150
PLAYGROUND GRADING

DRAWN BY: BP
DESIGNED BY: BG
APPROVED BY: IMF
DRAWING NAME: PLAYGROUND GRADING
DATE: SEPTEMBER 2018
SHEET NO.: L402



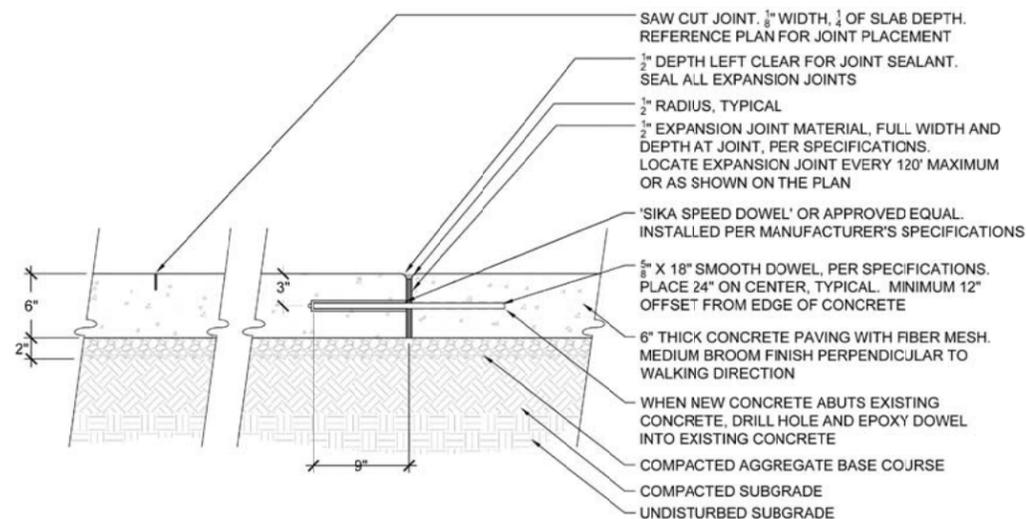
GRADING NOTES:

1. MAINTAIN 2% SLOPE FROM TOP OF SIDEWALK TO CURB
2. 1.5% MINIMUM, 2% MAXIMUM CROSS SLOPE FOR SIDEWALK
3. LONGITUDINAL SLOPE NOT TO EXCEED 4.9%

LAYOUT NOTE:

1. TRAIL WIDTH VARIES, RE: SHEET L101

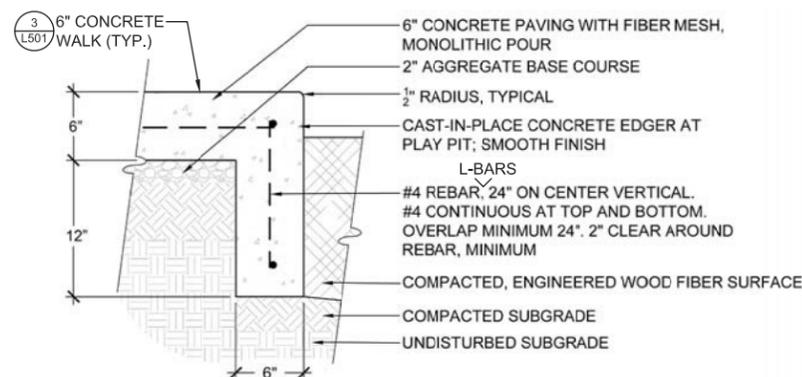
1 6" CONCRETE WALK
L501 SECTION NTS



NOTE:

1. REFER TO SPECIFICATIONS FOR ALL MATERIALS CALLED OUT IN DETAIL

2 CONCRETE JOINT
L501 SECTION N.T.S.

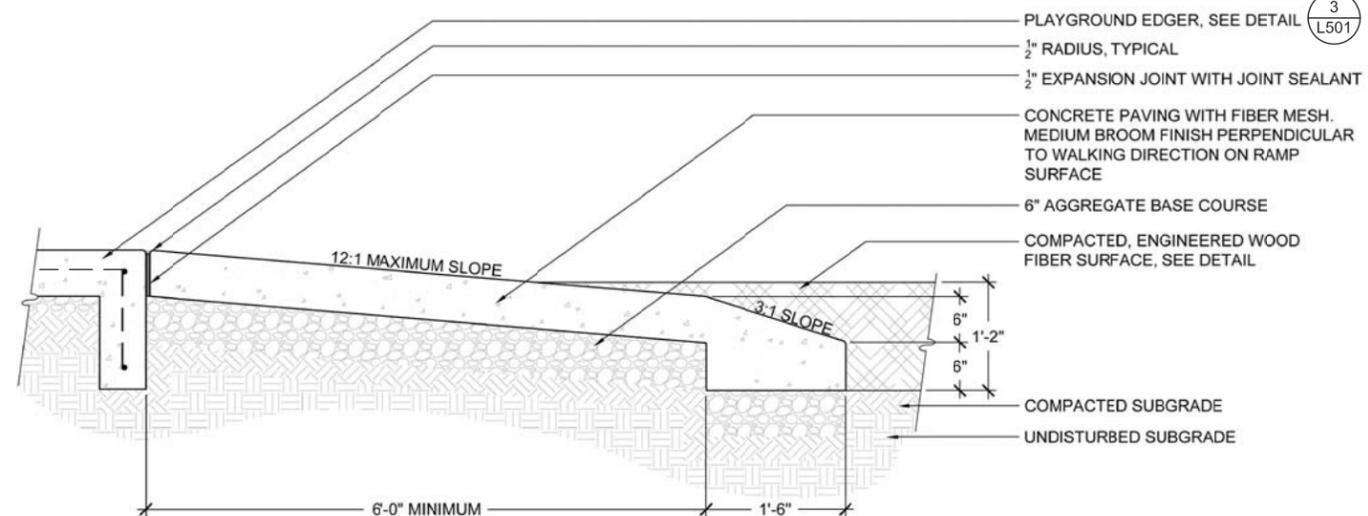


NOTES:

JOINT SPACING AT EDGER:

1. SAW CUT CONTROL JOINTS EQUALLY SPACED AT 8' MINIMUM, 10' MAXIMUM AND CONTINUE DOWN ENTIRE FACE OF EDGER
2. EXPANSION JOINTS EQUALLY SPACED AT 80' MINIMUM, 100' MAXIMUM
3. REFER TO SPECIFICATIONS FOR ALL MATERIALS CALLED OUT IN DETAIL

3 CONCRETE WALK WITH THICKENED EDGE
L501 SECTION 1" = 1'-0"



NOTE:

1. REFER TO SPECIFICATIONS FOR ALL MATERIALS CALLED OUT IN DETAIL

4 CONCRETE RAMP AT PLAYPIT
L501 SECTION 1" = 1'-0"

NO.	DESCRIPTION OF REVISIONS	DATE	BY

CALL UNCC
TWO WORKING DAYS
BEFORE YOU DIG
1-800-922-1887
UTILITY WORKING CENTER OF
COLORADO



CITY AND COUNTY OF DENVER
DEPARTMENT OF PUBLIC WORKS AND
DEPARTMENT OF PARKS AND RECREATION
201 WEST COLFAX AVE. DENVER, CO 80202
TEL.: (720) 913-1311

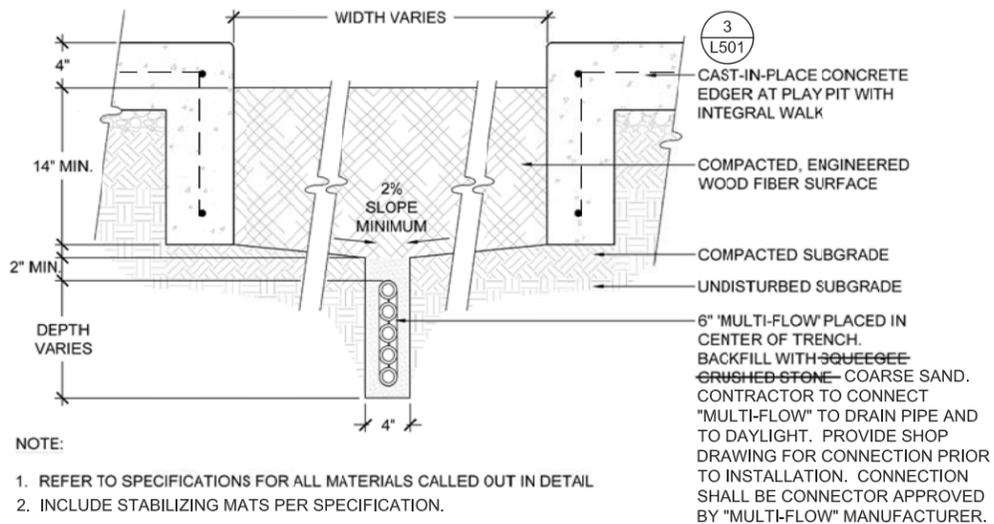
ASBURY & TEJON PARK
RETROFIT DESIGN
PRO TRACKING NO: PWWW 2017 - 004
PROJECT MASTER NO: 2017-PROJIMSTR-0000150
PLAYGROUND DETAILS

DRAWN BY:	BP
DESIGNED BY:	BG
APPROVED BY:	IMF
DRAWING NAME:	PLAYGROUND DETAILS
DATE:	SEPTEMBER 2018
SHEET NO.:	L501

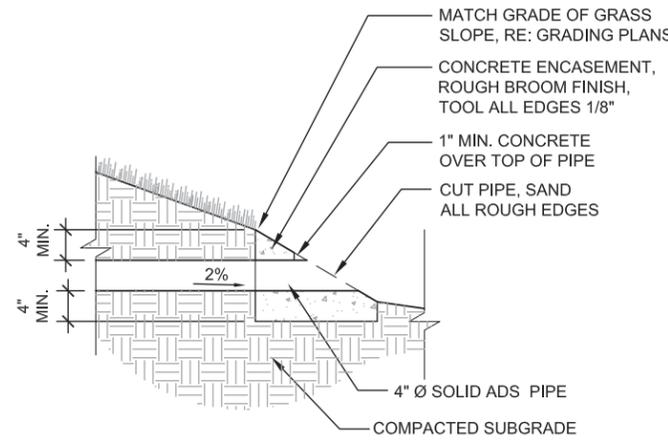
PLOT DATE: September 5, 2018

\\SERVER\CPG\PROJECTS\ASBURY TEJON\CAD\ASBURY & TEJON - DE.DWG

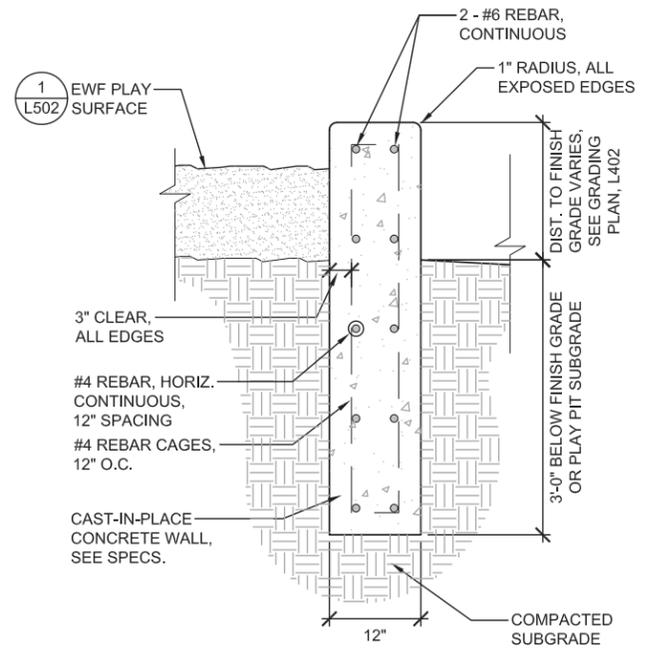
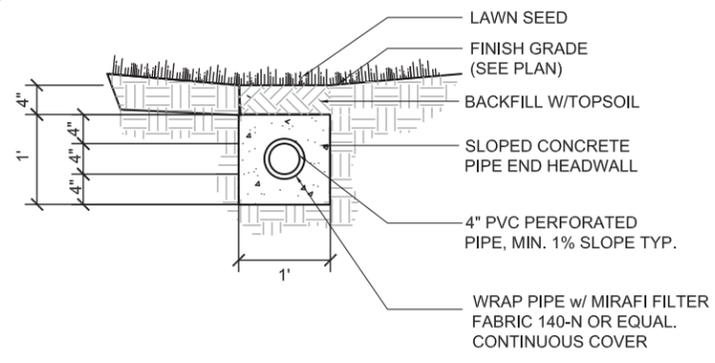




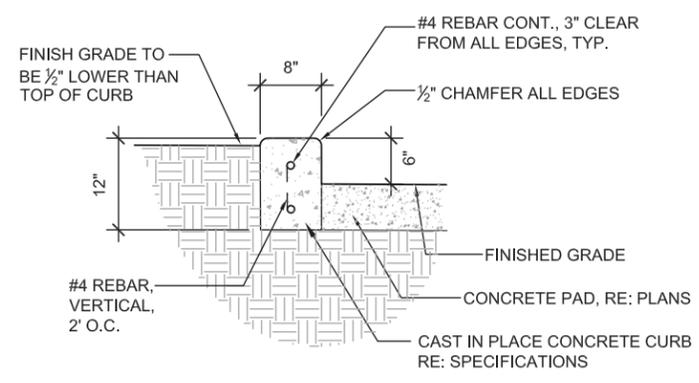
1 ENGINEERED WOOD FIBER (EWF) PLAY SURFACE & DRAINAGE SYSTEM
 L502 SECTION N.T.S.



2 DRAIN PIPE END
 L502 SECTION & ELEVATION 1"=1'-0"



3 CONCRETE CURB WALL
 L502 SECTION 1"=1'-0"



4 CONCRETE CURB
 L502 SECTION 1"=1'-0"

PLOT DATE: September 5, 2018

\\SERVER\CPG_PROJECTS\ASBURY_TEJON\CAD\ASBURY & TEJON - DE.DWG



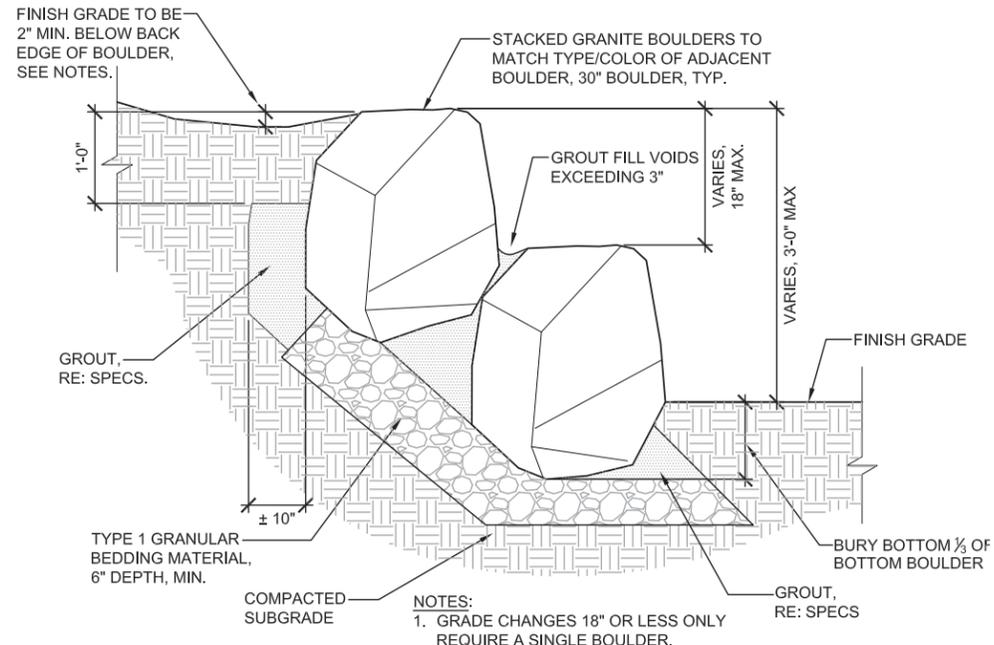
NO.	DESCRIPTION OF REVISIONS	DATE	BY

CALL UNCC
 TWO WORKING DAYS
 BEFORE YOU DIG
 1-800-922-1987
 UTILITY WORKING GROUP CENTER OF EXCELLENCE

CITY AND COUNTY OF DENVER
 DEPARTMENT OF PUBLIC WORKS AND
 DEPARTMENT OF PARKS AND RECREATION
 201 WEST COLFAX AVE. DENVER, CO 80202
 TEL.: (720) 913-1311

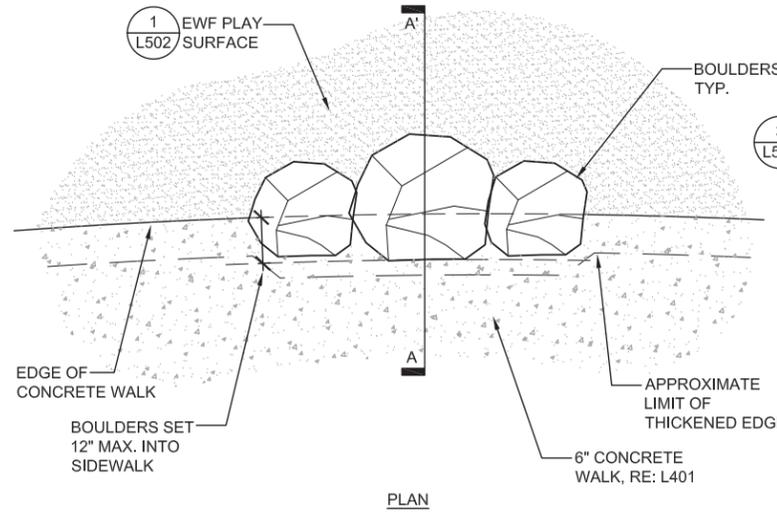
ASBURY & TEJON PARK
 RETROFIT DESIGN
 PRO TRACKING NO: PWWW 2017 - 004
 PROJECT MASTER NO: 2017-PROJIMSTR-0000150
 PLAYGROUND DETAILS

DRAWN BY:	BP
DESIGNED BY:	BG
APPROVED BY:	IMF
DRAWING NAME:	PLAYGROUND DETAILS
DATE:	SEPTEMBER 2018
SHEET NO.:	L502

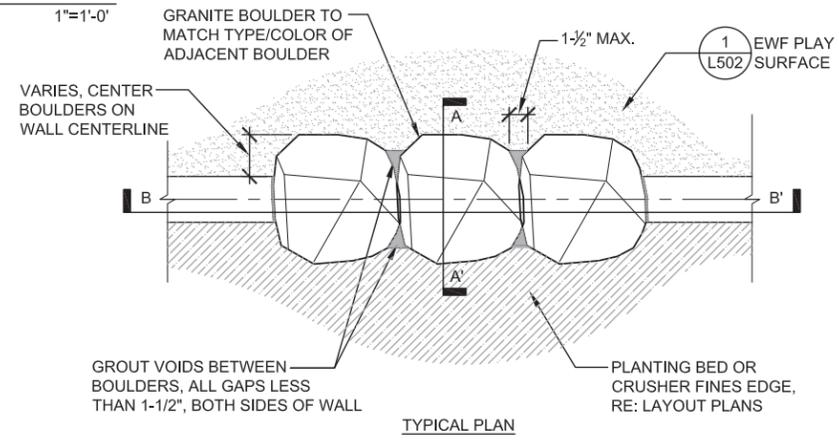


1 STACKED BOULDERS
L503 SECTION

NOTES:
1. GRADE CHANGES 18" OR LESS ONLY REQUIRE A SINGLE BOULDER.
2. SEE BOULDER AND STACKED BOULDER PLACEMENT NOTES, THIS SHEET.

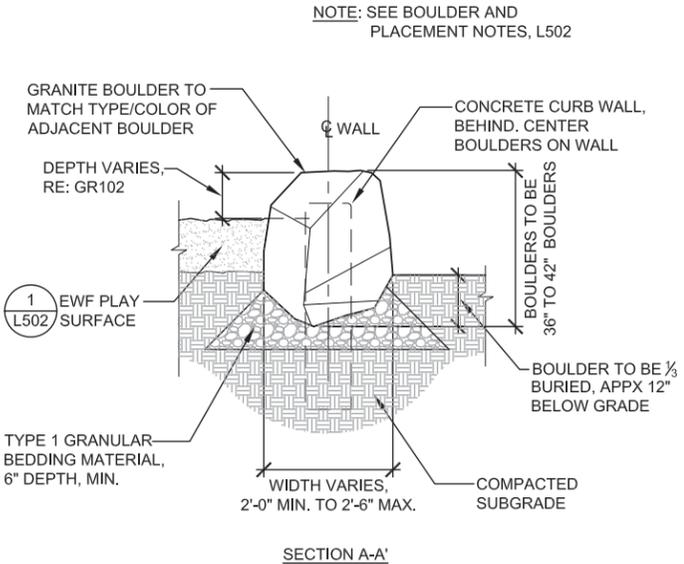


2 BOULDER IN CONCRETE WALK
L503 SECTION

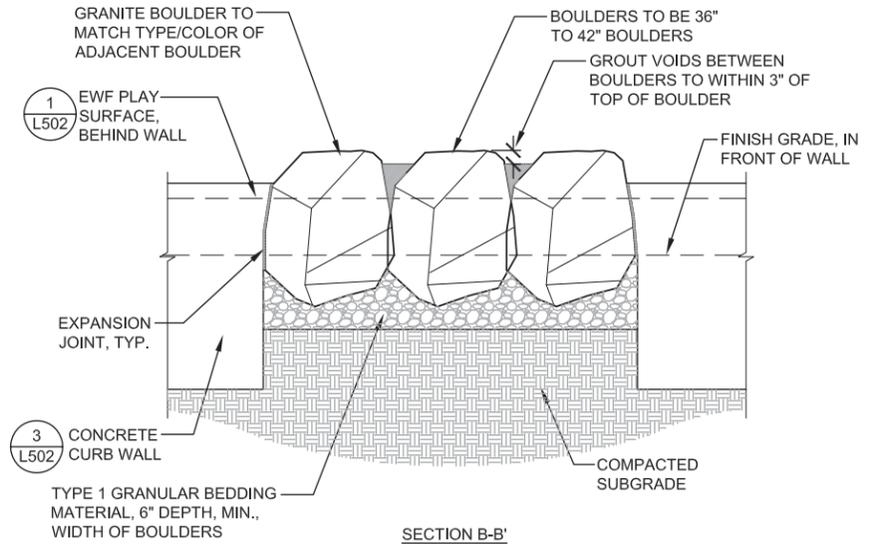


BOULDER & STACKED BOULDER PLACEMENT NOTES:

1. BURY APPROXIMATELY 1/3 OF BOULDER BELOW GRADE, MINIMUM.
2. AVERAGE SIZE OF BOULDERS IN WALL TO BE 36"-42".
3. AVERAGE SIZE OF STACKED BOULDERS TO BE 30".
4. BOULDERS TO BE PLACED WITH "FLATTEST" SIDE UP, AS THE "SEAT."
5. THE TOPS OF BOULDERS MAY VARY FROM THE DESIGN GRADE BY 2"±. AT THE FACE OF THE BOULDER, GRADE SHALL NOT VARY FROM THE DESIGN GRADE BY MORE THAN 1" OR AS INDICATED ON THE DRAWINGS. THE PROJECT MANAGER MAY REQUEST GREATER VARIATION AT SELECT LOCATIONS.
6. BEFORE GROUTING, CLEAN FROM THE BOULDERS ALL DIRT AND MATERIALS THAT COULD PREVENT THE GROUT FROM BONDING TO THE BOULDERS. FINAL PLACEMENT OF THE BOULDERS TO BE APPROVED BY THE PROJECT MANAGER PRIOR TO GROUTING.
7. GROUT BEHIND BOULDER TO 1' BELOW TOP OF BOULDER.
8. INJECT GROUT BEHIND AND BETWEEN BOULDERS TO FILL VOIDS BETWEEN BOULDERS' FINISH. USE CONCRETE VIBRATOR TO CONSOLIDATE THE GROUT. THE CONTRACTOR SHALL CONTROL GROUT PLACEMENT TO ACHIEVE THE REQUIRED DEPTH OF CONCRETE. CLEAN EXCESS GROUT FROM ALL SURFACES TO BE EXPOSED. TROWEL THE GROUT SURFACE TO ACHIEVE A SMOOTH SURFACE BETWEEN BOULDERS WITHOUT PUDDLES.
9. GRADE TOPSOIL BEHIND BOULDER TO DRAIN AWAY FROM BOULDER WHERE APPLICABLE, AS SHOWN.
10. SET BOULDER AS SHOWN. WHEN SET IN CONCRETE WRAP TOP AND SIDES OF BOULDER TO COMPACTED SUBGRADE IN TWO LAYERS OF 1/4" FOAM PRIOR TO POURING CONCRETE. AFTER POURING CONCRETE, CUT FOAM AT SURFACE OF CONCRETE. SEAL JOINT BETWEEN CONCRETE AND BOULDER.



3 BOULDERS IN CONCRETE CURB WALL
L503 SECTION



EXAMPLE BOULDER PHOTO

NO.	DESCRIPTION OF REVISIONS	DATE	BY

CALL UNCC
TWO WORKING DAYS
BEFORE YOU DIG
1-800-922-1987
UTILITY WORK CENTER OF
COLORADO

CITY AND COUNTY OF DENVER
DEPARTMENT OF PUBLIC WORKS AND
DEPARTMENT OF PARKS AND RECREATION
201 WEST COLFAX AVE. DENVER, CO 80202
TEL.: (720) 913-1311

ASBURY & TEJON PARK
RETROFIT DESIGN
PRO TRACKING NO: PWWW 2017 - 004
PROJECT MASTER NO: 2017-PROJIMSTR-0000150
PLAYGROUND DETAILS

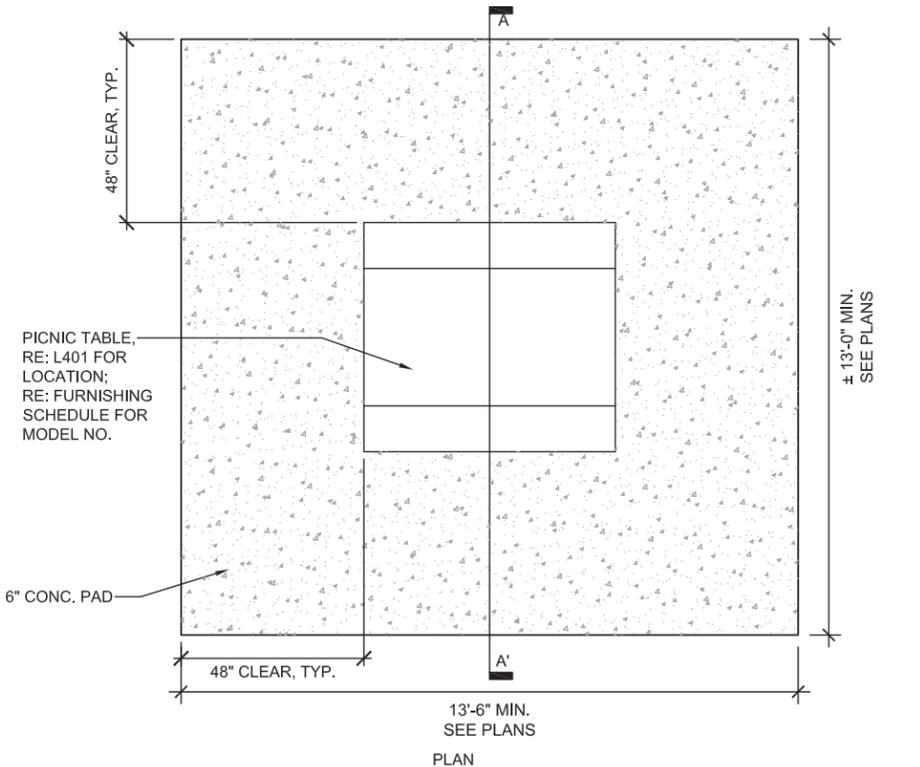
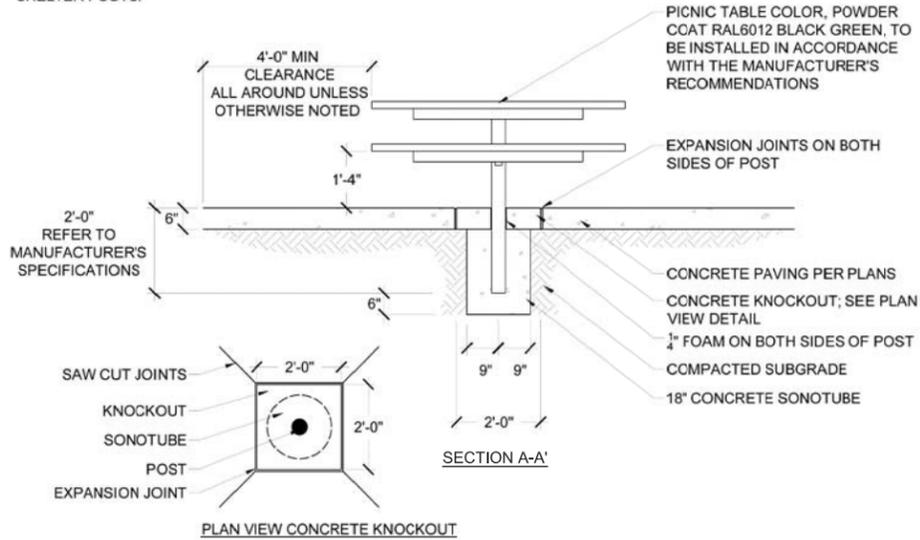
DRAWN BY:	BP
DESIGNED BY:	BG
APPROVED BY:	IMF
DRAWING NAME:	PLAYGROUND DETAILS
DATE:	SEPTEMBER 2018
SHEET NO.:	L503

PLOT DATE: September 20, 2018

\\SERVER\CPG_PROJECTS\ASBURY_TELON\CAD\ASBURY & TEJON - DE.DWG



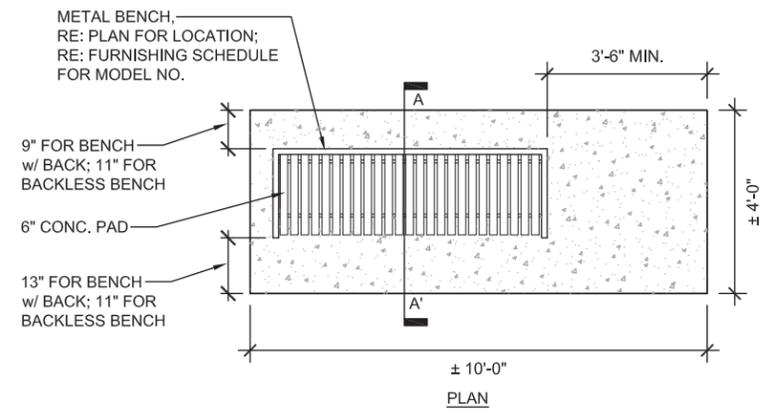
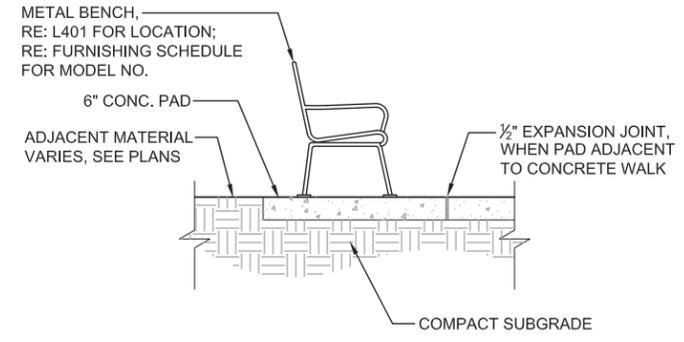
NOTE:
ALL TABLES TO HAVE AT LEAST 48" OF CLEARANCE
BETWEEN THE EDGE OF THE TABLE AND SET
OBJECTS SUCH AS OTHER TABLES AND PICNIC
SHELTER POSTS.



NOTES:
1. MOUNT ALL SITE FURNISHINGS PER MANUFACTURER'S DIRECTIONS.

1 PICNIC TABLE
L504 SECTION

1/2" = 1'-0"



NOTES:
1. MOUNT ALL SITE FURNISHINGS PER MANUFACTURER'S DIRECTIONS.
2. LOCATE FURNISHINGS PER LAYOUT PLAN

2 BENCH
L504 SECTION

1/2" = 1'-0"

SITE FURNISHINGS SCHEDULE			
ITEM	QTY	MOUNT	NOTES
BENCH	3	CONCRETE PAD	WAUSAU, MODEL #MF2200; COLOR TO BE RAL 6012
PICNIC TABLE	2	DIRECT BURY	LITTLE TYKES MODEL #266-6-07; COLOR TO BE RAL 6012
TRASH RECEPTACLE	2	CONCRETE PAD	NOT IN CONTRACT
FUTURE: PICNIC SHELTER	1	CONCRETE PAD	NOT IN CONTRACT

NOTE: ALL FURNISHING MANUFACTURERS AS NOTED ABOVE OR APPROVED EQUAL. ALL SUBSTITUTIONS TO BE APPROVED BY PROJECT MANAGER. SEE SPECIFICATIONS FOR ADDITIONAL INFORMATION. INSTALL ALL SITE FURNISHINGS PER MANUFACTURER'S DIRECTIONS.

SITE FURNISHING SCHEDULE

PLOT DATE: September 5, 2018

\\SERVER\CPG PROJECTS\ASBURY TEJON\CAD\ASBURY & TEJON - DE.DWG



NO.	DESCRIPTION OF REVISIONS	DATE	BY

CALL UNCC
TWO WORKING DAYS
BEFORE YOU DIG
1-800-922-1987
UTILITY WORK CENTER OF
UTAH

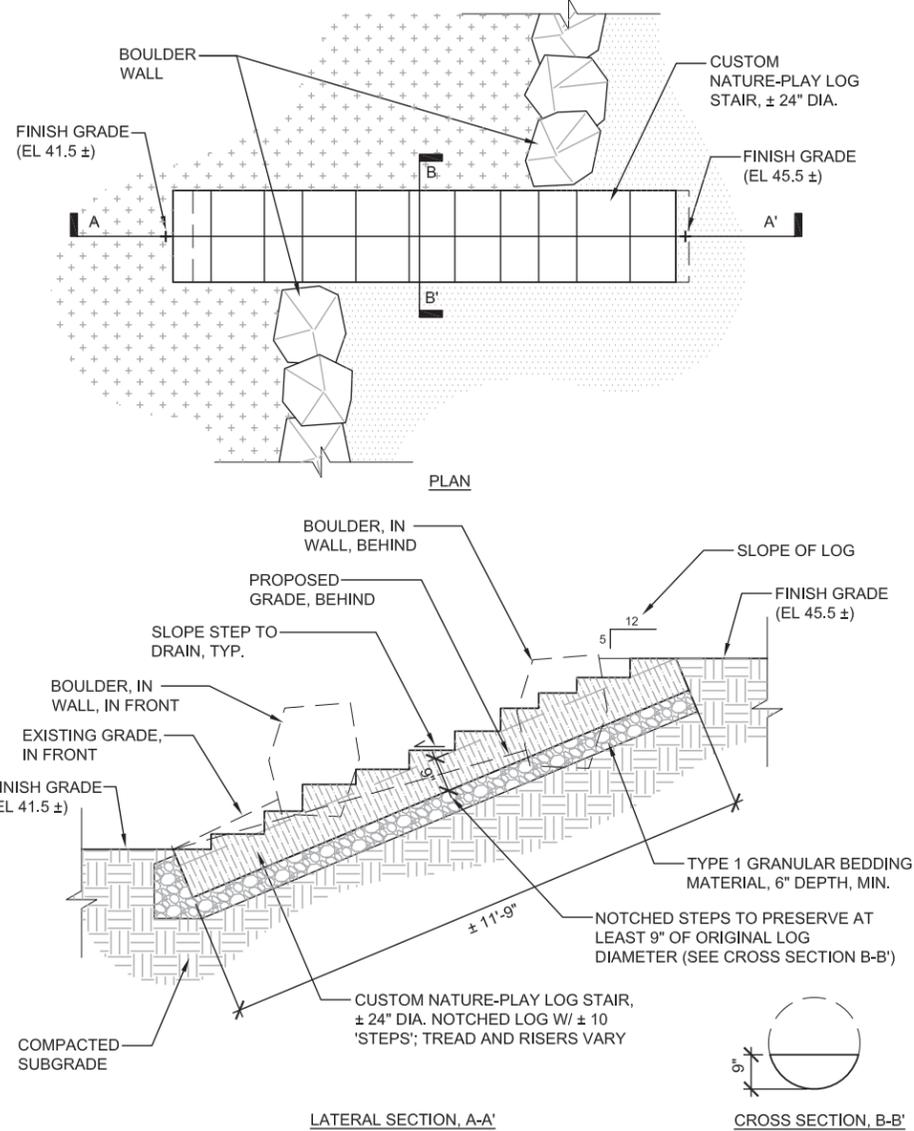
CITY AND COUNTY OF DENVER
DEPARTMENT OF PUBLIC WORKS AND
DEPARTMENT OF PARKS AND RECREATION
201 WEST COLFAX AVE. DENVER, CO 80202
TEL.: (720) 913-1311

ASBURY & TEJON PARK
RETROFIT DESIGN
PRO TRACKING NO: PWWW 2017 - 004
PROJECT MASTER NO: 2017-PROJ.MSTR-0000150
PLAYGROUND DETAILS

DRAWN BY:	BP
DESIGNED BY:	BG
APPROVED BY:	IMF
DRAWING NAME:	PLAYGROUND DETAIL
DATE:	SEPTEMBER 2018
SHEET NO.:	L504



EXAMPLE OF LOG STAIR



NOTES:

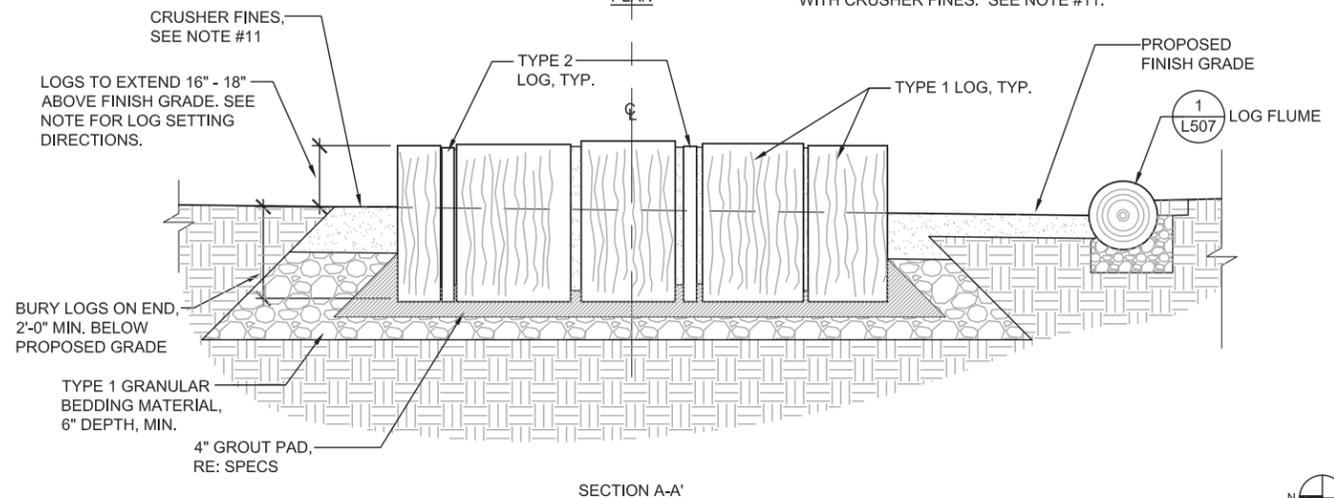
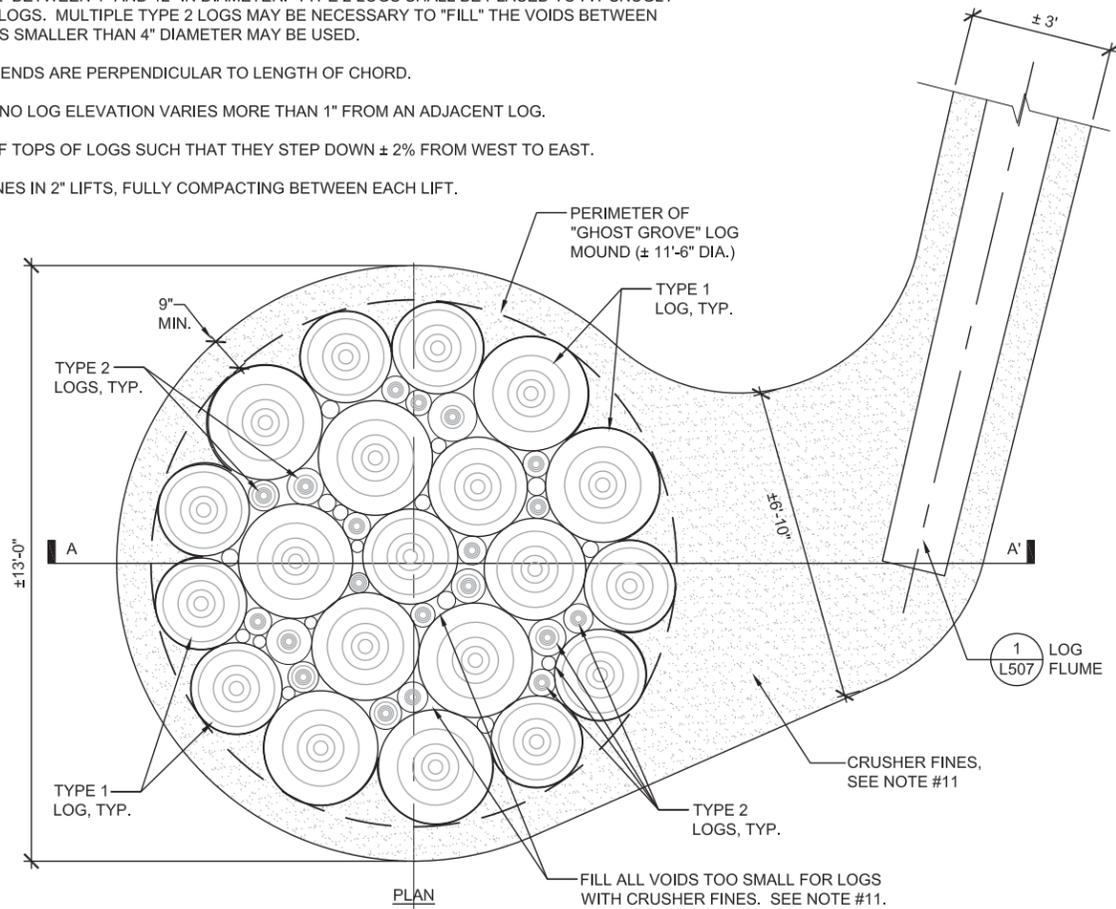
1. PRIOR TO CONSTRUCTION OF LOG STAIR, CONTRACTOR TO SUBMIT SHOP DRAWINGS TO PROJECT MANAGER FOR REVIEW AND APPROVAL.

1 LOG STAIR
L505 SECTION

1/2"=1'-0"

NOTES:

1. ALL LOGS TO BE SALVAGED AMERICAN ELM OR ASH, SOURCED FROM CITY OF DENVER FORESTRY, IF POSSIBLE. BARK TO BE COMPLETELY REMOVED FROM THE LOG. PROJECT MANAGER TO APPROVAL ALL LOGS PRIOR TO INSTALLATION.
2. LOGS TO BE PLANED TO ENSURE SNUG FITS, BUT MUST RETAIN THEIR ROUND PROFILE.
3. ROUND EDGES OF ENDS OF LOGS TO ABOUT A 1" RADIUS.
4. LOGS TO BE SEALED WITH ANCHORSEAL, OR APPROVED EQUAL. PROVIDE PROJECT MANAGER WITH PRODUCT INFORMATION PRIOR TO APPLICATION.
5. TYPE 1 LOGS SHALL BE BETWEEN 24" AND 30" IN DIAMETER. TYPE 1 LOGS SHALL BE SET FIRST IN THE MOUND AND COMPRISE THE MAJORITY OF THE MOUND SURFACE.
6. TYPE 2 LOGS SHALL BE BETWEEN 4" AND 12" IN DIAMETER. TYPE 2 LOGS SHALL BE PLACED TO FIT SNUGLY BETWEEN THE TYPE 1 LOGS. MULTIPLE TYPE 2 LOGS MAY BE NECESSARY TO "FILL" THE VOIDS BETWEEN TYPE 1 LOGS. NO LOGS SMALLER THAN 4" DIAMETER MAY BE USED.
7. CUT LOGS SUCH THAT ENDS ARE PERPENDICULAR TO LENGTH OF CHORD.
8. SET LOGS SUCH THAT NO LOG ELEVATION VARIES MORE THAN 1" FROM AN ADJACENT LOG.
9. SLOPE ELEVATIONS OF TOPS OF LOGS SUCH THAT THEY STEP DOWN $\pm 2\%$ FROM WEST TO EAST.
10. INSTALL CRUSHER FINES IN 2" LIFTS, FULLY COMPACTING BETWEEN EACH LIFT.



2 GHOST GROVE LOG MOUND
L505 SECTION

1/2"=1'-0"

PLOT DATE: September 20, 2018

\\SERVER\CPG_PROJECTS\ASBURY_TEJON\CAD\ASBURY & TEJON - DE.DWG



Landscape Architecture & Planning

NO.	DESCRIPTION OF REVISIONS	DATE	BY

CALL UNCC
TWO WORKING DAYS
BEFORE YOU DIG
1-800-922-1987
UTILITY WORKING CENTER OF
COLORADO

CITY AND COUNTY OF DENVER
DEPARTMENT OF PUBLIC WORKS AND
DEPARTMENT OF PARKS AND RECREATION
201 WEST COLFAX AVE. DENVER, CO 80202
TEL.: (720) 913-1311

ASBURY & TEJON PARK
RETROFIT DESIGN
PRO TRACKING NO: PWWW 2017 - 004
PROJECT MASTER NO: 2017-PROJ.MSTR-0000150
PLAYGROUND DETAILS

DRAWN BY:	BP
DESIGNED BY:	BG
APPROVED BY:	IMF
DRAWING NAME:	PLAYGROUND DETAILS
DATE:	SEPTEMBER 2018
SHEET NO.:	L505



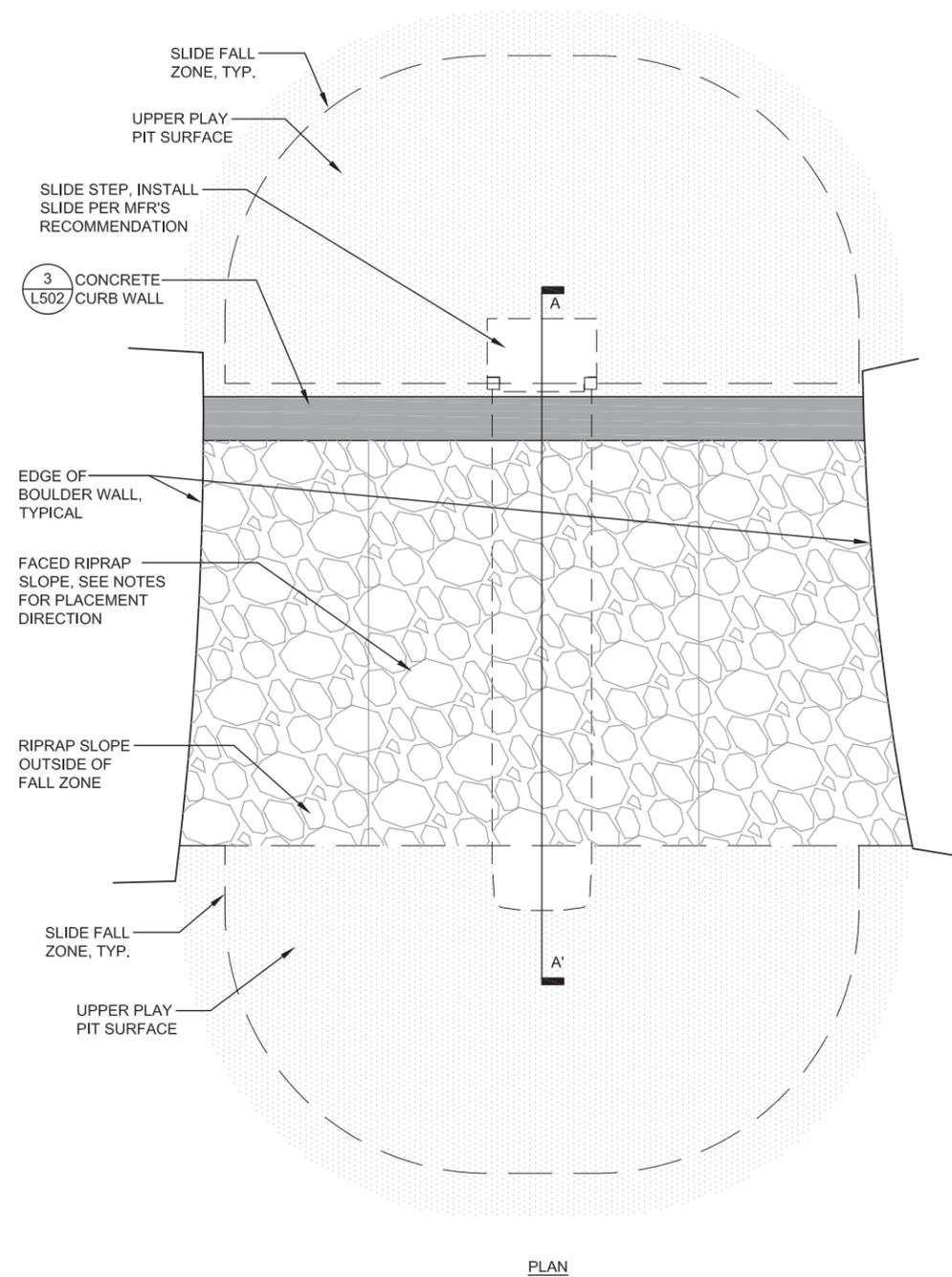
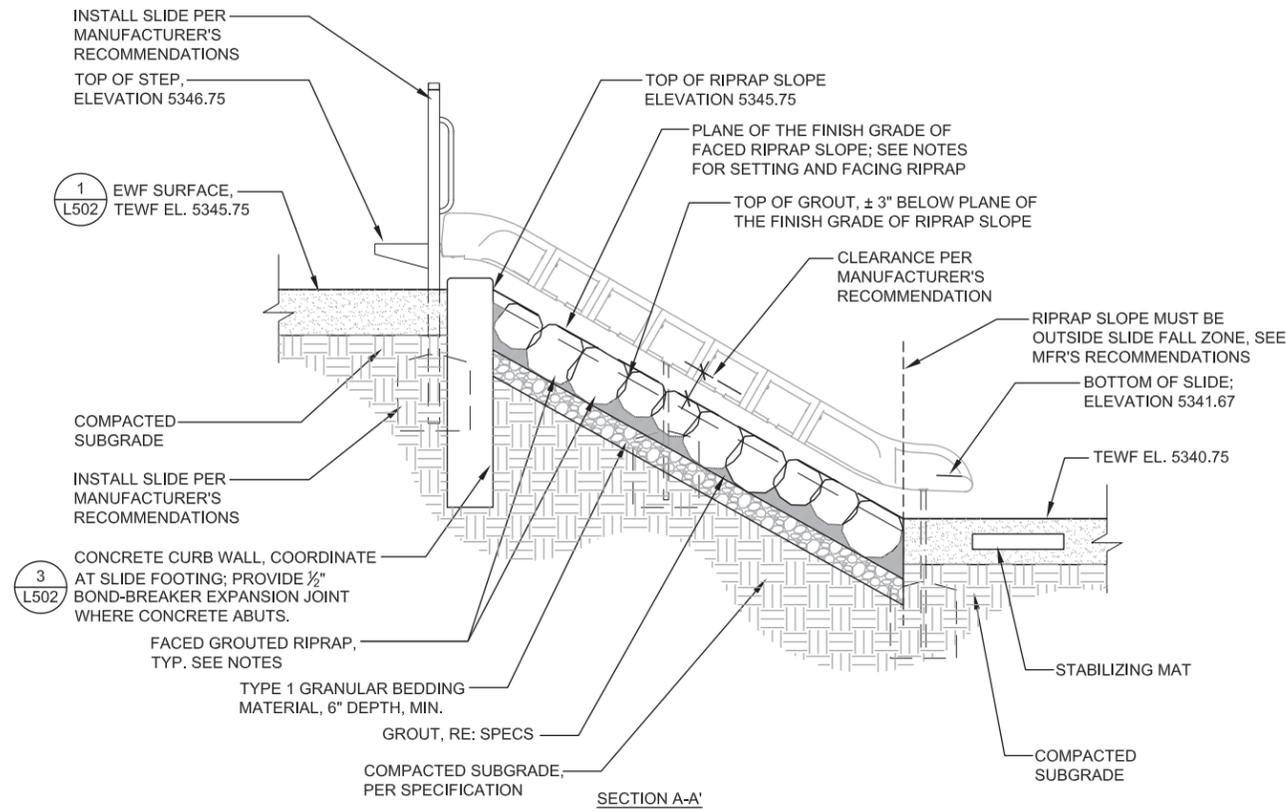
1
L506 FACED RIPRAP SLOPE

DESIGN STATEMENT:

THE INTENT OF THE FACED RIPRAP SLOPE UNDER THE SLIDE IS TO MIMIC THE APPEARANCE OF A WATER CHANNEL CONSTRUCTED FROM A NATURAL ROCK RIPRAP (SEE IMAGES). THE PLAYGROUND FOCUSES ON MAN-MADE EQUIPMENT AT THE UPPER LEVEL AND TRANSITIONS TO PLAY FEATURES WITH NATURAL FORMS AND MATERIALS DOWN THE HILL. THE SLIDE PLAY FEATURE SETS IN THE TRANSITION BETWEEN THESE TWO AREAS, WHERE IT EVOKES MAN-MADE FORMS, BUT CREATES THEM FROM NATURAL ELEMENTS.



EXAMPLE FACED RIPRAP PHOTOS

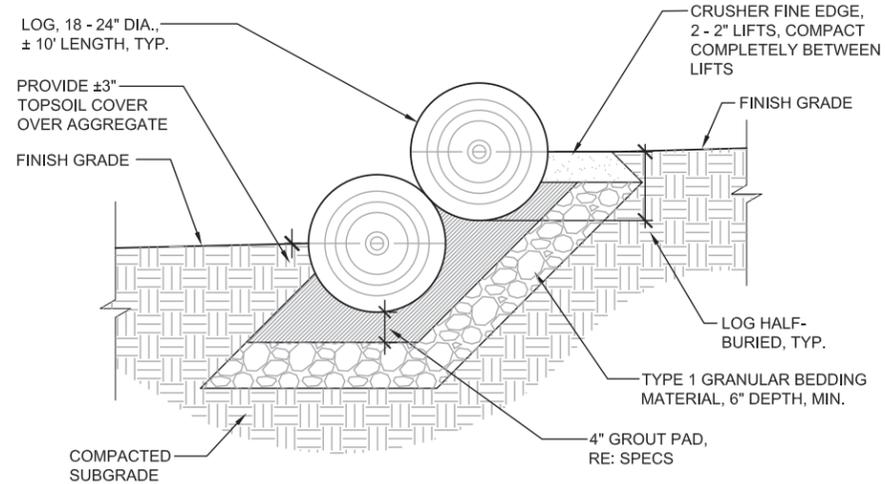


NOTES:

1. RIPRAP SLOPE TO BE CONSTRUCTED OF RIPRAP TYPE L AND TYPE M.
2. **FACED RIPRAP:** SET ALL RIPRAP STONE SUCH THAT "FLATTEST" SIDE DEFINES THE PLANE (FACE) OF THE FINISH GRADE. RIPRAP STONE FACES SHALL NOT HAVE VARIANCE FROM PLANE GREATER THAN +/- 2".
3. PLACE LARGEST RIPRAP STONES FURTHEST FROM SLIDE TOWARD BOULDER WALL, USING SMALLEST PIECES TOWARD CENTER.
4. PLACE RIPRAP STONE AS TIGHTLY AS POSSIBLE TO MINIMIZE VOIDS AND GROUT.
5. BEFORE GROUTING, CLEAN ALL DIRT AND MATERIALS FROM STONE THAT COULD PREVENT THE GROUT FROM BONDING TO THE STONE.
6. PLACE GROUT IN MANNER THAT FILLS ALL VOIDS TO THE SPECIFIED GROUT THICKNESS.

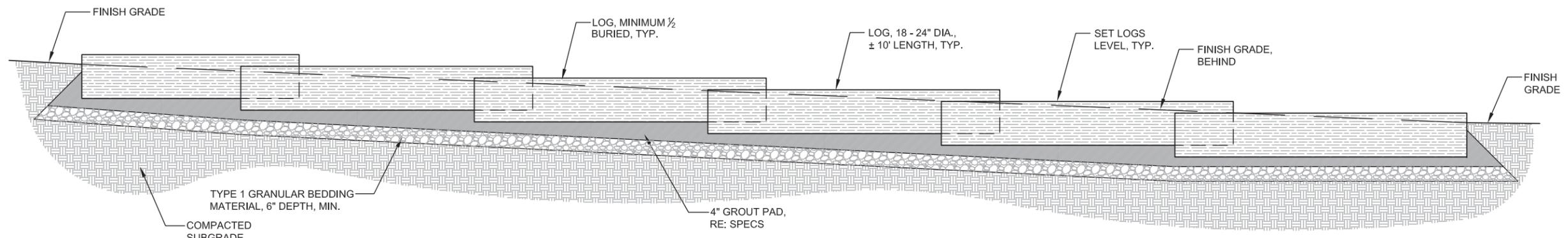
1/2"=1'-0"

NO.	DESCRIPTION OF REVISIONS	DATE	BY
CALL UNCC TWO WORKING DAYS BEFORE YOU DIG 1-800-922-1987 UTILITY WORKING CENTER OF COLORADO			
CITY AND COUNTY OF DENVER DEPARTMENT OF PUBLIC WORKS AND DEPARTMENT OF PARKS AND RECREATION 201 WEST COLFAX AVE. DENVER, CO 80202 TEL.: (720) 913-1311			
ASBURY & TEJON PARK RETROFIT DESIGN PRO TRACKING NO: PWWW 2017 - 004 PROJECT MASTER NO: 2017-PROJMSTR-0000150 PLAYGROUND DETAILS			
DRAWN BY: BP			
DESIGNED BY: BG			
APPROVED BY: IMF			
DRAWING NAME: PLAYGROUND DETAILS			
DATE: SEPTEMBER 2018			
SHEET NO.: L506			



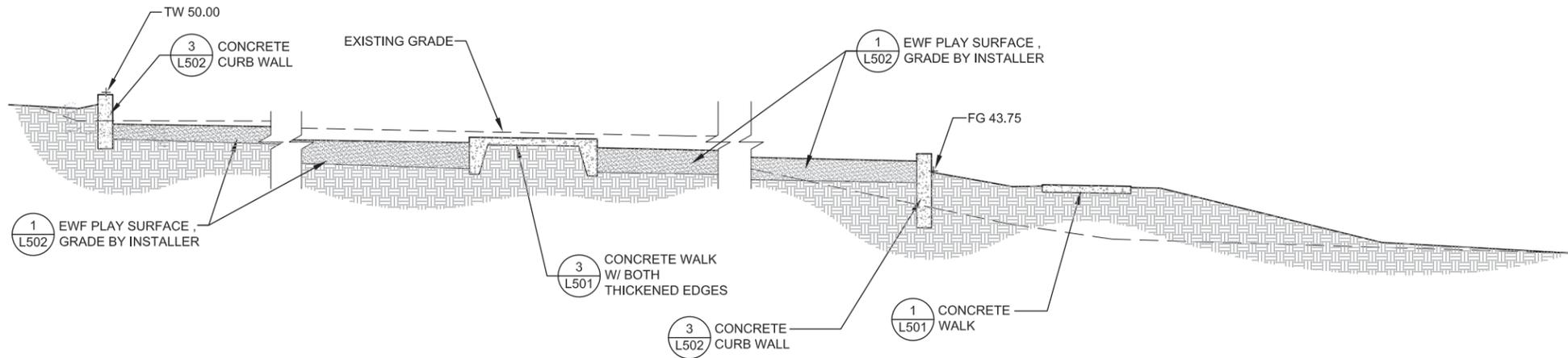
- NOTES:**
1. ALL LOGS TO BE SALVAGED AMERICAN ELM OR ASH, SOURCED FROM CITY OF DENVER FORESTRY, IF POSSIBLE. BARK TO BE COMPLETELY REMOVED FROM THE LOG.
 2. LOGS TO BE PLANED TO ENSURE SNUG FITS, BUT MUST RETAIN THEIR ROUND PROFILE.
 3. LOGS SHALL BE HEWN SUCH THAT THE END IS PERPENDICULAR TO THE LENGTH OF THE LOG.
 4. ROUND EDGES OF ENDS OF LOGS TO ± 1" RADIUS. LOG ENDS SHALL BE FREE OF SPLINTERED ENDS OR TEARS.
 5. LOGS TO BE SEALED WITH ANCHORSEAL, OR APPROVED EQUAL. PROVIDE PROJECT MANAGER WITH PRODUCT INFORMATION PRIOR TO APPLICATION.
 6. LOGS SHALL BE LAID WITH TAPERED END UPHILL.
 7. LOGS SHALL BE BURIED AT LEAST ½ INTO THE GRADE, UNLESS ADJACENT TO A DOWNHILL LOG.
 8. LOG SHALL BE SET SUCH THAT BOTTOM ¼ HAS 3" AGGREGATE COVER WITH ±6" DEPTH AGGREGATE UNDER LOG.
 9. INSTALL CRUSHER FINES IN 2" LIFTS, FULLY COMPACTING BETWEEN EACH LIFT.

CROSS SECTION LOOKING UPHILL (WEST)
SCALE: 1" = 1'-0"



LATERAL SECTION LOOKING NORTH
SCALE: 1" = 1'-0"

1 LOG FLUME
L507 DIAGRAM



2 SECTION THRU PLAYGROUND (RE: L401)
L507 SECTION

1"=5'-0"

NO.	DESCRIPTION OF REVISIONS	DATE	BY

CALL UNCC
TWO WORKING DAYS
BEFORE YOU DIG
1-800-922-1987
UTILITY WORKING CENTER OF
COLORADO

CITY AND COUNTY OF DENVER
DEPARTMENT OF PUBLIC WORKS AND
DEPARTMENT OF PARKS AND RECREATION
201 WEST COLFAX AVE. DENVER, CO 80202
TEL.: (720) 913-1311

ASBURY & TEJON PARK
RETROFIT DESIGN
PRO TRACKING NO: PWWW 2017 - 004
PROJECT MASTER NO: 2017-PROJMSTR-0000150
PLAYGROUND DETAILS

DRAWN BY:	BP
DESIGNED BY:	BG
APPROVED BY:	IMF
DRAWING NAME:	PLAYGROUND DETAILS
DATE:	SEPTEMBER 2018
SHEET NO.:	L507

PLOT DATE: September 20, 2018

\\SERVER\CPG_PROJECTS\ASBURY-TEJON\CAD\ASBURY & TEJON - DE.DWG



Irrigation Construction Notes

- ALL BASE INFORMATION HAS BEEN TAKEN FROM DRAWINGS PREPARED BY GREAT ECOLOGY.
- REFER TO TECHNICAL SPECIFICATIONS AND CONSTRUCTION DETAILS FOR INSTALLATION PROCEDURES.
- CONTRACTOR SHALL FIELD VERIFY PRESSURE AT BACKFLOW PREVENTER LOCATION FOR EACH TAP PRIOR TO ORDERING MATERIALS OR STARTING ANY IRRIGATION INSTALLATION AND NOTIFY CONSULTANT OF ANY DIFFERENCES FROM STATED PRESSURE. IF CONTRACTOR FAILS TO NOTIFY CONSULTANT HE ASSUMES FULL RESPONSIBILITY FOR ANY SYSTEM ALTERATIONS. EACH SYSTEM HAS BEEN DESIGNED FOR A STATIC PRESSURE OF 75 PSI (MEASURED ON SITE).

TAP LOCATION/NUMBER	REQUIRED PRESSURE
1	75 PSI
2	75 PSI
- CONTRACTOR SHALL COORDINATE INSTALLATION OF SLEEVING WITH INSTALLATION OF CONCRETE FLATWORK AND PAVING. ALL SLEEVING IS BY CONTRACTOR UNLESS OTHERWISE NOTED. UNLESS NOTED OTHERWISE ON IRRIGATION PLANS INSTALL SLEEVING BASED ON SLEEVE SIZING GUIDE BELOW:

PIPE SIZE OR WIRE QUANTITY	REQUIRED SLEEVE
1" PIPING	1-2" PVC SLEEVE
1-1/2" - 2" PIPING	1-4" PVC SLEEVE
2-1/2" - 3" PIPING	1-6" PVC SLEEVE
1-25 CONTROL WIRES	1-2" PVC SLEEVE
26-75 CONTROL WIRES	1-3" PVC SLEEVE

NOTE: EACH LENGTH OF SLEEVED PIPE SHOWN SHALL BE ROUTED THROUGH SEPARATE SLEEVE. IRRIGATION WIRE BUNDLE SHALL BE ROUTED IN SEPARATE SLEEVE/CONDUIT WITHOUT IRRIGATION PIPING
- WHERE NOT NOTED ON IRRIGATION PLANS CONTRACTOR TO INSTALL PLASTIC 15 SERIES NOZZLES ON POP-UP SPRAY HEADS SPACED GREATER THAN 12 FEET. INSTALL 12 SERIES NOZZLES ON POP-UP SPRAY HEADS SPACED 10-12 FEET. INSTALL 10 SERIES NOZZLES ON ALL POP-UP SPRAY HEADS SPACED 8-10 FEET. INSTALL 8 SERIES NOZZLES ON POP-UP SPRAY HEADS SPACED 8 FEET AND LESS.
- REFER TO PLANTING PLAN FOR EXACT TREE LOCATIONS AND QUANTITIES, TREES SHOWN ON IRRIGATION PLANS ARE APPROXIMATE.
- CONTRACTOR SHALL REPAIR OR REPLACE ANY EXISTING IRRIGATION EQUIPMENT, TURF, PLANT MATERIAL OR SITE FEATURES DAMAGED DURING NEW INSTALLATION. REPLACEMENT OR REPAIR OF DAMAGED EQUIPMENT OR MATERIAL SHALL BE DETERMINED BY THE OWNER AND THE CONSULTANT.
- VALVE BOXES SHALL BE LOCATED 36" MINIMUM FROM CENTERLINE OF ALL SWALES, 24" MINIMUM FROM EDGES OF ALL WALKS, CURBS, DRIVES AND OTHER HARD SURFACE AREAS.
- REFER TO IRRIGATION TECHNICAL SPECIFICATIONS FOR PLANTING AND IRRIGATION LAY-OUT REQUIREMENTS, COORDINATION AND PRIORITIES.
- LATERAL PIPING DIAMETERS SHALL INCLUDE 1", 1 1/2" AND 2". 3/4" AND 1 1/4" DIAMETER LATERAL PIPE IS NOT ACCEPTABLE.
- IRRIGATION MAINLINE SHALL BE INSTALLED 10 FT. FROM TREES. LATERAL PIPING SHALL BE INSTALLED 4 FT. FROM TREES. ANY VARIANCES TO THIS REQUIREMENT MUST BE APPROVED BY DP&R PROJECT MANAGER PRIOR TO INSTALLATION.
- DENVER DEPT. OF PARKS AND RECREATION SHALL FURNISH TWO TORO SENTINEL CONTROLLER ASSEMBLIES TO CONTRACTOR. CONTRACTOR IS RESPONSIBLE FOR INSTALLATION OF CONTROLLER INCLUDING CONCRETE PAD, CONDUITS, ELECTRICAL POWER AND WIRING. OPTIMIZATION, TESTING AND CERTIFICATION OF CONTROLLER INSTALLATION TO BE PROVIDED BY CPS DISTRIBUTORS AT NO ADDITIONAL CHARGE TO CITY.
- TRENCHES 12" IN WIDTH OR GREATER, BORE/SLEEVE PITS AND DISTURBED AREAS EXCEEDING 10 S.F. IN EXISTING TURF AREAS SHALL BE GRADED AND SODDED WITH FULL-WIDTH ROLLS OF FRESH-CUT SOD. SOD SHALL BE INSTALLED SO THERE IS NO RAISED SEAM WHERE NEW SOD ADJOINS EXISTING TURF. TRENCHES LESS THAN 12" IN WIDTH IN EXISTING TURF AREAS AND DISTURBED AREAS 10 S.F. OR LESS SHALL BE GRADED AND SEEDED WITH BLUEGRASS BLEND. SUBMIT PROPOSED SEED MIX TO OWNER FOR REVIEW AND APPROVAL PRIOR TO START OF SEEDING OPERATIONS
- CONTRACTOR SHALL BE RESPONSIBLE FOR MAINTAINING EXISTING, REMAINING TURF, TREES AND PLANT MATERIAL IN GREEN, VIABLE CONDITION DURING THE CONSTRUCTION PERIOD. THIS SHALL INCLUDE WATERING TREES AND TURF UNTIL THE IRRIGATION SYSTEM IS OPERATIONAL.
- AT ON-SET OF PROJECT (DURING DEMOLITION PHASE) CONTRACTOR SHALL WALK EXISTING IRRIGATION SYSTEM WITH DENVER PARKS PROJECT MANAGER TO DETERMINE WHICH ELECTRIC VALVES AND HEADS ARE TO REMAIN TO IRRIGATE AREAS OUTSIDE OF WORK LIMITS. EXISTING VALVES TO REMAIN OPERATIONAL SHALL BE EQUIPPED WITH TORO SINGLE-STATION DECODERS.
- NO MAINLINE PIPE JOINTS SHALL BE LOCATED WITHIN SLEEVES.

Irrigation Equipment and Materials Schedule

SYMBOL	MANUFACTURER	MODEL NO.	DESCRIPTION	DETAIL NO.	COMMENTS
• x	RAIN BIRD	RD-06-S-P30-F W/ MPR NOZZ.	POP-UP SPRAY HEAD	1	
■ ■ ■ ■	RAIN BIRD	RD-12-S-P30-F W/ MPR NOZZ.	HI-POP SPRAY HEAD	1	
• M	RAIN BIRD	RD-06-S-P45-F W/ HUNTER MP1000-90 NOZZ.	POP-UP HEAD W/ ROTARY NOZZ.	1	
• O	RAIN BIRD	RD-06-S-P45-F W/ HUNTER MP1000-360 NOZZ.	POP-UP HEAD W/ ROTARY NOZZ.	1	
• Bk	RAIN BIRD	RD-06-S-P45-F W/ HUNTER MP2000-90 NOZZ.	POP-UP HEAD W/ ROTARY NOZZ.	1	
• R	RAIN BIRD	RD-06-S-P45-F W/ HUNTER MP2000-90 NOZZ.	POP-UP HEAD W/ ROTARY NOZZ.	1	
• B	RAIN BIRD	RD-06-S-P45-F W/ HUNTER MP3000-90 NOZZ.	POP-UP HEAD W/ ROTARY NOZZ.	1	
• 4.0	HUNTER	I-20-06-SS W/ #4.0 NOZZLE	GEAR DRIVEN ROTOR	3	
• 2.5	HUNTER	I-20-06-SS W/ #2.5 NOZZ.	GEAR DRIVEN ROTOR	3	
• 12-4.0	HUNTER	I-20-12 W/ #4.0 NOZZLE	HI-POP GEAR DRIVEN ROTOR	2	
• 12-5.0	HUNTER	I-20-12 W/ #5.0 NOZZLE	HI-POP GEAR DRIVEN ROTOR	2	
• 12-350 • 12-35F	HUNTER	I-20-12 W/ #35-MPR SERIES NOZZ.	HI-POP GEAR DRIVEN ROTOR	2	
○		LINE SIZE	GATE VALVE	9	
—		CLASS 200 SOLVENT WELD - 1" DIA. UNLESS NOTED OTHERWISE	PVC LATERAL	13	
—		CLASS 200 GASKETED	PVC MAINLINE	10 & 13	
—		CLASS 200 SOLVENT WELD	PVC SLEEVING	8	
▼	BUCKNER-SUPERIOR	QB44LRCAR10	QUICK COUPLING VALVE	7	
⊕	RAIN BIRD	PEB SERIES	ELECTRIC CONTROL VALVE	4	W/ TORO DECODER
⊕	TORO	SENTINEL SBTW204-U2/AC-SB18SS/PC/DG-VRA-FK-GFI	ELECTRIC CONTROLLER	11	TWO-WIRE SYSTEM CONTROLLERS TO BE FURNISHED BY CITY
⊕		EXISTING	WATER METER		
⊕	NETAFIM	LHM2TR1-MEL-NO (2" DIA.)	HYDROMETER	15	NORMALLY OPEN REED SWITCH HD.
⊕	TORO	SB-BLA	TWO-WIRE SURGE ARRESTOR	12	
⊕		EXISTING - 2"	BACKFLOW PREVENTER	14 & 15	
⊕	HUNTER	WRC	WIRELESS RAIN SENSOR	6	

① CONNECT NEW MAINLINE TO EXISTING VALVE CLUSTER AT INDICATED LOCATION. EXTEND NEW TWO-WIRE CABLE FROM CONTROLLER TO CLUSTER. INSTALL TORO SINGLE-STATION VALVE DECODERS WITHIN BOX TO CONVERT TO TWO-WIRE SYSTEM.

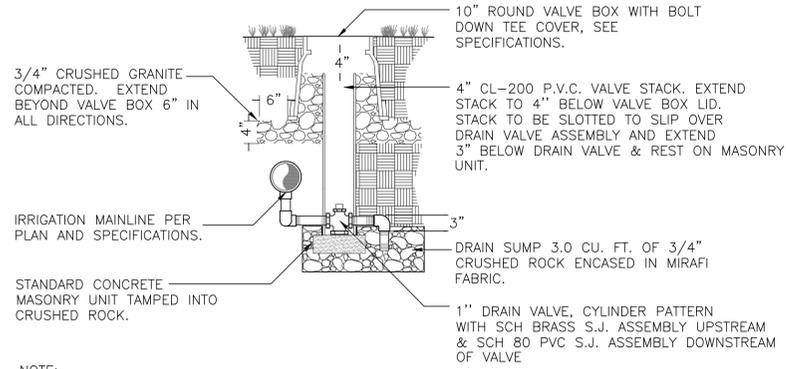
MECHANICAL MAINLINE PIPE RESTRAINTS
 INDICATES MAINLINE PIPING TO BE SECURED VIA MECHANICAL PIPE RESTRAINTS. ALL PIPE-TO-PIPE JOINTS, FITTINGS (I.E. CHANGES IN DIRECTION), SERVICES TEES AND/OR GATE VALVES THAT FALL WITHIN INDICATED DISTANCE SHALL BE RESTRAINED. REFER TO DETAILS. RESTRAINTS SHALL BE MANUFACTURED BY LEECMCO.

DATE	BY	
NO.	DESCRIPTION OF REVISIONS	
CALL UNCC TWO WORKING DAYS BEFORE YOU DIG 1-800-922-1987 UTMUN SUBIRATOR CENTER OF COLORADO		
CITY AND COUNTY OF DENVER DEPARTMENT OF PUBLIC WORKS AND DEPARTMENT OF PARKS AND RECREATION 201 WEST COLFAX AVE. DENVER, CO 80202 TEL.: (720) 913-1311		
ASBURY & TEJON PARK RETROFIT DESIGN PRO TRACKING NO: PWWW2017-004 PROJECT MASTER NO: 2017-PROJMSTR-0000150 IRRIGATION SCHEDULE AND NOTES		
DRAWN BY:		DZ
DESIGNED BY:		DZ
APPROVED BY:		DZ
DRAWING NAME:		
DATE:		SEPTEMBER 2018
SHEET NO.:		1100

C:\DWG\ASBURY-TEJON PARK\IRRIGATION 9-10-18.DWG PLOT DATE: September 10, 2018

PLOT DATE: September 10, 2018

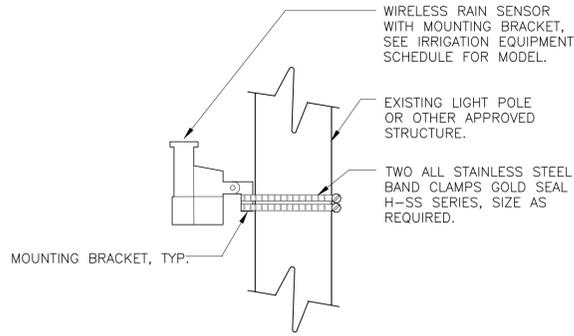
C:\DWG\ASBURY-TEJON PARK IRRIGATION 9-10-18.DWG



- NOTE:
1. BRAND (DV) INTO VALVE BOX LID WITH 1" HIGH LETTERS MIN.
 2. EXTEND VERTICAL DISCHARGE NIPPLE INTO DRAIN SUMP A MINIMUM OF 3".
 3. SET TOP OF VALVE BOX LID LEVEL WITH FINISHED GRADE OF ADJACENT TURFGRASS AREAS.

MANUAL DRAIN VALVE

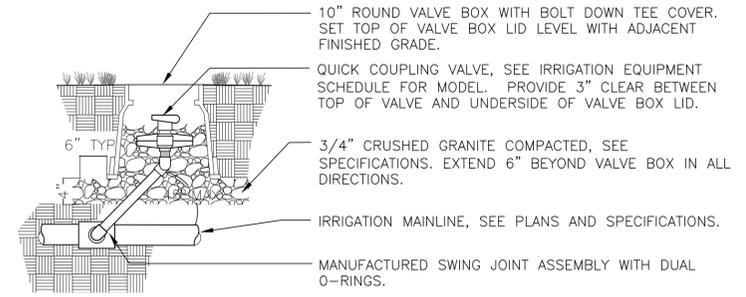
5



- NOTE:
1. MOUNT TO POLE OR LIGHT POLE WITHIN 200 FEET OF CONTROLLER.
 2. INSTALL A MINIMUM OF 15' ABOVE GRADE.
 3. ENSURE SENSOR IS NOT SHIELDED BY TREE CANOPIES OR STRUCTURES AND NOT AFFECTED BY IRRIGATION OVERSPRAY.

RAIN SENSOR

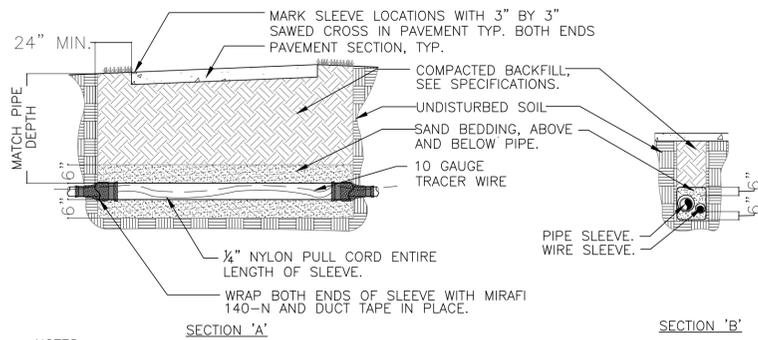
6



- NOTE:
1. ENSURE THAT HANDLE ON QUICK COUPLER KEY WILL CLEAR VALVE BOX IN ALL DIRECTIONS.
 2. BRAND (QC) INTO VALVE BOX LID WITH 1" HIGH LETTERS MINIMUM.
 3. NIPPLE ANGLE TO BE 10 DEGREES MINIMUM AND 45 DEGREES MAXIMUM. INSTALL SWING JOINT SUCH THAT DOWNWARD PRESSURE ON VALVE WILL TIGHTEN FITTING INTO MAINLINE TEE.
 4. FOR QUICK COUPLERS LOCATED WITHIN 100 FEET OF BACKFLOW PREVENTION DEVICES AND INTENDED FOR WINTERIZATION USE, ALL FITTINGS AND NIPPLES OF THE SWING JOINT ASSEMBLY MUST BE CONSTRUCTED ENTIRELY OF BRASS.

QUICK COUPLING VALVE

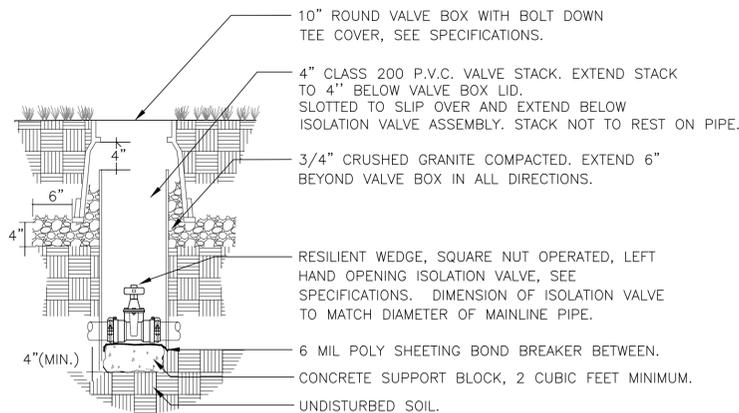
7



- NOTES:
1. SLEEVING SHALL BE CL-200 P.V.C. UNLESS OTHERWISE NOTED ON PLAN.
 2. ALL MAINLINE SLEEVES HAVE A SEPARATE COMPANION SLEEVE FOR WIRE, PLACED SIDE BY SIDE.
 3. MULTIPLE SLEEVES INSTALLED ADJACENT TO ONE ANOTHER ARE TO BE PLACED SIDE BY SIDE, NEVER STACKED.
 4. ALL MAINLINE AND LATERAL SLEEVES SHALL BE A MINIMUM OF 2 PIPE SIZES LARGER THAN THE PIPE BEING SLEEVED.
 5. BACKFILL ANY RELATED SLEEVING EXCAVATIONS AND MECHANICALLY AND COMPACT IN 6" MAX. LIFTS TO 95% BY VIBRATORY COMPACTION METHOD UNDER ALL PAVEMENT SECTIONS.
 7. SLEEVES SHALL BE INSTALLED AT SAME DEPTH AS MAINLINE OR LATERALS. SLEEVES TO BE INSTALLED AT 24" DEPTH MINIMUM UNDER ROADWAYS.
 8. WATER SETTLING OF TRENCHES UNDER PAVEMENT IS NOT PERMITTED.

SLEEVING

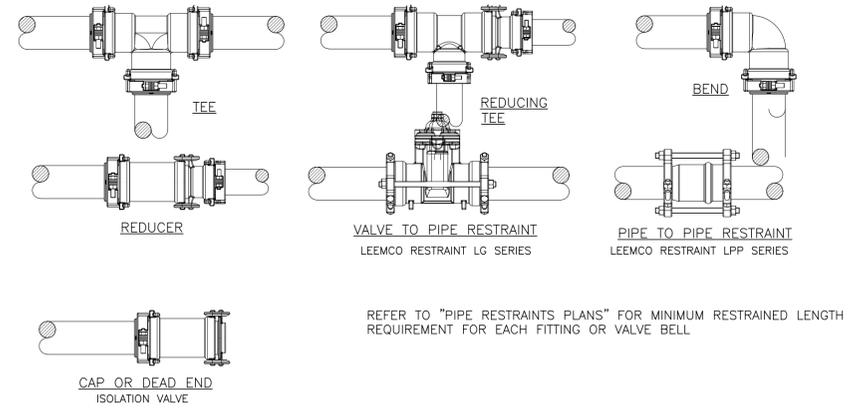
8



- NOTES:
1. BRAND (GV) INTO VALVE BOX LID WITH 1" HIGH LETTERS MIN.
 2. SET TOP OF VALVE BOX LID LEVEL WITH FINISHED GRADE OF ADJACENT TURF GRASS AREAS.
 3. PROVIDE MINIMUM 4" CLEAR BETWEEN TOP OF STACK AND UNDERSIDE OF VALVE BOX LID.

GATE VALVE

9



- NOTES:
1. THE RESTRAINT SCHEMES HERE ARE FOR SYSTEM PRESSURES UP TO 125 PSI. FOR HIGHER PRESSURES, CALL THE LEEMCO FACTORY.
 2. EACH FITTING AND VALVE BELL MUST BE RESTRAINED TO THE LENGTH OF PIPE NOTED ON PLANS USING FITTING TO PIPE RESTRAINT, VALVE TO PIPE RESTRAINT, AND PIPE TO PIPE RESTRAINT AS REQUIRED.
 3. PIPE JOINTS WITHIN THE RESTRAINED LENGTH REQUIREMENT MUST BE RESTRAINED WITH PIPE TO PIPE RESTRAINTS.
 4. SERVICE TEES AND COUPLINGS WITHIN THE RESTRAINED LENGTH REQUIREMENT MUST BE RESTRAINED WITH FITTING TO PIPE RESTRAINTS.

MAINLINE PIPE RESTRAINTS

10

NO.	DESCRIPTION OF REVISIONS	DATE	BY



CITY AND COUNTY OF DENVER
DEPARTMENT OF PUBLIC WORKS AND
DEPARTMENT OF PARKS AND RECREATION
201 WEST COLFAX AVE. DENVER, CO 80202
TEL.: (720) 913-1311

ASBURY & TEJON PARK
RETROFIT DESIGN
PRO TRACKING NO: PWWW2017-004
PROJECT MASTER NO: 2017-PROJMSTR-0000150
IRRIGATION DETAILS

DRAWN BY:	DZ
DESIGNED BY:	DZ
APPROVED BY:	DZ
DRAWING NAME:	Z
DATE:	SEPTEMBER 2018
SHEET NO.:	1501

NO.	DESCRIPTION OF REVISIONS	DATE	BY

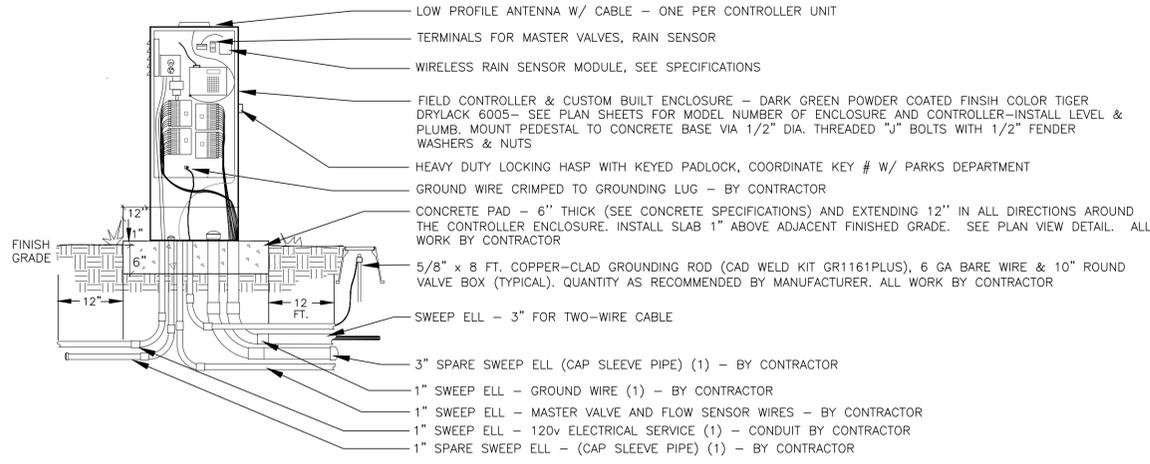
CALL UNCC
TWO WORKING DAYS
BEFORE YOU DIG
UTAH'S WATER CENTER OF EXCELLENCE
1-800-922-1987



CITY AND COUNTY OF DENVER
DEPARTMENT OF PUBLIC WORKS AND
DEPARTMENT OF PARKS AND RECREATION
201 WEST COLFAX AVE. DENVER, CO 80202
TEL.: (720) 913-1311

ASBURY & TEJON PARK
RETROFIT DESIGN
IRRIGATION DETAILS
PRO TRACKING NO: PWWW2017-004
PROJECT MASTER NO: 2017-PROJMSTR-0000150

DRAWN BY:	DZ
DESIGNED BY:	DZ
APPROVED BY:	DZ
DRAWING NAME:	
DATE:	SEPTEMBER 2018
SHEET NO.:	1502



ALL CONDUIT SHALL EXTEND 12" MIN./16" MAX. BEYOND EDGE OF NEW CONCRETE PAD

GENERAL NOTES AND REQUIRMENTS

- 450 MHz RADIO COMMUNICATION SYSTEM SHALL BE FULLY COMPATIBLE WITH EXISTING DENVER DEPARTMENT OF PARKS AND RECREATION CENTRAL CONTROL UNIT RADIO FREQUENCY.
- FLOW SENSOR SHIELDED CABLE (PAIGE 7171D-A) SHALL BE CONNECTED TO FLOW SENSOR TERMINAL AT TOP OF CONTROLLER.
- MASTER VALVE WIRE SHALL BE CONNECTED TO THE TORO ESB-NET WIRE HARNESS LOCATED AT TOP OF CONTROLLER BASE UNIT
- ALL WIRE CONDUITS SHALL BE SCH. 40 PVC CONDUIT AND SHALL EXTEND A MINIMUM OF 12" BEYOND THE CONCRETE SLAB AND CUT FLUSH WITH CONCRETE PAD.
- CONTRACTOR SHALL PROVIDE 48" LENGTH OF SPARE CABLE WITHIN ENCLOSURE. NEATLY COIL CABLE AT BASE OF ENCLOSURE. BUNDLE AND LABEL WIRES ACCORDING TO CONTROLLER DESIGNATION SHOWN ON PLANS.
- LOCATE CONTROLLER ENCLOSURE SO THAT IRRIGATION HEADS DO NOT SPRAY INTO CABINET.
- CONTRACTOR SHALL ARRANGE AND PAY FOR A SITE SURVEY FOR ANTENNA SET-UP FOR MAXIMUM SIGNAL QUALITY FOR EACH CONTROLLER SITE AND OPTIMIZATION OF CENTRAL CONTROL COMMUNICATION AFTER INSTALLATION. CONTACT BRANDON GULLY AT OPS (303) 961-6959). SURVEY TO BE CONDUCTED PRIOR TO CONSTRUCTION AND ORDERING OF EQUIPMENT AND IN SUMMER TIME DURING FULL TREE LEAF OUT.

ELECTRICAL AND GROUNDING NOTES:

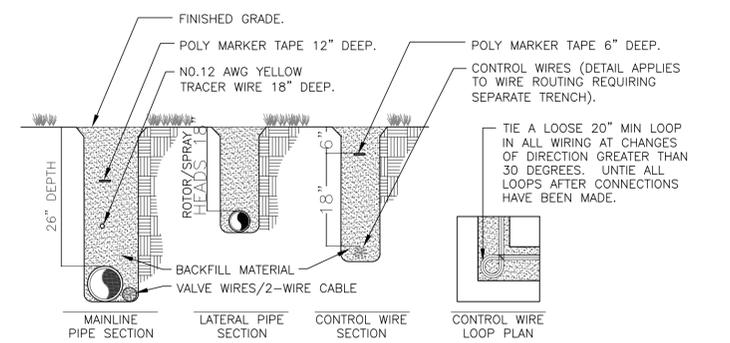
- CONTRACTOR TO GROUND AND PROVIDE SURGE PROTECTION FOR FIELD UNIT IN ACCORDANCE WITH MANUFACTURER'S RECOMMENDATIONS AND GROUND ROD(S) SHOWN. 6 GA. (MIN) BARE COPPER GROUND WIRE SHALL BE CONNECTED AND CRIMPED TO STUDS ON THE BACKSIDE OF THE PANEL.
- CONTROLLER(S) SHALL BE EARTH GROUND TESTED VIA MEGGER WITH ACCEPTABLE GROUND RESISTANCE OF 10 OHMS OR LESS. CONTRACTOR SHALL PERFORM GROUNDING TEST IN PRESENCE OF DENVER PARKS & RECREATION REPRESENTATIVE OR CONSULTANT.
- EARTH GROUND MUST BE IN ACCORDANCE WITH ARTICLE 250 OF THE NATIONAL ELECTRICAL CODE (NEC).
- ALL ELECTRICAL WORK TO CONFORM TO LOCAL AND STATE CODES.

CONTROLLER

11

TWO-WIRE SURGE ARRESTOR

12

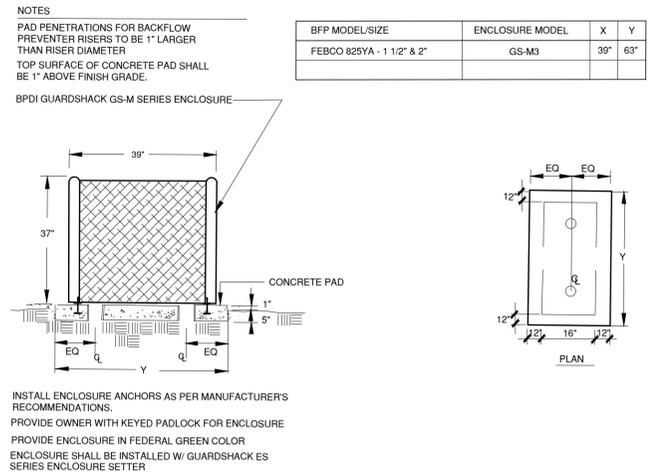


NOTE:

- TRENCH DEPTHS ARE SHOWN AS MINIMUMS. MAXIMUM DEPTH VARIATION ALLOWABLE IS 2". SEE SPECIFICATIONS FOR MINIMUM TRENCH WIDTHS.
- MULTIPLE IRRIGATION PIPES SHALL NOT BE INSTALLED IN THE SAME TRENCH.
- IRRIGATION WIRE SHALL BE PLACED BESIDE IRRIGATION PIPE, NEVER STACKED.
- BUNDLE AND TAPE ALL WIRES AT 10'-0" MINIMUM SECTIONS.
- BACKFILL MATERIAL SHALL BE FREE OF RUBBISH, FROZEN MATERIALS, AND STONES LARGER THAN 1". SEE SPECIFICATIONS FOR TYPICAL BACKFILL MATERIAL, PROCEDURES, AND REGULATIONS.

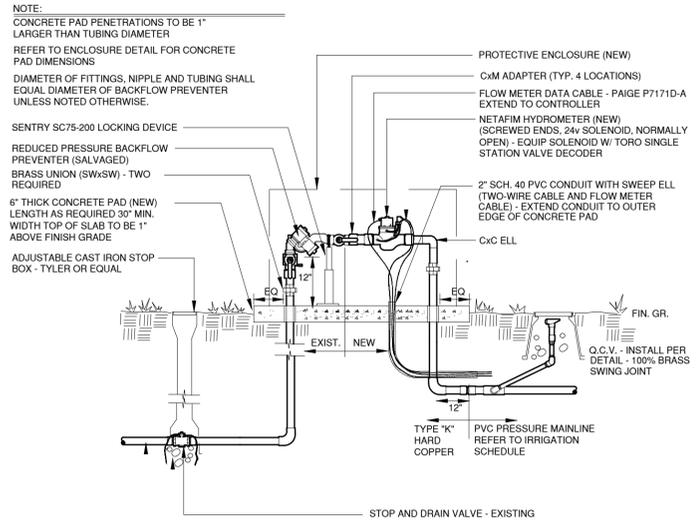
TRENCHES

13



BACKFLOW ENCLOSURE

14



POINTS OF CONNECTION

15

