

A panoramic view of the Denver skyline at sunset. The sky is filled with large, dramatic clouds illuminated by the setting sun, creating a warm orange and yellow glow. The city lights are visible in the foreground and middle ground, with the Colorado State Capitol building prominently lit in the center. The mountains are visible in the distance under the twilight sky.

Climate Adaptation

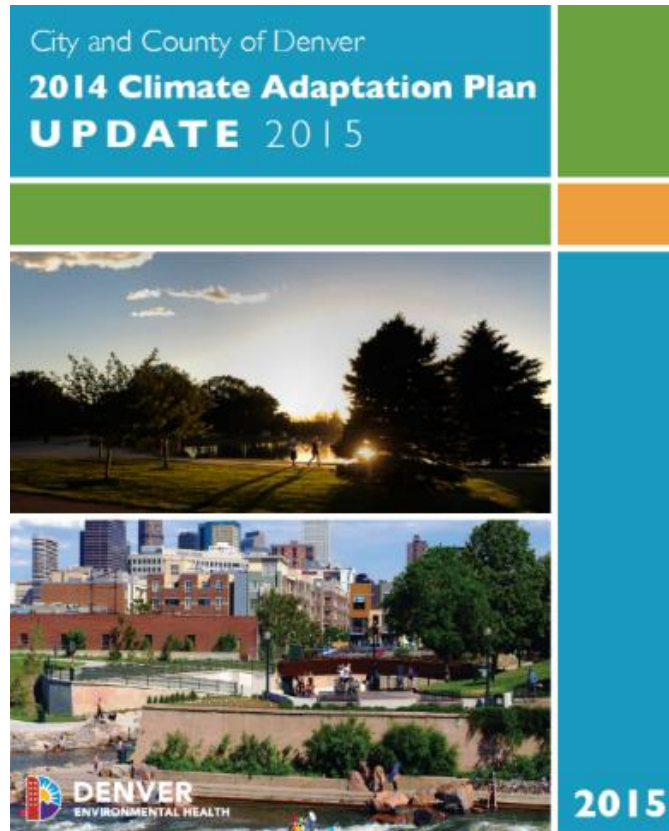
An overview of Denver's Adaptation Goals, Efforts, Gaps and Resource Needs

Key Terminology

- **Adaptation**: Adjustments in ecological, social, or economic systems in response to actual or expected climatic stimuli and their effects or impacts.
- **Hazard**: The potential occurrence of a natural or human-induced physical event that may cause harm.
- **Risk**: The probability that a situation will produce harm under specified conditions. It is a combination of two factors: the probability that an adverse event will occur; and the consequences of the adverse event.
- **Vulnerability**: The propensity or predisposition to be adversely affected.



Climate Adaptation Plan (2014)



Top vulnerabilities:

- An increase in temperature and urban heat island effect
- An increase in extreme weather events (prolonged heat, hail, etc.)
- Reduced snowpack and earlier snowmelt
- Focused solely on agency/operational impacts

Adaptation Requirements

While mitigation and adaptation efforts have expanded . . . they do not yet approach the scale considered necessary to avoid substantial damages to the economy, environment, and human health over the coming decades.

4th National Climate Assessment
2018



Provides evidence of a recent climate adaptation plan covering at least the city boundary¹



Has engaged key stakeholders in adaptation planning



Has an update process for the adaptation plan



Demonstrates action being taken on at least 50% of the hazards identified, with those actions being in operation or completed

1. Denver's 2014 Plan will not be "recent" as of 2020 and was limited in scope to impacts to government operations.

Hurdles to Adaptation

- Perception of problem, especially as an inland city
- Uncertainty as it relates to economic costs of climate ready efforts
- Recognizing natural environment's inherent adaptation and mitigation elements

Green Infrastructure

Versatile Tool for Adapting to a Changing Climate

- Living infrastructure that uses vegetation, soils and natural processes to manage stormwater and create healthier urban environments
- Ranges in scale from a single tree --- site scale applications such as stormwater planters---- regional approaches including constructed wetlands, protection of floodplains and interconnected greenways





Green Infrastructure Works on Many Scales in Denver

Climate Change in Denver

Precipitation Variability

- Increasing variability = increasing uncertainty

Wetter-than-normal years

Drought years increase in frequency & severity

More extreme events

- More precipitation falling as rain instead of snow



Green Infrastructure

& Precipitation Variability

- Manage runoff from variable, high intensity storms
- More resilient/flexible than grey infrastructure alone
- Appropriate native and adapted vegetation can be withstand periods of wet weather and drought
- Replenish groundwater supplies
- Reduces demand on potable water supplies



Climate Change in Denver

Temperature Increases

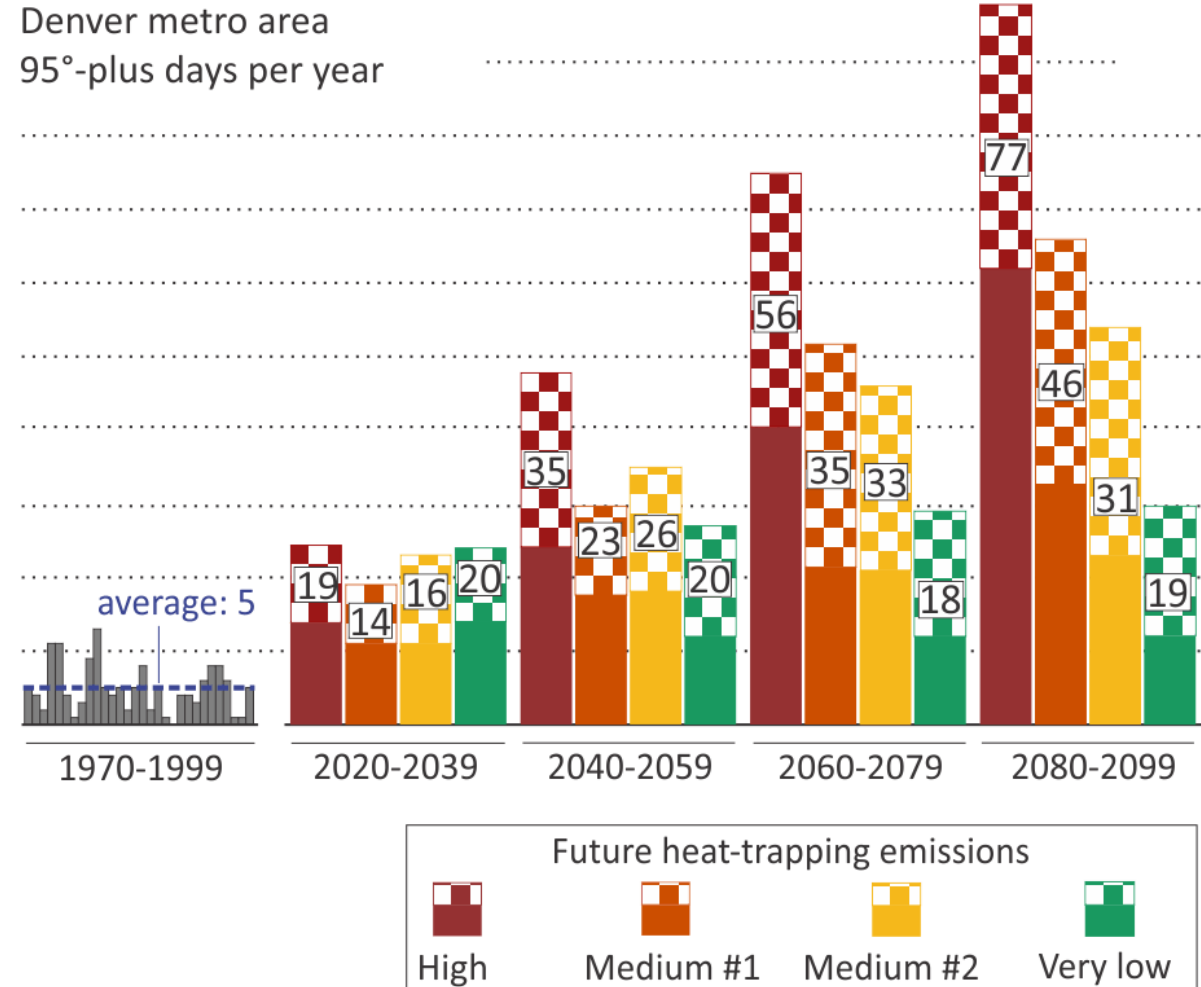
Observed

- 2.5° F increase in past 50 years
- Daily minimums increasing more than daily maximums

Mid-century:

- More than a month's worth of days >95°
- Fewer extreme cold months, more extreme warm months
- Temperature regimes in the Front Range will look like the current region at the Colorado/Kansas border

Denver metro area
95°-plus days per year



Green Infrastructure

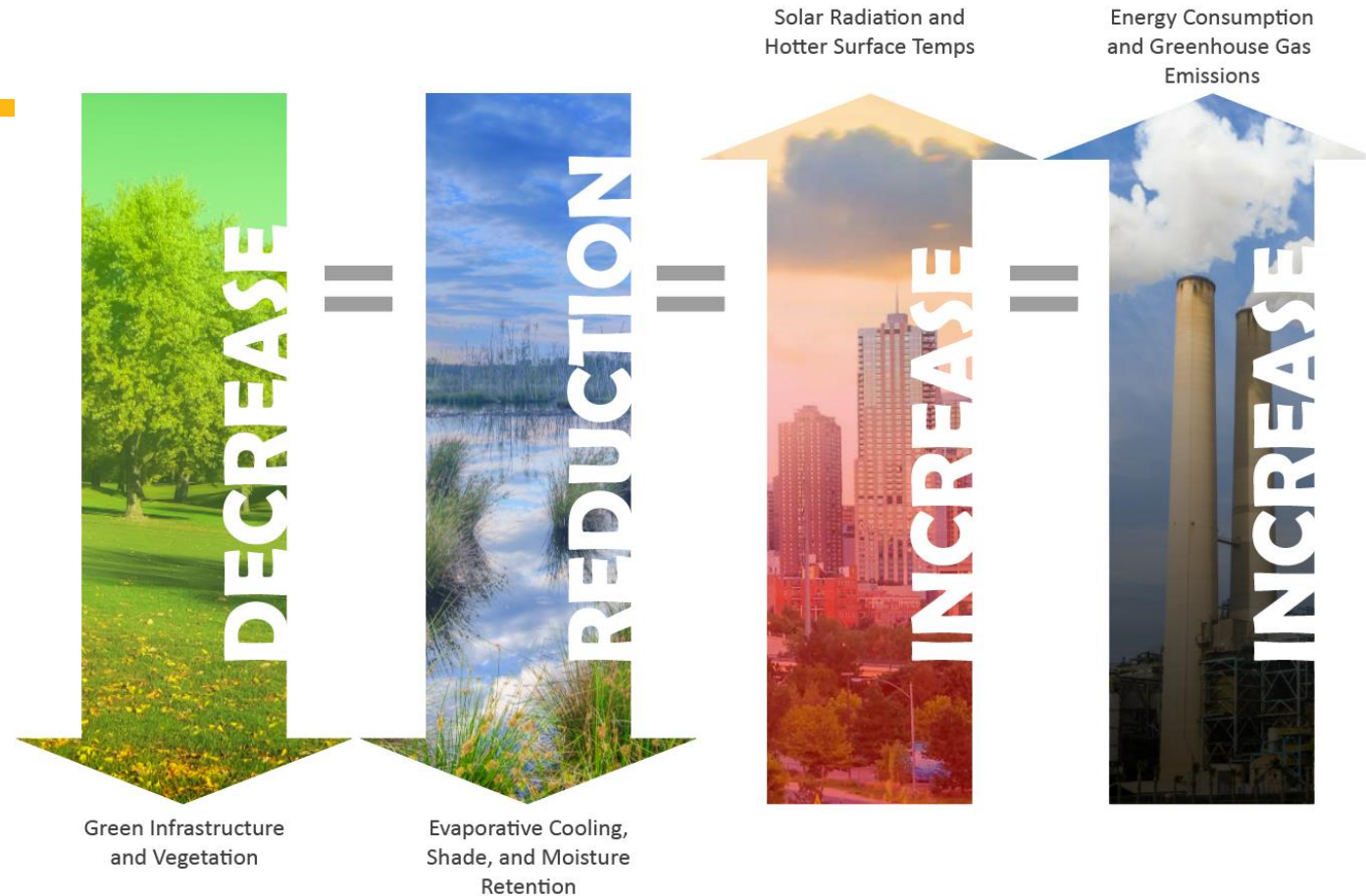
& Temperature Increases

Loss of green contributes to a warmer environment

- Reduction in evaporative cooling
- Reduction in shade
- Loss of moisture retention

Resurfacing with impervious materials (i.e., asphalt, concrete, brick)

- Lower albedo/reflectivity
- Increased solar radiation
- Hotter surface temperatures
- Greater energy consumption



Green Infrastructure Co-Benefits Studies & Research

Green Infrastructure for Climate Resiliency

Climate change is impacting urban areas in many ways, from exacerbating the urban heat island effect to elevating flood risk. Build green infrastructure to help improve community resilience.

FLOODING

By the end of the century, annual damages from flooding in the U.S. are projected to **increase by 30%**.¹

DROUGHT

1 out of 3 U.S. counties in the lower 48 states face higher risks of water shortages by mid-century.²

COASTAL DAMAGE

50% of Americans live in coastal counties, where water and energy infrastructure are increasingly vulnerable to higher sea levels.³

URBAN HEAT

Climate change will likely lead to **more frequent and severe** heat waves during summer months.⁴

Green Infrastructure Builds Resiliency

- Vegetation-based green infrastructure practices can mitigate carbon pollution.
- Build green infrastructure like rain gardens and permeable pavement to manage flooding.
- Reduce dependence on imported water and save money. Let water soak into the ground to recharge local groundwater supplies.
- Keep water local. Capture runoff in cisterns and rain barrels to reduce municipal water use.
- Plant trees and green roofs to mitigate the urban heat island effect.
- Use living shorelines, buffers, dunes and marsh restoration to reduce the impact of storm surges.

Green Infrastructure Investment Opportunities AUSTRALIA 2019

Climate Bonds
ANZ
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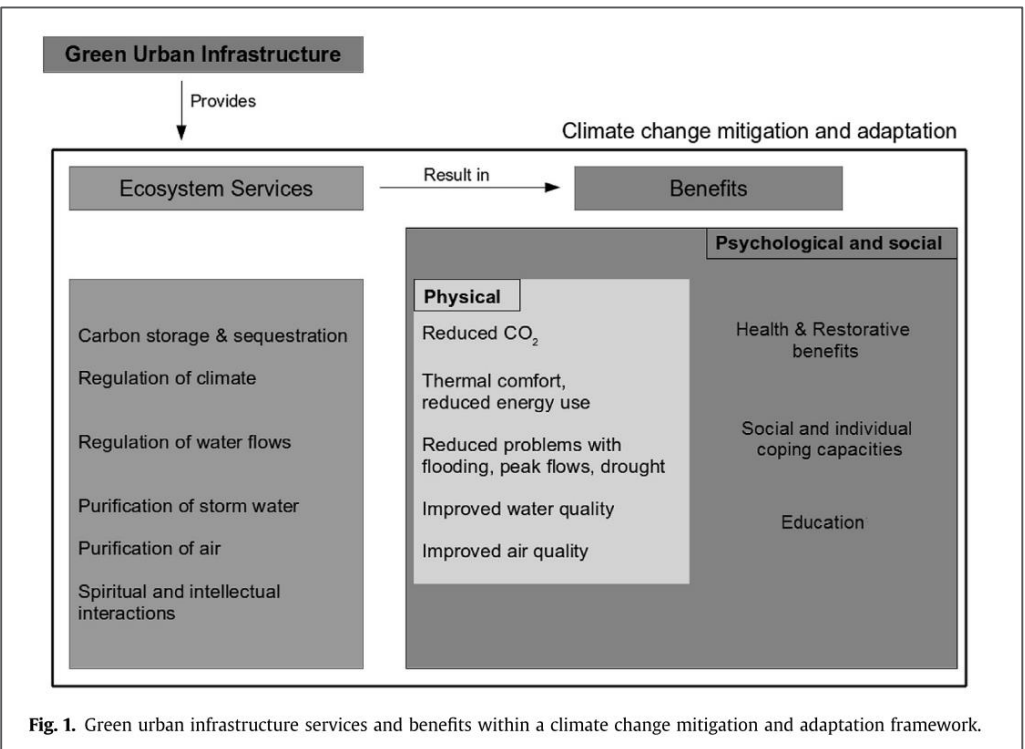
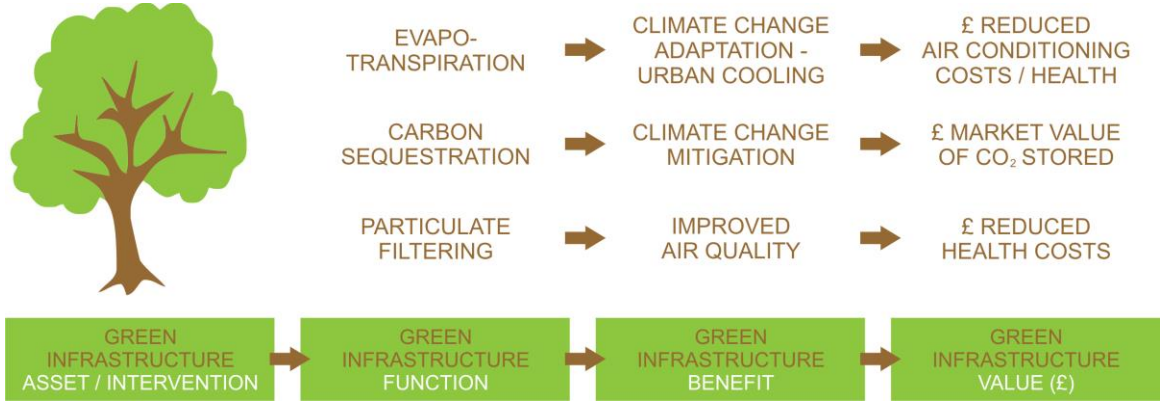


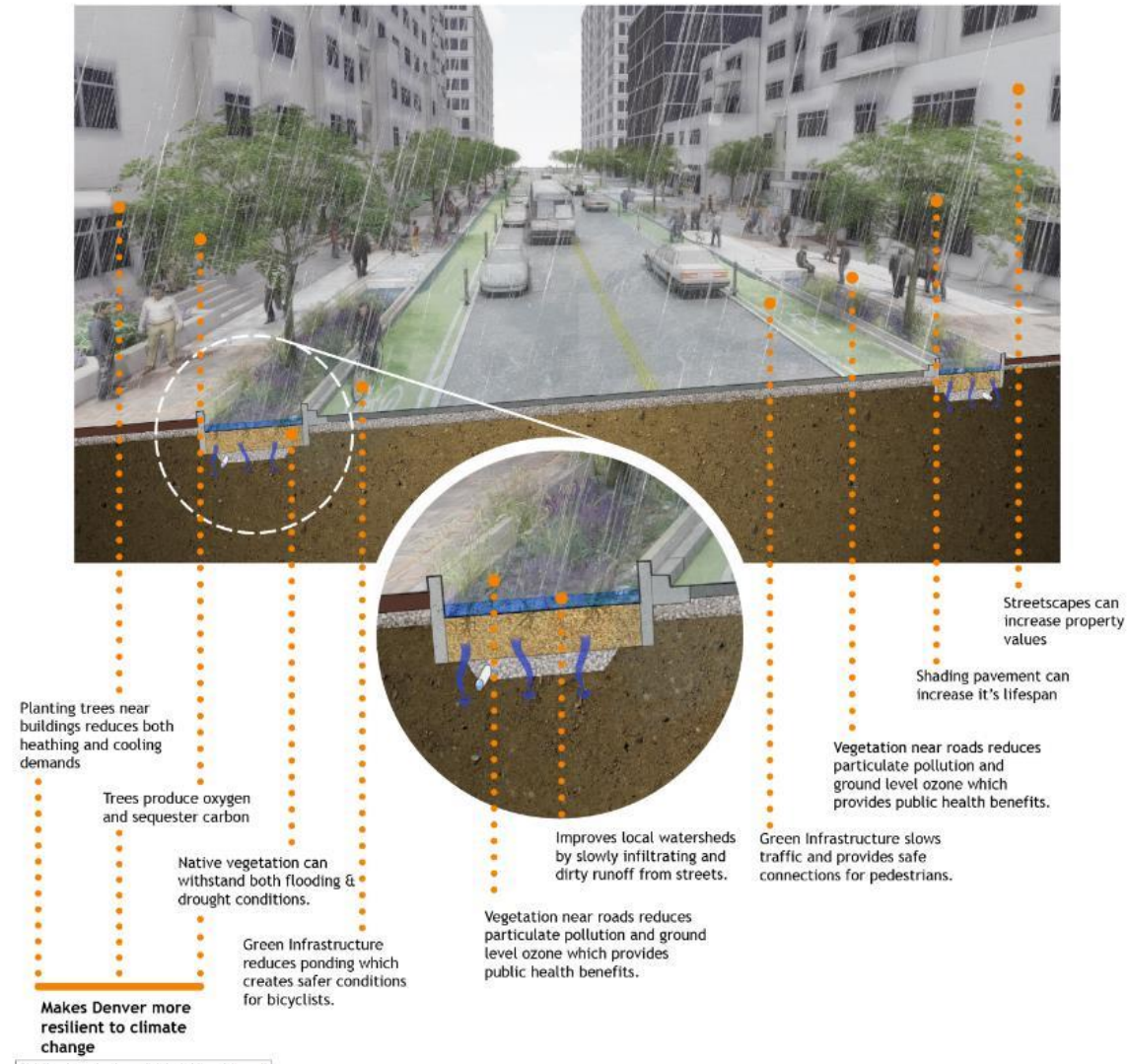
Fig. 1. Green urban infrastructure services and benefits within a climate change mitigation and adaptation framework.



Green Infrastructure

25 Miles of Green Streets in 5 Years

- Shading streets increases pavement lifespan
- Shading streets creates more comfortable environments for people walking & biking
- Vegetation near roads reduces particulate pollution & ground level ozone
- Trees produce oxygen and sequester carbon



Green Infrastructure

Citywide Benefit at All Scales

- ✓ Climate Resiliency
- ✓ Implementable in most vulnerable areas
- ✓ + Public Health Outcomes
- ✓ Urban Heat Mitigation
- ✓ Improved Air Quality
- ✓ Reduced Flood Risks
- ✓ Improved Water Quality
- ✓ Reduced Energy Demands
- ✓ Creates Comfortable, Safe Environments for People Walking and Biking



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DPR PROGRAMS TO ADDRESS CLIMATE CHANGE

Community Livability

- Emission reduction
- Health benefits
- Stormwater Management

Forestry

- Mountain park forest fire reduction program
- Enhanced pruning effort citywide
- Neighborhood forestry initiative
- EAB preventative program

Habitat Restoration

- Waterway restoration
 - Rivers, gulches and lakes
- Promote and establish habitat:
 - Pollinators
 - Wetland and aquatic
 - Riparian and upland
- Land acquisition

Water Resources

- Water Re-Use Program
- Water Conservation: improved technology
- Landscape conversions
- Flood reduction and improved water quality (partnership with PW)

Community Livability

Parks are the original “green infrastructure” and play an increasingly critical role in a city’s ability to adapt to a changing climate. Parks improve community livability by directly contributing to: property value, tourism, direct use, health, community cohesion, clean air, and clean water

Health

Denver Parks contribute to an estimated **\$65 million** in total health benefits.



Stormwater Management

Denver parks reduces typical annual runoff in Denver by 78M cu/ft providing a significant savings to the city’s infrastructure.

Emission Reduction

Denver Parks reduced **27 tons** of emissions including CO2, Nitrogen dioxide, Ozone, particulate matter and Sulfur dioxide.

Trust for Public Land , The
Economic Benefits of Denver’s
Park and Recreation System,2010

Forestry

Mountain Parks – Fuel Reduction

7,000 acre of Mountain Parks are in need of treatment to reduce fuel loads and restore the forest to a historic state.

- 250 acres are typically being treated each year.
- 2A will provide additional funding for staffing and equipment



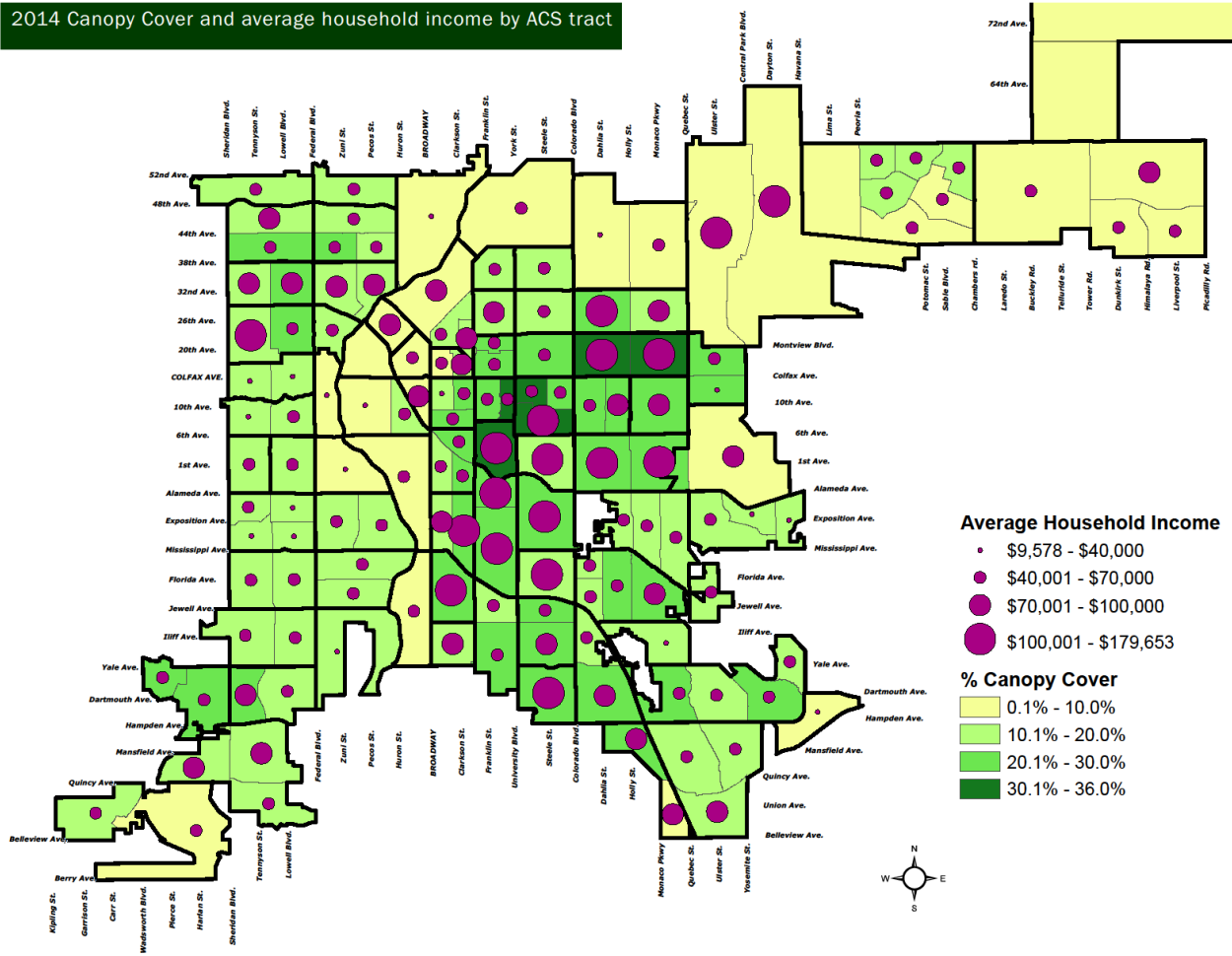
Urban Parks and Parkways – Proactive tree care

Increased pruning rotation to lessen damage from more frequent spring and fall storms and to produce additional canopy.



Forestry

2014 Canopy Cover and average household income by ACS tract



Neighborhood Planting Initiative
Focus on planting high heat/low equity neighborhoods.

Downtown Planting Initiative Partner
with the Downtown Denver Partnership to increase existing 4% canopy.

Be A Smart Ash Program

- Plants 3,000 new trees
- Protects and preserves existing canopy

Habitat Restoration

Waterway Restoration

- **Over 10 miles** of waterway restoration completed in partnership with Public Works – Wastewater and Mile High Flood District (formerly UDFCD) in the last 15 years.
- Actively working to secure Federal funding for the Urban Waters/USACE project
- **250 acres** of habitat identified for restoration and enhancement.
- 2A funding for additional staffing, equipment and restoration projects



Habitat Restoration

Acquisition

Over \$60 million allocated from 2A funds for:

- Closing the 10-min walk to a park gap
- Resiliency and habitat restoration
- Downtown, high density & growth areas
- Equity focus areas
- New DPR facilities
- Mountain Parks

Landscape Conversion and Restoration

- Converted **40%** of annual flower beds to perennial and pollinator species.
- 100+ acres currently identified to convert from bluegrass to native for wildlife, pollinators and water conservation



Water Resources

Water Reuse Program

- **995.1 Acres** (including City Park Golf) converted to reuse and the City Ditch
 - 440,340,180 gallons potable water saved annually
 - \$942,328 cost savings

Landscape conversions to no water:

- **25.2 acres**
 - Water savings = 20,528,424 gallons
 - Cost of savings = \$48,857



Water Resources



Water Conservation: Improved Technology

- Sentinel central control: 856 units, 56% of complete buildout
 - 1230 irrigated acres on central control (50.5%)
 - Water savings = 150,380,884 gallons
 - Cost savings at 2019 rate: \$2.38/1000 gals = \$357,907
 - Labor savings at 15 trips rain on/off and seasonal adjusts at 1 hour round trip per unit: 8,400 hours

Weather station and rain cups:

- 8 weather stations
- 10 rain cups