

City and County of Denver **Climate Adaptation Plan**



JUNE 24, 2014

Dear Neighbors:

Recognizing that climate change is among the defining issues of the 21st century, Denver strives to be one of the most sustainable cities in the nation – an innovative and climate resilient city. We are committed to facing the challenges through preparedness, collaboration and cost-effective strategies.

Under those guiding principles, over the past 18 months the Department of Environmental Health has led a citywide committee dedicated to developing Denver's Climate Adaptation Plan. The objectives of the plan are to prepare for and mitigate the risks associated with potential climate impacts to Denver, including higher temperatures, more extreme weather events, changes to annual snowpack and the resultant change to downstream flows.

This Climate Adaptation Plan provides a collaborative path forward to protect what we cherish so that future generations will enjoy economic opportunity, effective and efficient infrastructure, parks and open spaces, and an environment conducive to supporting resident health and well-being.

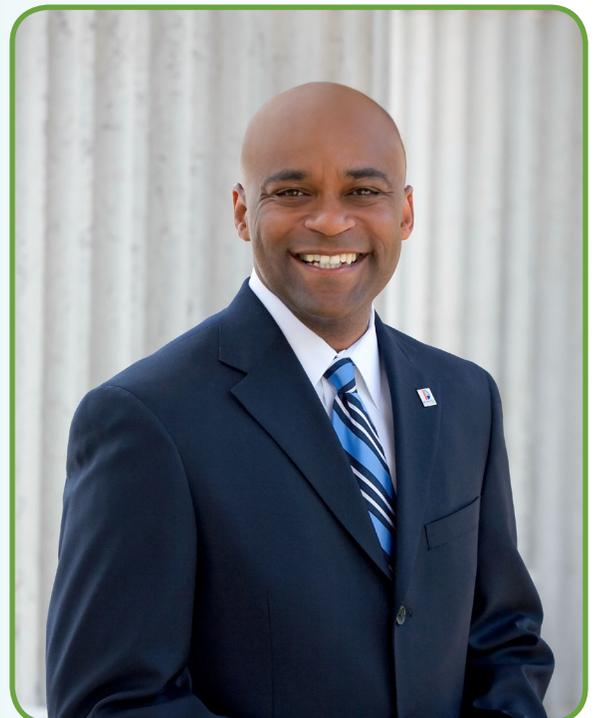
Over the next year, we will begin to incorporate short- and long-term priorities into agency strategic plans, our Peak Performance efforts and the city's nationally accredited environmental compliance program, the Environmental Management System. We will also be releasing an updated Climate Action Plan, which has guided citywide efforts to improve air quality, reduce energy consumption and greenhouse gas emissions.

I encourage you to read Denver's Climate Adaptation Plan and join us in creating a vibrant city that is environmentally responsible and resilient to climate challenges.

Respectfully,



Michael B. Hancock
Mayor



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LIST OF ACRONYMS

BMO: Budget Management Office

BPS: By-Product Synergy Network

CAO: City Attorney Office

CDOT: Colorado Department of Transportation

CH₄: Methane

CHP: Combined Heat and Power Technology

CO₂: Carbon dioxide

CPD: Department of Community Planning and Development

DEAP: Denver Energy Assurance Plan

DEH: Department of Environmental Health

DFD: Denver Fire Department

DGS: Department of General Services

DHHA: Denver Health and Hospital Authority

DHS: Department of Human Services

DIA: Denver International Airport

DMNS: Denver Museum of Nature & Science

DPR: Department of Parks and Recreation

DPS: Denver Public Schools

DPW: Department of Public Works

DRH: Denver Road Home

DS: Development Services

DW: Denver Water

EMS: Environmental Management System

EV: Electric Vehicle

GES: Globeville Elyria-Swansea neighborhoods

GHG: Greenhouse gas

IPCC: Intergovernmental Panel on Climate Change

IRP: Integrated Resource Plan

LEAP: Low Income Energy Assistance Program

MCG: Meister Consultants Group

MW: Megawatts

NDCC: North Denver Cornerstone Collaborative

N₂O: Nitrous oxide

NO_x: Nitrous oxides

OED: Office of Economic Development

OEMHS/OEM: Office of Emergency Management and Homeland Security

OHR: Office of Human Resources

OOS: Office of Sustainability

PPB: Parts per billion

PPM: Parts per million

RTD: Regional Transportation District

STP: Strategic Transportation Plan

TOD: Transit Oriented Development

UDFCD: Urban Drainage and Flood Control District

UTC: Urban Tree Canopy

VBZD: Vector-Borne and Zoonotic Diseases

VOCs: Volatile organic compounds



EXECUTIVE SUMMARY

In 2007, Denver unveiled its Climate Action Plan and set a greenhouse gas reduction goal to reduce emissions by 10 percent per capita below 1990 levels. Denver is on track to meet this goal and continues to be proactive in reducing city-wide per capita emissions. However, the planet is warming and the resulting effects have the potential to harm Denver's social, economic, and environmental sectors. Along with mitigation practices aimed to reduce greenhouse gas emissions, Denver must address and prepare for the impacts of climate change already occurring and those projected to occur, in order to prosper in the future. Supplementing Denver's Climate Action Plan, the Climate Adaptation Plan offers collaborative strategies to adapt to a future climate with higher temperatures, more extreme weather events, and changes to annual snowpack. Denver recognizes climate change as a defining issue of the 21st century and remains committed to facing the challenges of a changing climate through preparedness, forward thinking, and cost-effective strategies. Denver strives to not only be one of the greenest cities in the nation, but also one of the most innovative and climate resilient cities in the face of rapid climate change. The objectives of the Climate Adaptation Plan are to prepare, mitigate, and plan for risks associated with the following potential climate impacts to Denver:

Denver's Climate Adaptation Plan visions to provide a collaborative path forward to prepare for a hotter climate, protecting what we cherish.

1. An increase in temperature and urban heat island effect
2. An increase in frequency of extreme weather events
3. Reduced snowpack and earlier snowmelt

Denver's Climate Adaptation Plan was prepared with the following values understood: The City and County of Denver is preparing for a hotter and more variable climate. The Plan provides a collaborative path forward to prepare for these climate changes, protecting what we cherish so future generations will enjoy a quality of life characterized by economic opportunity, parks and open spaces, recreational activities, and an environment conducive to support residents' health and well-being. The focus of this Plan is to identify adaptation strategies within Denver City agencies and community organizations that will lead to future adaptation efforts Denver can implement. Successful implementation of the Plan supports a vibrant Denver that is resilient to climate challenges and continues to prosper as a world-class city where everyone matters.

Long-term planning and coordinated implementation are needed to address the social, economic and environmental consequences of climate change impacts on Denver. In response, Denver convened a working group made up of department representatives in spring, 2012 to begin assessing the impacts Denver may face as a result of a changing climate. In coordination with City agencies, the working group identified Denver's top vulnerabilities to climate change. These were used as a framework to establish short, medium, and long-term climate adaptation activities.

A resilient community will be able to enjoy economic opportunity, parks, open spaces, recreational activities, and an environment conducive to support resident's health and well being.

These activities will allow Denver to reach its long-term vision to be one of the most innovative and resilient cities in the face of climate change. The short, medium, and long-term activities are categorized by sectors throughout the Climate Adaptation Plan. The sectors refer to broad planning areas that will be affected by climate change impacts. The sectors used in the Climate Adaptation Plan are: buildings and energy, health and human services, land use and transportation, urban natural resources,

water consumption, and food and agriculture. Each sector is facing different impacts from climate change and can adapt in different ways. Systematically examining which climate impacts affects each sector helps identify where climate adaptation action is most needed, allowing Denver to create forward-thinking and cost-effective adaptation strategies.



CHAPTER 1: INTRODUCTION TO CLIMATE ADAPTATION

1.1 Plan Contents

Denver’s Climate Adaptation Plan is the result of a collaborative effort of Denver City Agencies and Denver Water. Staff from the various agencies began meeting in the spring of 2012 to (1) identify vulnerabilities to climate change and (2) identify responses that would allow Denver to adapt to potential climate change issues. [Chapter 1](#) of this plan provides an introduction to climate change and includes discussion of observed and expected climate trends in Colorado, the Front Range, and Denver. [Chapter 2](#) identifies the agencies that have been involved in Denver’s climate change adaptation planning and highlights adaptation activities the agencies were already involved with prior to the writing of this plan. [Chapter 3](#) provides a summary of major concerns or vulnerabilities Denver will likely encounter as the climate changes. In response to these vulnerabilities, short, medium and long-term adaptation activities were developed. [Chapter 4](#) provides a description of short-term (one to two years) adaptation activities, and [Chapter 5](#) discusses longer-term goals and strategies for adapting to a changing climate. Finally, [Chapter 6](#) provides a discussion of future steps Denver will take to implement and continue climate change adaptation activities.

1.2 Introduction to Climate Change

There is mounting evidence that our planet is warming rapidly. The Intergovernmental Panel on Climate Change (*IPCC*) states “warming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia.”¹

Global climate change refers to long term average trends in weather, like temperature and precipitation, across a region.² When referring to global climate change it is important to look at long-term climate trends, generally 30 years or more, rather than short-term patterns which reflect natural climate variability. From 1880 to 2012, the globally averaged combined land and ocean surface temperature shows a warming of 0.85 degrees Celsius (1.53°F) ([figure 1.1](#)), and virtually the entire globe has seen an increased average surface temperature from 1901-2012 ([figure 1.2](#)).³ Globally, the atmosphere and oceans have warmed, the amounts of snow and ice have diminished, and sea level has risen. The IPCC concludes that it is undisputable that the global climate is warming.⁴

Since the industrial revolution began in the 1750s, the atmospheric concentrations of the greenhouse gases carbon dioxide (CO₂), methane (CH₄), and nitrous oxide (N₂O) have all increased dramatically. In 2011, the concentrations of these greenhouse gases were 391 parts per million (ppm), 1803 parts per billion (ppb), and 324 ppb, respectively, which exceed the pre-industrial revolution levels by 40%, 150%, and 20% respectively.⁵ CO₂ levels are higher now than at any time in at least 800,000 years.⁶ There is widespread scientific consensus that the increases in emissions are primarily the result of the burning of fossil fuels (coal, natural gas, gasoline, and diesel), industrial agriculture, and land-use change, and that this increase in greenhouse gases is the dominant cause of the warming global climate.⁷

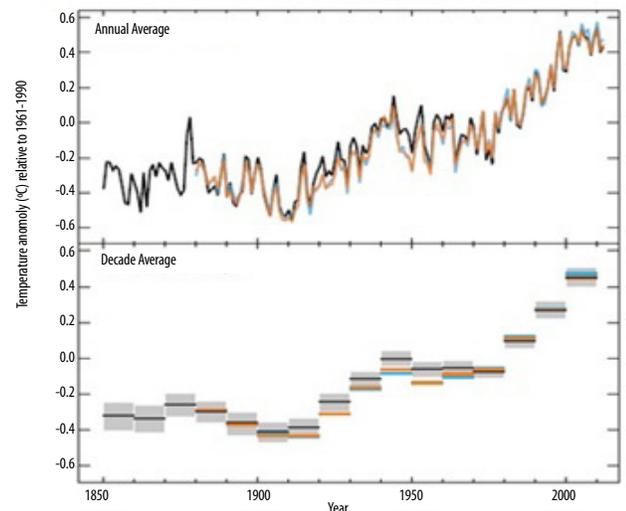


Figure 1.1: Observed rise in globally averaged combined land and ocean surface temperatures from 1850-2012 (IPCC, 2013)

1.2 Introduction to Climate Change (Cont.)

The IPCC has identified specific effects of global climate change that are impacting climate conditions in many locations around the globe including: warmer days and fewer colder nights, higher frequency and duration of warm days and nights, increased frequency of heavy precipitation events, increased intensity and duration of droughts, increase in tropical cyclone activity, and increased incidence of global sea level rise.⁸ These impacts and their implications differ in different regions of the world. It is imperative that Denver recognizes its most critical climate change impacts and acts to mitigate and adapt to these changes in order to become a city resilient to climate change.

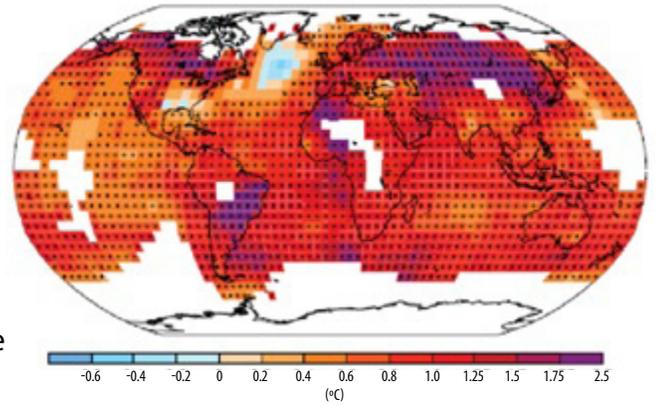


Figure 1.2: Observed change in average surface temperature from 1901-2012 (IPCC, 2013)

1.3 Climate Impacts on the Front Range

1.3.1 Climate Observations and Projections for Colorado

Historical climate trends show that the western United States is warming and Colorado is experiencing increased temperatures and a drier climate (figure 1.3).⁹ According to a Western Water Assessment report, the following are observed and projected climate changes in Colorado:¹⁰

- » Statewide, temperatures have increased about 2°F over 30 years, with slightly more observed warming on the Front Range.
- » Climate models project Colorado will warm 4°F (2.5 to 5.5°F) by 2050 relative to a 1971-2000 baseline.
- » Temperatures in the Front Range are predicted to be similar to temperature regimes that currently occur near the Colorado-Kansas border by 2050.
- » Typical summer temperatures in 2050 are projected to be as warm as or warmer than the hottest 5% of summers that have occurred since 1900.
- » The January climate of the Eastern Plains of Colorado is expected to reflect that currently experienced by areas approximately 150 miles further south, making for fewer extreme cold months and more extreme warm months.
- » April 1st snowpack is expected to decline in Colorado’s mountains as the projected warming increases the fraction of precipitation falling as rain, and also increases moisture loss from the snowpack.
- » Peak runoff has shifted earlier by 1-4 weeks over the last 30 years. By 2050, warming is projected to shift runoff an additional 1-3 weeks earlier and reduce late summer streamflows.
- » Droughts are projected to increase in frequency and severity.¹¹

		Winter	Spring	Summer	Autumn	Annual
Arkansas Valley	Tmax	+2.1	+3.8	+0.4	+1.0	+1.8
	Tmin	+3.2	+3.0	+1.4	+1.4	+2.2
North Central Mountains	Tmax	+1.3	+4.6	+1.8	-0.1	+1.9
	Tmin	+2.7	+4.7	+3.0	+2.7	+3.2

Figure 1.3: Difference in the average minimum and average maximum temperatures in each season in the Arkansas Valley and North Central Mountains in Colorado from 1957-2006. Red indicates a significant temperature difference (Ray, 2008)

1.3.2 Importance of Climate Projections for Denver

The Climate Adaptation Plan has identified the following three key potential impacts for Denver based on climate change projections for the Front Range:

1. Increase in temperature and urban heat island effect
2. Increase in extreme weather events
3. Reduced snowpack and earlier snowmelt

Increase in Temperature and Urban Heat Island Effect^{1 12}

Urban heat islands refer to the elevated temperatures in developed areas compared to more rural surroundings. Urban heat islands are a result of surface properties of building materials, such as pavement and asphalt, combined with reduced vegetation. On a hot, sunny, summer day, surfaces exposed to the sun can reach 50 to 90°F hotter than the air temperature, while shaded or moist surfaces, often in more rural surroundings, remain close to air temperatures (figure 1.4). On average the difference in daytime surface temperatures between developed and rural areas is 18 to 27°F and the difference in nighttime temperatures is 9 to 18°F. Denver, being highly urbanized, already sees an urban heat island effect and the increased temperatures due to climate change would exacerbate that effect. The projected increase in temperature along with increased heating due to the urban heat island effect will have several impacts to Denver including: increased energy consumption, human health issues, and a change in water quality in the rivers and streams that run through the city.

During the summer months, elevated temperatures in Denver will increase energy demand for cooling. This adds additional stress on the electric grid during peak periods of demand. This generally occurs on hot, sunny, summer weekday afternoons when offices and homes are running cooling systems, lights, and appliances. For every 1°F increase in temperature, the peak urban electric demand increases 1.5 to 2%.¹³ Steadily increasing temperatures may result in overloaded cooling systems causing power outages. An increase in energy consumption using the carbon-intensive fuel mixture that powers our region at the current time also causes higher levels of air pollution as well as further release of CO₂ into the atmosphere. Ground level ozone concentrations may also increase with an increase in average temperature in Denver.

An increase in temperatures and urban heat island effect can impair Denver's air quality, water quality, and affect human health.

Ground level ozone is created by chemical reactions between nitrogen oxides (NO_x) and volatile organic compounds (VOCs) in the presence of sunlight. Major sources of NO_x and VOCs are emissions from industrial facilities and electric utilities, motor vehicle exhaust, gasoline vapors, and chemical solvents.¹⁴ If all other variables are equal, such as levels of NO_x and VOC emissions and wind speed and direction, ground level ozone levels will be higher in hotter and sunnier weather.¹⁵ Therefore, elevated air temperatures due to climate change and the urban heat island effect have the potential to increase the rate of ground level ozone formation in Denver. Ground level ozone is a component of urban smog and has adverse health effects on the respiratory system, particularly those of children and the elderly.¹⁶

Some of these adverse health effects include:

- » More difficulty breathing deeply and vigorously.
- » Shortness of breath and pain when taking a deep breath.
- » Coughing and sore or scratchy throat.
- » Aggravation of lung diseases such as asthma, emphysema, and chronic bronchitis.
- » The lungs are more susceptible to infection.
- » The lungs may continue to be damaged even when the symptoms have disappeared.¹⁷

¹ Heat island information in this section is retrieved from EPA's "Reducing Urban Heat Islands: Compendium of Strategies" document, unless otherwise noted.

Increase in Temperature and Urban Heat Island Effect (Cont.)

Denver already suffers from days with elevated ground level ozone concentrations in the summer months, so increases in temperatures and urban heat island effect will only add to currently observed concentrations.

Increased temperatures and heat waves can cause public health emergencies due to increased daytime temperatures and reduced nighttime cooling. Citizens may not be able to cool down and seek relief from extreme daytime temperatures. The Center for Disease Control estimates that from 1979 to 1999, excessive heat exposure contributed to more than 8,000 premature deaths in the United States.¹⁸ A report released by the Rocky Mountain Climate Institute and the City of Fort Collins found that the number of 90°F or higher days in Fort Collins increased 162% from 1961-2013 and the number of heat waves (three consecutive days at 90° or higher) increased 533% from 1961-2013.¹⁹ This increase in number of 90° days and heat waves is anticipated to bring changes to water use and needs, human health and comfort, agriculture, and ecosystems.²⁰ It has been suggested by policy makers and health professionals that the harmful health impacts of climate change may be partially offset by a decline in excess winter deaths in temperate countries as winters warm. A recent study published online²¹ concluded that in England and Wales no evidence exists that excess winter deaths will decrease if winters warm with climate change. Whether this conclusion is valid for other countries with temperate climates is still being debated.

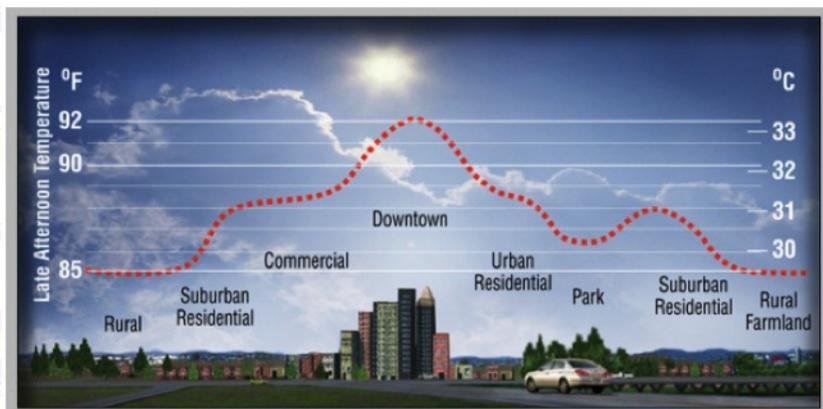


Figure 1.4: Temperatures increase over urbanized areas (heatisland.lbl.gov/coolscience)

Human health can also be affected by changing disease patterns due to shifts in trade and transport of diseases as a result of changing climate patterns and increased temperatures.²² These disease vectors can spread quickly in a dense, urban environment. Vulnerable populations such as low income residents, the elderly, children, and people with compromised or less developed immune systems will face disproportionate risks and difficulties regarding health impacts of increased temperatures. Adverse effects on Denver's health levels may also increase medical costs associated with allergies and respiratory conditions.²³

Denver Water completed a simple sensitivity assessment to examine how a 5°F increase in average temperature could change water supply and demand. Findings show available water supplies could decrease by 20%, while water use could simultaneously increase by 7 percent assuming a continuation of current patterns of consumption.²⁴ Denver Water is preparing for warming, as well as other future uncertainties, by incorporating these findings into their long-term Integrated Resource Plan (*IRP*). The *IRP* is Denver Water's long-term decision-making guide and includes the complete water system, water collection, treatment, distribution, efficiency, recycling, conservation, and demand.²⁵

Increased air temperatures can also cause an increase in water temperatures in streams, rivers, and lakes. Elevated surface temperatures are transferred to stormwater during rain events, which is released in a water body and raises the temperature. Studies have shown that during rain events runoff from urban areas was about 20 to 30°F hotter than runoff from nearby rural areas.²⁶ This impairs water quality and compromises aquatic species' metabolism and reproduction. Elevated water temperatures can inhibit aquatic life, especially if a species can only survive in a small range of water temperatures.

Increase in Extreme Weather Events

An extreme weather event is defined as “an event that is rare at a particular place and time of year.”²⁷ Extreme weather events in Colorado include heat waves, drought, flooding, wildfires, and storms. As mentioned above, there are numerous impacts resulting from an increased amount of heat waves in Denver. A Natural Resource Defense Council study estimates by mid century Denver’s number of extreme heat days² will increase by 79 days from the historical average of nine days, for a total of 88 extreme heat days per summer, causing an increase in the adverse effects on human health and the environment.²⁸

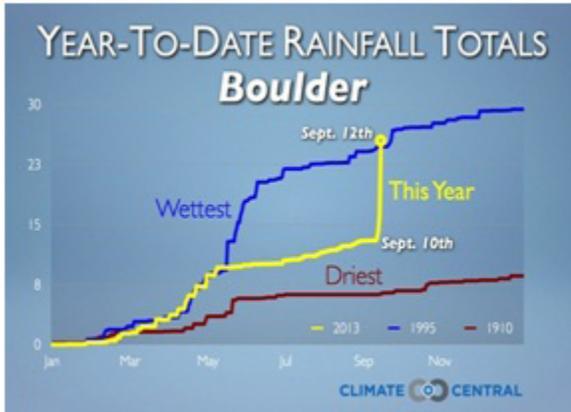


Figure 1.5: Boulder, CO received record amounts of rainfall within a 2 day time span in September, 2013. (Climate Central, 2013)

Unlike increasing temperatures, there has been no clear long term trend in total average yearly rainfall in Colorado. However, Colorado has experienced extreme weather in the form of heavy downpours.²⁹ Heavy downpours can have several negative impacts such as flash floods and mudslides. Also, nutrient and debris loading in waterways resulting from heavy rain events can cause a decrease in water quality, impacting human health and aquatic ecosystems. Flash floods and mudslides can cause property damage and cost human lives.³⁰ The 2013 Colorado Flood is a recent example of how a heavy rain event can impact an area. After a dry summer, many communities along the Front Range received most of their normal annual rainfall in the span of five days. This produced catastrophic flooding that caused an estimated \$2 billion in property losses and 10 fatalities (figure 1.5).³¹

An increase in spring temperatures, earlier snowmelt, hot, dry summers, and stressed forests from pest infestation all contribute to an increase in the number of large wildfires in Colorado (figure 1.6³²).³³ Compared to the 1970s, in the past decade there were:

- » Seven times more fires larger than 10,000 acres each year
- » Nearly five times more fires larger than 25,000 acres each year
- » Twice as many fires over 1,000 acres each year

In Colorado, the number of fires greater than 1,000 acres burning each year on Forest Service land has doubled since the 1970s. In 2012, more than 4,000 fires, including The Waldo Canyon Fire in Colorado Springs and the High Park fire near Fort Collins, caused a total of \$500 million in property damage across the state. Wildfires also contribute to poor air quality in Denver, again impacting human health and the environment.³⁴ In addition, fires can severely damage forested areas and watersheds that are critical to Denver’s drinking water supply. Denver Water receives its drinking water supply from watersheds in the mountains and foothills, so healthy ecosystems in these forested areas are imperative to ensure drinking water for Denver residents. Catastrophic wildfires have a high probability of occurring in certain forest types that are unhealthy due to tree density. In 1996 and 2002, two major wildfires occurred above Denver Water’s reservoirs. Subsequent rain events resulted in significant erosion, transporting large volumes of sediment into these water supply reservoirs. The sediment resulted in water quality impacts to the water supply that caused increased water treatment and management costs, and a reduction in storage capacity.

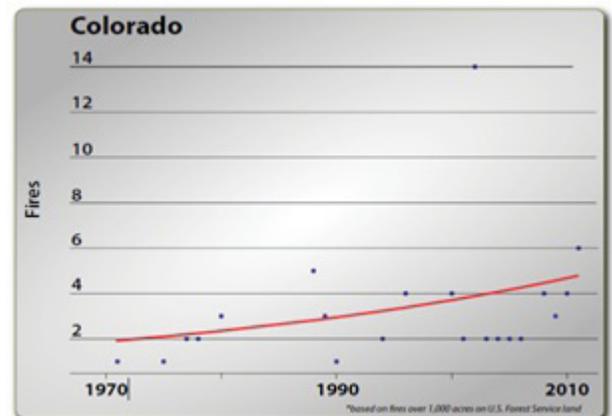


Figure 1.6: An increase in the number of fires greater than 1,000 acres on U.S. Forest Service Land in Colorado from 1970-2010 (Climate Central, 2012)

² Occurs when a location’s temperature, dew point temperature, cloud cover, wind speed, and surface atmospheric pressure throughout the day combine to cause heat related deaths.

Reduced Snowpack and Earlier Snowmelt

Denver Water provides the citizens of Denver with reliable, high-quality drinking water. The source of Denver Water's water supply comes from streamflows driven by the annual snowmelt.³⁵ As the snowpack melts earlier due to warmer spring temperatures, streamflows shift to earlier in the spring and has the potential to result in less water available to fill reservoirs for use during the summer months when consumers use it most.

As noted earlier, there is no long-term trend in annual average precipitation in Colorado. Increasing temperature trends; however, have been observed and are projected to continue into the future. Warming alone can have significant impacts to the water systems in Denver and across the mountainous watersheds that supply Denver Water's drinking water. Warmer spring temperatures, along with factors such as dust-on-snow events, are already triggering earlier snowmelt (figure 1.7).³⁶

Dust-on-snow events result from deposition of soils originating from the desert southwest and the Colorado Plateau and Great Basin onto snowpack in Colorado. Land-use changes in the regions where the dust originates, such as grazing, oil and gas drilling, agriculture, and off-road vehicle use, causes disturbances in the soil. During strong wind events these soil particles are picked up and transported hundreds of miles from the source and have been deposited in the mountains of Colorado.³⁷ When the snowpack begins to melt, the dust is exposed and absorbs more solar radiation, causing faster snowmelt and earlier spring runoff.³⁸ Snowpack helps keep water at high elevations and feeds streams, rivers, and reservoirs throughout the year. Earlier snowmelt decreases the amount of snow available later in the year for summer and fall streamflows, which can potentially impact water resources and needs, river recreation, and the aquatic environment.

Additionally, earlier snowmelt and warmer average temperatures may cause soil moisture to decline during the summer, increasing drought stress in trees and making them more susceptible to wildfires.³⁹ Increased temperatures may also make forests more susceptible to mountain pine beetle infestation. The mountain pine beetle has killed more than 70,000 square miles of trees across the west over the past decade.⁴⁰ Stressed trees, due to lack of soil moisture during the growing season, can become more vulnerable and lose their ability to fight infestation. Also, warmer winter temperatures decrease the amount of deep freezes that typically keep the mountain pine beetle population in check.

It is evident that climate change will have various impacts on Denver, and it is important to plan for climate change so that Denver continues to provide long-term prosperity for its people and businesses by securing the basic resources on which economic activity and quality of life depend.

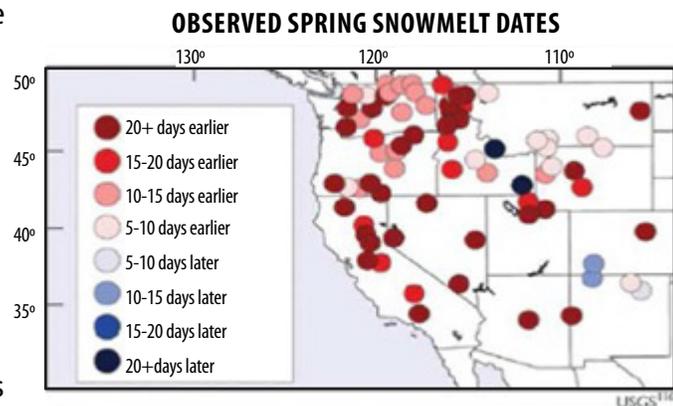
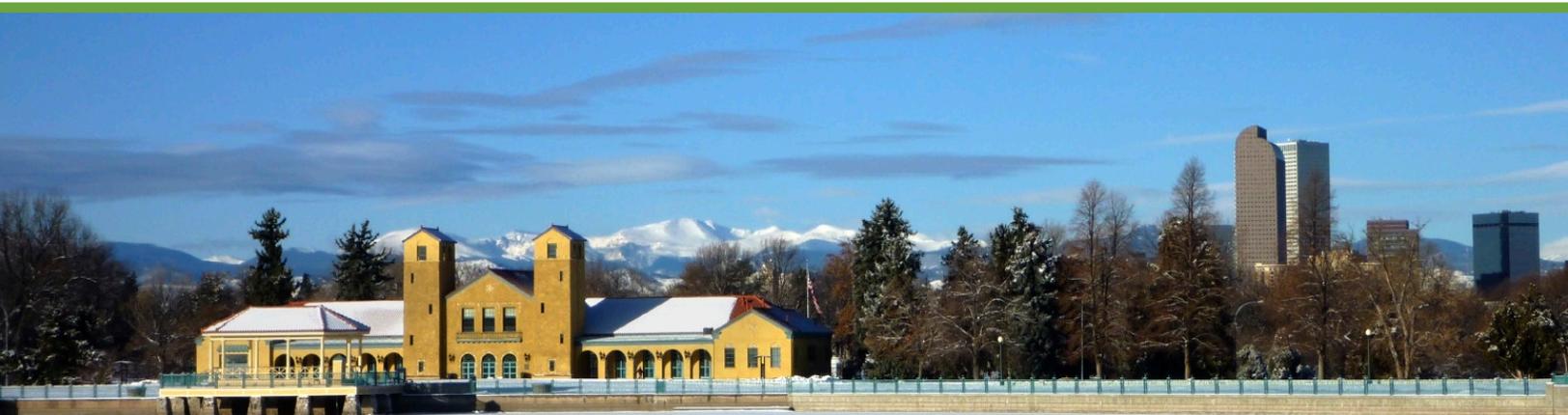


Figure 1.7: Changes in observed spring snowmelt dates for the western United States from 1948 – 2002. Spring snowmelt is 20+ days earlier on the Front Range. (ICLEI, 2011)



1.4 Climate Mitigation vs. Climate Adaptation

As Denver is preparing for the impacts of climate change it is important to note the difference between climate mitigation and climate adaptation.

- » Climate mitigation refers to “efforts to reduce or prevent emission of greenhouse gases.” Mitigation can include greater use of renewable energy sources, making older equipment more energy efficient, or changing management practices or consumer behavior. It can range from designing plans to increase public transportation and bicycle pathways to protecting natural carbon sinks such as forests and natural vegetation. Any practice that decreases the amount of greenhouse gases emitted into the atmosphere to reduce the rate and severity of global climate change is considered climate mitigation.⁴¹
- » Climate adaptation refers to “efforts by society or ecosystems to prepare for or adjust to future climate change.” Adaptation can consist of a wide variety of actions by an individual, community, or organization to prepare for, or respond to, climate change impacts. Examples of climate adaptation include breeding crop varieties more tolerant of heat and drought and upgrading current infrastructure to better withstand climate changes.⁴²

Climate mitigation activities reduce the amount of greenhouse gases in the atmosphere. Sourcing renewable energy instead of fossil fuels is one example of a climate mitigation technique.

Climate adaptation activities are efforts to prepare or adjust to future climate changes. Updating building infrastructure to better withstand a hotter climate is one example of adapting to climate change.

Climate mitigation and adaptation should be implemented simultaneously to effectively reduce climate change impacts and prepare for a future of change. If greenhouse gas emissions are not reduced through mitigation efforts, then the ability to adapt will be impacted by the rapid pace and severity of climate change. Since the effects of climate change are already happening it is also necessary to include adaptation as an important part of climate change planning.

1.5 Why Climate Adaptation is Important^{3 43}

Reducing global greenhouse gas emissions is critical to avoiding the worst effects of rapid climate change. While we work on reducing emissions to help mitigate the impacts of global climate change, it is also Denver’s responsibility to prepare for climate change. Reducing greenhouse gas emissions is only one part of the climate change puzzle; we cannot wait for a crisis to occur to begin adapting to climate change impacts. Climate change adaptation is a critical component of City planning for the following reasons:

- » **Climate change is already happening:** As mentioned above, Colorado is already experiencing an increase in average temperature and temperatures are projected to continue to rise. The climate system responds slowly to reductions in greenhouse gas emissions, meaning that the climate today is being affected by emissions from the past. CO₂ can remain in the atmosphere for up to 200 years, so many of the changes predicted through at least the middle of the 21st century will be driven in part by current greenhouse gas concentrations. Therefore, climate mitigation will help with long-term climate change impacts, but will do little to alter the near-term impacts that have already been set in motion.

³ Unless otherwise noted, information in this section was retrieved from ICLEI document, “Preparing for Climate Change: A Guidebook for Local, Regional, and State Governments.”

1.5 Why Climate Adaptation is Important (Cont.)

- » **It is unlikely that greenhouse gas emissions will be stabilized or reversed in the near term:** Over the past 20 years, 75% of CO₂ emissions were due to burning of fossil fuels. Avoiding the worst climate impacts will require reducing greenhouse gas emissions to the point where the concentrations in the atmosphere stabilize and then decline. Due to the current global dependence on fossil fuels and the time required for new technologies that reduce or replace fossil fuels to become available to the global market, CO₂ emissions are not likely to stabilize soon enough to avoid projected climate change impacts.
- » **Climate change will have largely negative economic consequences:** Climate change will affect a wide array of economic sectors including: agriculture, forestry, water supply, health, energy, transportation, recreation, and tourism. Non-economic resources such as biodiversity, air quality, and water quality will also be affected. Planning for specific regional impacts to Denver will help reduce economic costs to these sectors.
- » **Planning for the future can benefit the present:** Many projected climate change impacts are more extreme versions of events already happening in the present. For example, the Front Range is expected to see an increase in frequency and severity of drought. Implementing a stringent water conservation program today will decrease Denver's vulnerability to more frequent and severe drought, and also benefit management of current droughts.
- » **Proactive planning is more effective and less costly than responding reactively to climate change impacts as they happen:** Being proactive and flexible to anticipate and address expected climate change impacts can save money and protect the well being of the community. It has been found that one dollar of hazard mitigation today can prevent the spending of four dollars of post-disaster reconstruction in the future.⁴⁴ This can also be applied to incremental climate changes. For example, considering the impacts of climate change on streamflows and drought while designing a reservoir can ensure that the reservoir meets future water supply needs, and may be less costly than expanding the reservoir in the future.
- » **Climate readiness is a potential competitive advantage for Denver, and can generate additional community benefits:** Proactive investments can ensure Denver remains economically competitive for new business development. Investment in resilient systems, such as green infrastructure, can enhance the livability of neighborhoods.
- » **Denver has a responsibility to plan for the future:** Denver will be impacted by climate change and future residents will be benefited by adaptation planning completed today that result in Denver being a more resilient city to climate change impacts.

Overall, proactive and strategic planning for climate change can reduce vulnerabilities to climate change impacts. Climate adaptation planning can save Denver money in the long term, as well as promote human health and lead to a community resilient to local climate change impacts.

1.6 Denver's Climate Adaptation Plan

The City and County of Denver recognizes the importance of implementing a climate adaptation plan along with a climate mitigation plan to effectively reduce climate change risks to the city. The Climate Adaptation Plan was drafted based on Denver's most pressing vulnerabilities.⁴ Pressing vulnerabilities are defined here as systems that are highly sensitive to climate change and lacking the capability to adapt to the changing climate. These vulnerabilities will be the ones most impacted by climate change. City agencies and partners were asked to assess their vulnerabilities based on the three selected climate change impacts to Denver (increase in temperature and urban heat island effect, increase in extreme weather events, and reduced snowpack and earlier snowmelt). Once vulnerabilities by agency were established, the ones determined to be most pressing were grouped by sector in order for the City to develop and prioritize short, medium, and long-term climate adaptation strategies.

The sectors addressed in the Climate Adaptation Plan are:

- » Buildings and Energy
- » Health and Human Services
- » Land Use and Transportation
- » Urban Natural Resources
- » Water Consumption
- » Food and Agriculture

City agencies will be held accountable for climate adaptation strategies through a city-wide Environmental Management System (EMS). EMS targets are audited annually, allowing agencies to track implementation and measure success of climate adaptation strategies.

With vulnerabilities, responsible agencies, and sectors identified, Denver established long-term adaptation goals for the City. For our long-term goals, short-term activities were identified that move the City towards these goals. Short-term activities were established by each agency and placed within the Environmental Management System (EMS). EMS is a tool used to incorporate environmental considerations into the City's day-to-day operations. With EMS, climate adaptation strategies are integrated within agency's existing goals, processes, and plans, and are analyzed annually. This allows agencies to track implementation and measure success of adaptation activities. Quarterly updates will be scheduled to discuss progress and barriers among agency staff, and yearly targets and progress will be released in a report coordinated by the Department of Environmental Health. Through the use of EMS each agency will be held accountable to implement short-term climate adaptation activities that address their established pressing vulnerabilities. Incorporating additional short-term adaptation activities in annual planning cycles will move Denver forward in tackling our long-term climate adaptation goals. Short-term adaptation strategies and related EMS activities are discussed in [Chapter 4](#), and long-term adaptation goals are discussed in [Chapter 5](#).

⁴ Chapter 3 provides a complete overview of the Vulnerability Assessment.

CHAPTER 2: DENVER'S CURRENT CLIMATE CHANGE Resiliency Programs and Efforts

Many of Denver's current programs increase Denver's ability to adapt to climate change impacts already occurring on the Front Range. These programs offer benefits of climate adaptation that continue to enhance Denver's sustainability, livability, and resiliency towards climate change. Resilience towards climate change results from coordinated and independent adaptation and mitigation activities to manage and react to issues brought about by climate change in Denver. Not all of Denver's climate change adaptation planning will result in new strategies and objectives. Rather, in many cases, Denver will continue programs and policies that contain co-benefits of best management practices and climate resiliency. Also, many of the current programs and policies offer co-benefits between climate adaptation and climate mitigation. Included in this chapter are examples of actions currently being implemented by multiple City agencies and partners.

Denver agencies participating in adaptation activities are briefly discussed below.

2.1 Agency Descriptions

- » **Department of Environmental Health (DEH):** As the health department for the City/County of Denver, the mission of *DEH* is to build healthy communities. The Department's Environmental Quality Division provides environmental regulatory compliance services for City owned facilities and activities, ensuring Denver's compliance with environmental laws protecting public health and the environment. *DEH* is engaged in climate adaptation planning and expects to respond more frequently to extreme heat events affecting vulnerable populations, and increases in vector-borne diseases. *DEH* initiated the agency-wide climate adaptation planning process to address city-wide vulnerabilities resulting from changing climate conditions.
- » **Office of Emergency Management and Homeland Security (OEMHS/OEM):** *OEMHS* provides planning, training, exercises, and educational outreach programs related to natural and man-made disasters to assist and prepare citizens, government agencies, and private/non-profit organizations prior to, during, and after a local emergency or disaster. *OEMHS* acknowledges that climate change can have a severe impact on the health and safety of Denver residents. Plans need to be in place to clearly identify the roles and responsibilities of City agencies during an extreme weather event, including how Denver would notify the public about how to respond during such an event.
- » **Department of Parks and Recreation (DPR):** *DPR* is dedicated to customer satisfaction and enriching lives by providing innovative programs and safe, beautiful, sustainable places. Due to expected climate changes for Denver, *DPR* is preparing for a reduction in water supplies dedicated for irrigation and stresses to ecosystems, plants, and riparian corridors. *DPR* will continue to assess how increasing temperatures, extreme weather events, and early snowmelt will affect Denver's natural environment, public spaces, green infrastructure, and citizens utilizing parks and recreation services. Also, *DPR's* facilities can serve as important venues for educating the public about climate change.

»

2.1 Agency Descriptions (Cont.)

- » **Department of Public Works (DPW):** *DPW* aims to deliver high quality, cost effective, efficient, and safe public infrastructure to enhance the quality of life in Denver. As one of the largest departments within the City and County of Denver, *DPW* provides a wide range of services from snow removal and trash collection to designing and managing capital improvement projects in the City. Denver expects an increase in extreme weather events resulting in more frequent and severe localized storm events. The resulting vulnerabilities affecting *DPW* include stresses to stormwater management, flood control, and decreased water quality. *DPW* is beginning to assess how paving materials and gray infrastructure such as concrete, pipes, and sewers, may exacerbate Denver's urban heat island effect. *DPW* looks to develop technologies and approaches that enhance Denver's adaptive capacity, including those related to watershed resilience.
- » **Department of General Services (DGS):** *DGS* provides internal and external support services, including purchasing, facilities management, central services, and energy/sustainability operations. *DGS* faces vulnerabilities associated with increased demands for energy and water in the summer months due to expected higher temperatures. Resulting impacts include a potential for increased costs and the possibility of decreased productivity within the City's workforce. *DGS* must budget for increased utility costs associated with maintaining current cooling and heating set points. *DGS* will analyze heating and cooling set points during occupied and unoccupied hours in order to make any modifications necessary to avoid an increase of utility costs. *DGS* also will address the vulnerabilities by continuing strategic initiatives such as energy efficient upgrades, retrofitting, energy audits, and environmentally preferred purchasing.
- » **Department of Community Planning & Development (CPD):** *CPD* is responsible for planning and regulating land use and development in Denver. *CPD* provides policy and planning expertise and enforces land use, design, and construction standards to enhance and protect Denver's natural and built environments. *CPD* will address climate impacts and vulnerabilities resulting in extreme heat events, higher water and energy consumption on private property, and assess climate change planning needs within urban design standards and development plans. In preparation for a changing climate, *CPD* will utilize land use policies to guide development in Denver in a manner that is sustainable and forward thinking.
- » **Office of Economic Development (OED):** *OED* creates a local environment that stimulates balanced growth through job creations, business assistance, housing options, neighborhood redevelopment, and the development of a skilled workforce. *OED* strives to be a driving force that advances economic prosperity for the City of Denver, its businesses, neighborhoods, and residents. *OED* expects to monitor the in-and-out migration of the workforce and businesses in Denver or other regions. *OED* must prepare for possible changes in tourism as a result of potentially shorter winter season and longer summer season. Also, *OED* is cognizant of resource constraints for industries relying on water supplies and the resulting impacts on production and services. *OED* will continue many of its sustainable initiatives such as low interest financing for energy efficient appliances or renewable energy upgrades. Broadly, *OED* remains committed to providing assistance to attract and retain successful companies and individuals to Denver in conjunction with a changing climate.
- » **Denver International Airport (DIA):** The City of Denver owns and operates Denver International Airport. Under the city charter, the management, operation, and control of *DIA* are delegated to the City's Department of Aviation. *DIA's* primary vulnerability to a changing climate is the potential for increased interruptions of flight schedules due to extreme weather events. Other impacts include higher energy consumption in the summer months, damage to runways or infrastructure due to extreme heat or weather, and an increase in high winds reducing the number of runways available for use.

2.1 Agency Descriptions (Cont.)

- » **Department of Human Services (DHS):** *DHS* partners with the community to protect those in harm's way and to help all people in need. *DHS* strives to provide a structure which enables those in need of assistance or protection to have a proven, timely path to safety and self sufficiency, allowing *DHS* to focus on preventions and strengthening the community. Climate change is expected to disproportionately affect vulnerable populations and *DHS* expects to respond to more frequent extreme heat events, higher energy consumption and demand, and the possibility of long-term disruptions of service delivery, all affecting Denver's vulnerable populations.
- » **Budget Management Office (BMO):** *BMO* facilitates fiscally responsible service delivery by ensuring and managing a balanced annual budget and strategic citywide capital plan, while informing and developing solutions to achieve efficient and effective operations. *BMO's* vision is to be a trusted partner in fiscally sound decision making. A primary vulnerability affecting *BMO* is an increased need for funds to address potential increased utility expenditures, maintenance, and capital improvements resulting from climate impacts and stress. Also, extreme weather events may cause severe damage to Denver's self-insured property. In response, city agencies will partner with *BMO* to analyze potential funding streams and/or budget allocations for future climate adaptation projects.
- » **Partnership - Denver Water (DW):** Denver Water serves high-quality water and promotes its efficient use to 1.3 million people in the City of Denver and many surrounding suburbs. Established in 1918, the utility is a public agency funded by water rates and new tap fees, not taxes. Denver Water actively incorporates climate adaptation planning in its future supply and demand planning by identifying potential impacts, assessing vulnerabilities, and planning for potential changes due to a warmer climate. The City and County of Denver actively partners with Denver Water on climate adaptation planning. Future partnership includes collaboration on scenario planning research to guide future planning using a unified approach between Denver Water and the City and County of Denver. Denver Water is not integrated into the City-wide EMS, but are active participants in short, medium, and long-term climate adaptation planning.



2.2 Current Resilience Efforts

2.2.1 Buildings and Energy

Many of the current actions and programs within the Buildings and Energy sector offer climate adaptation and climate mitigation co-benefits. Implementing energy efficiency and alternative energy measures, including energy efficient appliances, solar energy generation capacity, increased insulation, and energy efficient building techniques all reduce the amount of energy demand being added to the grid in Denver if lifestyles do not otherwise change. Reduced energy demand adds increased resilience, especially in the summer months when the grid is at the highest risk to be overloaded. Energy efficient appliances, solar energy generation capacity, increased insulation, and energy efficient building techniques all result in less greenhouse gas emissions than their traditional counterparts. Current programs are reducing Denver's per capita greenhouse gas emissions, as well as creating resilience in Denver's building stock that can withstand an increase in energy demands and prolonged heat waves that result from climate change.

Many of Denver's current city operations in the building and energy sector have both climate mitigation and climate adaptation benefits, such as incorporating solar energy and improving energy efficiency.

- » **Solar Power Plant Capacity:** The City and County of Denver has an installed capacity of 9.4 Megawatts (MW) of solar PV on city facilities capable of powering the equivalent of 9,400 homes.⁴⁵ 8MW of Denver's 9.4MW solar plant capacity is located at DIA. DIA is also the first airport to implement an ISO 14001-certified environmental management system covering the entire airport, which will facilitate its ability to incorporate additional climate change adaptation measures.
- » **Encouragement of private sector solar capacity:** Denver was selected by the U.S. Department of Energy to receive funding starting in 2008 for the Solar America Cities grant to increase penetration of solar energy in the Denver market. Denver also worked closely with the Colorado Solar Energy Industries Association to develop the 12 best practices for the Solar Friendly Communities program. Denver became the first certified Solar Friendly Community in Colorado. The City and County of Denver also partnered with the State of Colorado and the Federal Executive Board to launch (through Group Energy) Solar Benefits Colorado—a solar discount program available to 150,000 local, state and federal employees in Colorado. By leveraging economies of scale, the program was able to realize the lowest installed costs for residential PV in the country.
- » **3.2 MW Landfill Gas-to-Energy Plant:** The gas to energy plant at Denver Arapahoe Disposal Site has a capacity to power the equivalent of 3,000 homes.⁴⁶
- » **EnergyCAP Utility Tracking:** The City and County of Denver is Xcel Energy's largest customer due to street lighting and City building demands. The City has transitioned to an electronic system allowing the City to view its energy consumption data and can track its energy use per building and quickly respond to inefficiencies or spikes in energy use.
- » **Continual Commissioning Program:** Denver has implemented energy audits and a retro-commissioning program which have identified 500 operational and capital improvement opportunities. Identifying opportunities to pursue energy efficiency upgrades increases the resiliency of Denver's buildings and infrastructure, while reducing costs associated with rising energy demands.⁴⁷ ARRA-funded retrofits, combined with energy audits and retro-commissioning, has resulted in a 23% reduction in energy use across core City facilities.

2.2.1 Buildings and Energy (Cont.)

- » **City Energy Project:** Denver is one of ten cities nationally participating in the City Energy Project, with specific goals and plans to increase energy efficiency in commercial buildings. In most large American cities, the operation of buildings account for the majority of energy use and carbon pollution—in Denver it is as much as 50 percent. Operations of a relatively small number of large buildings often account for a considerable portion of a city’s energy use. Fortunately, we have the technology to make these buildings vastly more energy efficient, and by doing so, cities will slash energy waste, save money for their citizens, and improve their quality of life. Denver, like most major cities, needs to focus a large amount of resources on increasing energy efficiency in commercial buildings. This effort results in less GHG in our atmosphere, reduced energy demands, and overall better air quality and a healthier, more resilient Denver. To facilitate this effort, Denver applied for and has been accepted as one of 10 cities to participate in the City Energy Project. The City Energy Project is a national initiative to create healthier and more prosperous American cities by improving the energy efficiency of buildings. Working in partnership, the Project and Denver will support innovative and practical solutions that reduce pollution, boost local economies, and create healthier environments. Denver’s participation in the City Energy Project will help shape and define next-generation energy efficiency efforts in our community.
- » **LEED® Standard and Enterprise Green Community Standard:** Denver requires new municipal construction and major renovations to earn a minimum of LEED Gold Certification.⁴⁸ Also, all affordable housing projects receiving City subsidies must meet the Enterprise Green Communities Standards,⁴⁹ using building methods and materials that promote environmental quality, economic vitality, and social benefits.
- » **Denver’s Building Code:** Denver is on track to adopt the 2015 International Building Code which results in up-to-date building and energy efficiency standards for all new construction in Denver.
- » **Low Interest Financing:** Denver’s Office of Economic Development provides low-interest loans for energy intensive businesses to invest in renewable energy or energy efficiency projects.
- » **Denver Energy Challenge and Certifiably Green Denver:** The Denver Energy Challenge offers free energy advising and exclusive rebates and energy loans for energy improvements.⁵⁰ Residential successes from the Denver Energy Challenge include:
 1. In 2011, 2,262 homes participated and saved 1,035,396 kWhs and 164,733 therms, equating to a reduction of 1,769 tons of CO₂.⁵
 2. In 2012, 2,857 homes participated and saved 1,279,900 kWhs and 371,546 therms, equating to a reduction of 3,168 tons of CO₂.
 3. In 2013, 1,891 homes participated and saved 676,915 kWhs and 114,532 therms, equating to a reduction of 1,196 tons of CO₂.

Certifiably Green Denver helps local businesses eliminate, avoid, and reduce pollution and waste through source reduction, reuse, recycling, and treatment alternatives. (figures 2.1 and 2.2)

- » **Denver Energy Assurance Plan (DEAP):** DEAP provides guidance in preparing for, responding to, coordinating, and recovering from natural or human caused energy disruptions; measures to manage energy supply shortages; and strategies to reduce energy demand. Denver will face increased temperatures and more extreme heat days, intensifying energy demand and usage in the summer months. The Denver Energy Assurance Plan is an important step towards preparing for climate change impacts, such as energy disruption.



Figure 2.1: Certifiably Green Denver



Figure 2.2: With help from low-cost energy loans through the Denver Energy Challenge, Postmodern was able to finance and install energy efficiency upgrades and a full solar system for their building in a matter of months (photo: Cascade Solar USA).

⁵ Over life of the measure.

2.2.2 Health and Human Services

Monitoring of air quality, water quality, and vector populations and providing community assistance offer climate adaptation benefits. Continuous monitoring of air quality and water quality protects the public from any adverse health effects associated with decreased air quality or water quality. Review of long term data also allows Denver to recognize the relationship among factors such as increased air temperature and the associated effects on air and water quality. Vector monitoring prepares Denver for the potential increase of pests or changing patterns of vectors, protecting public health. Ensuring vulnerable populations have access to basic resources through community assistance is essential to adapt to climate change impacts that disproportionately affect low income populations, such as rising energy consumption and increased public health impacts. Additionally, Denver's Road Home (*DRH*) works to provide homes and shelter to the homeless population around Denver. The homeless are extremely vulnerable to climate impacts such as extreme heat, cold, and weather events, so providing homes for the homeless increases Denver's overall resiliency to climate change.

- » **Air Quality, Stream Water Quality, and Vector Monitoring:** The Department of Environmental Health monitors Denver's air quality, stream water quality, and vector (disease carrying organism) populations. Air and stream water quality monitoring allows Denver to protect the health of its citizens and better understand ecosystem changes. Robust vector monitoring and controls prepares Denver for the potential increase of pests or changing migration patterns of vectors or other animals.⁵²
- » **Community Assistance:** Denver's Department of Human Services administers several benefit programs ensuring families and individuals have the basic resources necessary to meet financial, medical, nutritional, and housing needs. Examples include the Low Income Energy Assistance Program (*LEAP*), housing and shelter assistance, and robust child and protective services.⁵³
- » **Denver's Road Home:** *DRH* is a collaborative effort between the City and County of Denver, Mile High United Way, homeless service providers, foundations, businesses, faith-based organizations and the greater community. It is a ten-year plan to provide permanent housing, shelters, and services to the homeless population in Denver. After year eight *DRH* added 2,795 housing opportunities, generated 6,702 employment and training opportunities, prevented 6,199 families and individuals from becoming homeless through eviction prevention assistance, mentored 1,208 families and seniors out of homelessness, housed 2,275 individuals, and leveraged over \$63 million in public and private dollars to help people.⁵⁴
- » **Cold Weather Plan:** Denver's Department of Human Services and *DRH* provide emergency shelters for the homeless in the case of frigid temperatures. The Cold Weather Plan may also provide framework for initiating an Extreme Heat Plan to ensure citizens have a safe place to stay in the case of extreme heat events in Denver.

2.2.3 Land Use and Transportation

Many of Denver's programs within the Land Use and Transportation sector offer climate adaptation and climate mitigation co-benefits. The Land Use and Transportation goals relate to reducing the amount of vehicles on the road, promoting public transportation, bicycles, and walking as primary modes of transportation, and increasing more dense, mixed-use, transportation-oriented development in order to create resilient communities. Reduced amounts of vehicles on the road result in less greenhouse gas emissions and ground level ozone, creating a healthier community. This in turn reduces impacts on air quality and ground level ozone that result from an increase in air temperatures from climate change. Mixed use transportation-oriented development provides resilient communities where residents have access to services, amenities, alternative transportation options, can practice resource-conserving lifestyles, and are more likely to know their neighbors.

Denver's current city programs provide opportunities for biking, walking, and public transportation as primary modes of transportation.

2.2.3 Land Use and Transportation (Cont.)

- » **Denver Moves:** The Department of Public Works' Complete Streets policy and transportation plan, Denver Moves, support the goal of increasing Denver's bicycle and walking commute mode share to 15% by 2020 and installing a network of 442 miles of multi-use and bicycle facilities.⁵⁵
- » **Bicycle Sharing B-Cycle Program:** In 2010, Denver B-cycle, a 501c3 nonprofit organization, launched its community wide bicycle sharing program. By the end of 2013, the program operated 82 stations with more than 700 bicycles available to rent.⁵⁶
- » **Transit Oriented Development:** Transit oriented development plans locate development near public transit stations. Denver strives to provide affordable housing and mixed-use development near transit locations.⁵⁷ The Denver Union Station Project, expected to be completed in May, 2014, will serve as a multi-modal transportation hub, integrating multiple rail lines, buses, taxis, shuttles, vans, and limousines, as well as bicycles and pedestrians⁵⁸ (figure 2.3).
- » **Transit Oriented Development Strategic Plan Update:** The TOD Strategic plan is intended to be a short-term, implementation-driven document that guides the critical city-led actions needed for successful TOD in Denver. The strategic plan focuses the multiple efforts of various city departments and agencies into a concise work program for Denver over the next five to six years, providing a foundation to guide public and private investment at rail stations.
- » **Blueprint Denver and Denver's Zoning Code:** Integrates land use and transportation planning to support mixed use development and increased density in areas serviced by multi-modal transportation networks to minimize the need for single-occupant vehicle travel.
- » **Sustainable Neighborhoods Program:** The sustainable neighborhoods program provides residents the ability to become involved in increasing the livability of their neighborhood while reducing their ecological footprint. With the help of the Department of Environmental Health, neighborhoods can become certified under the Sustainable Neighborhoods Program by focusing on initiatives to better their neighborhood under the broad categories of water, air, land, energy, and people.



Figure 2.3: Denver Light Rail (en.wikipedia.org)

2.2.4 Urban Natural Resources

Denver's programs in the Urban Natural Resources sector also offer climate adaptation and climate mitigation co-benefits. Activities offer climate mitigation by increasing the amount of trees and green space within Denver which offer climate sequestration benefits, reducing the amount of greenhouse gas in the atmosphere. An increase in trees and green space offer several climate adaptation benefits as well. First, they reduce the amount of impervious surfaces in Denver which decreases the severity of the urban heat island effect and increases the ability of the City to deal with extreme runoff events. Also, tree cover produces shade which offers relief and cooling for citizens during extreme heat events. Implementing green infrastructure also reduces the nutrient load entering our waterways during rain events, improving water quality. Ecosystem health is also important to protect watersheds west of Denver that provide critical water supply for Denver's residents, and for wildlife around Denver.

Denver was named a top 10 Best U.S. City for Urban Forests by the nonprofit American Forests. Urban forests provide many climate adaptation benefits such as increased shade for cooling and improved air quality.

- » **Mile High Million Program:** In 2006, Denver adopted a goal of planting one million trees in the metropolitan area by 2025. Through this program, 250,000 trees were planted in the metro area offering multiple climate adaptation and mitigation benefits such as increased shade and cooling, while also engaging the public towards natural resource stewardship.⁵⁹ With the help of the Mile High Million Program, the City of Denver's urban tree canopy reached 19.7%, and metro Denver's urban tree canopy averaged 16.4%.⁶⁰ The program is still in operation, but the goal has changed from a simple count of new plantings to strategic management of the existing canopy of over two million trees.
- » **Green Infrastructure:** The Department of Public Works utilizes green infrastructure as a tool to promote efficient and natural stormwater infiltration, while promoting air quality, water quality, and carbon reduction and sequestration (figure 2.4).



Figure 2.4: Example of green infrastructure along the South Platte River near downtown Denver (epa.gov/region8/green-infrastructure)

2.2.5 Water Consumption

Denver area programs in the Water Consumption sector offer climate adaptation and mitigation co-benefits. The installation of low flow water fixtures saves water and energy, reducing greenhouse gas emissions. Reducing the amount of water we consume through irrigation efficiency and water recycling programs makes Denver more resilient in response to stressed water supplies, particularly during the hot, dry summer months. Denver Water offers extensive programs to encourage water conservation practices and to encourage low-water use landscaping. More dense land use also provides water conservation benefits.

2.2.5 Water Consumption (Cont.)

- » **Denver Water Conservation Programs:** Denver Water is pursuing a multi-pronged water strategy to secure water for the future through water efficiency measures, reuse and supply augmentation. Denver Water's robust conservation program is targeted to help every type of customer save water. The conservation program includes rebates and incentives for residential and commercial customers to replace inefficient water fixtures with new, more efficient ones; summer water use rules enforced by water monitors; requirements for new properties to amend their soil (to make it retain more water); tiered water rates (the more water you use, the more you pay) to discourage water waste; and much more. Denver Water also promotes water conservation through its Use Only What You Need campaign, which was designed to create overarching community awareness about wise water use.⁶¹ To read more on Denver Water's conservation efforts, visit denverwater.org/conservation, this provides a detailed look at current water conservation programs and activities.
- » **Irrigation Efficiency and Recycled Water System:** Many of Denver Water's public space customers, including school districts, park and recreation districts, universities and more are participating in Denver Water's Water Budget program. These customers receive monthly reports on water consumption compared with an efficient use target. Many of these customers have upgraded to Central Control irrigation systems enabling them to automatically adjust irrigation schedules to real-time weather conditions, detect leaks, and improve staff efficiency. Several of these customers, including Denver's Parks and Recreation Department, Denver Public Schools and Xcel Energy, have connected to the recycled water system. In addition to Denver's DPR, additional recycled water customers currently include: the Denver Zoo, the Rocky Mountain Arsenal Wildlife Refuge, East High School grounds, and Westerly Creek School grounds.⁶² Denver Water supplies about 7,000 acre-feet of recycled water a year and plans to supply about 17,500 acre-feet at buildout.⁶³
- » **Retrofitted and Updated Water Fixtures in City Buildings:** Between 2006 and 2011, Denver partnered with Denver Water to install 400 low flow water fixtures in public restrooms, saving over 2 million gallons of water per year.⁶⁴
- » **Denver Water's Integrated Resource Plan:** Denver Water's history of long-term planning is responsible for the highly reliable water system available in a rapidly growing, semi-arid region that benefits customers today. As part of its long-term planning process, Denver Water is working on an Integrated Resource Plan (*IRP*) to help guide decisions about the water system in its entirety for the next 40 years. Issues addressed in the *IRP* include potential future challenges to the water system, such as climate change; demographic change; new water use patterns; changes to watersheds including beetle kill and forest fires; and economic and regulatory changes. A wide variety of supply and demand management approaches will be considered and evaluated across financial, environmental and social costs, a process called "triple bottom-line" analysis.
- » **Denver Water's Water Quality Program:** Denver Water takes its water quality and safety very seriously. Each year more than 10,000 samples are collected and nearly 50,000 tests are conducted to ensure Denver's water is as clean and safe as possible. Denver Water vigilantly safeguards its mountain water supplies, and before the water reaches your tap, it's carefully filtered and treated.
- » **Denver Water's Supply Monitoring Program:** Denver Water collects readings at stream gauges and reservoirs throughout the system to track streamflow, diversions, snowpack and other water-supply data. Daily streamflow, reservoir levels and diversions are available on the Water Supply page at denverwater.org.
- » **Denver Water's From Forests to Faucets:** Denver Water has partnered with the U.S. Forest Service and plans to match the U.S. Forest Service's \$16.5 million investment, totaling \$33 million, toward forest treatment and watershed protection projects over a five-year period in priority watersheds critical to Denver's water supply. This helps protect the ecosystems from an increased risk of fire as well as mountain pine beetle infestation, protecting water supply, water quality, and overall ecosystem health.⁶⁵

Recycled water is treated wastewater reused for irrigation, industrial use, and in parks and golf courses. Using recycled water reduces the amount of water Denver needs to take from reservoirs and the energy needed to make water potable.

2.2.6 Food and Agriculture

Denver has a current sustainability goal to have a more sustainable local food economy. A more robust local food system makes Denver more resilient to disruptions to food systems occurring in other regions. Also, local food managed with a robust local-oriented distribution system travels far less to get from farm to table, resulting in less greenhouse gas emissions during transportation. Programs such as Denver’s Farmers Markets provide healthy and affordable food for all of Denver’s residents, create jobs, and honor both people and the planet.

» **Denver Farmer’s Markets:** Denver offers many farmers markets throughout the metro area that offer local food, art, jewelry, and more. A local food economy can increase Denver’s resilience towards climate change disruptions occurring in other regions.



Figure 2.5: Cherry Creek Fresh Market is one provider of fresh, local food in Denver. (farmersmarketonline.com/fm/CherryCreekFreshMarket.html)

2.3 Current Denver Programs with Climate Adaptation, Climate Mitigation and Combined-Benefits

The current Denver programs discussed above all have climate adaptation benefits, but many of them offer co-benefits that serve both climate adaptation and climate mitigation. [Table 2.1](#) displays examples of current programs including those that offer both climate adaptation and mitigation.

Table 2.1 Current Denver programs with climate adaptation, climate mitigation or combined benefits

Current Denver Program	Climate Adaptation	Climate Mitigation
<i>Buildings & Energy</i>		
Solar Power Plant Capacity/Private sector solar capacity	yes	yes
3.2 MW Landfill Gas-to-Energy Plant	yes	yes
EnergyCAP Utility Tracking	yes	yes
Continual Commissioning Program	yes	yes
City Energy Project	yes	yes
LEED Standard Enterprise Green Community Standard	yes	yes
Denver’s Building Code	yes	yes
Low Interest Finance	yes	yes
Denver Energy Challenge and Certifiably Green Denver	yes	yes
Denver Energy Assurance Plan	yes	yes

Table 2.1 (Cont.)

Current Denver Program	Climate Adaptation	Climate Mitigation
<i>Health & Human Services</i>		
Air Quality, Stream Water Quality, and Vector Monitoring	yes	no
Community Assistance	yes	no
Denver’s Road Home	yes	no
Cold Weather Plan	yes	no
<i>Land Use & Transportation</i>		
Denver Moves	yes	yes
Bicycle Sharing B-Cycle Program	yes	yes
Transit Oriented Development	yes	yes
Transit Oriented Development Strategic Plan Update	yes	yes
Blueprint Denver and Denver’s Zoning Code	yes	yes
Sustainable Neighborhoods Program	yes	yes
<i>Urban Natural Resources</i>		
Mile High Million	yes	yes
Green Infrastructure	yes	yes
<i>Water Consumption</i>		
Denver Water Conservation Programs	yes	yes
Irrigation Efficiency and Recycled Water System	yes	yes
Retrofitted and Updated Water Fixtures in City Buildings	yes	yes
Denver Water’s Integrated Resource Plan	yes	yes
Denver Water’s Water Quality Program	yes	no
Denver Water’s Supply Monitoring Program	yes	no
From Forests to Faucets	yes	yes
<i>Food & Agriculture</i>		
Denver Farmer’s Markets	yes	no

Continuing and building upon current Denver programs that provide climate adaptation, climate mitigation, and co-benefits will improve Denver’s overall climate resiliency as well as aid in reaching long-term climate adaptation goals.

CHAPTER 3:

VULNERABILITY ASSESSMENT

3.1 Background

Vulnerability assessments are a key tool for informing climate change adaptation planning. Vulnerability is defined as, “the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes.”⁶⁶ Stated another way, systems that are sensitive to climate and less able to adapt to changes are generally considered to be vulnerable to climate change impacts. Vulnerability assessments are a vital part of adaptation planning because they identify:

1. Which systems are likely to be most affected by the projected change in climate; and
2. Why these systems are likely to be vulnerable, including the interaction between climate shifts and existing stressors.⁶⁷

Knowing which systems are most vulnerable enables managers to set priorities for adaptation planning and provides a basis for developing appropriate management responses. Knowing why systems are vulnerable enables managers to identify appropriate short and long-term climate change adaptation strategies.

Vulnerability is defined as “the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes.”

The level or degree of vulnerability a system faces can be ranked according to the *sensitivity* of a particular system to climate change and its *capacity to adapt* to those changes.⁶⁸ Sensitivity is the degree to which a built, natural or human system is directly or indirectly affected by changes in climate conditions (i.e. temperature and precipitation) or specific climate change impacts. If the system is likely to be affected by projected climate change, it would be considered sensitive to climate change.⁶⁹ Adaptive capacity describes the ability of a built, natural or human system to accommodate changes in climate with minimum disruption or minimum additional cost. Generally, systems that have high adaptive capacity are better able to deal with climate change impacts.⁷⁰

3.2 Conducting the Vulnerability Assessment

The first step in conducting Denver’s vulnerability assessment was to identify the most significant effects of climate change in Denver. Denver Department of Environmental Health convened a climate adaptation working group consisting of City agency and department representatives. This group reviewed available information and agreed that a number of others in the Denver area had already compiled, analyzed, and summarized a great deal of information and literature regarding likely climate impacts in Denver. Extensive efforts had already been conducted by Denver Water, Boulder County, and the State of Colorado. Through review of these efforts, peer-reviewed literature, and individual expertise the working group concluded that the most critical climate change impacts in Denver are:⁷¹

1. Increase in temperature and urban heat island effects;
2. Higher frequency of extreme weather events; and
3. Reduced snowpack and earlier snowmelt.

Identifying which systems are most vulnerable to climate change enables managers to set priorities for adaptation planning.

3.2 Conducting the Vulnerability Assessment (Cont.)

The Climate Adaptation Working Group met regularly during 2012 and 2013 to identify vulnerabilities associated with the three most-likely principal climate change impacts. This multi-agency “bottom-up” approach was strongly favored because engaged participation from many agencies and partners with responsibilities for adapting to climate change will be needed for effective efforts. The process takes longer with such an approach, but long-term engagement is more likely when the process is inclusive.

This working group identified vulnerabilities that affected individual agencies and Denver as a whole. For example, extreme heat events may cause roadways to degrade more quickly than under previous climate conditions. This vulnerability would affect Public Works more than other agencies, whereas higher energy costs to cool buildings during extreme heat events would affect multiple agencies and partners. Additionally, the working group understood that some vulnerabilities would be more important to address than others. Accordingly, the working group used a system to rank the importance of the vulnerabilities by sensitivity and adaptive capacity.

3.2.1 Vulnerability Assessment: Sensitivity Analysis

The next step in conducting the vulnerability analysis was to conduct a sensitivity analysis by agency and sector. The working group evaluated each of the vulnerabilities identified in the first step with this question in mind: *will the systems associated with this vulnerability be significantly affected by projected changes in climate?* Sensitivity was evaluated by considering:

1. Who or what could be impacted?
2. How do weather and/or climate currently affect this system?
3. To what degree is the system sensitive to climate change?
4. Are the stresses to the system projected to get worse, stay the same or improve? Do new stresses to the system emerge altogether (ex: new infectious diseases/decline of species, etc.)?
5. How exposed is the system to climate change (greater exposure = higher sensitivity)?
6. Is the system subject to existing stress unrelated to climate change (stressed systems are more likely to be more sensitive)?
7. Will climate change cause the demand for a resource to exceed supply?
8. What is the impact threshold for the system (ex: thresholds that cause pavements to crack, temperature in which species/landscapes are affected)?

Based on this subjective analysis the level of sensitivity was ranked with a score ranging from low sensitivity to climate change (represented by S0) to high sensitivity to climate change (S4).

Primary Agencies and Organizations Involved in the Vulnerability Assessment

- » Budget and Management Office
- » Denver International Airport
- » Denver Water
- » Department of Community Planning and Development
- » Department of Environmental Health
- » Department of General Services
- » Department of Human Services
- » Department of Parks and Recreation
- » Department of Public Works
- » Office of Economic Development
- » Office of Emergency Management
- » Office of Sustainability

3.2.2 Vulnerability Assessment: Adaptive Capacity

Along with the sensitivity analysis, each agency evaluated associated systems' adaptive capacity, or its ability to be modified to accommodate future climatic changes or variability, with the question: *to what extent are the systems associated with this planning area able to accommodate changes in climate at minimum disruption or cost?* Adaptive capacity for each vulnerability was ranked with a score of low adaptive capacity (AC0 – not able to be modified) to high adaptive capacity (AC4 – highly capable of being modified), using the following criteria:

1. What does the system have in order for it (that allows it?) to adapt?
2. What does the system need in order for it to adapt?
3. Are there barriers to the system's ability to adapt (ex: regulatory/design standards, large number competing for use of the system, large number of ownership/jurisdiction of a system, biological or physical barriers that limit flexibility)?
4. Is the rate of climate change faster than the system's ability to adapt?
5. Are there efforts under way to address impacts of climate change related to systems in this planning area?

3.2.3 Vulnerability Assessment: Qualifying Vulnerability

Once scorings were agreed upon for sensitivity and adaptive capacity, the results were placed in a scoring matrix to identify an overall vulnerability score. The vulnerability scores ranged from potential opportunity (PO) to a low vulnerability score (V1), to a high vulnerability score (V5).

Table 3.1 Vulnerability scoring matrix:

		SENSITIVITY LOW TO HIGH				
		S0	S1	S2	S3	S4
ADAPTIVE CAPACITY LOW TO HIGH	AC0	V2	V3	V4	V5	V5
	AC1	V1	V2	V3	V4	V5
	AC2	V1	V1	V2	V3	V4
	AC3	P0	V1	V1	V2	V3
	AC4	P0	P0	P0	V1	V2

P0 = potential opportunity

V1= low vulnerability

V5= high vulnerability⁶

A full table of the vulnerabilities by Department is provided in [Appendix B](#) which lists vulnerabilities by department and includes the scoring values for sensitivity, adaptive capacity and vulnerability. Where insufficient information was available or little input was received from the working group the vulnerability was not ranked (NR).

⁶ Source: City of Flagstaff, 2012. City of Flagstaff Resiliency and Preparedness Study

3.2.3 Vulnerability Assessment: Qualifying Vulnerability (Cont.)

Key findings of the assessment for ranked vulnerabilities indicate the following:⁷

There were 65 ranked vulnerabilities relating to an increase in temperature and urban heat island effect

- » None of the vulnerabilities ranked V5 (highly vulnerable)
- » 37% of vulnerabilities ranked V3 or V4
- » 51% of vulnerabilities ranked V2 or V1 (low vulnerability)
- » 12% of vulnerabilities ranked PO (potential opportunity)

There were 42 ranked vulnerabilities relating to a higher frequency of extreme weather events

- » None of the vulnerabilities ranked V5
- » 43% of vulnerabilities ranked V3 or V4
- » 43% of vulnerabilities ranked V2 or V1
- » 14% of vulnerabilities ranked PO

There were 8 ranked vulnerabilities relating to reduced snowpack and earlier snowmelt

- » None of the vulnerabilities ranked V4 or V5
- » 63% of vulnerabilities ranked V3
- » 37% of vulnerabilities ranked V2 or less
- » None of the vulnerabilities ranked PO

3.3 Identification of Priority Vulnerabilities and Priority Planning Areas

The working group considered vulnerabilities ranked V3 and greater as a priority vulnerability and a priority planning area.⁸ [Table 3.2](#) presents a summary of priority vulnerabilities associated with the three primary climate change impacts used in Denver's Climate Adaptation Plan. Included in [Table 3.2](#) are the priority vulnerability, Denver agencies affected by the priority vulnerability and the sector associated with the priority vulnerability.

⁷ Denver Water vulnerabilities were not ranked

⁸ A full list of climate vulnerabilities is included in Appendix B

Table 3.2: Priority Climate Change Vulnerabilities⁹

Climate Impact	Priority Vulnerability	Affected Departments	Sector
Increase in temperature and urban heat island effect	Higher energy consumption and demand in the summer months	DGS, DEH, DIA, CPD, DHS*	Buildings and Energy
	Higher maintenance and equipment costs for Denver buildings	DGS, OED*, CPD*	Buildings and Energy
	Building design standards not addressing climate change scenarios	OEM, CPD*	Buildings and Energy
	Decrease in quality of living/reduced comfort or reduced occupant comfort in buildings/impacts to productivity	DPW, CPD, DEH, DGS, DPR, DHA*	Health and Human Services
	Extreme heat events affecting vulnerable populations	CPD, DEH, DHS, DPR	Health and Human Services
	Increase in vector borne diseases/increased use of pesticides	DEH, OEM	Health and Human Services
	Increase in number and/or severity of high ozone days	DEH, DHHA*	Health and Human Services
	Challenging environmental regulations	DIA	Health and Human Services
	Regulatory barriers to the adoption of adaptation strategies	CPD, DPW*	Land Use and Transportation
	Design standards not addressing climate change scenarios	DPW, UDFCD*	Land Use and Transportation
	Climate induced in-and out- migration of workforce populations and businesses	OED, BMO*	Land Use and Transportation
	Stress on trees and urban landscaping	DPR	Urban Natural Resources
	Warming of stream and lake systems affecting aquatic species and human recreation	DPR, DEH	Urban Natural Resources
	Higher water demands (City and private) ,possible higher cost of water and consumption in summer months	CPD, DEH, DPR, DW*	Water Consumption
	Reduced amount of water available from independent ditch water supplies for irrigation.	DPR, DW*	Water Consumption
	Increased threat of pests, invasive species and noxious weeds.	DPR	Food and Agriculture

⁹ (*) Represents City agencies or community organizations effected by priority vulnerability, but did not take part in the vulnerability assessment

Table 3.2: Priority Climate Change Vulnerabilities⁹

Climate Impact	Priority Vulnerability	Affected Departments	Sector
Higher frequency of extreme weather events	Denver buildings structurally vulnerable to extreme weather events	OEM, CPD*	Buildings and Energy
	Unanticipated increase in emergency management funding and impacts on self-insured property	BMO	Buildings and Energy
	Ensuring health care services for people with chronic conditions during extreme weather events	OEM	Health and Human Services
	Increased stress on storm water management systems	DPW, CPD, DPR, UDFCD*	Land Use and Transportation
	Air quality impacts and increased ozone from increased frequency of drought-induced wildfires	DEH, OEM	Health and Human Services
	Long-term disruption in services delivery	DHS	Land Use and Transportation
	Interruptions to transportation and stress or damage to physical infrastructure and public assets	CPD, DPR	Land Use and Transportation
	Increase in high wind days; reduced amount of runways available	DIA	Land Use and Transportation
	Interruptions in business and flight schedule	DIA	Land Use and Transportation
	Degradation of surface water quality including microbial contaminants	DEH, DPW	Urban Natural Resources
	Park damages and debris generation, damage to riparian corridors and stress on landscapes and trees	DPR, DEH	Urban Natural Resources
	Contaminant loading from increased flooding and heavy rain spells	DPW	Urban Natural Resources
	Stormwater management and flood control	DIA	Urban Natural Resources
Reduced snowpack and earlier snowmelt	Changes in ski tourism may lead to fewer travelers/fewer flights	DIA	Land Use and Transportation
	Decrease in water quality due to low-water flow in discharge areas during summer season	DPW, DEH, DPR	Urban Natural Resources
	Increase in frequency, size and duration of wildfires in mountain parks	DPR	Urban Natural Resources

Climate change adaptation is a necessary effort as some level of climate change is already happening and additional, more significant impacts are projected. Accordingly, the working group identified climate change vulnerabilities affecting Denver and next, with the assistance of Meister Consultants Group (MCG), identified climate change adaptation strategies and activities that could be implemented to adapt to a hotter and drier Denver ([Chapters 4 and 5](#)).

CHAPTER 4: SHORT-TERM CLIMATE ADAPTATION ACTIVITIES

As a first step toward addressing Denver’s vulnerabilities related to climate change, Denver’s agency staff selected short-term adaptation activities to implement based on agency expertise, feasibility, and the ability to synergize within existing strategic goals. The activities address the expected climate change impacts of (1) an increased temperature and urban heat island effect and (2) an increase in frequency of extreme weather events in Denver, and (3) reduced snowpack and earlier snowmelt.

Short-term climate adaptation activities will be embedded into the city-wide EMS and implemented within one to two years.

Agency staff identified short-term adaptation activities they felt could be implemented within one or two years. The short-term adaptation activities were subsequently embedded within the EMS, as previously described in Section 1.6. Due to the short-term nature and expectation that these activities will be implemented within one to two years, these activities are largely those that can be accomplished directly by City agencies.

4.1 Short-Term Climate Adaptation Actions by Sector

4.1.1 Buildings and Energy Sector

Table 4.1 identifies short-term adaptation activities associated with the Buildings and Energy Sector and the principal agencies involved.

Table 4.1: Summary of Short Term Adaptation Activities for Buildings and Energy Sector

Climate Impact	Vulnerability	EMS Adaptation Activities	Responsible Agency	Agency Plan
Increase in temperature and urban heat island effect	Higher energy consumption and demand in summer months	<ol style="list-style-type: none"> 1) Reduce energy use in City facilities by 2.5% per square foot over 2011 baseline 2) Reduce energy use in Facilities Management portfolio by 2.5% per square foot over 2011 baseline 3) Complete 95% of Priority 1 and 2 deficiencies and operational improvements identified in 2013 Facility Condition and Assessment studies within 6 months of project completion 4) Complete Facility Condition and Assessment studies on 8-10 facilities 	Department of General Services	Strategic Initiatives Year End Report

Table 4.1: Summary of Short Term Adaptation Activities for Buildings and Energy Sector

Climate Impact	Vulnerability	EMS Adaptation Activities	Responsible Agency	Agency Plan
Increase in temperature and urban heat island effect	Climate induced in and out migration of workforce populations and businesses	1) Complete outreach to the top 20 energy companies in Denver 2) Begin implementation of the By-Product Synergy Network (BPS)	Office of Economic Development	Jumpstart 2013
Increase in temperature and urban heat island effect	Higher energy demands and use	Approve and implement DIA Energy Management Program and Energy Team Charter	Denver International Airport	Energy

EMS Activities

- » **Reduce energy use in City facilities and in Facilities Management Portfolio:** *DGS* will work with other Denver agencies to implement capital, operational, and behavioral improvements. The energy use and reduction will be measured using annual building utility data.
- » **Complete Priority 1 and 2 deficiencies:** *DGS* recommendations will be uploaded into their Infor database as work order requests. The requests will be reviewed and assigned as work orders to Facilities staff. A report will be generated using the Infor database to determine the status of each recommendation to ensure completion.
- » **Facility Condition Assessments:** *DGS* will procure on-call energy services and manage building assessments. The assessments provide valuable information regarding both immediate and long term liabilities. The identified liabilities can then be reviewed against expected climate changes.
- » **Outreach to Energy Businesses:** *OED* plans to continue outreach to executives of the top 20 energy companies in 2013 to express the City’s appreciation for their contribution to the job base and explore ways in which Denver can be a better partner. This effort is aimed to communicate that the City understands the significant value both traditional and renewable energy companies have to the local economy, and the impacts they have on efforts to curb climate change. For example, Denver recently signed onto a Memorandum of Understanding with the state to buy more natural gas-fueled vehicles.
- » **By-Product Synergy Network (BPS):** *OED*, in collaboration with the US Business Council on Sustainable Development, plans to initiate a regional By-Product Synergy Network for Colorado. The BPS network will match under-valued waste or by-product streams from one firm to another to create new sources of revenue and supply chain benefits, while reducing environmental burden. The strategy reduces the overall volume of waste from manufacturing facilities that is transported to landfills. In addition, the network creates valuable connections among manufacturing facilities in Colorado to advance sustainable business practices in Colorado, which ultimately serves to increase a company’s cost-competitiveness, improve regional self-sufficiency, and strengthen the financial viability of local businesses. As a result, the private sector is less susceptible to climate disruptions in other areas of the country and the world which advances the national security, economic viability, and resilience to climate change of communities. Project development will be executed in eight phases and reach completion once funding, partners, and network memberships are secured. After completion, ongoing operations to identify and facilitate by-product synergies will begin in 2014.
- » **DIA Energy Management Program:** The *DIA* Energy Management Program will improve energy related procedures, re-commission and optimize major energy using equipment and facilities, and install cost-effective energy efficiency measures. Increasing energy efficiency and optimizing energy management will reduce costs, reduce emissions, and increase *DIA*’s overall resiliency to climate change impacts.

4.1.2 Health and Human Services Sector

Table 4.2 identifies short-term adaptation activities associated with the Health and Human Services Sector. The principal agencies involved in the Health and Human Services Sector are DEH, OEMHS, and DHS.

Table 4.2: Summary of Short Term Adaptation Activities for Health and Human Services Sector

Climate Impact	Vulnerability	EMS Activities	Responsible Agency	Agency Plan
Increase in temperature and urban heat island effect	Extreme heat affecting vulnerable populations	Define extreme heat event; specify how DEH will interact/ cooperate with other agencies such as Public Health or the Office of Emergency Management	Department of Environmental Health	Emergency Operations Plan (OEMHS)
	Increase in vector-borne diseases	Write a city-wide vector control plan in which both existing and emerging vectors are discussed	Department of Environmental Health	Vector Control Plan
Increase in temperature and urban heat island effect, and extreme weather events	Extreme heat affecting vulnerable populations	1) Draft an extreme heat annex for the Emergency Operations Plan 2) Create and execute an extreme events educational campaign for the public	Office of Emergency Management and Homeland Security	Emergency Operations Plan n/a
Increase in temperature and urban heat island effect	Extreme heat affecting vulnerable populations	Specify how DHS will interact/ cooperate with other agencies, or OEMHS, during extreme heat events	Department of Human Services	Emergency Operations Plan (OEMHS)

EMS Activities

- » **Define Extreme Heat Event:** *DEH* and *OEMHS* will identify the conditions or events that will trigger Denver’s declaration of an extreme heat event. Such an event will necessitate coordination with other city agencies, particularly *DEH* and *OEMHS*. To complete this task, *DEH* will work with *OEMHS* to establish a local definition of an extreme heat event. This will provide a basis for promptly reacting to conditions that may negatively affect Denver, particularly its vulnerable populations.
- » **Draft an Extreme Heat Annex:** *OEMHS* will draft this annex to include a local definition of an “extreme heat event” in Denver and establish thresholds to activate emergency operations, based on lessons learned during a city-wide exercise in May 2013 to determine gaps in the City’s current response to an extreme heat event. The annex will include a plan for cooling centers if needed, and outline the roles and responsibilities of agencies during an extreme heat event. An extreme heat annex allows Denver to be prepared and organized during extreme heat events and reduces the risk of costly, adverse public health effects. *OEMHS* tested the City’s ability to respond to an extreme heat event in 2013.

EMS Activities (Cont.)

- » **Extreme Heat Educational Campaign:** *OEMHS* plans to initiate a community wide extreme heat educational campaign to better prepare the general public for an extreme heat event. *OEMHS* will collect community input from a public survey to determine how concerned the public is about extreme heat in Denver, and how the public would like to receive information about extreme heat hazards. *OEMHS* will use all methods that the public identifies in the survey to ensure public engagement methods are reaching as many people as possible. Some of the potential methods include: 1) an extreme heat brochure, 2) posting the information on the *OEMHS* website, 3) adding extreme heat to all presentations *OEMHS* gives to the community, and 4) engaging schools in an extreme heat educational program for children. Expected outcomes include increased outreach through the public information campaign and a measurement of how well prepared for an extreme heat event the public feels as a result of the campaign.
- » **Extreme Heat Protocol:** When conditions are declared an extreme heat event, *DHS* will implement an outlined process partnering with other agencies to protect and to assist Denver’s citizens assuring basic needs are met. This strategy responds to impacts on vulnerable populations during extreme heat events by reducing public health concerns and protecting the well-being of Denver’s citizens. *DHS* will collaborate with *OEMHS* and other agencies, to establish a local definition of extreme heat and an efficient course of action.
- » **Vector Control Plan:** *DEH* expects that a warmer climate will result in more vectors than currently observed due to an expanded season, which could result in an increase in vector-borne diseases. This activity responds to an increased presence of animal vectors carrying an expanded array of disease-causing organisms in Denver. Working with Parks and Recreation along with other agencies, *DEH* will complete a draft Vector Control Plan which will provide technical advice to *DEH* and Parks and Recreation personnel on the management and control of insect and animal disease vectors

4.1.3 Land Use and Transportation Sector

Table 4.3 identifies short-term adaptation activities associated with Land Use and Transportation, led principally by *CPD*.

Table 4.3: Summary of Short Term Adaptation Activities for Land Use and Transportation

Climate Impact	Vulnerability	EMS Activities	Responsible Agency	Agency Plan
ALL	Design standards not addressing climate change scenarios	Address climate change in upcoming Golden Triangle Small Area Plan	Department of Community Planning and Development	Golden Triangle Small Area Plan
Increase in urban heat island effect/ extreme weather events	Increased stress on stormwater management	Begin scoping process and update of Streetscape standards to address climate adaptation	Departments of Community Planning and Development, Public Works and Parks and Recreation	Streetscape Standards

EMS Activities

- » **Golden Triangle Small Area Plan and others:** *CPD* will release a Golden Triangle Small Area Plan addressing unique planning issues of that area. The Golden Triangle is bounded by Lincoln-Broadway, Colfax, and Speer Boulevard. The Plan will identify key development and infrastructure strategies with a specific focus on impacts and opportunities related to zoning, building heights, multi-modal streets, and place making. *CPD* plans to include climate change as a consideration during planning by increasing park spaces and emphasizing sustainability. The Golden Triangle Small Area Plan will serve as an example to prompt further planning efforts to include climate change considerations in their plan and serve as a model for adaptation strategies in other neighborhood-level plans.
- » **Streetscape Standards update:** The City's Streetscape Standards set guidelines for the design of city streets and was last updated in 1993. *CPD* plans to begin the scoping process in 2014 or 2015 and expects to complete the updated streetscape design standards in 2016. *CPD* will consider expected climate change impacts for Denver during the update process. The updated guidelines will align regulatory tools with an expected future that is hotter and likely drier.

4.1.4 Urban Natural Resources Sector

Table 4.4 identifies short-term adaptation activities associated with Urban Natural Resources Sector; the principal agencies are DPR and DPW.

Table 4.4: Summary of Short-Term Adaptation Activities for Urban Natural Resources

Climate Impact	Vulnerability	EMS Activities	Responsible Agency	Agency Plan
Increase in temperature and urban heat island effect	Stress on trees and urban landscaping	1) Publish and begin the outreach of the Metro Denver Urban Forest Assessment	Department of Parks and Recreation	Metro Denver Urban Forest Assessment
		2) Initiate a contract to inventory existing trees within the City in preparation for a Tree and Shade Master Plan		Tree and Shade Master Plan
		3) Update the right-of-way tree list that focuses on trees that can thrive in future climates		Right-of-Way Tree List Storm
Higher frequency of extreme weather events	Stormwater management and flood control	Include a discussion section on climate adaptation and mitigation in the Storm Drainage Master Plan documentation update currently underway by DPW planning staff	Department of Public Works	Storm Drainage Master Plan
	Contaminant loading from increased flooding and heavy rain spells	Include climate adaptation and mitigation in discussion and documentation related to 6 year Water Quality Strategic Implementation Plan currently underway by DPW planning staff		Water Quality Strategic Implementation Plan

» **Metro Denver Urban Forest Assessment:**⁷² There is growing recognition that trees provide long-term environmental, economic, and health benefits critical to vibrant and livable cities. To affirm the relevance of Metro Denver’s urban forest, the Metro Denver Urban Forest Assessment was conducted to quantify the distribution of tree canopy cover and the value of the ecosystem services provided by its 10.7 million trees. This serves as a platform for planning the future urban forest by mapping locations of potential tree planting sites and valuing ecosystem services provided by an additional 4.25 million trees. This assessment provides data on the location of sites in Denver where there is elevated heat to be used as a guide to the planting of new trees in order to mitigate the urban heat island effect. Additionally, its findings will be used to inform the public and key decision makers on the value and benefit the urban forest provides.

Metro Denver’s urban tree canopy (*UTC*), defined as the area covered by the leaves and branches of trees, covers 15.7% of the 721 square mile study area. It provides \$551 million in property value increases, energy savings, carbon storage, stormwater reduction, and air quality benefits annually. Adding an additional 4.25 million trees will fill nearly one-half of the region’s vacant tree sites, increasing the *UTC* from 16% to 31% once trees mature. The annual value of ecosystem services will increase to \$1 billion. The asset value of Metro Denver’s urban forest is \$13 billion, or \$5,897 per tree, calculated at a 4.125% discount rate for 100 years.

In 2013, *UTC* covered approximately 19.7% of the City, a relatively high amount compared to the overall average found for Metro Denver. Also, approximately 50% of the land area is impervious surfaces such as roads, buildings, water and sidewalks, while only 31% of the City is grass and bare soil that can be easily planted with trees, leaving 1.1 million vacant planting sites.

Denver has 2.2 million existing trees and 3.7 trees per capita. Denver’s urban forest produces ecosystem services and property value benefits valued at \$122 million annually. This is the highest value of benefits in Denver. Property value increases account for 76% of the total amount, followed by stormwater runoff reduction from rainfall interception (20%), and cooling energy savings (4%). Planting 68,316 trees in 49% of the vacant sites in hot spots would help mitigate the urban heat island effect, thereby improving air quality and human health. The asset value of the City’s *UTC* is \$2.9 billion and will increase to \$6 billion, or \$2,176 per tree, when *UTC* reaches 31.1%.

Figure 4.1⁷³ displays Metro Denver’s percent *UTC* cover by city in the study area.

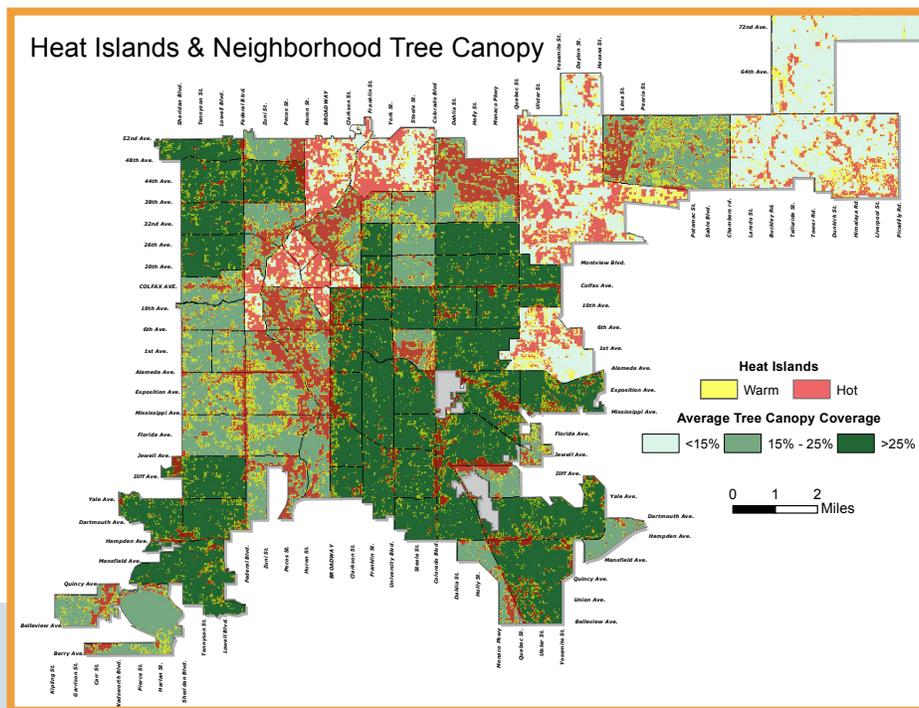


Figure 4.1: Metro Denver’s percent urban tree canopy cover by city. Darker shaded green represents higher percent cover.

EMS Activities (Cont.)

- » **Tree and Shade Master Plan:** As the climate changes the urban forest has the potential to become stressed. Different tree species react differently to stress. The City Forester’s Office is beginning a multi-year inventory and risk assessment of the trees in the parks, parkways and golf courses. Once this inventory is complete, a Tree and Shade Master Plan can be created to allow for strategic planting and management of the urban forest to benefit a population experiencing increased temperature.
- » **Right-of-Way Plant Growing List:** The City Forester is responsible for permitting the planting of all trees planted in public property and the public right of way. A list of approved trees for planting is published by the City Forester’s Office. As the climate changes the trees planted today must have characteristics that will allow them to survive decades into the future in order for them to reach their mature size to provide optimal benefits. The list of trees approved for planting will be reviewed annually and updated with species that are demonstrating the ability to thrive in climates similar to those that Denver is anticipating in the next forty years.
- » **Storm Drainage Master Plan:** The stormwater master planning efforts will plan and design infrastructure for sustainability and resilience related to climate impacts. *DPW* staff will work with regional organizations to update existing criteria to reflect the existing climate information as changes in rainfall, storm frequency, and intensity are better understood.
- » **Water Quality Strategic Implementation Plan:** Water quality strategic planning is ongoing by *DPW* and the Water Quality Task Force. Strategic planning encapsulates floodplain, lakes, streams, rivers, and stormwater issues relating to water quality.

4.1.5 Water Consumption Sector

Table 4.5 identifies short-term adaptation activities associated with the Water Consumption Sector and the principal agencies involved.

Table 4.5: Summary of Short Term Adaptation Activities for Water Consumption Sector

Climate Impact	Vulnerability	EMS Activities	Responsible Agency	Agency Plan
Reduced snowpack and earlier snowmelt	Reduced amount of water available from independent ditch water supplies for irrigation	Implement Phase II of the Central Control Master Plan	Department of Parks and Recreation	Central Control Master Plan
	Higher water demands and consumption in summer months	Require xeric planting or low water use landscape plantings in the urban design standards and guidelines for Cherry Creek East	Department of Community Planning and Development	Cherry Creek East Urban Design Standards and Guidelines

EMS Activities

- » **Central Control Master Plan:** *DPR* has been actively pursuing water conservation initiatives for over 20 years. The 2010 Central Control Master Plan provides a five-year plan for the complete build out of irrigation central control systems. Central control provides the greatest water management capabilities with the most efficient use of labor when used in tandem with flow sensing and a master valve. *DPR* is comprised of many large independent sites, with limited personnel to individually manage each site with stand-alone controllers. Central control allows necessary seasonal and weather related schedule adjustments of multiple sites quickly from centrally located computer instead of requiring staff to make multiple trips to adjust each controller on site. Flow sensing also provides *DPR* with the capability to monitor and analyze water use through consumption reporting, which allows the opportunity to maximize the efficient use of water.
- » **Urban Design Standards and Guidelines for Cherry Creek East:** Under the landscape section of the urban design standards and guidelines, *CPD* will require xeric planting, or low-water use landscape plantings in Cherry Creek East. The urban design standards and guidelines for Cherry Creek East could become a model for other neighborhoods. As Denver expects more frequent and intense droughts, drought-tolerant landscaping provides a smart solution to address the trade-off between water quantity and green infrastructure. Cherry Creek East is bordered by Steele Street, Cherry Creek North Drive, Alameda Avenue, Colorado Boulevard, and 1st Avenue. The area supports a mix of residential and office uses and some of the highest residential and employment densities in all of Cherry Creek, as well as the greatest diversity of housing types.

Integrating these short-term activities into Denver's EMS puts Denver on the right track to meet its long-term climate adaptation goals, as discussed in the following chapter.

CHAPTER 5: MEDIUM AND LONG-TERM CLIMATE ADAPTATION ACTIVITIES

Chapter 4 provided a description of short-term (one to two years) adaptation activities various Denver agencies are implementing to adapt to what likely will be a hotter and drier Denver. Chapter 5 discusses longer-term goals and strategies for adapting to a changing climate. The longer-term (medium-term and long-term) climate adaptation goals and strategies were developed for each sector through collaboration among Denver agency partners, community organizations, *DEH*, and Meister Consultants Group. These longer-term adaptation goals correspond to the priority vulnerabilities previously identified in Chapter 3. Strategies for meeting these adaptation goals are introduced along with proposed activities for implementation of the strategies. Whereas the short-term adaptation activities discussed in Chapter 4 were primarily those that would be implemented by Denver and partner agencies, the longer-term term adaptation activities discussed in the following sub sections will need to be implemented by both Denver and partner agencies and the private community. Medium-term goals and strategies would be expected to be implemented in two to five years and long-term-term goals and strategies would be expected to be implemented in five to ten years.

5.1 Buildings and Energy Sector

Residential, commercial, and industrial buildings shelter Denver residents and house businesses and institutions key to the region’s economic vitality. Ensuring these facilities are able to withstand climate impacts, require less energy during extreme temperature conditions, operate continuously during extreme weather events, and maintain a reliable power supply are high priorities for Denver’s adaptation planning.

In addition, adaptation activities in this sector are closely linked to the City’s energy and greenhouse gas emissions reduction activities. Reducing the vulnerabilities affecting Denver’s buildings and energy systems are closely linked to mitigating global climate change, lowering energy expenditures, and reducing local and regional air pollution.

As described in [Chapter 3](#), Denver is expected to face increasing temperatures, extreme weather events, and shifting stream flows, all of which will significantly affect Denver’s built environment. Higher temperatures will increase electricity demand, especially during extreme heat events, placing greater strain on the energy grid. In some cases, building codes and design standards may not be adequate to withstand the increases in extreme weather conditions, which will also increase the need for building maintenance and repairs. Higher emergency management funding needs and insurance premiums may place additional financial burdens on the City and on private property owners. [Table 5.1](#) summarizes climate vulnerabilities for the Buildings and Energy sector and notes which City departments and community organizations will be most directly affected by each.

Table 5.1: Buildings and Energy Sector High Priority Vulnerabilities

Priority Vulnerabilities Identified by Denver	Affected City Departments	Affected Community Organizations
Higher energy consumption and demand in the summer months	General Services Environmental Health Community Planning & Development Economic Development Denver International Airport Office of Strategic Partnerships	Xcel Energy Colorado Energy Office Denver Housing Authority U.S. Green Building Council (Colorado Chapter)
Higher maintenance costs for Denver building maintenance and building equipment	General Services Economic Development	Denver Housing Authority Denver Metro Building Owners and Managers Association
Design standards do not address climate change scenarios	Emergency Management Community Planning & Development	U.S. Green Building Council (Colorado Chapter)
Denver buildings structurally vulnerable to extreme weather events	Emergency Management Community Planning & Development	
Unanticipated increase in emergency management funding and impacts on self-insured property	Budget Management Office	

To adapt to these climate impacts, Denver has identified two key goals for the Buildings and Energy sector:

- » Reduce vulnerability to building energy supply disruptions
- » Reduce vulnerability of buildings to extreme weather

Four strategies have been identified to achieve these goals, as summarized in [Table 5.2](#) and described in detail below. Each is supported by a variety of medium and long-term activities. Selected example activities are listed, and a full summary of activities is provided in [Appendix C](#).

Table 5.2: Summary of Goals and Strategies for Increasing Resilience in the Buildings and Energy Sector

Goal 1

- » *Reduce vulnerability to building energy supply disruptions*
- » **Strategy 1:** Energy efficiency to reduce the demand for energy thereby reducing pressure on the grid during extreme heat days
- » **Strategy 2:** Cooling infrastructure to cool the City thereby reducing the demand for energy.
- » **Strategy 3:** Alternative and distributed generation to diversify the City's energy mix and increase distributed generation

Goal 2

- » *Reduce vulnerability of buildings to extreme weather*
- » **Strategy 1:** Encourage construction of resilient buildings

5.1.1 Goal 1: Reduce vulnerability to building energy supply disruptions

Reducing stress on the electricity grid in a hotter, drier climate requires both supply and demand-side strategies. Denver has identified three strategies that support the goal of reducing vulnerability to building energy supply disruptions:

Strategy 1: Energy efficiency

The City of Denver has been actively engaged in promoting energy efficiency as a climate mitigation strategy through the Denver Climate Action Plan and the Denver Energy Challenge. Other community partners, including the Colorado Energy Office and Xcel Energy, also have a number of programs directed at increasing energy efficiency. However, energy efficiency can also serve as an adaptation strategy; lowering total consumption reduces demand during extreme heat events, mitigating the risk of outages.

Denver has developed a number of, medium and long-term activities that encourage energy conservation in municipal facilities and in the wider community. Example activities are described below in [table 5.3](#); [Appendix C](#) includes a more complete list of activities.

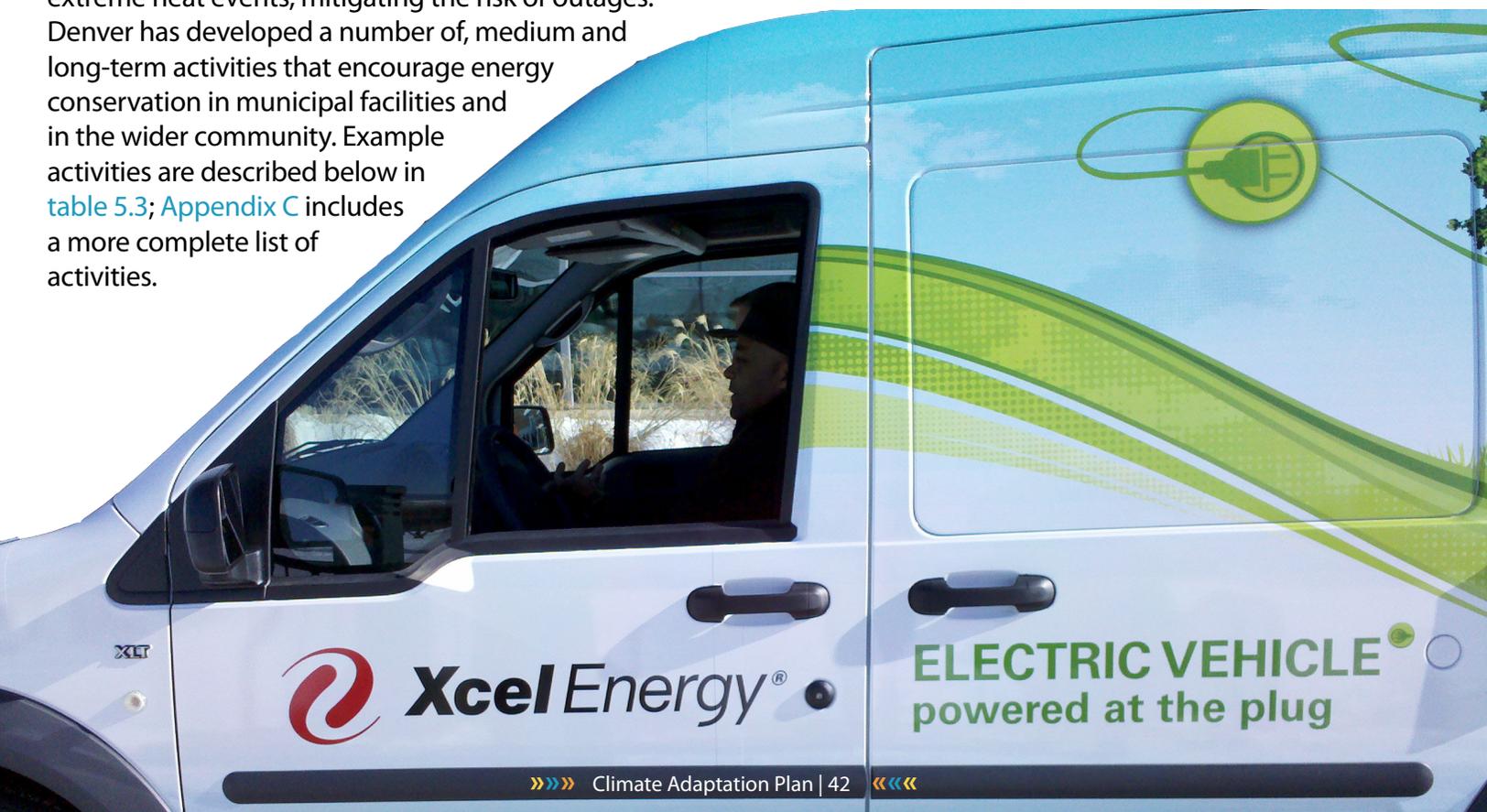


Table 5.3: Activities for increasing energy efficiency in the buildings and energy sector

Example Activities	Time Frame (long/medium-term)	Lead Agency	Supporting Agencies	Status
Increase commercial building energy efficiency through a variety of mechanisms, including commercial building energy benchmarking and disclosure options through the City Energy Project	Medium-term	DEH	Denver Water, CPD, DPW, and OED	In progress
Adopt the 2015 International Energy Conservation Code	Medium-term	CPD	DEH	Not started
Use energy performance contracting model to generate funds for capital improvements at City facilities	Medium-term	DGS	BMO, DPW, and CAO	In progress

Strategy 2: Cooling infrastructure

Green infrastructure—such as shade trees, open space, green roofs, and other techniques—can be used to reduce the urban heat island effect during hot days, as well as increase water infiltration and improve air quality. For example, shaded areas can be up to 15-45°F cooler than their surroundings during the hottest hours of the day.⁷⁴ Trees and other vegetation also remove heat from the air through evapotranspiration, reducing ground-level air temperatures. Other built environment design elements, such as light colored pavement or roofing materials, can also serve to reduce surface temperatures by reflecting sunlight away from buildings and streets.⁷⁵ Denver plans to undertake a number of activities by the end of this decade to increase the use of natural and cooling infrastructure in the city (see below and [Appendix C](#)). This will reduce the effects of rising temperatures community-wide, reducing overall energy demand and placing less stress on energy infrastructure during extreme weather events.

Table 5.4: Activities for increasing cooling infrastructure in the buildings and energy sector

Example Activities	Time Frame (long/medium-term)	Lead Agency	Supporting Agencies	Status
Reduce urban heat island effect through infrastructure such as shade trees, urban gardens, green roofs, and lighter colored hardscapes	Long-term	DPW	DPR	In progress
City facilities permanently commit to save energy by regulating thermostats all year long and allowing a relaxing dress code, eliminating personal appliances, replacing desktop computers with laptops and tablets, and expand to private sector facilities	Medium-term	DGS	Mayor's office	In progress
Develop non-vegetation shade structures	Medium-term	DPR		In progress

Strategy 3: Alternative and distributed generation

Denver can enhance the stability of its energy system by expanding distributed renewable energy generation. Distributed generation refers to electricity from multiple small energy sources. Like energy efficiency, distributed energy generation can reduce air pollution and greenhouse gas emissions and can also serve as an adaptation strategy. Distributed energy can help reduce demands on centralized power generation, thus enhancing reliability of the system during extreme heat events. In particular, solar energy systems offer synergies during extreme heat events because daily solar insolation (full sun hours) periods overlap with peak demand for cooling. Because distributed energy systems are not centralized the system is less likely to be totally knocked off line during an extreme weather event. These systems and other interconnected, distributed generation technologies could supplement available electricity supply during peak load periods.

Some off-grid distributed energy systems could also provide backup power for facilities in the event of a power outage or could be used to expand demand response programs. Distributed generators provide the framework for community-based micro-grids, which could eventually operate independently of the larger utility network. There are also opportunities to expand off-grid utility networks through district energy systems. These off-grid solutions would reduce the risk of demand outpacing available grid-provided electricity by allowing discrete sectors to remain in operation even in the face of a generalized outage of the grid.

Table 5.5: Activities for increasing alternative and distributed generation

Example Activities	Time Frame (long/medium-term)	Lead Agency	Supporting Agencies	Status
Update solar site assessment of City facility rooftops and other City-owned locations, and solicit proposals for eligible sites	Medium-term	DGS		Not started
Identify opportunities for the city to become a subscriber in community solar gardens	Medium-term	DGS	CAO	In progress
Develop community-scale renewable and district energy pilot systems and remove existing regulatory barriers	Medium-term	DEH	CPD and OED	Not Started
Install sustainable energy generation systems such as wind systems on local properties	Medium-term			In progress

5.1.2 Goal 2: Reduce vulnerability of buildings to extreme weather

Denver also seeks to reduce the vulnerability of buildings to extreme weather. Current building codes and design standards need to be reviewed to ensure they are adequate not only for past and current climate conditions, but for the projected future climate of the Denver region as well. In order to better protect community assets, existing buildings may need to be retrofitted and new buildings may need to be constructed to higher standards to ensure resilience to more extreme weather.

Strategy 1: Encourage construction of resilient buildings

The vulnerability of buildings to extreme weather can be reduced by incentivizing resilience-building retrofits to existing structures, and providing regulatory support to apply climate-informed design and construction standards to new buildings. Increasing a building's structural integrity will provide protection against high winds, heavy or prolonged precipitation, and other extreme weather impacts, reducing damage to buildings and the associated cost to property-owners. See below and [Appendix C](#) for activities design to increase building resilience in Denver.

Table 5.6: Activities for encouraging construction of resilient buildings

Example Activities	Time Frame (long/medium-term)	Lead Agency	Supporting Agencies	Status
Develop incentives or regulation to improve resiliency of buildings in areas facing increased risk of flood	Medium-long-term	CPD/ Development Services	DPW	Not started
Publish a guide on steps that commercial and residential property owners can take to make their existing buildings more resilient to climate change	Medium-term	DEH	OED and OEM	Not started
Require construction of “safe rooms” as described in the 2015 ICC building code to protect citizens during extreme weather events	Medium-term	Development Services		Not started

5.2 Health and Human Services Sector

As mentioned in [Chapter 1](#), Colorado has already seen a 2°F increase in temperatures over the past 30 years, and climate models project Colorado will warm by another 2.5°F by 2025 relative to the 1950-1999 baseline.⁷⁶ Also, because Denver is a highly urbanized area with high percentages of impervious surfaces, Denver will see an even higher increase in temperatures than rural Colorado communities. This increase in temperature may create negative health impacts for the community and the most vulnerable populations may be disproportionately affected by these impacts. Denver will experience increased daytime and nighttime temperatures, leaving less nighttime cooling relief for residents. Also, hot, sunny days can result in an increased rate of ground level ozone formation, contributing to urban smog and compromising Denver residents’ health. Warmer weather can also facilitate the movement of disease vectors, such as mosquitoes, that can spread diseases quickly in a dense, urban environment.

It is important for Denver to adapt to climate impacts brought by an increase in temperatures and urban heat island effect to protect the health and vitality of Denver’s residents. Ensuring health care providers are able to provide care during extreme heat events and providing relief during extreme daytime temperatures will be necessary to adapt to a hotter, drier Denver, while maintaining a community of healthy residents. [Table 5.7](#) illustrates Denver’s priority vulnerabilities for the Health and Human Services sector and the associated affected City departments and community organizations.

Table 5.7: Health and human services sector high priority vulnerabilities

Priority Vulnerabilities Addressed	Affected City Departments	Affected Community Organizations
Decrease in quality of living/reduced comfort or reduced occupant comfort in buildings/impacts to productivity	Public Works Community Planning and Development Environmental Health General Services Parks and Recreation	Denver Metro Building Owners and Managers Association U.S. Green Building Council, Colorado Chapter
Extreme heat events affecting vulnerable populations	Community Planning and Development Environmental Health Human Services Parks and Recreation	Homeless shelters, Nursing homes, Hospitals
Increase in vector borne diseases/increased use of pesticides	Environmental Health Emergency Management	
Ensuring health care services for people with chronic conditions during extreme weather events	Emergency Management	Hospitals

5.2 Health and Human Services Sector (Cont.)

To adapt to these climate impacts, Denver has identified two key goals for the Health and Human Services Sector:

- » Safeguard health of Denver residents in the context of climate impacts
- » Preserve ability of health care and other human service providers to continue service during extreme events

A set of strategies were identified in order to achieve each goal, as summarized in [Table 5.8](#) and described below. A set of medium-term and long-term activities were then identified to support each strategy.

Table 5.8: Summary of goals and strategies for increasing resilience in the Health and Human Services sector

Goal 1

- » *Safeguard health of Denver citizens in the context of climate impacts*
- » **Strategy 1:** Reduce health impacts of extreme weather events
- » **Strategy 2:** Reduce health vulnerabilities from vector-borne diseases

Goal 2

- » *Preserve ability of health care providers to provide utilities during extreme heat events*
- » **Strategy 1:** Develop energy and IT systems that are resilient to power outages

5.2.1 Goal 1: Safeguard health of Denver residents in the context of climate impacts

Denver can maintain and improve the health of its residents by preparing for anticipated risks and educating and informing its residents on how to respond appropriately to the changing climate. Hotter conditions will increase risk of heat-related illness and increase populations of disease-spreading agents. The strategies outlined below can mitigate these challenges through integrated planning and responsive policies.

Strategy 1: Reduce health impacts of extreme weather events

Climate change will likely bring increasingly frequent and severe heat waves and extreme weather events. These changes have the potential to negatively affect human health in direct and indirect ways. Health effects related to heat exposure can range from mild heat rashes to heat stroke. Heat exposure can also aggravate chronic health conditions such as cardiovascular and respiratory disease. Heat also increases ground-level ozone concentrations, causing direct lung injury and increasing the severity of respiratory diseases such as asthma and chronic obstructive pulmonary disease. Extreme weather in the form of storms may also impact health. Direct effects of extreme weather include drowning from floods and injuries sustained from building structural collapse. Indirect effects include aggravation of chronic diseases due to interruptions in health care service and significant mental health concerns from interrupted care and geographic displacement. Suggested activities to mitigate the health effects of extreme weather are:

Table 5.9: Activities for reducing health impacts of extreme weather events

Example Activities	Time Frame (long/medium-term)	Lead Agency	Supporting Agencies	Status
Increase the number of shelter spaces available to homeless and at-risk populations	Long-term	Road Home	OEM and DHS	In progress
Designate public cooling shelters for extreme heat events	Medium-term	DPR	OEM	In progress
Adopt a severe weather ordinance to allow shelters to expand the number of persons served during extreme weather events	Medium-term	Road Home	DEH, DHHS and OEM	Not started

Strategy 2: Reduce health vulnerabilities from vector-borne diseases

Climate is one of many variables known to affect the rates of vector-borne and zoonotic diseases (VBZD). “Vector-borne disease” is the term commonly used to describe an illness caused by an infectious microbe that is transmitted to people by blood-sucking arthropods (insects or arachnids). Zoonotic refers to a disease that can be transmitted from animals to people or, more specifically, a disease that normally exists in animals but that can infect humans. The changing climate may result in altered distribution of VBZD prevalent in the U.S. This could cause formerly-prevalent diseases such as malaria and dengue fever to re-emerge. For example, as temperature increases, the malaria parasite reproduces at a higher rate and mosquitoes take blood meals more frequently than during cooler periods. Proposed example adaptation activities for this strategy include;

Table 5.10 Activities to reduce health vulnerabilities from vector-borne diseases

Example Activities	Time Frame (long/medium-term)	Lead Agency	Supporting Agencies	Status
Work with partners to develop water VBZD surveillance system to improve prediction of epidemics and prevent incidents leading to epidemics	Medium-term	DEH	OEM	In progress
Evaluate and scale the VBZD control program as warranted	Medium-term	DEH	DPR	In progress

5.2.2 Goal 2: Preserve ability of health care and other service providers to provide utilities during extreme heat events

Denver residents and health care patients will need access to services even during extreme events. During Hurricane Sandy, many of New York’s health care providers were without power, and had no access to long-term back-up generation services. Patient records were inaccessible, and many critically ill patients had to be transferred to other facilities. Denver needs to prepare its healthcare network for climate-related disruptions. Activities are presented below to address this vulnerability.

Strategy 1: Develop utility and IT systems that are resilient to power outages

Extreme weather will likely strike Denver, but some of the cost and impact can be reduced with the deployment of more resilient infrastructure. One example of resilient infrastructure is Combined Heat and Power (**CHP**) technology. **CHP** technologies generate efficient and reliable electricity and heat (or cooling) near the consumer. Distributed **CHP** power plants can form nodes for microgrids that can supply heat and electricity to people and businesses even if portions of the network are knocked offline. The conventional driver for a **CHP** plant is gas-fired turbines. Due to a high exhaust temperature and flow, gas turbines are able to generate a large amount of heat, which can then be converted to steam, hot water, chilled water, and/or electricity. Example long-term and medium-term adaptation activities for Denver are listed below and in [Appendix C](#).

Table 5.11: Activities to develop utilities and IT systems that are resilient to power outages

Example Activities	Time Frame (long/medium-term)	Lead Agency	Supporting Agencies	Status
Explore programs for hospitals and other service facilities to install off-grid distributed alternative energy systems with islanding capabilities	Long-term	DEH	OED OEM	Not started
Explore incentives for hospitals and other service providers to identify power needs for critical systems and obtain adequate back-up generation capacity	Medium-term	DEH	OED OEM	Not started
Advise hospitals and other service providers to evaluate whether critical infrastructure is at risk to flash flooding and identify risk mitigation solutions	Medium-term	DEH	OED OEM DPH	Not started

5.3 Urban Natural Resources Sector

In Denver, the Urban Natural Resources sector is affected by a variety of climate impacts. An increase in temperature and urban heat island effect can put stress on trees and vegetation which provides Denver with cooling and shade benefits, as well as carbon sequestration. Trees and vegetation may also be affected by an increase in frequency and intensity of droughts, suffering from prolonged time without a rain event. An increase in surface temperatures also increases water temperatures, which degrades water quality and negatively impacts aquatic ecosystems. Extreme weather events such as heavy downpours cause increased nutrient loads entering Denver’s waterways, also degrading water quality.

It is important to adapt to climate impacts affecting Denver’s Urban Natural Resources sector to ensure residents receive maximum benefits from ecosystem services urban natural resources can provide. Trees can provide shade for cooling during extreme heat events as well as decrease impervious surface cover, mitigating some of the impacts of the urban heat island effect. Like trees, vegetative cover also provides urban heat island effect mitigation benefits. Vegetation also acts as a natural filtering mechanism during rain events so Denver’s waterways are not being overloaded with pollutants that degrade water quality, allowing Denver’s residents to enjoy lakes and streams for fishing and other recreational activities. [Table 5.12](#) illustrates Denver’s priority vulnerabilities for the Urban Natural Resources sector and the associated affected City departments and community organizations.

Table 5.12: Urban Natural Resources sector priority vulnerabilities

Priority Vulnerabilities Addressed	Affected City Departments	Affected Community Organizations
Stress on trees and urban landscaping	Parks and Recreation	
Park damages and debris generation, damage to riparian corridors and stress on landscapes and trees	Parks and Recreation Environmental Health	Greenway Foundation
Warming of stream and lake systems affecting aquatic species	Parks and Recreation	Greenway Foundation
Degradation of surface water quality including microbial contaminants	Environmental Health Public Works	Denver Water, UDFCD
Contaminant loading from increased flooding and heavy rain spells	Public Works	Denver Water, UDFCD
Decrease in water quality due to low-water flow in discharge areas	Public Works Environmental Health Parks and Recreation	Denver Water, UDFCD

To adapt to these climate impacts, Denver has identified two key goals for the Urban Natural Resources sector:

- » Enhance and preserve existing urban forest resources
- » Ensure all Denver streams are fishable and swimmable

A set of strategies were identified in order to achieve each goal, as summarized in [Table 5.13](#) and described below. A set of medium-term and long-term activities were then identified to support each strategy.

Table 5.13: Summary of goals and strategies for increasing resilience in the Urban Natural Resources sector

Goal 1

- » *Enhance and preserve existing urban forest resources*
- » **Strategy 1:** Standards and regulations to strengthen and protect urban forest resources
- » **Strategy 2:** Increase Denver’s canopy coverage and maintain existing street resources
- » **Strategy 3:** Expand fire mitigation and forest management programs in Denver’s Mountain Parks

Goal 2

- » *Ensure all Denver streams are fishable and swimmable*
- » **Strategy 1:** Maintain and enhance health of Denver water bodies
- » **Strategy 2:** Improve and maintain surface water quality
- » **Strategy 3:** Improve water and wastewater infrastructure to reduce risk of overflows or spills

5.3.1 Goal 1: Enhance and preserve existing urban forest resources

Terrestrial resources, such as street trees, forests and other plant life, will face harsher growing conditions due to rising temperatures and shifting rainfall patterns. These natural resources provide Denver with valuable ecosystem services, such as shading and water management as well as serving as shelter and food sources for many species. Denver has developed strategies to preserve and expand these valuable resources in a changing climate.

Strategy 1: Standards and regulations to strengthen and protect urban forest resources

The conservation organization American Forests, www.americanforests.org, has found that Denver is doing much better than other cities in protecting and developing its urban forest. Through a combination of an in-depth survey, independent data and a vote by a blue-ribbon panel of leading urban forest experts, the nonprofit has named the 10 best U.S. cities for urban forests: Austin, Charlotte, Denver, Milwaukee, Minneapolis, New York, Portland, Sacramento, Seattle and Washington, D.C. American Forests observed that Denver and the remaining nine top cities recognized that trees don't just provide aesthetic value, they also help in a number of other ways, including increasing property values, reducing energy costs and lowering medical costs by improving human health. For example, Denver estimates its urban forest provides \$122 million worth of annual property value and environmental services.⁷⁸

Protecting Denver's urban forest will be a focus of future adaptation activities including the following:

Table 5.14: Activities supporting standards and regulations to strengthen and protect urban forest resources

Example Activities	Time Frame (long/medium-term)	Lead Agency	Supporting Agencies	Status
Update the right of way tree list that focuses on those that can thrive in future climates	Medium-term	DPR	DPW	In progress
Conduct outreach campaign to educate and encourage residents to plant trees that can thrive in future climates	Medium-term	DPR	DPW	In progress

Strategy 2: Increase Denver's urban forest and canopy coverage

Denver's urban forest, aside from making Denver attractive to residents and visitors, provides benefits that support climate adaptation efforts. The Arbor Day Foundation's⁷⁹ publication extolling the value of trees to a community notes that an acre of forest absorbs six tons of carbon dioxide and releases four tons of oxygen, meeting the needs of 18 people. Denver's more than 19,000 acres of urban forest and tree canopy shades 19.7 percent of Denver and saves 56,471 mega watt hours each year in cooling, equaling more than \$6.7 million dollars in energy savings.⁸⁰ Protecting and enhancing Denver's urban forest is an important adaptation strategy; example activities to support this strategy include:



Table 5.15: Activities to increase Denver’s urban forest and canopy coverage

Example Activities	Time Frame (long/medium-term)	Lead Agency	Supporting Agencies	Status
Implement/complete the Tree and Shade Master Plan while ensuring the Plan includes a component specifically addressing the additional services required to adapt to climate change	Medium-term	DPR	OEM	In progress
Continue to participate in Emerging Pests in Colorado Roundtable and the Denver Pest Roundtable to find best practices to reduce stress on urban landscapes	Medium and long-term	DPR	DEH CPD OEM	In progress

Strategy 3: Expand fire mitigation and forest management programs in Denver’s Mountain Parks

In the southwest alone, since 2000, the states of Arizona, California, Colorado, and New Mexico have experienced several successive worst fires or fire seasons in their respective histories, as measured in lives lost and property destroyed.⁸¹ Climate change may be contributing to the increase in severe fires in Colorado and the Mountain West. As a result, the fire season has begun earlier in the spring and lasted later into the fall. Climate change has also weakened the trees’ ability to resist diseases and insect infestations. A visible example is the mountain bark beetles, whose attacks have killed millions of trees on public and private lands, leaving them standing as prime fuel for fires in Colorado and the Mountain West every fire season. Accordingly, it is important that climate adaptation efforts in Denver’s Mountain Parks continue and adapt to changing forest conditions.

Table 5.16: Activities to expand fire mitigation and forest management programs in Denver’s Mountain Parks

Example Activity	Time Frame (long/medium-term)	Lead Agency	Supporting Agencies	Status
Continue aggressive fire mitigation program in Mountain Parks and support fire mitigation programs by others	Medium and long-term	DPR	OEM and DFD	In progress

5.3.2 Goal 2: Ensure all Denver streams are fishable and swimmable

Denver has made the preservation of its water bodies a priority through its existing 2020 Sustainability Goals. Climate impacts are projected to directly impact Denver’s streams. Storms will generate debris, increase runoff and potentially introduce contaminants into existing water bodies. Warming will cause changes in aquatic ecosystems, which will need to be carefully monitored to maintain current species composition and ecological health. Community organizations such as Denver Water and the Urban Drainage and Flood Control District (**UDFCD**) will also play a large role in ensuring all Denver’s streams are fishable and swimmable, and reaching the City’s 2020 Sustainability Goal for water quality. Below are a number of strategies to ensure all Denver streams are fishable and swimmable.

Community Target

“Ensure all Denver rivers and streams are fishable and swimmable.”

Municipal Target

“Achieve and maintain 100% compliance with existing and future MS4 permit requirements and reduce storm water outfall E. coli dry weather discharges in priority S. Platte river basins under current permit to 126 colony forming units (cfu)/100 milliliters (ml).”

5.3.2 Goal 2: Ensure all Denver streams are fishable and swimmable (Cont.)

Strategy 1: Maintain and enhance health of Denver water bodies

Urban stream corridors provide many critical functions in the life of Denver’s residents. During storm events they function to convey storm runoff. This function will be even more important during extreme weather. Their linear nature is well suited to trails and a variety of recreational activities. Denver residents seek an active outdoor lifestyle and value natural areas for beauty and the appreciation of wildlife. Accordingly, thoughtful treatment of urban stream corridors creates and maintains community assets that are important to Denver’s current and future residents.⁸² Therefore it is critical to enhance and preserve floodplains, wetlands, and riparian areas particularly as the climate becomes hotter and drier. Future activities in Denver water bodies include:

Table 5.17: Activities for maintaining and enhancing the health of Denver water bodies

Example Activities	Time Frame (long/medium-term)	Lead Agency	Supporting Agencies	Status
Continue noxious weed abatement program	Medium-and long-term	DPR	DEH	In progress
Continue to implement the South Platte River Vision Implementation Plan, the Gulch Master Plan and Natural Area Management Plans	Medium-and-long term	DPR/DPW	OED ,DEH and NDCC	In progress
Continue to implement the Water Quality Master Plan	Medium-and-long term	DPW		In progress

Strategy 2: Improve and maintain surface water quality

Denver has a goal to have fishable and swimmable waters in all our rivers and streams by 2020. In order to meet that goal, the City has implemented a number of programs and studies to improve water quality in Denver.

- » The City has developed a program to improve stormwater infrastructure with the intent of protecting water quality in the river. To date, the program has successfully reduced the amount of E. coli entering the South Platte River from the City’s storm sewers.
- » The City is developing a Water Quality Strategic Plan which will identify areas where additional water quality treatment is needed and will allow the City to prioritize use of limited resources to areas where they will be most effective.

Organizations such as Denver Water and the **UDFCD** also have programs and beneficial studies to improve water quality in Denver. Denver Water “takes its water quality very seriously” and provides detailed information about their water treatment process, as well as annual water quality reports available to the public.⁸³ **UDFCD** provides examples of best management practices around the city that reduce stormwater runoff and improve water quality. **UDFCD** also provides a detailed report and fact sheets about urban storm drainage criteria, which leads to healthy water bodies around Denver.

Example activities aimed at improving water quality as the climate changes include:

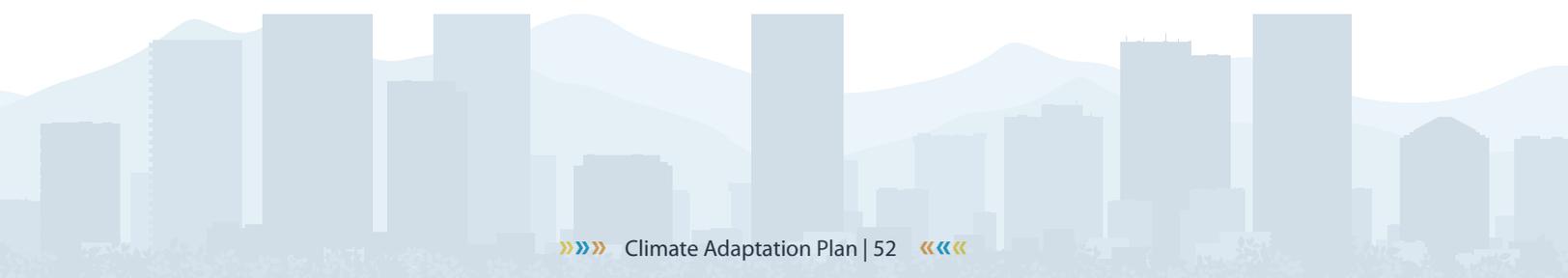


Table 5.18: Activities to improve and maintain surface water quality

Example Activities	Time Frame (long/medium-term)	Lead Agency	Supporting Agencies	Status
Partner with Denver Water to expand water quality monitoring in Denver watersheds	Medium-and long-term	DW	DEH	Not started
Include climate adaptation and mitigation in discussion and documentation related to 6-year Water Quality Strategic Implementation Plan currently underway by DPW planning staff	Medium-term	DPW	DEH	In progress
Prioritize and implement UDFCD gulch improvement projects, Re-gulch Mater Plans and Natural Area Management Plans	Medium-term	DPW/DPR		In progress

Strategy 3: Improve water and wastewater infrastructure to reduce risk of overflows or spills

The heavy rainfall and resulting flooding in September 2013 illustrated the impact of extreme weather on infrastructure such as storm sewers, dams and waterways. As the climate changes, it is likely that risks for infrastructure failure will increase in Denver. Existing studies indicate that small increases in weather and climate extremes have the potential to bring large increases in damages to existing infrastructure. Almost all of today's infrastructure has been designed using climatic design values calculated from historical climate data on the assumption that past extremes will represent future conditions.⁸⁵ Changes in climate will require changes to these climatic design values, as well as larger societal changes. Denver staff will work with regional organizations to update existing criteria to reflect the existing climate information as changes in rainfall, storm frequency, and intensity are better understood.

Table 5.19: Activities to improve water and wastewater infrastructure to reduce risk of overflows or spills

Example Activity	Time Frame (long/medium-term)	Lead Agency	Supporting Agencies	Status
Incorporate green infrastructure and other climate resilient design structures within storm system designs in the Storm Drainage Master Plan documentation update	Medium-term	DPW	CPD DPR	In progress

5.4 Water Consumption Sector

Denver, being situated in a semi-arid climate, traditionally receives only about 15 inches of precipitation in a year.⁸⁶ The majority of the precipitation in Colorado falls on the western slope, while about 80% of the population resides on the Front Range.⁸⁷ These settings naturally make long-term water supply planning a high priority for Denver Water. A warmer climate coupled with continued growth in the Denver-metro area further emphasizes the criticality of robust long-term water resources planning. Projected hydrologic changes to Denver Water's collection system due to a warmer climate may include changes in snowpack lifespan and magnitude, more intense and frequent droughts and floods, increases in evaporation and evapotranspiration, decreases in soil moisture, changes to watersheds from forest fires and pest infestation, changes in water quality of rivers and streams, and changes in water needs. These potential changes make it essential for Denver Water to prepare for climate change. Unfortunately, no single strategy is sufficient to prepare for a changing and unknown future.⁸⁸ Denver Water is committed to ensuring its customers have an adequate water supply for the future through aggressive conservation efforts, innovative recycled water systems and the securing new supplies.⁸⁹

5.4 Water Consumption Sector (Cont.)

The City and County of Denver supports Denver Water in their adaptation efforts. Specifically, the City will coordinate with Denver Water to reduce water demand and increase the use of recycled water. [Table 5.20](#) illustrates Denver’s priority vulnerabilities for the Water Consumption sector and the associated affected City Departments and community organizations.

Table 5.20: Water Consumption Sector Priority Vulnerabilities

Priority Vulnerabilities Addressed	Affected City Departments	Affected Community Organizations
Higher water demands (City and private) and consumption in summer months	Community Planning and Development Environmental Health Parks and Recreation	Denver Water, Watts to Water

To adapt to these climate impacts, Denver has identified a key goal for the Water Consumption sector. All activities and strategies address the following goal:

- » Reduce per capita use of potable water

A set of strategies were identified in order to achieve each goal, as summarized in [Table 5.21](#) and described below. A set of medium-term and long-term activities were then identified to support each strategy.

Table 5.21: Summary of Goals and Strategies for Increasing Resilience in the Water Consumption Sector

Goal 1

- » *Reduce per capita use of potable water*
- » **Strategy 1:** Continue and expand water conservation planning and programs
- » **Strategy 2:** Encourage the use of water conserving technologies and products in buildings
- » **Strategy 3:** Water-conserving irrigation techniques
- » **Strategy 4:** Water-conserving landscaping techniques
- » **Strategy 5:** Expand recycled water infrastructure and use

Water Quantity Community Goal

“Work with Denver Water to reduce per capita use of potable water in Denver by 22% over a 2001 baseline, and take additional steps using the City’s independent authority, in partnership with the Denver community, to keep the rate of increase in absolute consumption of potable water below the rate of population increase.”

5.4.1 Goal 1: Reduce per capita use of potable water

As mentioned in [Chapter 2](#), Denver Water has many conservation programs in place to successfully reduce the per capita use of potable water. Denver Water uses a three-pronged approach to ensure Denver’s residents have adequate water supply: conserve, recycle, and supply.⁹⁰ Through extensive conservation programs and the expansion of recycled water, Denver is working to reduce the demand for potable water instead of solely relying on developing new supply sources to meet Denver’s water needs. Denver Water residential customers (Denver and suburbs), use approximately 85 gallons of water per day.⁹¹ It has been proposed that Denver residents could easily get by on 50 gallons of water per day.⁹² Through public campaigns such as “Use only what you need” and rebates for high efficiency fixtures and irrigation products, such as toilets and low precipitation rate irrigation nozzles, customers are using more than 20 percent less on average than they were prior to the 2002 drought, even as population has increased. Continued water conservation efforts will be essential to enable continued decreases in water use to help adapt to a possibly drier Denver.

Strategy 1: Continue and expand water conservation planning and programs

As noted in [Chapters 2](#) and [4](#), Denver has current operations that help the City conserve water including retrofit of water fixtures and irrigation systems and assistance provided to Denver Public Schools to retrofit water fixtures, saving more than 250 million gallons of water per year since 2007. In 2008, Denver Water began updating its Integrated Resource Plan (*IRP*) to help guide decisions related to Denver’s water system over the next 40 years. The new *IRP* addresses a broader range of water issues compared to last *IRPs* including:

- » Potential challenges to the water system, such as climate change; more severe and frequent droughts; changes in demographics and water use patterns; changes to watersheds, including beetle kill and forest fires; Colorado River water shortages; and economic and regulatory changes
- » New opportunities for conservation, water-use efficiency and environmental enhancements
- » The frequency of water-use restrictions for customers
- » Water quality
- » Priorities for improving and maintaining the water treatment and distribution systems⁹⁴

Incorporating climate change impacts and conservation measures into long-term water supply planning plays an important role in increasing Denver’s resiliency to climate change.

Table 5.22: Activities to continue and expand water conservation planning programs

Example Activities	Time Frame (long/medium-term)	Lead Agency	Supporting Agencies	Status
Fully implement DPR GamePlan: Green infrastructure, wise water management water conservation plans	Long-term	DPR	DPW and DW	In progress
Continue implementation of Denver Water’s Integrated Resource Plan	Long-term	DW		In progress
Continuing to assess Denver Water’s resilience to climate change using the latest local climate projections, coordinate and be aware of new City adaptation policies and adjust practices accordingly	Medium-term	DW	CPD and DPW	In progress

Strategy 2: Encourage the use of water conserving technologies and products in buildings

In the United States we use almost 5 billion gallons of water daily at a shared energy cost of 150 million kilowatt-hours.⁹⁵ Denver residential customers (Denver residents and suburbs) each use an average of 85 gallons of water per day. Efficiency of water use brings a variety of benefits including reduced costs and lower energy use, and prepares a community to be adaptable to changing conditions. Denver is a leader in water conservation and will continue in that role in the future through adaptation to a future drier environment.

Table 5.23: Activities to encourage the use of water conserving technologies and products in buildings

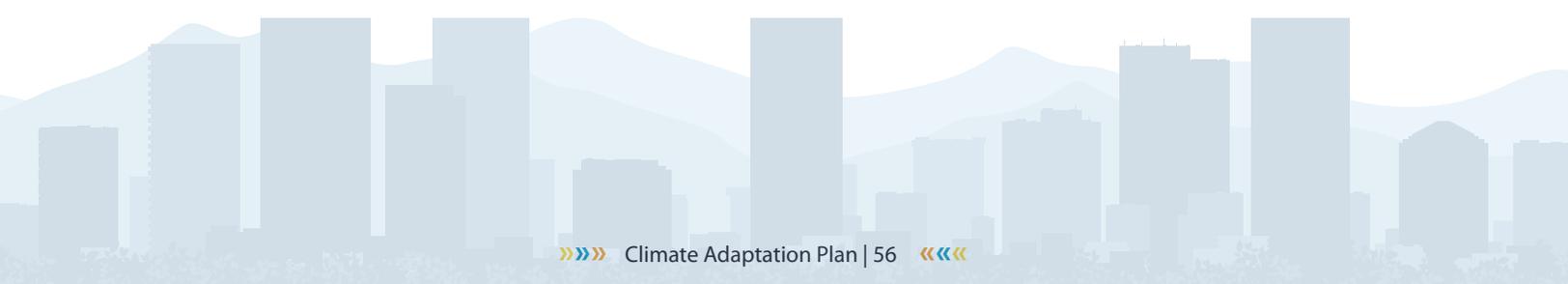
Example Activities	Time Frame (long/medium-term)	Lead Agency	Supporting Agencies	Status
Include reporting on water use in a building energy disclosure benchmark to track and monitor water use in major commercial properties around Denver	Medium-term	DEH,DW	DW	In progress
Collaborate with Denver Water to pilot a neighbor-to-neighbor comparison of water use on utility bills to encourage conservation behavior in residences	Medium-term	DEH, DW	DPW, CPD, DW	In progress
Continue and promote water efficient rebates for residential, commercial, and industrial buildings	Medium-term	DW		In progress

Strategy 3: Water-conserving irrigation techniques

Parks and Recreation are upgrading irrigation systems to make them more efficient and effective to adapt to changing climate conditions. Denver’s Parks are being upgraded with central control irrigation systems to achieve greater water efficiency and to reduce the time and expense of maintenance and repair. In addition, Denver Water offers commercial buildings rebates for 25% of the purchase price to install smart irrigation controllers, as well as rebates for the purchase of high efficiency or rotary nozzles for irrigation systems. Also, Denver Water offers free large scale irrigation system audits for large irrigation customers to identify ways that they can cut back on water use. Continuing and building upon programs like these will help improve irrigation techniques and lower per-capita use of potable water.

Table 5.24: Activities for water-conserving irrigation techniques

Example Activities	Time Frame (long/medium-term)	Lead Agency	Supporting Agencies	Status
Continue to increase the efficiency of park irrigation systems, including conversions to recycled water where feasible	Medium-term	DPR	DW	In progress
Continue to improve and expand upon Denver Water’s irrigation conservation programs	Medium-term	DW		In progress



Strategy 4: Water-conserving landscaping techniques

Colorado averages only about 15 inches of precipitation a year. Using Xeriscape techniques promotes efficient irrigation and sustainable practices that can reduce water use while allowing for attractive landscapes. Xeriscape uses low-water use plants to create a landscape that is sustainable in Colorado’s semi-arid climate.⁹⁶ Xeriscaped landscapes do not require as much water and upkeep as traditional lawns because the plants used are adapted to the dry climate on the Front Range. Increased use of Xeriscape techniques will be a feature in Denver as the climate changes.

Table 5.25: Activities for water-conserving landscaping techniques

Example Activity	Time Frame (long/medium-term)	Lead Agency	Supporting Agencies	Status
Advocate for and implement xeric landscaping	Medium-term	CPD/ Development Services, DW	DPR and Mayor’s office	In progress

Strategy 5: Expand recycled water infrastructure and use

Recycled water is treated wastewater used for irrigation, commercial and industrial use, freeing up potable water for other purposes. Denver Water expects ultimately to deliver 17,500 acre-feet (approximately 5.7 billion gallons) of recycled water each year. Recycled water serves irrigation customers at Denver Public Schools, several Denver parks and zoo, and is planned for Denver International Airport.

Additionally, the Denver Museum of Nature & Science (*DMNS*), in collaboration with Denver Water, is using heat pump technology and recycled water to heat and cool its recently completed 125,000 square foot wing. The system, which is expected to be at least 50 percent more efficient than traditional HVAC systems, utilizes recycled water to sink/source heat for the heat pumps, before the water is ultimately returned to the recycled water system.

In May 2013 House Bill 13-1044 was signed into law by Governor Hickenlooper authorizing the use of gray water. Gray water complements recycled water in that it can substitute for potable drinking water. Gray water is wastewater collected from fixtures within residential, commercial or industrial buildings for the purpose of being put to beneficial uses. Sources of gray water include discharges from sinks, bathtubs and showers and laundry machines. Gray water does not include wastewater from toilets, urinals, kitchen sinks or dishwashers. Gray water may only be used in areas where the local city or county has adopted an ordinance approving the use of gray water. Denver’s adoption of a gray water ordinance will further reduce demand for treated potable water thereby conserving this important resource.

Table 5.26: Activities to expand recycled water infrastructure and use

Example Activities	Time Frame (long/medium-term)	Lead Agency	Supporting Agencies	Status
Expand the use of recycled water (purple pipe)	Medium-term	DW	DPW and DPR	In progress
Develop a gray water ordinance for Denver	Medium-term	Mayor’s Office	DEH and DW	Not started

5.5 Land Use and Transportation sector

Climate change impacts will be exacerbated by current urban land-use patterns which heavily utilize surfaces that increase surface temperatures and contribute to less efficient stormwater management. Climate change is expected to disrupt existing urban transportation networks, which were not built to withstand projected conditions. Expanding transportation options will enhance the resilience of communities. Transitioning towards pedestrian-friendly communities will decrease reliance on automobiles and other more at-risk transportation methods. The following strategies are designed to cover the range of techniques and activities which can adapt Denver’s land use and transportation systems to create a more resilient urban landscape. The City of Denver has identified the following vulnerabilities as priorities, as summarized below.

Table 5.27: Land Use and Transportation Sector Priority Vulnerabilities

Priority Vulnerabilities Addressed	Affected City Departments	Affected Community Organizations
Increase in extreme heat events and increased stress on storm water management and increased flooding	Public Works Community Planning and Development Parks and Recreation	Red Cross
Regulatory barriers to the adoption of adaptation strategies	Community Planning and Development	
Design standards not addressing climate change scenarios	Public Works	
Climate induced in-and out- migration of workforce populations and businesses	Office of Economic Development	Chamber of Commerce
Long-term disruption in services delivery	Human Services	
Interruptions to transportation and stress or damage to physical infrastructure and public assets	Community planning and development Public Works	RTD, Denver Regional Council of Governments

To adapt to these climate changes, Denver has identified two key goals for the Land Use and Transportation sector:

- » Improve mobility options within the City and its communities
- » Prepare and enable urban infrastructure to adapt to climate impacts

A set of strategies were identified in order to achieve each goal, as summarized in [Table 5.28](#) and described below. A set of medium-term and long-term activities were then identified to support each strategy.

Table 5.28: Summary of Goals and Strategies for Increasing Resilience in the Land Use and Transportation Sector

Goal 1

- » *Improve mobility within the City and its communities*
- » **Strategy 1:** Create transit oriented and sustainable neighborhoods
- » **Strategy 2:** Increase alternative transportation options

Goal 2

- » *Prepare and enable urban infrastructure to adapt to climate impacts*
- » **Strategy 1:** Integrate pavement options and alternatives that reduce the urban heat island effect
- » **Strategy 2:** Integrate pavement options and alternatives that reduce stormwater runoff
- » **Strategy 3:** Integrate climate change into planning and zoning considerations

5.5.1 Goal 1: Improve mobility within the City and its communities

Denver believes that expanding transportation options, and making communities more accessible to a broadened array of transit choices can reduce the vulnerability of Denver’s transportation network. Expanded transportation options include bicycles, walkways, and expansion of mass transit options.

Municipal Target

“Provide incentives and other programs to City employees so that no more than 55% of these employees commute in single-occupant vehicles.”

Community Target

“Provide mobility options (transit, car-pooling, biking, walking) that reduce personal travel in Denver done in single-occupant vehicles to no more than 60% of all trips.”

Strategy 1: Create transit oriented and sustainable neighborhoods

The Regional Transportation District’s FasTracks Project is a catalyst for development at and around the system’s transit stations. This Transit Oriented Development (**TOD**) is characterized by a pedestrian-oriented environment that allows people to live, work, shop and play in places accessible by transit. The primary benefits of **TOD** include:

- » Reducing sprawl and protecting existing neighborhoods
- » Reducing commute times and traffic congestion
- » Improving environmental quality and open space preservation
- » Encouraging pedestrian activity and discouraging automobile dependency

An example of where **TOD** may have a major beneficial impact is the Globeville Elyria-Swansea (**GES**) neighborhoods in Denver. Two FasTracks Stations will be constructed near the **GES** neighborhoods. These stations will play an increasingly important role for transportation as the reconstruction of Interstate 70 gets underway, just south of the GES neighborhoods.¹⁰ The GES neighborhoods suffered from neglect for years that produced cracked sidewalks and haphazard road systems and alienated neighborhoods. These projects will lead to new transportation and housing opportunities and less reliance on automobile-centric options.

Table 5.29: Activities to create transit oriented and sustainable neighborhoods

Example Activities	Time Frame (long/medium-term)	Lead Agency	Supporting Agencies	Status
Implement Strategic Transportation Plan for Transit Oriented Development	Long-term	DPW	CPD and RTD	In progress
Improve connectivity in Globeville Elyria-Swansea neighborhoods and add pedestrian bridges, in tandem with I-70 Reconstruction	Long-term	DPW	CPD, CDOT, NDCC and DEH	In progress
Update the Denver Comprehensive Plan and Blueprint Denver	Long-term	CPD	PW	Not started
Implement the Transit Oriented Development Strategic Plan	Long-term	CPD	PW	In progress
Continue to improve social connectivity in communities through programs such as the Sustainable Neighborhoods Program	Medium-term	OED	OEM	In progress

¹⁰ Read more: I-70 remake at heart of plan to revive Denver’s Swansea neighborhood - The Denver Post –http://www.denverpost.com/news/ci_24737851/i-70-remake-at-heart-plan-revive-denvers#ixzz2ohn2HpNo

Strategy 2: Increase alternative transportation options

Denver’s Strategic Transportation Plan (*STP*) advocates transportation choices that move people rather than simply automobiles. The *STP* offers transportation options to link land use with transportation, limit roadway footprints, and offers transportation choices that improve the health and well-being of Denver’s residents.

Transportation choices include electric vehicles (*EV*) which are a form of low-carbon transportation, and Denver has started to install charging stations in the City to support their use. Supporting an *EV* agenda is not only good for public health and the environment, it also helps create a demand for jobs within Denver’s growing clean technology industry. An increased use in low-carbon EVs would reduce ground level ozone levels and forms of air pollution in Denver, particularly in areas immediately adjoining highways increasing resilience to anticipated climate impacts. Denver is working to reduce barriers for the EV-traveling public, from permitting to parking. Ten free electric vehicle charging stations are now open to the public at Denver International Airport’s east and west parking garages. Ten charging stations are also located in downtown Denver and Cherry Creek. The Denver Performing Arts Center (Level 4), the Art Museum Cultural Facilities Garage (Level 3), and at the Denver Museum of Nature and Science all have EV charging stations as well. Additionally, in order to advance infrastructure Executive Order 123 requires all new City-owned parking lots and garages over 100 spaces available for use by the public to have at least one parking space equipped exclusively for EVs.¹¹

Table 5.30: Activities to increase alternative transportation options

Example Activities	Time Frame (long/medium-term)	Lead Agency	Supporting Agencies	Status
Strategic Transportation Plan (STP): Promote and encourage multi-modal transportation and maintain current transit infrastructure (Built environment’s ability to withstand multiple climate scenarios, air quality)	Medium-to long-term	DPW	CPD and OED	In progress
Promote and install electric vehicle charging stations within the county and expand XO123-chptr 4 (EV parking lot standard) into a City ordinance	Medium-to long-term	DPW	DEH and DIA	In progress

5.5.2 Goal 2: Prepare and enable urban infrastructure to adapt to climate impacts

Existing built urban infrastructure, such as road networks and walking pathways, were not designed for projected climatic conditions. Built infrastructure must be maintained and adapted for climate change and contribute to mitigating impacts where possible. Strategies are outlined below to both prepare infrastructure for climate change and reduce the impacts of the urban heat island effect on Denver residents.

Strategy 1: Integrate pavement options and alternatives that reduce the urban heat island effect

The albedo effect is a strong contributor to factors influencing the Earth’s temperature. Albedo is a measure of how much sunlight is reflected by a material. For example, forest leaves have a low albedo, meaning that they reflect a limited amount of incoming sunlight back into the atmosphere and absorb the rest where the light may be converted to heat. Alternatively, snow has a high albedo reflecting about 80 percent of the incoming sunlight back into the sky as visible light.⁹⁷ Building materials having high albedo can be effective in combating urban heat island effect.

¹¹ Read more: Denver Airport opens 10 free electric vehicle charging stations - The Denver Post –http://www.denverpost.com/breakingnews/ci_24452679/denver-airport-opens-10-free-electric-vehicle-charging#ixzz2oiHefw7K

5.5.2 Goal 2: Prepare and enable urban infrastructure to adapt to climate impacts (Cont.)

Urban areas can be much warmer than nearby more pristine surroundings. The low albedo (reflectivity) of roofs and pavements can contribute to the higher urban temperatures. For example, asphalt roads can absorb 95 percent of sunlight whereas concrete may only absorb 50 percent of incoming sunlight. Installing reflective building materials can be an effective means of adapting to warmer summers in Denver.

Table 5.31: Activity to integrate pavement options and alternatives that reduce the urban heat island effect

Example Activities	Time Frame (long/medium-term)	Lead Agency	Supporting Agencies	Status
Install high-albedo hardscape when resurfacing roads, multi-use paths, and city parking lots, and identify life-cycle costs associated with concrete vs. asphalt	Medium-to long-term	DPW	DPR, CPD, OED, and DEH	In progress

Strategy 2: Integrate green infrastructure, pavement options, and alternatives that reduce stormwater runoff

It was noted earlier that extreme weather can exert demands on infrastructure particularly pertaining to stormwater runoff. Permeable paving is a range of sustainable materials and techniques for permeable pavements with a base and sub base that allow the movement of stormwater through the surface. In addition to reducing runoff, this effectively traps and removes suspended solids from the stormwater to improve water quality. In Denver the use of permeable pavement to reduce stormwater runoff is another opportunity for climate adaptation. In addition, landscaping can be designed to encourage retention of stormwater on properties and tree lawns, effectively reducing runoff and removing suspended solids from stormwater.

Table 5.32: Activities to integrate green infrastructure, pavement options, and alternatives that reduce stormwater runoff

Example Activities	Time Frame (long/medium-term)	Lead Agency	Supporting Agencies	Status
Integrate green infrastructure for retaining stormwater during development stage	Long-term	DPW		In progress
Require permeable pavement for a portion of parking lots larger than one acre	Medium-term	DPW	CPD	Not started

Strategy 3: Integrate climate change into planning and zoning considerations

Climate change is having an impact on planning and zoning considerations of new and existing projects. For example, in November 2013, the Boston Redevelopment Authority approved new planning and zoning initiatives in response to observed and expected effects of climate change.⁹⁸ The initiatives were developed to assess whether new development is accounting for higher average temperatures, more frequent and longer extreme heat events and droughts, more severe freezing rain and heavy rainfall events, and increased wind gusts as well as sea level rise. Additionally, the initiatives will require analysis of secondary weather event impacts on developments such as interruptions to utilities, communications systems, and transportation networks. The following adaptation activities will help Denver adapt to the impacts of climate change.

Table 5.33: Activities to integrate climate change into planning and zoning considerations

Example Activities	Time Frame (long/medium-term)	Lead Agency	Supporting Agencies	Status
Conduct climate preparedness survey of major City employers and business owners to identify planning opportunities	Medium-term	OOS	DEH and OED	Not started

5.6 Food and Agriculture sector

Climate change will affect the types of plants that are adapted to survive in Denver’s climate, affecting the robustness of local agriculture. The following strategies are designed to cover the range of techniques and activities that can adapt Denver’s food and agricultural systems to changing conditions. The City of Denver has identified the following vulnerabilities as priorities, as summarized below.

Table 5.34: Food and Agriculture Sector Priority Vulnerabilities

Priority Vulnerability Identified by Denver	Affected Departments	Affected Community Organizations
Reduced amount of water available for irrigation and changes to ditch water supplies	Parks and Recreation	Denver Urban Gardens
Increased threat of pests, invasive species and noxious weeds	Parks and Recreation	Denver Urban Gardens

To adapt to these climate changes, Denver has identified the following key goals for the Food and Agriculture sector:

- » Increase food security
- » Protect local agricultural resources against increased threat of pests, invasive species and noxious weeds

A set of strategies were identified in order to achieve each goal, as summarized in [Table 5.35](#) and described below. A set of medium-term and long-term activities were then identified to support each strategy.

Table 5.35: Summary of goals and strategies for increasing resilience in the Food and Agriculture Sector

Goal 1

- » *Increase food security*
- » **Strategy 1:** Encourage local agriculture

Goal 2

- » *Protect local agricultural resources against increased threat of pests, invasive species and noxious weeds*
- » **Strategy 1:** Identify, assess and communicate invasive species and other threats to local natural resources

5.6.1 Goal 1: Increase food security

Food security means having access at all times to enough food for an active, healthy life. Researchers and government organizations use the term “food insecurity” to describe this condition. In 2011, Denver’s food insecurity rate was 18 percent for the overall population, while 25 percent of children in Denver lived in food insecure families.⁹⁹ In the case of extreme weather events and prolonged droughts, access to adequate food will become critical. Having a robust local food system allows continuous access to food supply when transportation from distant places may be disrupted, ensuring Denver families have continuous food security.

Strategy 1: Encourage local agriculture

Locally grown food can offer many advantages to the consumer. The average distance local food travels from farm to table is far less than the average distance industrial agricultural foods travel to reach a grocery store. This reduction in miles traveled greatly reduces transportation related carbon dioxide emissions, air pollution, and ground level ozone formation. In addition, as mentioned above, local food options can increase Denver’s food security ensuring residents have access to food during any climate related disruptions that may occur during transportation of food over long distances. Purchasing locally grown food also supports local farms and keeps those farms near Denver now and in the future, boosting Denver’s economy. Therefore, encouraging local agriculture will increase Denver’s resiliency to climate related food supply disruptions while at the same time support our local economy.

Table 5.36: Activities to encourage local agriculture

Example Activities	Time Frame (long/medium-term)	Lead Agency	Supporting Agencies	Status
Encourage a broad range of food outlets and regional food hubs for processing and distribution of local food	Medium-term	To Be Determined	DEH, and Denver Sustainable Food Policy Council (Mayor-appointed commission)	In progress

5.6.2 Goal 2: Protect local agricultural resources against increased threat of pests, invasive species and noxious weeds

Climate change may introduce new pests, diseases, and invasive species into Denver’s climate, or exacerbate problems with existing species. A number of activities are proposed to help understand and respond to these threats.

Strategy 1: Identify, assess, and communicate invasive species and other threats to local natural resources

Invasive species are plants, animals, or other organisms that are introduced to a given area outside their original range and cause harm in their new home. Typically they have no natural enemies to limit their reproduction and they usually spread rampantly. Invasive species are recognized as one of the leading threats to biodiversity and impose large costs to agriculture, forestry, fisheries, and other human enterprises, as well as to human health.

Table 5.37: Activities to identify, assess, and communicate invasive species and other threats to local natural resources

Example Activities	Time Frame (long/medium-term)	Lead Agency	Supporting Agencies	Status
Partner with Colorado State University Extension to support education and outreach programs on integrated pest management and other sustainable farming techniques for local agriculture	Medium-term	DPR	DEH and NDCC	Not started
Support a public outreach campaign integrating social media to help Denver residents identify, tag (via crowd-sourcing) and assist the City in managing key invasive species populations	Medium-term	DPR	DEH	In progress

CHAPTER 6: NEXT STEPS

Earlier chapters of this plan presented practical activities Denver agencies, businesses, and residents can implement to prepare for and adjust to what will likely be a warmer and drier Denver. This chapter contains several components, including:

1. Discussion of the overall approach for implementing adaptation activities.
2. Discussion of the future consolidation of this adaptation plan with Denver’s greenhouse gas mitigation plan.
3. Climate adaptation planning and implementation will be iterative. Climate conditions are expected to be more dynamic and changeable, and our understanding is incomplete. We fully expect that this plan will need to be updated and modified as conditions change and our understanding of best practices changes. In fact, our adaptation planning activities revealed a number of areas where additional effort will be necessary. A high level overview of those areas is included here.

6.1 Implementation

This plan identifies early steps in what will likely be a long-term effort to adapt to changing climate conditions in Denver. It has been said, “to plan is human, to implement is divine.” Accordingly, to have meaningful impact on adapting to a changing climate many of the activities identified within this plan will need to be implemented. Already, as identified in [Chapter 4](#), Denver agencies have embedded adaptation activities that can and are being implemented in the next couple of years into the Environmental Management System (*EMS*).

To ensure that selected medium and long-term adaptation activities are implemented, *DEH* will convene staff from other Denver agencies in early 2015 to identify those additional adaptation strategies the staff believes can be implemented. The identification process will begin by reviewing and updating, if necessary, the list of climate-related vulnerabilities faced by Denver agencies and residents. The adaptation activities identified in [Chapter 5](#) and [Appendix C](#) of this plan will be reviewed and updated as needed. Medium or long-term adaptation activities selected by Denver agencies will be embedded in the Denver *EMS* and subsequently monitored for successful implementation.

Denver’s Climate Resilience Committee meets on a regular basis with the purpose of preparing Denver for a rapidly-changing climate. A description of the Climate Resilience Committee is found in Memorandum 123-G attached to Executive Order 123.¹⁰⁰ Memorandum 123-G notes that this plan will be integrated into individual Agency Strategic Plans, Peak Performance Reviews and Capital Improvement Plans.

Staff in various Denver agencies will plan future activities using strategic planning, Peak Performance Reviews and Capital Improvement Plans. Strategic planning is used to set priorities, focus energy and resources, strengthen operations, ensure that employees and other stakeholders are working toward common goals, and assess and

6.1 Implementation (Cont.)

adjust the organization's direction in response to a changing environment.¹⁰¹ Peak Performance invests in Denver's employees by giving them the tools to solve city problems. Through the Peak Performance initiative, City employees have identified inefficiencies and embraced a new culture of innovation and improvement to eliminate inadequacies and provide the best service possible.¹⁰² Performance reviews begin with meaningful strategic plans that depict and measure the ways agencies support city-wide priorities.¹⁰³ Capital Improvement Plans typically identify a capital improvement project which can be any improvement to, construction or acquisition of buildings, viaducts, roads, streets, streetscape projects, pedestrian malls, plazas, designated parks or other real property of a permanent nature.¹⁰⁴

Starting in early 2015, *DEH* and Denver's Climate Resilience Committee will meet to identify ongoing strategic planning efforts through which strategic plans are being created or updated. The Committee will make recommendations as to how adaptation activities can be incorporated into the subject strategic plan. The Committee will also recommend on-going processes to ensure that adaptation planning and implementation can be regularly incorporated within other planning efforts. Peak Performance reviews will be suggested with the intent of finding improvements in agency plans. Similarly, the Committee will poll committee members regarding capital improvement projects under consideration. The capital improvement project will be evaluated to identify where adaptation practices can be incorporated into the project to guard against future extreme storms or heat.

6.2 Consolidation

Reducing greenhouse gas emissions has been a fixture in Denver since before 2007. Denver has also adopted 2020 sustainability goals related to climate change that include a reduction of total community-wide CO₂ emissions from Denver to below the level of emissions in 1990, (i.e. less than 11.8 million metric tons of CO₂). Denver's 2007 Climate Action Plan details strategies and activities to achieve this goal. Because CO₂ reduction strategies (mitigation) often include an adaptation component it makes sense to include mitigation and adaptation in one plan. Accordingly, *DEH* plans to combine the Climate Action Plan (GHG mitigation) with this Climate Adaptation Plan in late 2014 or 2015.

6.3 Areas for Additional Analysis

6.3.1 Climate Projections and Vulnerabilities

The range of climate projections is large, and contains a great deal of uncertainty, especially at a regional or local level. The science is expected to continually change and improve, although it may be many years before uncertainties are narrowed significantly. This plan is based upon broad characterizations of current knowledge in order to move the City forward rather than wait for more certainty. Subsequent iterations of this plan will require review of up-to-date climate understanding. Similarly, the vulnerability analysis of this plan focused, for the most part, on built infrastructure and natural ecosystems within Denver, and modifications of the City's current abilities to respond to these systems. Less attention is paid to economic vulnerabilities, disparities for different social groups in the community, and the ability of community institutions and regional partners to cooperate and coordinate in response to vulnerabilities. Subsequent iterations of the plan will incorporate additional focus in these areas.

6.3.2 Planning Scale and Integration

This plan focuses on actions that the City and County can take to adapt to a changing climate, within a relatively short timeframe. Long-term climate adaptation will require cooperation and planning at multiple scales: regionally across political jurisdictions; with a broad variety of stakeholders in the larger community; among federal, state, and local agencies; and within ecosystem sheds, such as watersheds or foodsheds. In addition, future planning will need to more fully address integration across existing silos, and address interdependencies between systems. For example, water, wastewater, and stormwater system planning will need better integration, as will water planning with land use and building codes. Planning that encompasses a longer time horizon than used in this document will also be necessary.

6.3.3 Adaptive Management

This plan focuses on “no and low-regrets” responses, which generally are shorter-term, have co-benefits such as greenhouse gas reductions, smart-growth principles, and align with overall City development plans. Further investigation is needed in this arena, to help Denver’s adaptation planning assist in positioning Denver for economic and social benefit. At the same time, additional focus will be needed to address long-term needs that do not result in economic or social advantage, such as disaster relief or the need to limit development in vulnerable areas.

6.3.4 Metrics and Accountability

Throughout this planning process, we have struggled to find a balance between creating measurable actions that can be implemented, and anticipating long-term needs that are subject to a great deal of uncertainty. We have chosen to focus on shorter term actions and outcomes, which can be incorporated within the City’s Environmental Management System to assure accountability. As we move forward, additional attention will be needed to establish clear metrics by which to measure success, assign responsibility and timelines for those actions and metrics, and provide a scorecard by which to communicate progress and areas for improvement.

6.3.5 Community Engagement

Any plan is strengthened by robust community involvement in order to reflect the larger community’s vision for Denver’s future, to make sure that community disparities are effectively addressed by planning efforts, priorities align with that vision, and barriers to achieving that vision are identified and addressed. In addition, building social resilience within Denver’s communities will be extremely important to the success of our adaptation efforts. Finding ways to work with many different communities to identify their wants and needs, to leverage others’ engagement efforts, and to utilize and build upon existing community assets to strengthen neighborhood capacity will be important.



Appendix A: Glossary¹²

100-Year Flood Levels: Severe flood levels with a 1-in-100 likelihood of occurring in any given year.

Adaptation: Adjustment or preparation of natural or human systems to a new or changing environment which moderates harm or exploits beneficial opportunities.

Adaptive Capacity: The ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences.

Carbon Dioxide: A naturally occurring gas, and also a by-product of burning fossil fuels and biomass, as well as land-use changes and other industrial processes. It is the principal human caused greenhouse gas that affects the Earth's radiative balance. It is the reference gas against which other greenhouse gases are measured and therefore has a Global Warming Potential of 1.

Carbon Dioxide Equivalent: A metric measure used to compare the emissions from various greenhouse gases based upon their global warming potential (GWP). Carbon dioxide equivalents are commonly expressed as "million metric tons of carbon dioxide equivalents (MMTCO₂Eq)." The carbon dioxide equivalent for a gas is derived by multiplying the tons of the gas by the associated GWP.

$MMTCO_2Eq = (\text{million metric tons of a gas}) * (\text{GWP of the gas})$

Carbon Footprint: The total amount of greenhouse gases that are emitted into the atmosphere each year by a person, family, building, organization, or company. A person's carbon footprint includes greenhouse gas emissions from fuel that an individual burns directly, such as by heating a home or riding in a car. It also includes greenhouse gases that come from producing the goods or services that the individual uses, including emissions from power plants that make electricity, factories that make products, and landfills where trash gets sent.

Climate Change: Climate change refers to any significant change in the measures of climate lasting for an extended period of time. In other words, climate change includes major changes in temperature, precipitation, or wind patterns, among others, that occur over several decades or longer.

Climate: Climate in a narrow sense is usually defined as the "average weather," or more rigorously, as the statistical description in terms of the mean and variability of relevant quantities over a period of time ranging from months to thousands of years. The classical period is 3 decades, as defined by the World Meteorological Organization (WMO). These quantities are most often surface variables such as temperature, precipitation, and wind. Climate in a wider sense is the state, including a statistical description, of the climate system.

Emissions: The release of a substance (usually a gas when referring to the subject of climate change) into the atmosphere.

Energy Efficiency: Using less energy to provide the same service

ENERGY STAR: A U.S. Environmental Protection Agency voluntary program that helps businesses and individuals save money and protect our climate through superior energy efficiency.

Enhanced Greenhouse Effect: The concept that the natural greenhouse effect has been enhanced by increased atmospheric concentrations of greenhouse gases (such as CO₂ and methane) emitted as a result of human activities. These added greenhouse gases cause the earth to warm.

Fossil Fuel: A general term for organic materials formed from decayed plants and animals that have been converted to crude oil, coal, natural gas, or heavy oils by exposure to heat and pressure in the earth's crust over hundreds of millions of years.

Global Average Temperature: An estimate of Earth's mean surface air temperature averaged over the entire planet.

Global Warming: The recent and ongoing global average increase in temperature near the Earth's surface.

Greenhouse Effect: Trapping and build-up of heat in the atmosphere (troposphere) near the Earth's surface. Some of the heat flowing back toward space from the Earth's surface is absorbed by water vapor, carbon dioxide, ozone, and several other gases in the atmosphere and then reradiated back toward the Earth's surface. If the atmospheric concentrations of these greenhouse gases rise, the average temperature of the lower atmosphere will gradually increase.

Greenhouse Gas (GHG): Any gas that absorbs infrared radiation in the atmosphere. Greenhouse gases include, carbon dioxide, methane, nitrous oxide, ozone, chlorofluorocarbons, hydrochlorofluorocarbons, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride.

Industrial Revolution: A period of rapid industrial growth with far reaching social and economic consequences, beginning in England during the second half of the 18th century and spreading to Europe and later to other countries including the United States. The industrial revolution marks the beginning of a strong increase in combustion of fossil fuels and related emissions of carbon dioxide.

¹² All definitions retrieved from EPA Glossary of Climate Change Terms

Appendix A: Glossary (Cont.)

Intergovernmental Panel on Climate Change (IPCC): The IPCC was established jointly by the United Nations Environment Programme and the World Meteorological Organization in 1988. The purpose of the IPCC is to assess information in the scientific and technical literature related to all significant components of the issue of climate change. The IPCC draws upon hundreds of the world's expert scientists as authors and thousands as expert reviewers. Leading experts on climate change and environmental, social, and economic sciences from some 60 nations have helped the IPCC to prepare periodic assessments of the scientific underpinnings for understanding global climate change and its consequences. With its capacity for reporting on climate change, its consequences, and the viability of adaptation and mitigation measures, the IPCC is also looked to as the official advisory body to the world's governments on the state of the science of the climate change issue. For example, the IPCC organized the development of internationally accepted methods for conducting national greenhouse gas emission inventories.

Methane (CH₄): A hydrocarbon that is a greenhouse gas with a global warming potential most recently estimated at 25 times that of carbon dioxide (CO₂). Methane is produced through anaerobic (without oxygen) decomposition of waste in landfills, animal digestion, decomposition of animal wastes, production and distribution of natural gas and petroleum, coal production, and incomplete fossil fuel combustion. The GWP is from the IPCC's Fourth Assessment Report (AR4).

Mitigation: A human intervention to reduce the human impact on the climate system; it includes strategies to reduce greenhouse gas sources and emissions and enhancing greenhouse gas sinks.

Natural Gas: Underground deposits of gases consisting of 50 to 90 percent methane (CH₄) and small amounts of heavier gaseous hydrocarbon compounds such as propane (C₃H₈) and butane (C₄H₁₀).

Ozone: Ozone, the triatomic form of oxygen (O₃), is a gaseous atmospheric constituent. In the troposphere, it is created by photochemical reactions involving gases resulting both from natural sources and from human activities (photochemical smog). In high concentrations, tropospheric ozone can be harmful to a wide range of living organisms. Tropospheric ozone acts as a greenhouse gas. In the stratosphere, ozone is created by the interaction between solar ultraviolet radiation and molecular oxygen (O₂). Stratospheric ozone plays a decisive role in the stratospheric radiative balance. Depletion of stratospheric ozone, due to chemical reactions that may be enhanced by climate change, results in an increased ground-level flux of ultraviolet (UV-) B radiation.

Peak Runoff: The maximum rate at which water is expected to be discharged from an area.

Renewable Energy: Energy resources that are naturally replenishing such as biomass, hydro, geothermal, solar, wind, ocean thermal, wave action, and tidal action.

Resilience: A capability to anticipate, prepare for, respond to, and recover from significant multi-hazard threats with minimum damage to social well-being, the economy, and the environment.

Sensitivity: The degree to which a system is affected, either adversely or beneficially, by climate variability or change. The effect may be direct (e.g., a change in crop yield in response to a change in the mean, range or variability of temperature) or indirect (e.g., damages caused by an increase in the frequency of coastal flooding due to sea level rise).

Snowpack: A seasonal accumulation of slow-melting snow.

Streamflow: The volume of water that moves over a designated point over a fixed period of time. It is often expressed as cubic feet per second (ft³/sec).

Urban Heat Island: An urban area characterized by temperatures higher than those of the surrounding non-urban area. As urban areas develop, buildings, roads, and other infrastructure replace open land and vegetation. These surfaces absorb more solar energy, which can create higher temperatures in urban areas.

Vector: An organism, typically a biting insect or tick, that transmits a disease or parasite from one animal or plant to another.

Vulnerability: The degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed; its sensitivity; and its adaptive capacity.

Weather: Atmospheric condition at any given time or place. It is measured in terms of such things as wind, temperature, humidity, atmospheric pressure, cloudiness, and precipitation. In most places, weather can change from hour-to-hour, day-to-day, and season-to-season. Climate in a narrow sense is usually defined as the "average weather", or more rigorously, as the statistical description in terms of the mean and variability of relevant quantities over a period of time ranging from months to thousands or millions of years. The classical period is 30 years, as defined by the World Meteorological Organization (WMO). These quantities are most often surface variables such as temperature, precipitation, and wind. Climate in a wider sense is the state, including a statistical description, of the climate system. A simple way of remembering the difference is that climate is what you expect (e.g. cold winters) and 'weather' is what you get (e.g. a blizzard).

Appendix B: Summary Table of Vulnerabilities

Climate Change Impact	DEPARTMENT OF PUBLIC WORKS	DEPARTMENT OF COMMUNITY PLANNING AND DEVELOPMENT	DEPARTMENT OF ENVIRONMENTAL HEALTH	DEPARTMENT OF GENERAL SERVICES	DEPARTMENT OF PARKS AND RECREATION	DEPARTMENT OF HUMAN SERVICES	OFFICE OF EMERGENCY MANAGEMENT	OFFICE OF ECONOMIC DEVELOPMENT	BUDGET AND MANAGEMENT OFFICE	DENVER WATER	DENVER INTERNATIONAL AIRPORT
Increase in temperature and urban heat island effect	Decrease in quality of living/ reduced comfort (Denver Citizens) Streetscape S4, AC2=V4	Extreme heat events affecting vulnerable populations S3, AC1=V4	Extreme heat events affecting vulnerable populations S3, AC1=V4	Higher energy demands and use in the summer S4, AC2=V4	Reduced amount of water available for irrigation, changes to ditch water supplies S4, AC2=V4	Extreme heat events affecting vulnerable populations S3, AC3=V2	Increase in vector-borne diseases S3, AC2=V3	Climate induced in-migration of businesses/people S3, AC2=V3	Increased need for funds for energy/utilities, maintenance, and capital improvements S3, AC2=V4	1) Increased risk of drought NR	2) Higher energy demands S2, AC3=V1
	Extreme heat events/ Paving materials exacerbating urban heat island effect. S3, AC3=V2	Decrease in quality of living (Denver Citizens) S4, AC2=V4	Decrease in quality of living/ reduced comfort (Denver Citizens) S4, AC2=V4	Reduced occupant comfort in buildings/ impacts to productivity S4, AC2=V4	Decrease in quality of living/ reduced comfort (Denver Citizens) S4, AC2=V4	Higher energy rates affecting vulnerable populations S3, AC3=V2	Public health crises due to extreme heat events S3, AC3/4=V2	Impacts to industries reliant on water supplies S3, AC3=V2	City-wide aesthetic standards not compatible with climate change scenarios NR	2) Difficulty in meeting increasing water demand, especially plant watering requirement NR	3) Higher building/ infrastructure equipment costs S3, AC3=V2
	Higher fleet maintenance S3, AC3/4=V1/V2	Higher energy demands/ costs (Private property) S4, AC2=V4	Higher energy demands/ costs (Private property) S4, AC2=V4	Higher maintenance costs/ HVAC equipment failures AC1, S2=V3	Extreme heat events affecting vulnerable populations S3, AC1=V4	Higher water rates affecting vulnerable populations S3, AC3=V2	Lack of public access to shade or cooling centers S3, AC3/4=V2	Poor air quality and increased temperatures' impact on tourism industries S0, AC4=P0	Lack of climate change planning/ Design standards not addressing climate change scenarios NR	3) Watershed changes/ ecosystem changes NR	4) Damaged infrastructure such as pavement buckling S2, AC2=V2
	Degradation of roads S1, AC3=V1	Higher water demand/ costs (Private property) S2, AC3=V4	Higher water demand/ costs (Private property) S2, AC3=V4	Higher building equipment costs (HVAC, roofs, hardscape/ landscape) S2, AC1=V3	Stress on street trees and urban landscaping S3, AC1=V3/V4	Decrease in quality of living/ reduced comfort (Denver Citizens) S2, AC2=V2	Blackouts or brownouts in the summer S1, AC3=V1	Vulnerable outdoor workforce interruptions S0, A4=P0		Water infrastructure's ability to withstand multiple climate scenarios NR	6) Increased use of energy to cool aircrafts and increased use of pre-conditioned aircraft increasing electric costs S2, AC3=V1
	Impacts to outdoor workforce S3, AC4=V1	Regulatory barriers to the adoption of adaptation strategies S2, AC2=V2/V3	Diminished air quality and public health risks such as an increase in respiratory illnesses S2, AC2=V2	Higher costs for water S1, AC3=V1	Increased threat of pests, invasive species, and noxious weeds. S3, AC2=V3	Public health risks/ vector-borne diseases S2, AC2=V2	Private rail line derailment NR	Investors may require assessments of business-economic exposure to climate-related risks S0, A4=P0		Stresses to interstate water compacts NR	7) Challenging environmental regulations S3, AC2=V3

Appendix B: Summary Table of Vulnerabilities

Climate Change Impact	DEPARTMENT OF PUBLIC WORKS	DEPARTMENT OF COMMUNITY PLANNING AND DEVELOPMENT	DEPARTMENT OF ENVIRONMENTAL HEALTH	DEPARTMENT OF GENERAL SERVICES	DEPARTMENT OF PARKS AND RECREATION	DEPARTMENT OF HUMAN SERVICES	OFFICE OF EMERGENCY MANAGEMENT	OFFICE OF ECONOMIC DEVELOPMENT	BUDGET AND MANAGEMENT OFFICE	DENVER WATER	DENVER INTERNATIONAL AIRPORT
Increased level of infrastructure monitoring PO	Degradation of roads S1, AC3= V1	Difficulty meeting environmental regulations and compliance S2, AC2= V2	Lack of climate change planning/Design standards not addressing climate change scenarios NR	Warming of stream and lake systems affecting aquatic species S3, AC2= V3	Food insecurity and shortages PO	Lack of climate change planning/ Design standards not addressing climate change scenarios NR	Workforce development implications S2, AC2= V2	Reduced fresh water quality, higher concentration of pollutants NR	Flashpoint of aviation fuel exceeded on hot days S1, AC3 = V1		
City-wide aesthetic standards not compatible with climate change scenarios NR	City-wide aesthetic standards not compatible with climate change scenarios NR	Increase in pesticide use S2, AC2= V2		Changes in or reduced amount of recreation spent outdoors in the summer months/ increased pressure on recreation centers S3, AC3= V2	Impacts to agency outdoor workforce productivity NR		Low income tenants will need help paying for utilities in the summer S2, AC2= V2		Impacts to outdoor workforce S3, AC3= V2		
Lack of climate change planning/ Design standards not addressing climate change scenarios NR	Lack of climate change planning/ Design standards not addressing climate change scenarios NR	Migration of animal species interacting with human activities S1, AC3= V1		Increased cooling needs for visitors and inadequate cooling technology in buildings S3, AC3= V2	Lack of climate change planning/ Design standards not addressing climate change scenarios NR		Low-income housing may need to become more dense with different landscaping S2, AC2= V2		City-wide aesthetic standards not compatible with climate change scenarios NR		
		Public health risks/ Increase in vector-borne diseases S1, AC2= V1		Increased number of heat related emergency responses and/or overcrowding at cooler parks S3, AC3= V2			City-wide aesthetic standards not compatible with climate change scenarios NR		Lack of climate change planning/Design standards not addressing climate change scenarios NR		
		Loss or shifting of biodiversity PO		Impacts to agency outdoor workforce productivity S3, AC4= V1			Lack of climate change planning/ Design standards not addressing climate change scenarios NR				

Appendix B: Summary Table of Vulnerabilities

Climate Change Impact	DEPARTMENT OF PUBLIC WORKS	DEPARTMENT OF COMMUNITY PLANNING AND DEVELOPMENT	DEPARTMENT OF ENVIRONMENTAL HEALTH	DEPARTMENT OF GENERAL SERVICES	DEPARTMENT OF PARKS AND RECREATION	DEPARTMENT OF HUMAN SERVICES	OFFICE OF EMERGENCY MANAGEMENT	OFFICE OF ECONOMIC DEVELOPMENT	BUDGET AND MANAGEMENT OFFICE	DENVER WATER	DENVER INTERNATIONAL AIRPORT
			Water temperatures rising PO		Localized extinctions and loss (or shifting) of biodiversity PO						
			City-wide aesthetic standards not compatible with climate change scenarios NR		Increased use of chlorine in recreation center pools NR						
			Lack of climate change planning/ Design standards not addressing climate change scenarios NR		City-wide aesthetic standards not compatible with climate change scenarios NR						
					Lack of climate change planning/ Design standards not addressing climate change scenarios NR						
	Increase in extreme weather events	Increased stress on storm water management S3/4, AC2=V3/V4	Stormwater management and flood control S3/4, AC2=V3/V4	Higher microbial burden in surface water S3, AC2=V3	Damages to city facilities S1, AC1=V2	Park damages: debris generation S3, AC1=V3/V4	Long-term disruption in services delivery S3, AC1/2=V3/V4	Current buildings not built to earthquake code making them susceptible to extreme weather events. S3, AC1=V4	Loss of tourism dollars S0,AC4=P0	Unanticipated increase in emergency management funding S3,AC2=V3	Contaminant loading from increased flooding and heavy rain spells NR
	More frequent and intense localized storm events causing flooding NR	Interruptions to transportation S3, AC3=V2/V3	Diminished air quality due to wildfires in surrounding areas. S1, AC2=V1	Increased costs and availability of supplies needed by agencies S2, AC3=V1	Stress on landscape and trees S3, AC1=V3/V4	Increase in crisis response for vulnerable populations S2, AC3=V1	Ensuring health care services for people with chronic conditions during extreme weather events S2, AC1=V3	Low-income workers may need to find alternate modes of commuting in extreme weather NR	Impacts on self insured property S3,AC2=V3	4) Damaged infrastructure NR	4) Damaged infrastructure S2, AC2=V2

Appendix B: Summary Table of Vulnerabilities

Climate Change Impact	DEPARTMENT OF PUBLIC WORKS	DEPARTMENT OF COMMUNITY PLANNING AND DEVELOPMENT	DEPARTMENT OF ENVIRONMENTAL HEALTH	DEPARTMENT OF GENERAL SERVICES	DEPARTMENT OF PARKS AND RECREATION	DEPARTMENT OF HUMAN SERVICES	OFFICE OF EMERGENCY MANAGEMENT	OFFICE OF ECONOMIC DEVELOPMENT	BUDGET AND MANAGEMENT OFFICE	DENVER WATER	DENVER INTERNATIONAL AIRPORT
	Contaminant loading from increased flooding and heavy rain spells S3, AC1=V4	Built environment's lack of resiliency and ability to withstand multiple climate scenarios S2, AC2=V2	Increased costs and availability of supplies needed by agencies S2, AC3=V1	Higher heating costs S0, AC3 = PO	Increased stress on storm water management S3/4, AC2=V3/V4	Food insecurity and shortages PO	Damage and disruption of services due to increased flooding and heavy precipitation events S2, AC3=V1	Increased costs and availability of supplies needed by agencies S2, AC3=V1	Increased costs and availability of supplies needed by agencies S2, AC3=V1	Water infrastructure's ability to withstand multiple climate scenarios NR	9) Storm water management and flood control S3, AC2 = V3
	Stress or damage to physical infrastructure and public assets S3, AC2=V3	Climate refugees stress on community resources S2, AC2=V1/V2		Lack of generators at City facilities NR	Damage to riparian corridors S3, AC2=V3	Increased costs and availability of supplies needed by agencies S2, AC3=V1	Increased costs and availability of supplies needed by agencies S2, AC3=V1				Increase in high wind days: reduced amount of runways available S3, AC2 = V3
	Increased demands on staff to respond to damaged infrastructure S2/3, AC 2/3=V1/V2	Increased costs and availability of supplies needed by agencies S2, AC3=V1			Degradation or damage of historic structures, wooden structures, and green infrastructure S1, AC3=V1		Climate refugees stress on community resources and response capabilities. PO				Increased costs and availability of supplies needed by agencies NR
	Increased costs and availability of supplies needed by agencies S2, AC3=V1	Flood elevation height building codes may be inadequate. PO			Increased costs and availability of supplies needed by agencies S2, AC3=V1		Increase in emergency response / stress on staff PO				Interruptions to transportation NR
	Decrease in water quality due to low-water flow in discharge areas S3, AC2=V3		Decrease in water quality due to low-water flow in discharge areas. S3, AC2=V3		Decrease in water quality due to low-water flow in discharge areas. S3, AC2=V3			Changes in ski-related business S1, AC3 = V1	Increased need for funds to implement adaptation strategies S2, AC2=V2	Stresses to interstate water compacts NR	8) Changes in ski (or tourism) may lead to fewer travelers/ fewer flights S3, AC2 = V3
Reduced snowpack and earlier snowmelt					Increase in frequency, size, and duration of wildfires in mountain parks					Decrease in water quality due to low-water flow in discharge areas. NR	
					S3, AC2=V3 Reduced amount of recreation on rivers (fishing, rafting) S3, AC3=V2						

Appendix B: Summary Table of Vulnerabilities

Climate Change Impact	DEPARTMENT OF PUBLIC WORKS	DEPARTMENT OF COMMUNITY PLANNING AND DEVELOPMENT	DEPARTMENT OF ENVIRONMENTAL HEALTH	DEPARTMENT OF GENERAL SERVICES	DEPARTMENT OF PARKS AND RECREATION	DEPARTMENT OF HUMAN SERVICES	OFFICE OF EMERGENCY MANAGEMENT	OFFICE OF ECONOMIC DEVELOPMENT	BUDGET AND MANAGEMENT OFFICE	DENVER WATER	DENVER INTERNATIONAL AIRPORT
		Built environment's lack of resiliency and ability to withstand multiple climate scenarios S2, AC2= V2	Increased costs and availability of supplies needed by agencies S2, AC3= V1	Higher heating costs S0, AC3 = PO	Increased stress on storm water management S3/4, AC2= V3/V4	Food insecurity and shortages PO	Damage and disruption of services due to increased flooding and heavy precipitation events S2, AC3= V1	Increased costs and availability of supplies needed by agencies S2, AC3= V1	Increased costs and availability of supplies needed by agencies S2, AC3= V1	Water infrastructure's ability to withstand multiple climate scenarios NR	9) Storm water management and flood control S3, AC2 = V3
		Climate refugees stress on community resources S2, AC2= V1/V2		Lack of generators at City facilities NR	Damage to riparian corridors S3, AC2= V3	Increased costs and availability of supplies needed by agencies S2, AC3= V1	Increased costs and availability of supplies needed by agencies S2, AC3= V1				Increase in high wind days: reduced amount of runways available S3, AC2 = V3
		Increased costs and availability of supplies needed by agencies S2, AC3= V1			Degradation or damage of historic structures, wooden structures, and green infrastructure S1, AC3= V1		Climate refugees stress on community resources and response capabilities. PO				Increased costs and availability of supplies needed by agencies NR
		Flood elevation height building codes may be inadequate. PO			Increased costs and availability of supplies needed by agencies S2, AC3= V1		Increase in emergency response / stress on staff PO				Interruptions to transportation NR
			Decrease in water quality due to low-water flow in discharge areas. S3, AC2= V3		Decrease in water quality due to low-water flow in discharge areas. S3, AC2= V3			Changes in ski-related business S1, AC3 = V1	Increased need for funds to implement adaptation strategies S2, AC2= V2	Stresses to interstate water compacts NR	8) Changes in ski (or tourism) may lead to fewer travelers/ fewer flights S3, AC2 = V3
					Increase in frequency, size, and duration of wildfires in mountain parks S3, AC2= V3					Decrease in water quality due to low-water flow in discharge areas. NR	

Appendix C: Activities supporting Denver's adaptation strategies

This Appendix includes the activities for Denver's six priority sectors:

- » Buildings & Energy
- » Health & Human Services
- » Urban Natural Resources
- » Water Consumption
- » Land Use & Transportation
- » Food & Agriculture

BUILDINGS & ENERGY

Goal 1: Reduce vulnerability to building energy supply disruptions

Strategy 1: Energy efficiency

Energy Efficiency Activities	Lead Agency	Supporting Agencies	Status
Long-term			
Encourage green building standards in Office of Economic Development projects in coordination with Denver Water, Community Planning & Development, and Public Works	OED	CPD, DW, DPW	Not started
Explore zero-net energy building options as part of Sustainable Neighborhoods program	DEH	OED	Not started
Pilot net-zero building strategies in new City facility	DGS		Not started
Medium-term			
Continue to support energy efficiency/savings in private housing through the activities of the Denver Energy Challenge	DEH	Denver Water, CPD, DPW, OED	In progress
Explore commercial building energy benchmarking and disclosure options through the Natural Resources Defense Council and Institute for Market Transformation's City Energy Project	DEH	Denver Water, CPD, DPW, OED	In progress
Adopt 2015 International Energy Conservation Code	CPD/Development Services	DEH	Not Started
Continue CIP and FIT programs to secure dedicated funding for energy efficiency operations and maintenance projects in annual budgets and future bond issuances	DGS	BMO	In progress
Use energy performance contracting model to generate funds for capital improvements at City facilities.	DGS	BMO, DPW, CAO	In progress
Improve effectiveness of preventative maintenance programs and ensure continual commissioning and maximum efficiency of mechanical systems in City facilities	DGS		In progress
Increase market penetration of energy efficiency efforts into the commercial and private markets through technical assistance and outreach using Certifiably Green Denver and the Denver Energy Challenge	DEH	OED	Not Started
Reinvest utility rebates to City into Sustainability Fund to fund future energy efficiency projects in City facilities	DGS	BMO	In progress
Approve and implement City energy management plan	DGS	DEH, Mayor's Office, OOS	Not started
Complete energy efficiency outreach to the top twenty energy users in Denver, if known and not already being served by the utility	DEH	OED	Not Started
Complete energy audits and retro commissioning on City facilities	DGS	Mayor's Office	In progress
Expand energy conservation and sustainability training for employees through City University or similar programs	DGS	OHR	In progress

Appendix C: Activities supporting Denver's adaptation strategies (Cont.)

Energy Efficiency Activities	Lead Agency	Supporting Agencies	Status
Medium-term			
Partner with Xcel Energy to pilot LED technology in street lights	DPW	DGS	In Progress
Regularly inspect heat-sensitive data centers to ensure reliable performance	DGS	DPW	Not Started
Personal appliance pilot plug load reduction interventions in municipal buildings	DGS	Mayor's Office	In Progress

BUILDINGS & ENERGY

Goal 1: Reduce vulnerability to building energy supply disruptions
Strategy 2: Cooling Infrastructure

Activities	Lead Agency	Supporting Agencies	Status
Long-term			
Reduce urban heat island effect through infrastructure such as shade trees, urban gardens, green roofs, and lighter colored hardscapes	DPW	DPR	In Progress
Medium-term			
Create a contest for residents to win energy efficiency upgrades and cool roofs	DEH		Not Started
City facilities permanently commit to save energy by regulating thermostats all year long	DGS	Mayor's Office	In Progress
Examine species distribution of street trees with projected climate impacts to ensure existing trees can survive high temperatures and/or drought and provide shade	DPR		Not Started
Create a "tree bank" where projects can meet shade tree requirements by contributing funds for the installation of trees at other more suitable sites, as selected by the City	DPR		Not Started
Preserve and enhance cooling infrastructure for extreme events by increasing street tree planting and maintenance, and encouraging green roofs, green water quality infrastructure (wetlands, bioswales), and high albedo surfaces	DPR		Not Started
Create educational campaign to promote Energy Star qualified roofing products targeted at roofers, builders, and architects	DEH		Not Started
Develop non-vegetation shade structures	DPR		In progress

BUILDINGS & ENERGY

Goal 1: Reduce vulnerability to building energy supply disruptions
Strategy 3: Alternative and Distributed Generation

Activities	Lead Agency	Supporting Agencies	Status
Long-term			
Update solar site assessment of City facility rooftops and solicit proposals for eligible sitesgardens, green roofs, and lighter colored hardscapes	DGS		Not Started
Medium-term			
Identify opportunities for the City to become a subscriber in community solar gardens	DGS	CAO	In progress
Develop community-scale renewable and district energy pilot systems and remove existing regulatory barriers	DEH	CPD, OED	Not Started
Support state-wide incentives and regulatory support for efficient back-up power systems in case of blackouts (combined heat and power, solar with battery back-ups, etc.)	OEM		Not Started
Develop a fourth PV array at Denver International Airport (DIA Solar IV)	DIA		In progress

Appendix C: Activities supporting Denver's adaptation strategies (Cont.)

BUILDINGS & ENERGY			
Goal 2: Reduce vulnerability of buildings to extreme weather			
Strategy 1: Encourage construction of resilient buildings			
Activities	Lead Agency	Supporting Agencies	Status
Long-term			
Require integration of resilient building design elements in building codes or zoning for major retrofits on existing buildings and new construction	CPD/Development Services		Not started
Medium-term			
Revise asset management plans to consider climate impacts and make operational adjustments such as increased maintenance and monitoring and accelerated infrastructure refurbishment schedules	DGS		Not started
Implement financing program for resilient building measures for major retrofits on existing properties and new construction	DEH		Not started
Develop incentives or regulation to improve resiliency of buildings in areas facing increased risk of flood	CPD/Development Services	DPW	Not started
Create city-wide design review checklist for new construction requiring evaluation of building resilience measures	DEH	CPD	Not started
Publish a guide on steps that commercial and residential property owners can take to make their existing buildings more resilient to climate change	DEH	OED OEM	Not started

HEALTH AND HUMAN SERVICES			
Goal 1: Safeguard health of Denver residents in the context of climate impacts			
Strategy 1: Develop protocol for inter-agency coordination and public communication during extreme weather events			
Activity	Lead Agency	Supporting Agencies	Status
Long-term			
Utilize protocols developed during extreme heat planning to develop procedures for integrated emergency planning and communications for other extreme events such as storms, flash floods and wildfires	OEM		In progress
Medium-term			
Establish an extreme heat and air quality notification system for residents and businesses	OEM		Not started
Continue to Integrate electric and water utilities into extreme heat scenario planning to prepare for extreme heat events accompanied by blackouts or water restrictions	OEM		In progress

HEALTH AND HUMAN SERVICES			
Goal 1: Safeguard health of Denver residents in the context of climate impacts			
Strategy 2: Reduce health impacts of extreme weather events			
Activity	Lead Agency	Supporting Agencies	Status
Long-term			
Increase number of shelter spaces available to homeless and at-risk populations	DRH	OEM, DHS	In progress
Medium-term			
Understand how increases in temperature may affect recreational activities	DPR		Not started
Designate public cooling shelters for extreme heat events	DPR	OEM	In progress
Request a change to the zoning code section to allow faith-based shelters to operate up to 120 days per calendar year	DRH		In progress
Adopt a severe weather ordinance to allow shelters to expand number of persons served during extreme weather events		DEH, DHS, OEM	Not started

Appendix C: Activities supporting Denver's adaptation strategies (Cont.)

Medium-term			
Request a change to the zoning code to allow temporary shelters with fewer than 100 residents in any zone, so long as the shelter is located in a structure owned by a non-profit or government for up to 120 days per calendar year	DRH		Not started
Conduct surveillance on heat related illness by surveying emergency department visits	DEH		Not started
Coordinate heat-related resources, donations, and volunteers during extreme events or heat waves	OEM		Not started

HEALTH AND HUMAN SERVICES

Goal 1: Safeguard health of Denver residents in the context of climate impacts
Strategy 3: Reduce health vulnerabilities from vector-borne diseases

Activity	Lead Agency	Supporting Agencies	Status
Long-term			
Evaluate areas of stagnant water where mosquitoes can breed	DEH	DPW, DPR	In progress
Medium-term			
Work with partners to develop water VBZD surveillance system to improve prediction of epidemics and prevent incidents leading to epidemics	DEH	OEM	In progress
Evaluate and scale the VBZD control program as warranted	DEH	DPR	In progress

HEALTH AND HUMAN SERVICES

Goal 2: Preserve ability of health care providers to provide services during extreme heat events
Strategy 1: Develop utility and IT systems that are resilient to power outages

Activity	Lead Agency	Supporting Agencies	Status
Long-term			
Encourage back-up power for pharmacies	DEH	OEM	Not started
Explore programs for hospitals to install off-grid distributed alternative energy systems with islanding capabilities	DEH	OED, OEM	Not started
Medium-term			
Pilot an off-grid distributed energy system with islanding capabilities at one or more Denver medical facilities	DPH		Not started
Build in IT systems for patient records and information and create resilient and redundant telecommunications systems to maintain patient contact with doctors in the event of flooding or outages	Denver Health	OEM	Not started
Advise hospitals to evaluate whether critical infrastructure is at risk to flash flooding and identify risk mitigation solutions	DEH	OED, OEM, DPH	Not started
Explore incentives for hospitals to identify power needs for critical systems and obtain adequate back-up generation capacity	DEH	OED, OEM	Not started
Encourage combined heat and power systems for hospitals for increased off-the-grid functionality in emergencies	OED	OEM	Not started

URBAN NATURAL RESOURCES

Goal 1: Enhance existing urban forest resources and expand range
Strategy 1: Enhance standards and regulations to strengthen and protect urban forest resources

Activity	Lead Agency	Supporting Agencies	Status
Long-term			
Adopt a tree protection ordinance for trees over six inches in diameter to help saplings establish and encourage growth of urban forest resources	DPR		Not started

Appendix C: Activities supporting Denver's adaptation strategies (Cont.)

Long-term			
Activity	Lead Agency	Supporting Agencies	Status
Review city ordinance in regards to tree permitting, tree protection on construction sites, heritage or historic trees, incentives and alternatives, planting and irrigation standards, and landscape standards	DPR		Not started
Evaluate sustainable forestry certification programs as a potential mechanism to increase resilience of forest resources	DPR		Not started
Medium-term			
Draft a new landscape ordinance to accommodate plants that can tolerate city's projected future climate	DPR		Not started
Update the right of way tree list that focuses on trees that can thrive in future climates	DPR	DPW	In progress

URBAN NATURAL RESOURCES

Goal 1: Enhance existing urban forest resources and expand range
Strategy 2: Increase Denver's canopy coverage and maintain existing street resources

Activity	Lead Agency	Supporting Agencies	Status
Medium-term			
Implement/complete the Tree and Shade Master Plan	DPR	OOS, OEM	In progress
Achieve the City's tree canopy cover goal of 18% of land area	DPR		In progress
Replace trees planted in public property and public right of way	DPR		In progress
Continue to participate in Emerging Pests in Colorado Roundtable and the Denver Pest Roundtable to find best practices to reduce stress on urban landscapes	DPR	DEH, CPD, OEM	In progress
Continue to follow Colorado Dept. of Agriculture invasive species list to control damage to Denver's existing terrestrial ecosystems	DPR		In progress
Address tree canopy in upcoming community plans	CPD		Not started
Create a Canopy Keepers program in which people adopt trees and commit to watering new trees for two years	DPR		Not started
Initiate a contract to inventory existing trees within the city in preparation for the tree and shade master plan	DPR		Not started
Continue to educate the public on the benefits the urban forest provides to encourage protection of tree resources on private lands based on the Denver Urban Forest Assessment findings	DPR		

URBAN NATURAL RESOURCES

Goal 1: Enhance existing urban forest resources and expand range
Strategy 3: Expand fire mitigation & forest management programs

Activity	Lead Agency	Supporting Agencies	Status
Medium-term			
Expand wildfire mitigation program	DFD	DPR	Not started
Pursue/implement forest management technology	DPR		In progress
Analyze forest management techniques such as prescribed burning and removal of excess vegetation and/or dead fuels	DPR	DFD	Not started
Continue aggressive fire mitigation program in Mountain Parks	DPR	DFD, OEM	In progress
Implement applicable wildfire risk mitigation techniques such as prescribed/controlled burns on pilot forests	DPR	DFD	Not started
Collaborate with Fire Corps to develop community partnerships and recruit volunteers to assist with managing and reducing the fire risks in urban forests	DPR	DFD	Not started

Appendix C: Activities supporting Denver's adaptation strategies (Cont.)

URBAN NATURAL RESOURCES

Goal 2: Ensure all Denver lakes and rivers are fishable and swimmable
Strategy 1: Maintain and enhance health of Denver water bodies

Activity	Lead Agency	Supporting Agencies	Status
Long-term			
Partner with Denver Water to expand water way evaluation in Denver watersheds	DEH	DW	Not started
Medium-term			
Continue noxious weed abatement program	DPR	DEH	In progress
Managing ecosystem changes, planning for extreme events through Lake Management Protection Plan	DEH		In progress
Water conservation, cooling, managing ecosystem changes through RiverVision	DEH	DPR	In progress
Continue to implement the South Platte River Vision Implementation Plan, the Gulch Master Plan and Natural Area Management Plans	DPW/DPR	DEH, OED, NDCC	In progress
Increase the frequency of waterway monitoring for early identification of changes in river and lake health including turbidity, and contaminant loading	DEH		In progress

URBAN NATURAL RESOURCES

Goal 2: Ensure all Denver lakes and rivers are fishable and swimmable
Strategy 2: Improve and maintain surface water quality

Activity	Lead Agency	Supporting Agencies	Status
Long-term			
Partner with public/private sectors to implement the South Platte River Vision Implementation Plan to improve water quality and residents' river experience	DPR	DEH, OED, DPW, NDCC, CPD	In progress
Partner with Denver Water to expand water quality monitoring in Denver watersheds	DW	DEH	Not started
Lake aeration to minimize algal blooms	DEH		Not started
Medium-term			
Include climate adaptation and mitigation in discussion and documentation related to 6-year Water Quality Strategic Implementation Plan currently underway by DPW planning staff	DPW	DEH	In-progress
Further studies on the impacts of warmer lake water on algae growth and the possible increase in taste, odor and water quality issues for water treatment plants	DEH		Not started
Study/understand effects of warming surface water on animal and plant species	DEH		Not started
Prioritize and implement UDFCD gulch improvement projects, Re-gulch Master Plan and Natural Area Management Plans	DPW, DPR		In progress
Monitor beaver dams along water ways for effects on water flow	DEH		Not started
Develop a waste management plan for debris generated by storms	OEM	DEH, DPW	In progress

URBAN NATURAL RESOURCES

Goal 2: Ensure all Denver lakes and rivers are fishable and swimmable
Strategy 3: Improve water and wastewater infrastructure to reduce risk of overflows or spills

Appendix C: Activities supporting Denver's adaptation strategies (Cont.)

Activity	Lead Agency	Supporting Agencies	Status
Long-term			
Encourage removal and relocation of water supply and treatment infrastructure which is vulnerable or at high-risk to climate change impacts	DW		Not started
Medium-term			
Include a discussion section on climate adaptation and mitigation in the Storm Drainage Master Plan documentation update	DPW	CPD, DPR	In progress

WATER CONSUMPTION

Goal 1: Reduce per capita use of potable water

Strategy 1: Continue and expand water conservation planning and programs

Activities	Lead Agency	Supporting Agencies	Status
Long-term			
Continue to use a fee structure that incentivizes reduced wastewater use	DPW		Complete
Fully Implement DPR GamePlan: Green infrastructure, wise water management, water conservation plans	DPR	DPW, DW	In progress
Medium-term			
Continue to assess Denver Water's resilience to climate change using the latest local climate projections, coordinate and be aware of new City adaptation policies and adjust practices accordingly	DW	CPD, DPW	Not started
Intensify water management and conservation through funding research and incentives	DW	DPR	Not started
Complete construction of Phase II of the Central Control Master Plan	DPR	DW	In progress

WATER CONSUMPTION

Goal 1: Reduce per capita use of potable water

Strategy 2: Encourage the use of water conserving technologies and products in buildings

Activity	Lead Agency	Supporting Agencies	Status
Long-term			
Include reporting on water use in a building energy disclosure benchmark to track and monitor water use in major commercial properties around Denver	DEH	DW	Not started
Medium-term			
Encourage the use of water conservation technologies, such as waterless urinals and cisterns, through the development of local guidelines that are consistent with the building code	DW	OED, CPD	In progress
Continue to create a more sustainable built environment in City facilities and the Denver metropolitan area. By using ENERGY STAR Portfolio Manager as a benchmarking tool, the Watts To Water partners help properties reduce their energy and water consumption rates by offering program participants free educational sessions, technical support and rebate programs	DEH	DGS, OOS	In progress

Appendix C: Activities supporting Denver's adaptation strategies (Cont.)

Activities	Lead Agency	Supporting Agencies	Status
Medium-term			
Continue to engage business community on water conservation through Certifiably Green Denver program	DEH	DW	In progress
Expand/offer rebates and market incentives for residential, commercial, industrial and institutional customers by offering free water saving devices, rebates for high-efficiency toilets, and grants for projects that demonstrate water-saving principles	DW		In progress
Collaborate with Denver Water to pilot a neighbor-to-neighbor comparison of water use on utility bills to encourage conservation behavior in residences	DEH	DW, DPW, CPD	Not started
Develop high water efficiency product standards for fixtures installed in new developments exceeding a certain size threshold	DW	CPD, DPW, DEH	Not started
Develop a leak notification program to inform customers whenever a spike in consumption meets requirements for a potential leak	DW		Not started
Install Automated Meter Reading (AMR) devices to allow consumers to track water usage and identify wasteful or costly consumption patterns	DW	DPW	Not started

WATER CONSUMPTION

Goal 1: Reduce per capita use of potable water

Strategy 3: Expand use of water-conserving irrigation techniques

Activity	Lead Agency	Supporting Agencies	Status
Medium-term			
Continue to increase the efficiency of park irrigation systems, including conversions to recycled water where feasible	DPR	DW	In progress
Retrofit three City parks with smart irrigation controllers and upgraded distribution systems	DPR	DW	In progress
Review which gulches are most affected by fluctuations in volume, their impact to the city and develop strategies to reduce flooding or shortages during weather events	DPR		In progress
Install rain sensors on existing irrigation systems	DPR	DW	In progress
Explore purple pipe irrigation for eligible park land	DPR	DW	In progress

WATER CONSUMPTION

Goal 1: Reduce per capita use of potable water

Strategy 4: Expand use of water-conserving landscaping techniques

Activity	Lead Agency	Supporting Agencies	Status
Medium-term			
Implement xeriscape landscape rebates for yards for residential and commercial properties	DW	DPR	In progress
Conserve soil moisture by mulching	DPR		In progress
Publish a new plant-growing list that focuses on plants that can thrive in altered climates	DPR		In progress
Continue the City's transition to low water use/drought resistant landscaping within medians, parks, and open space areas	DPR		In progress

Appendix C: Activities supporting Denver's adaptation strategies (Cont.)

Activity	Lead Agency	Supporting Agencies	Status
Medium-term			
Advocate for and implement xeric landscaping	CPD/DS	DPR, Mayor's Office	In progress
Installation of synthetic turf for ball fields	DPR		In progress
Address climate change in upcoming Golden Triangle Small Area Plan	CPD	DPW, DPR	In progress
Begin scoping process and update of streetscape standards to address climate adaptation	DPR		In progress
Require xeric planting or low-water use landscape plantings in the urban design standards and guidelines for Cherry Creek East	DPR	CPD, DPW	In progress

WATER CONSUMPTION

Goal 1: Reduce per capita use of potable water
Strategy 5: Expand recycled water infrastructure and use

Activity	Lead Agency	Supporting Agencies	Status
Long-term			
Continue to work with Denver Water to expand use of recycled water (purple pipe)	DPR	DW	In progress
Medium-term			
Expand the use of recycled water (purple pipe)	DW	DPW, DPR	In progress
Continue to partner with Denver Water on continuing recycled water tree species suitability trials	DPR	DW	In progress
Develop a Reclaimed Water Feasibility Study to inform decision makers of the current and possible future uses of reclaimed water	DW	DPR, DEH	Not started
Develop a gray water ordinance for Denver	Mayor's Office	DEH	Not started

LAND USE & TRANSPORTATION

Goal 1: Improve mobility within the City and its communities
Strategy 1: Create transit oriented and sustainable neighborhoods

Activity	Lead Agency	Supporting Agencies	Status
Long-term			
Implement Strategic Transportation Plan for Transit Oriented Development	DPW	CPD, RTD	In progress
Improve connectivity in Elyria-Swansea neighborhoods and add pedestrian bridges, in tandem with I-70 Reconstruction	DPW	CPD, CDOT, NDCC, DEH	In progress
Medium-term			
Promote transit-oriented and mixed-use development (encouraging location of high-density homes within walking/biking distance of public transit and essential services) through neighborhood and station area planning	CPD	OED	In progress
Community engagement and public forums to inform long-term, sustainable neighborhood planning	NDCC	DEH, DPW	In progress

LAND USE & TRANSPORTATION

Goal 1: Improve mobility within the City and its communities
Strategy 2: Increase alternative transportation options

Appendix C: Activities supporting Denver's adaptation strategies (Cont.)

Activity	Lead Agency	Supporting Agencies	Status
Long-term			
Strategic Transportation Plan (STP): Promote and encourage multi-modal transportation and maintain current transit infrastructure (built environment's ability to withstand multiple climate scenarios, air quality)	DPW	CPD, OED	In progress
Build out FasTracks	RTD	DPW	In progress
Develop and promote the entry of municipal and community car-sharing programs	DPW	DEH	In progress
Medium-term			
Implement Pedestrian Master Plan which shifts focus away from automobile-centric infrastructure planning	DPW		In progress
Require review of climate risks for new transportation or land use projects prior to project approval	DPW	BMO, CPD	Not started
Develop bike lanes on major transportation routes	DPW		In progress
Implement Strategic Parking Plans as it relates to adding bicycle parking to the zoning code	DPW		Not started
Promote and install electric vehicle charging stations within the county and expand XO123-chptr 4 (EV parking lot standard) into a City ordinance	DPW	DEH, DIA	In progress

LAND USE & TRANSPORTATION

Goal 2: Prepare and enable urban infrastructure to adapt to climate impacts

Strategy 1: Integrate pavement options and alternatives that reduce the urban heat island effect

Activity	Lead Agency	Supporting Agencies	Status
Long-term			
Annual Paving Plan: Paving options/and increasing use of reclaimed asphalt (built environment's ability to withstand multiple climate scenarios)	DPW	DIA	Not started
Strategic Parking Plan: Implement paving strategies which reduce urban heat island effect by using more green space and reflective pavements	DPW		Not started
Mandate high-albedo parking surfaces within designated city center area	DPW		Not started
Medium-term			
Install high-albedo hardscape when resurfacing roads, multi-use paths, and city parking lots, and identify life-cycle costs associated with concrete vs. asphalt	DPW	DPR, CPD, OED, DIA, DEH	Not started
Encourage private sector investment in reflective paving. This could include reduced permit fees, subsidized financing, tax breaks, etc.	CPD/Development Services	DPW	Not started
Investigate options for heat-resistant runway paving material	DIA		Not started

LAND USE & TRANSPORTATION

Goal 2: Prepare and enable urban infrastructure to adapt to climate impacts

Strategy 2: Integrate pavement options and alternatives that reduce stormwater runoff

Activity	Lead Agency	Supporting Agencies	Status
Long-term			
Increase cleaning regime for storm drains to ensure maximum capacity	DPW		Not started
Improve drainage in low-lying areas of transport system	DPW		Not started
Integrate green infrastructure for retaining stormwater	DPW		In progress

Appendix C: Activities supporting Denver's adaptation strategies (Cont.)

Medium-term			
Require permeable pavement for a portion of parking lots larger than one acre	DPW	CPD	Not started
Require large redeveloped projects to increase permeability by 15% compared to previous conditions	DPW	CPD	Not started
Initiate a business and public education program regarding storm water	DPW	OED, DEH	In progress
Identify areas at high risk for storm damage	OEM	DPW	Not started

LAND USE & TRANSPORTATION

Goal 2: Prepare and enable urban infrastructure to adapt to climate impacts
Strategy 3: Integrate climate change into planning and zoning considerations

Activity	Lead Agency	Supporting Agencies	Status
Long-term			
Implement Denver Zoning Code: Division 1.1 to balance conservation and development	CPD	OED	Not started
Explore options to request a climate preparedness survey to be completed as part of approval for new infrastructure projects	Development Services	CPD, BMO, DEH, OED	Not started
Medium-term			
Conduct climate preparedness survey of major City employers and business owners	OOS	DEH, OED	Not started
Review which economic sectors are at greatest risk to climate-induced workforce migration and identify which sectors could benefit	DEH	OED	Not started

FOOD & AGRICULTURE

Goal 1: Increase food security
Strategy 1: Encourage local agriculture

Activity	Lead Agency	Supporting Agencies	Status
Long-term			
Expand city-wide curbside compost collection with a goal of providing service to 100% of eligible residences.	DPW	DEH	In progress
Medium-term			
Strengthen regulations to protect the productive capacity of urban gardens	DEH	OED	Not started
Increase participation rate among Coloradans eligible for the Supplemental Nutrition Assistance Program (SNAP)	DEH		Not started
Create or identify financing resources for new community gardens and work to reduce tax barriers	OED/Development Services	CPD, DEH	Not started
Establish regional food hubs for processing and distribution of local food	DEH	OED, CPD	In progress
Identify vacant and underutilized lots for potential conversion to community gardens, urban food forests, urban orchards, outdoor agricultural educational facilities, etc.	Real Estate	OED	Not started
Create school gardens at select K-12 schools	DPS		In progress
Provide education and supplies to increase home gardening and backyard/front yard composting			Not started

Appendix C: Activities supporting Denver’s adaptation strategies (Cont.)

Medium-term			
Pilot a restaurant food composting program	DEH		Not started
Establish Denver FRESH (Food Retail Expansion to Support Health) to enhance internal city systems that accelerate healthy food retail development in underserved areas	DEH	OED, CPD	In progress
Establish Fresh Food Finance Fund to provide access to capital for developing supermarkets and grocery stores	DEH	OED, CPD	In progress
Expand compost pilot program	DPW	DEH	Not started
Review how food provision and delivery has been and could be affected by extreme weather events and prioritize action areas	DEH	OEM	Not started

FOOD & AGRICULTURE

Goal 2: Protect local agricultural resources against increased threat of pests, invasive species and noxious weeds

Strategy 1: Identify, assess, and communicate invasive species and other threats to local natural resources

Activity	Lead Agency	Supporting Agencies	Status
Medium-term			
Partner with Colorado State University Extension to host education and outreach programs on integrated pest management and other sustainable farming techniques for local agriculture	DPR	NDCC, DEH	Not started
Identify possible partners to support implementation of invasive species and pest management programs	DPR		Not started
Establish an inter-agency invasive species work group to identify problem species, assess risks, and prioritize high-priority infested areas for invasive species removal. This working would coordinate activities, map control efforts, and help educate the public on potential impacts and community actions that can help reduce risks from invasive species	DPR		Not started
Support a public outreach campaign integrating social media to help Denver residents identify, tag (via crowd-sourcing) and assist the City in managing key invasive species populations	DPR	DEH	In progress
Partner with Colorado State University Extension to host best practice sharing forum on pest management strategies with local farmers	DPR	NDCC	Not started

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