MEMORANDUM

To: Mayor and Council Members

CC: Marc A. Ott, City Manager; Michael McDonald, Deputy City Manager; Sue Edwards, Assistant City Manager; Robert Goode, Assistant City Manager; Anthony Snipes, Assistant City Manager; Rey Arellano, Assistant City Manager; Bert Lumbreras, Assistant City Manager; Ray Baray, Assistant to the City Manager; Larry Weis, Austin Energy General Manager; Greg Meszaros, Austin Water Director; Howard Lazarus, Public Works Department Director; Rob Spillar, Austin Transportation Department Director; Victoria Li, Watershed Protection Department Director; Jim Smith, Aviation Department Director; Mike Trimble, Capital Planning Officer; Rhoda Mae Kerr, Austin Fire Department Chief; Carlos Rivera, Health & Human Services Department Director; Otis Latin, Homeland Security and Emergency Management Director

From: Lucia Athens, Chief Sustainability Officer; Zach Baumer, Climate Program Manager

Date: May 12, 2014

Subject: **Report on Climate Resilience Resolution 20131121-060**

On November 21, 2013, City Council passed resolution 20131121-060 directing the City Manager to analyze climate change projections, determine how departmental planning efforts integrate future impacts of climate change, and identify a process for performing departmental vulnerability assessments. The resolution requested that the following be included in the scope of the assessment: transportation, electric utility, water utility, and drainage infrastructure; community health and wellness efforts; and disaster preparedness and emergency response management.

The Office of Sustainability has worked closely with department stakeholders to fulfill the resolution requirements. In addition, ATMOS Research, led by Dr. Katharine Hayhoe from Texas Tech University, was hired to conduct climate modeling through 2100. Dr. Hayhoe was a principal researcher in the National Climate Assessment report which was released this week and gained media attention. That report places Austin within the Great Plains region for data results. As a part of this effort, Dr. Hayhoe was able to do a more geographically specific data analysis for Austin using the Camp Mabry weather station. Staff used this information to identify potential future environmental, economic, and social impacts to operations, asset management, and long-term planning efforts. The attached report provides the details from this analysis, as well as recommendations for next steps.

We are planning to bring Dr. Hayhoe to Austin in the coming months to present her research results. We are available to answer any additional questions you may have.

Towards a Climate-Resilient Austin

Response to City Council Resolution 20131121-060

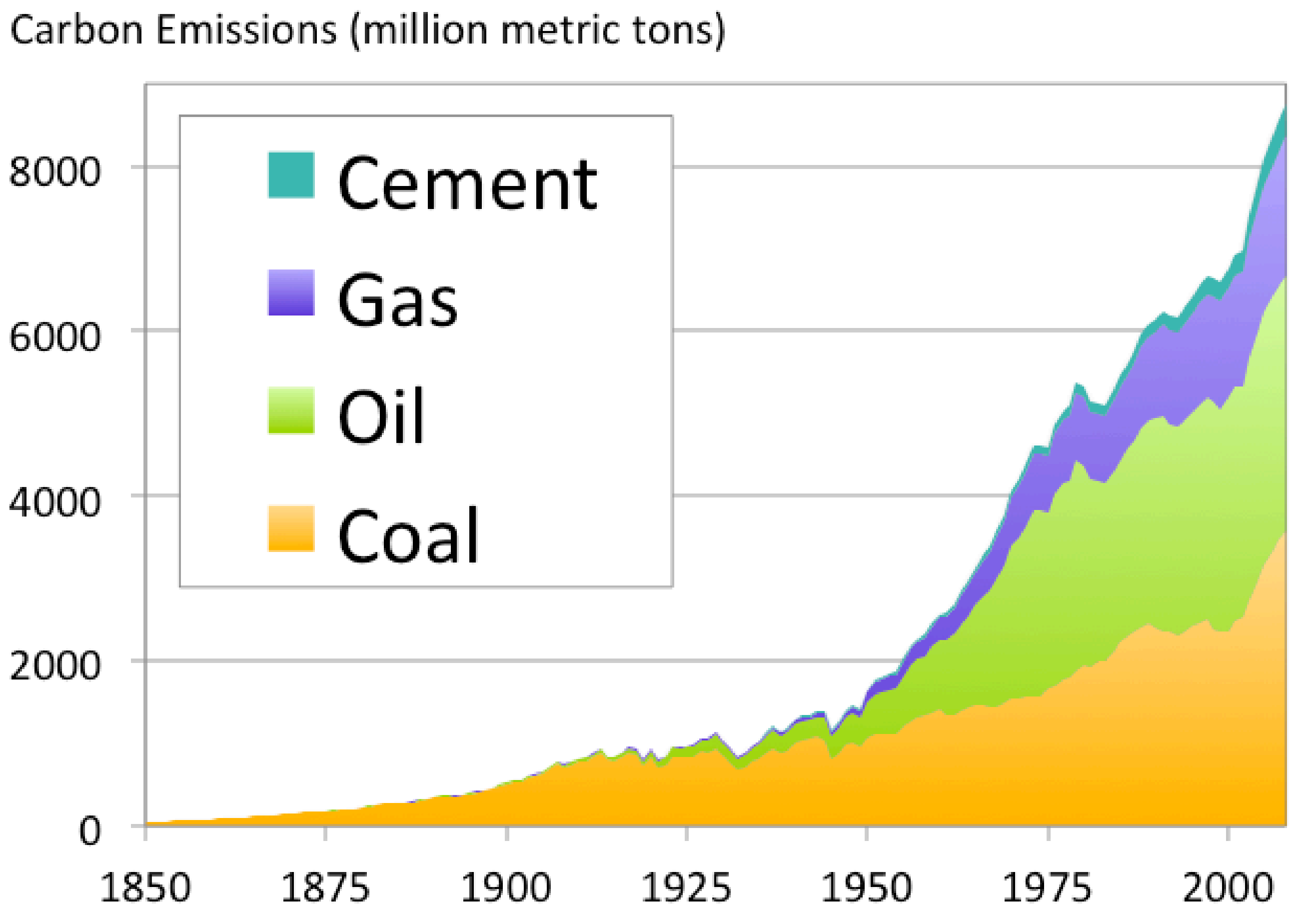
May 1, 2014

OFFICE OF SUSTAINABILITY
CITY OF AUSTIN

Topics to be covered

- Introduction and Resolution 20131121-060
- Climate Projections
- Impacts on our City
- Summary and Recommendations

Our activities produce heat-trapping gases



Source: K. Hayhoe for 2014 U.S. National Climate Assessment

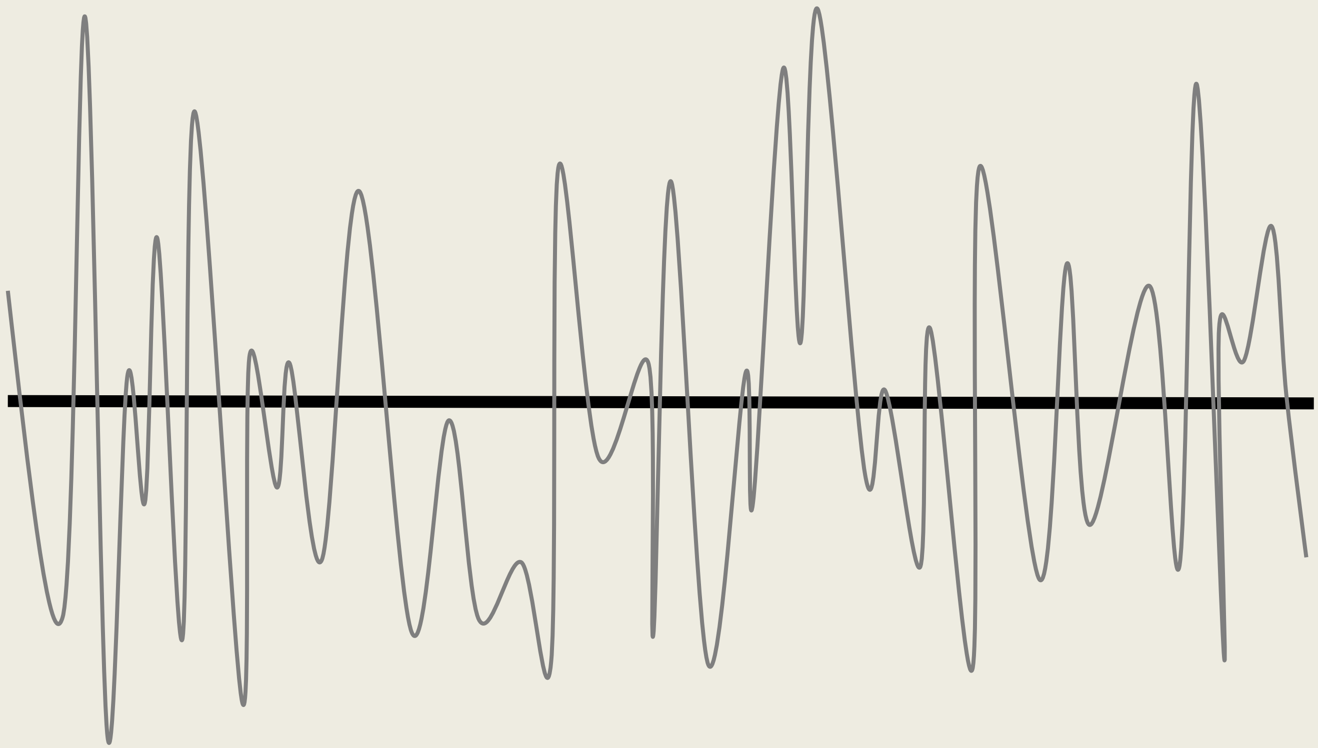
… that are building up in the atmosphere

THE NATURAL GREENHOUSE EFFECT

THE ARTIFICIAL HUMAN GREENHOUSE EFFECT

Why is this a problem?
Our civilization is built on a key assumption

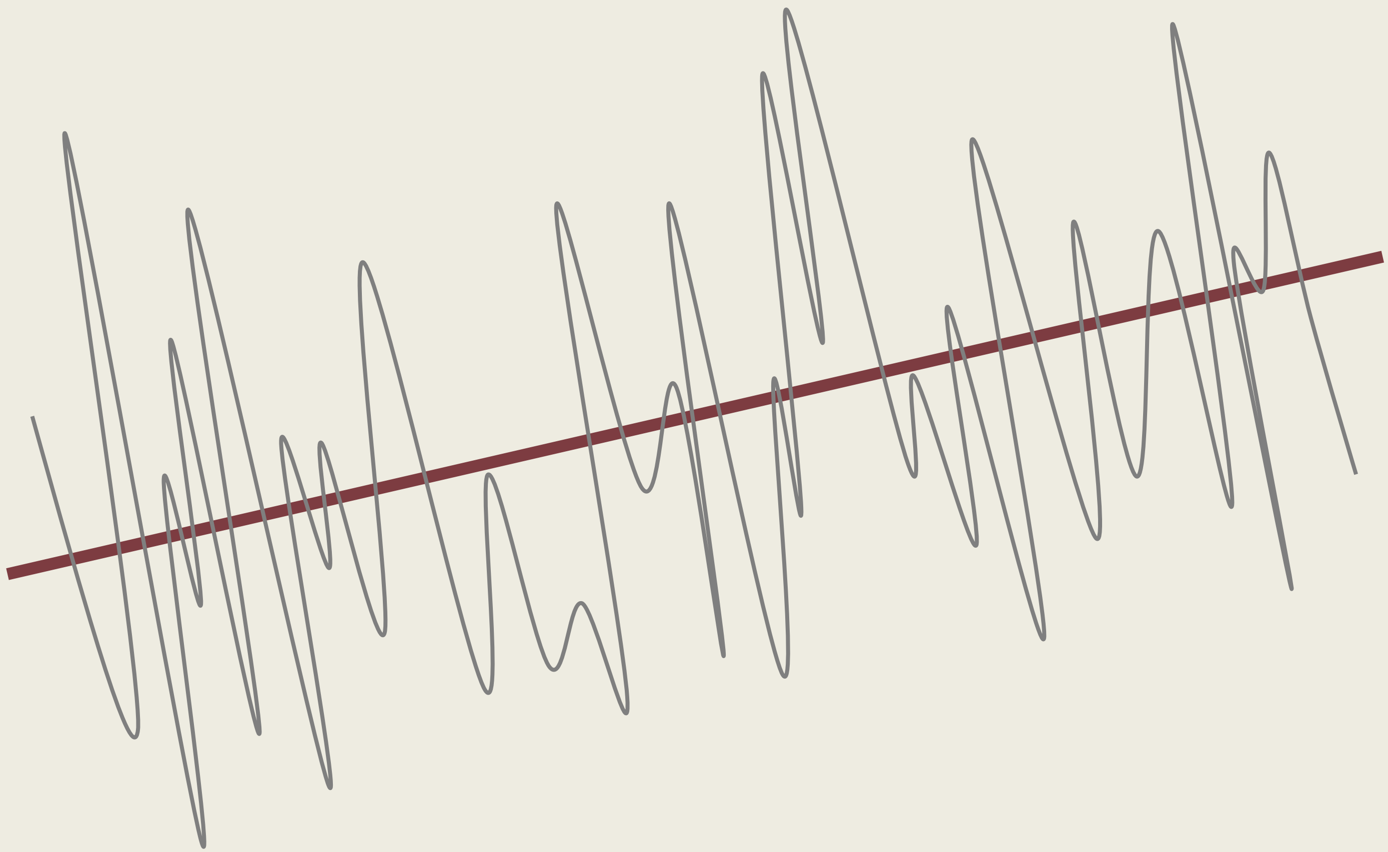
OFFICE OF SUSTAINABILITY
CITY OF AUSTIN



A STABLE CLIMATE

What happens if that climate isn't stable any more?

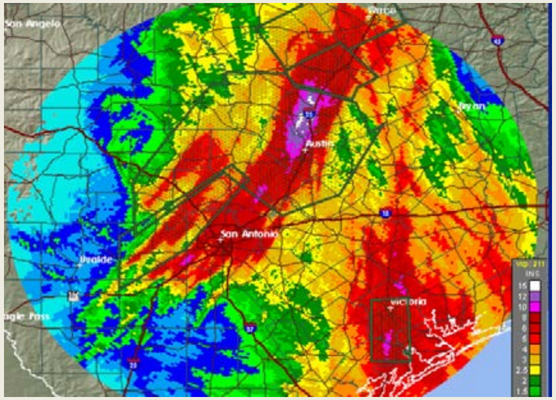
OFFICE OF SUSTAINABILITY
CITY OF AUSTIN



Extreme weather in Central Texas

Bastrop Wildfire, 2011

Lake Travis, 2013



Tropical Storm Hermine, 2010

Snow, 2011

Climate Change mitigation & resilience

Mitigation

- Actions that limit the magnitude and / or rate of climate change
  - Energy conservation
  - Renewable energy
  - Sustainable transportation
  - Reforestation
  - Methane capture and use

Resilience

- Actions taken to manage the unavoidable impacts of climate change
  - Infrastructure protection
  - Flood mitigation
  - Wildfire preparation
  - Emergency response
  - Business continuity plans

Benchmarking from leading cities

- **New York City – Heat, Sea level rise, and Storms**
  - Sea level rise is measurable, imminent, and extreme
  - Keeping residents cool and safe during the summer
  - Stormwater management and protection of infrastructure

- **Chicago: Heat, Stormwater, and Changing Hardiness Zones**
  - Strong correlation to co-benefits of mitigation
  - Keeping residents cool and safe during the summer
  - Focus on green urban design to mitigate multiple impacts

- **Flagstaff – Extreme Heat and Reduced Snowpack**
  - Vulnerability assessment across 115 areas of city operations
  - Focused on all key infrastructure areas
  - Detailed risk ranking of all stressors and infrastructure types

Climate resilience planning steps

OFFICE OF SUSTAINABILITY CITY OF AUSTIN

1. **Data Collection**
   a) **Climate projections**
   b) **Identify potential departmental impacts**
   c) **Determine next steps**

   Resolution 20131121-060

2. Vulnerability Assessment
   a) Identify Climate Thresholds
   b) Rank Vulnerable Assets
   c) Risk Analysis

3. Climate Resiliency Action Planning and Implementation
   a) Goals/Targets
   b) Develop action plan(s)
   c) Implement and Monitor

Climate Projections

Dr. Katharine Hayhoe
Texas Tech University
Atmos Research

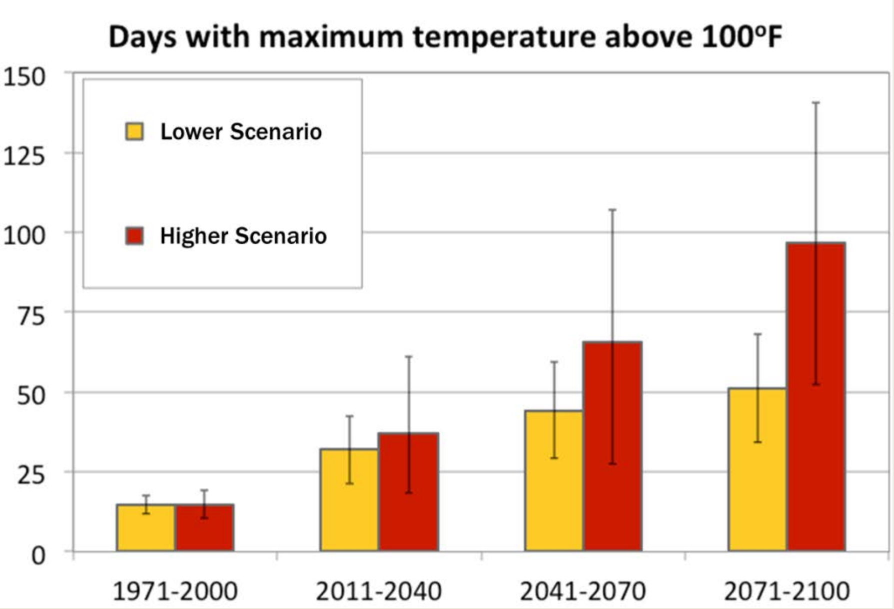
Lead Author of the
2014 National Climate Assessment

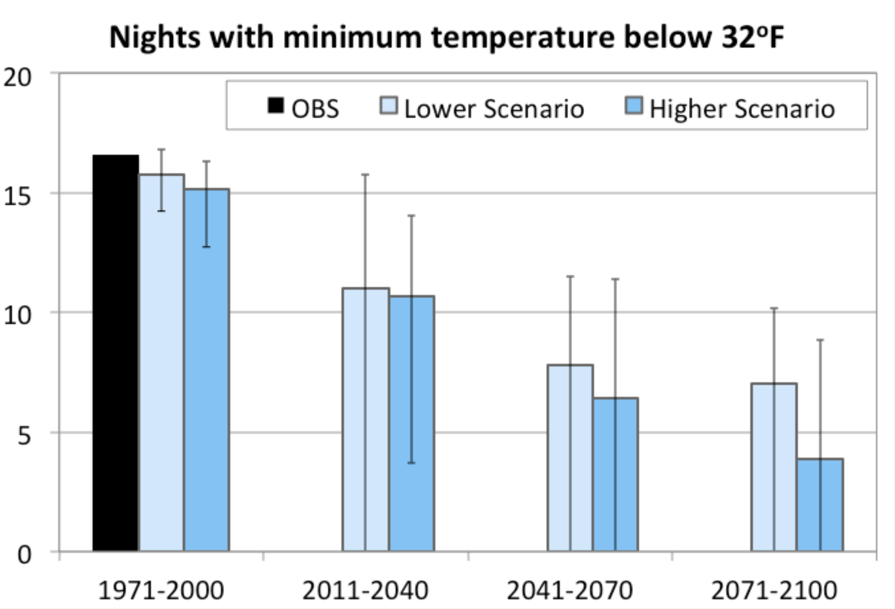
Austin specific climate data

- **Global Climate Models & the National Assessment return quality information, but too general for specific use**

- **Downscaled climate modeling for the Austin area**
  - Preliminary analysis
  - Latest generation of global climate model simulations
  - Camp Mabry weather station
  - Higher and lower emission scenarios
    - Lower Scenario = Intergovernmental Panel on Climate Change (IPCC) Representative Concentration Pathway 4.5 (RCP 4.5) scenario where global carbon emissions peak and decline by the end of the century
    - Higher Scenario = IPCC RCP 8.5 where continued dependence on fossil fuels drives continued growth of emissions through the end of the century
  - Daily temperature & precipitation
  - 10 other secondary climate indicators
  - Timeframe: 1960 – 2100

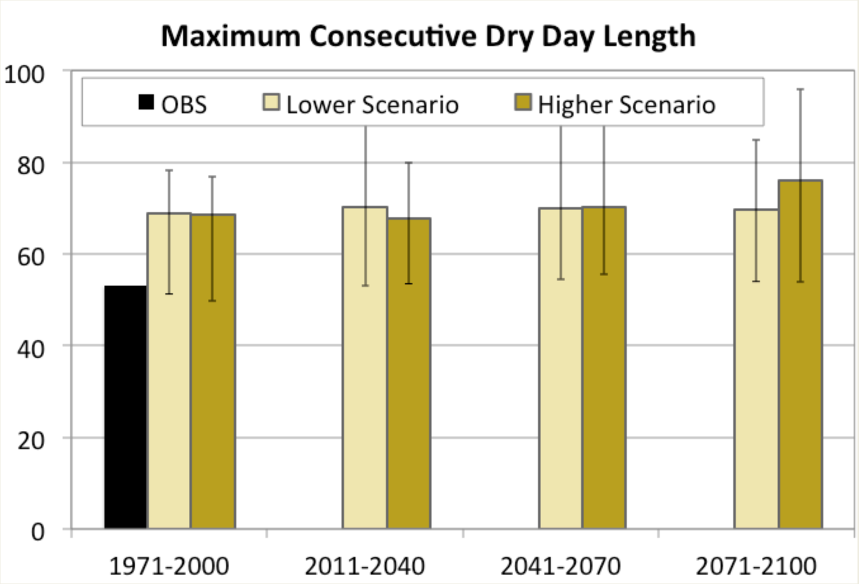
Climate change projections: Higher temperature averages and extremes

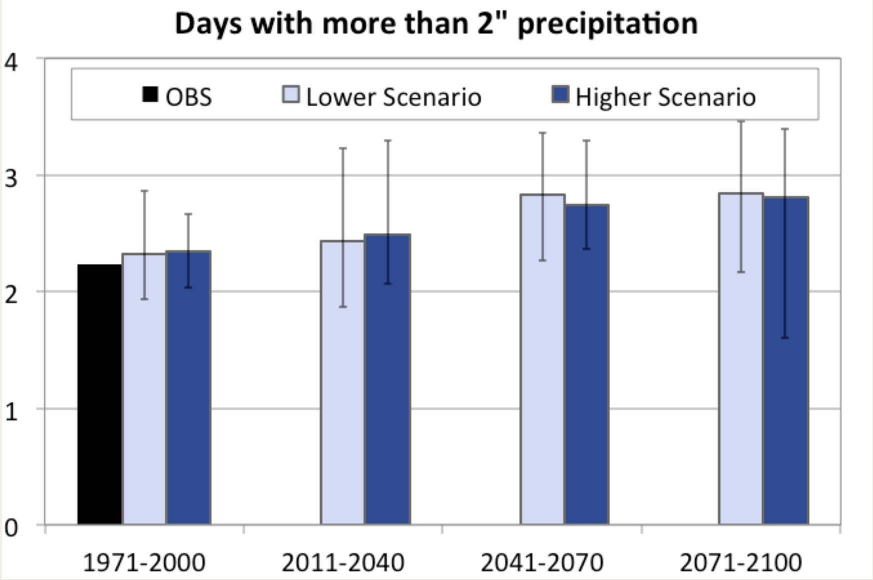




- OBS = Historical observations
- Bars = Average annual values from nine climate models over a 30 year time period
- Whiskers = Range in values projected by nine different climate models

Climate change projections: More extreme precipitation & drought conditions





Summary of climate projections

The science is certain that we will see:

- Increases in annual and seasonal average and extreme temperatures
- More frequent extreme precipitation
- More frequent drought conditions in summer due to hotter weather

The science is less certain that we will see:

- Change in annual average precipitation
- Increase in humidity and heat index
- Increase in the strength (but not frequency) of hurricanes

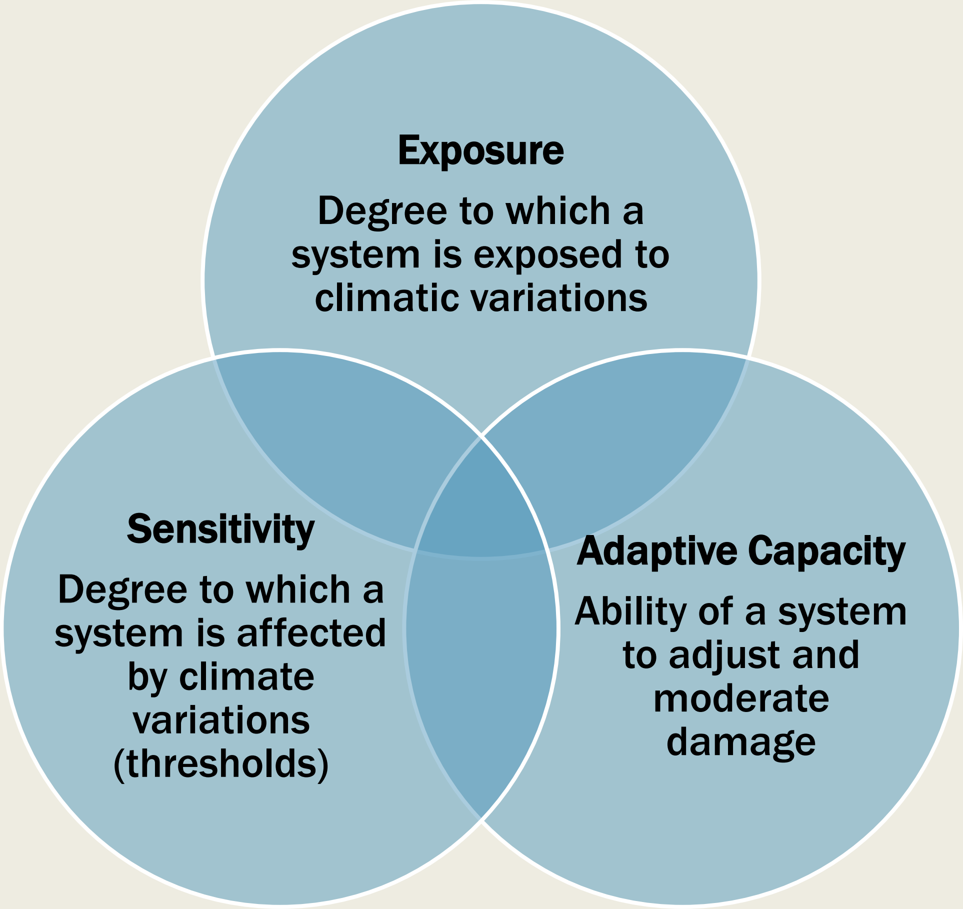
More data needed:

- More weather stations, 100 and 500 year floods, soil moisture, seasonal rainfall, hardiness zones, and heat index

Impacts on our City

Understanding risk and vulnerability to climate change

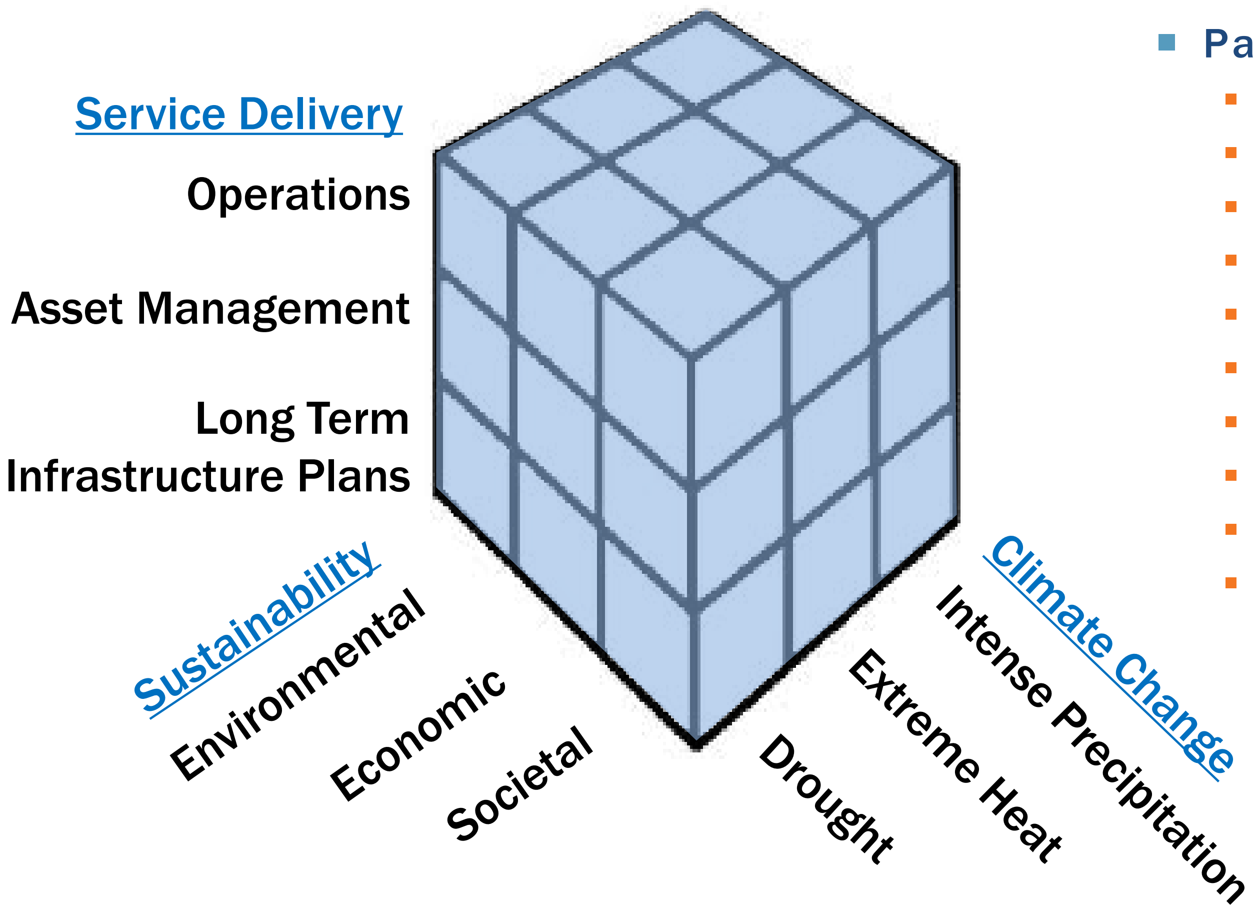
- **Vulnerability** = Exposure, Sensitivity, Adaptive Capacity



Minimizing Risk

- Reducing exposure
- Reducing sensitivity
- Increasing adaptive capacity

Complex interrelated impacts



- Participating Departments
  - Austin Energy
  - Austin Water Utility
  - Transportation Department
  - Public Works
  - Watershed Protection
  - Parks and Recreation
  - Homeland Security and
  - Emergency Management
  - Fire Department
  - Health and Human Services

Increased summer heat

OFFICE OF SUSTAINABILITY CITY OF AUSTIN

Important Thresholds

Days over 100⁰F, Days over 110⁰F, Nights over 80⁰F

Economic Impacts

- Increased energy operating costs
- Increased cost of infrastructure maintenance
- Loss of field staff productivity

Environmental Impacts

- Vegetation change and loss
- Water supply availability
- Air quality impacts
- Decreased local food production

Societal Impacts

- Increased heat stress at home on vulnerable populations
- Worker safety
- Increased utility usage/cost of living

More frequent drought

OFFICE OF SUSTAINABILITY
CITY OF AUSTIN

Important Thresholds

Duration with 0.0” rainfall, Frequency of dry spells, KBDI - Fire risk

Economic Impacts

- Increased water cost
- Increased vegetation maintenance cost
- Increased pavement maintenance
- Solutions to power plant cooling water scarcity
- Agricultural and tourism losses

Environmental Impacts

- Reduced stream, spring, and river flows
- Water quality protection land viability
- Vegetation, tree, and ecosystem loss

Societal Impacts

- Increased wildfire hazards
- Increased utility usage / cost of living
- Increase in vector borne diseases

More frequent extreme precipitation

Important Thresholds

Days with more than 2in. of rain, 2+ days in a row with extreme rainfall

Economic Impacts

- Property damage and rebuilding
- Increased cost of maintenance of infrastructure systems
- Increased emergency response cost
- Business economic losses

Environmental Impacts

- Vegetation damage
- Debris cleanup
- Groundwater and surface water quality

Societal Impacts

- Evacuee social services & temporary housing
- Need for continuity of service
- Increase in water borne diseases
- Emergency stress on communities

We are already moving in the right direction

- **Austin Water**
  - Water efficiency programs
  - Reclaimed water
  - Drought contingency plan
  - Analysis of future water source options

- **Fire, Health, and Emergency Management**
  - Emergency operations plan
  - Cooling and warming centers
  - Disease surveillance
  - Hazard mitigation plan
  - Community Wildfire Protection Plan
  - Comprehensive Wildfire Risk Assessment

- **Watershed and Parks and Recreation**
  - Flood Risk Mitigation including:
    - Pre-flood design solutions and buyouts
    - Flood Early Warning System operations and upgrades to gages and software
  - Austin's Urban Forest Plan
  - Green Roof and Heat Island Initiatives

- **Transportation and Public Works**
  - FHWA Vulnerability Assessment
  - Alternative transportation infrastructure

- **Austin Energy**
  - Efficiency, renewable energy, and demand response programs
  - Drought contingency and water resource planning for power plants

Imagine Austin

Priority Programs		How implementation increases climate resiliency
1: Invest In a Compact and Connected Austin	➡	Creates a more energy and water efficient community; less development in rural areas helps mitigate the depletion of natural systems.
2: Sustainably Manage Our Water Resources	➡	Provides an increasingly dependable and resilient water and wastewater systems.
3: Continue to Grow Austin's Economy by Investing in Our Workforce, Education Systems, Entrepreneurs, and Local Businesses	➡	Develops a skilled workforce able to mitigate, respond and adapt to climate impacts and extreme weather events.
4: Use Green Infrastructure to Protect Environmentally Sensitive Areas and Integrate Nature Into the City	➡	Reduces the heat island effect; reduces stormwater amounts and velocity.
5: Grow and Invest in Austin's Creative Economy	➡	Provides a diverse employment base for shifting job markets.
6: Develop and Maintain Household Affordability Throughout Austin	➡	Locates affordable housing near jobs, grocery stores, transit, and other community resources, increasing adaptive capacity.
7: Create a Healthy Austin	➡	Reduces vector and water-borne diseases and heat related stress.
8: Revise Austin's Development Regulations and Processes to Promote a Compact and Connected City	➡	Creates infrastructure that is resilient to drought, heat, and flooding.

Summary and Recommendations

OFFICE OF SUSTAINABILITY
CITY OF AUSTIN

Takeaways

1. Recent extreme events are likely to be the new normal

2. Vulnerable populations are likely to be disproportionately impacted due to limited ability to adapt

3. Infrastructure design and construction standards will change

4. Some very important issues are out of our direct control:
   - Grid-wide energy capacity
   - Basin-wide water availability
   - Food supply
   - Evacuees from other cities

Recommendations

- Develop more detailed climate projections
- Detailed vulnerability assessments, where necessary and cost effective
- Integration with current departmental planning efforts
  - Enterprise Risk Management
  - Business Continuity Plans
  - Long Term Plans
  - Capital Plans
- Regional coordination on climate issues:
  - LCRA & ERCOT
  - CAPCOG, CAMPO & TXDOT
  - Travis and surrounding counties

Toward a Climate-Resilient Austin

A report in response to City Council Resolution 20131121-060

May 1, 2014

Participating Departments:

Office of Sustainability
Austin Energy
Austin Water Utility
Watershed Protection Department
Transportation Department
Public Works Department
Parks and Recreation Department
Austin/Travis County Health and Human Services Department
Austin Fire Department
Homeland Security and Emergency Management

Executive Summary

Extreme weather is evident in Central Texas:

- During the summer of 2011, Austin had 90 days with temperatures of at least 100°F.
- The entire region is in the midst of an extreme drought that started in 2010.
- Wildfires destroyed homes and the forest surrounding Bastrop in 2011.
- The Halloween flood of 2013 caused extensive damages to homes and businesses and displaced many residents.

Climate in Texas is changing. Average temperatures are increasing, the risks associated with extreme temperatures are more pronounced, and precipitation patterns are shifting, with heavy precipitation becoming more frequent in many locations. These and other changes are consistent with trends across the United States and around the world that have been attributed to human-induced climate change – the result of human emissions of carbon dioxide and other heat-trapping gases released during fossil fuel combustion, deforestation, agriculture, and other activities.

Climate resiliency involves efforts to reduce a city's vulnerability to long-term changes in climate and major weather events in order to protect the economic, environmental, and social health of the community. The City of Austin's 23 Departmental Climate Protection Plans and 5 Building Plans are focused on how to reduce greenhouse gases emissions resulting from municipal operations, as well as the emissions generated in the broader community. However, these plans do not explicitly address strategies for climate adaptation or resiliency.

Recognizing that even with aggressive mitigation measures in place Austin will continue to experience impacts due to climate change, Austin City Council directed the City Manager to explore what it will take for the City to become more resilient. In particular, staff was asked to:

- analyze climate change projections;
- determine how current departmental planning efforts integrate the future impacts of climate change and could be enhanced moving forward;
- identify a process for performing departmental vulnerability assessments; and
- make recommendations about how to develop, prioritize, and implement departmental strategies to increase resilience, including working with strategic community partners to address key vulnerabilities and specifying methods for regular evaluation of the strategies.

Climate Change Projections

Climate change in Texas is consistent with larger-scale trends observed across the U.S. and the world. Based on the data collected at the Camp Mabry weather station in Austin, projected climate changes include:

- increases in annual and seasonal average temperatures
- more frequent high temperature extremes
- little change in annual average precipitation

- more frequent extreme precipitation
- a slight increase in the number of dry days per year
- more frequent drought conditions in summer due to hotter weather

City Departments have identified the following potential impacts from major climate stressors:

POTENTIAL FUTURE CLIMATE IMPACTS			
	More frequent high temperature extremes and increased average temperatures	**More drought conditions**	**More frequent extreme precipitation events**
Austin Energy	Higher peak energy demand and reliability risks due to higher grid-wide capacity demand	Power plant cooling water availability	Impacts to generation and distribution assets from flooding and storms
Austin Water Utility	Increased water demand for irrigation	Decreased water supplies	Impaired access to water and wastewater treatment infrastructure
Watershed Protection and Parks & Recreation	Stress on vegetation and outdoor recreation	Stress on vegetation and outdoor recreation	Increased urban stream flooding, impacts to drainage infrastructure, and changes to the floodplain
Transportation and Public Works	Stress on vehicles and outdoor workers	Damage to pavement and roadways	Transportation system disruptions and impacts to traffic signaling and low water crossings
Health & Human Services	Heat stress, dehydration, and other heat-related conditions; increases in vector-borne diseases as well as disease and conditions associated with water quality	Disease migration, air quality concerns related to smoke from wildfires, and water quality concerns	Protecting and assisting flood victims and first responders
Homeland Security & Emergency Management and Austin Fire Dept.	Heat stress and the need for more cooling centers Increased suppression difficulties resulting from more frequent and intense wildfires	Increased fire risk and the need for prevention and fire fighting	Changes to floodplains and supporting flood victims

Recommendations:

1. Develop more detailed climate projections.
2. Conduct detailed vulnerability assessments.
3. Integrate resilience strategies with current departmental planning efforts.
4. Coordinate with regional partners.

On the pages that follow, additional information is provided about climate vulnerability and approaches to adaptation and resilience, climate change projections for Central Texas, and detailed departmental analyses of climate-related stressors and their potential impacts to operations and assets.

Table of Contents

Introduction

The Intergovernmental Panel on Climate Change (IPCC) has stated that to avoid the worst impacts of climate change, the average global temperature must not rise more than 3.5°F above pre-industrial levels. In order to avoid that increase, the IPCC recommends that greenhouse gas emissions be reduced to 40% below 2005 levels by 2030, and 80% below 2005 levels by 2050. On April 10, 2014, Austin City Council passed resolution 20140410-024, which establishes the goal to reach net zero community-wide greenhouse gas emissions by 2050 or sooner, if feasible.

As of 2014, annual global greenhouse gas emissions have *increased* since 2005. Further exacerbating the situation, over 100 years of greenhouse gas emissions related to human activity have accumulated in the atmosphere. These emissions have already begun and will continue to change the climate for years to come. Bearing this in mind, it is not enough to create plans for mitigating these emissions; we must also become resilient to climate change.

Planning for Climate Resilience

This report contains a preliminary identification of climate-related threats and thresholds for key departments. However, climate change does not follow a linear path in terms of the timing and associated risks that come with specific threats; therefore, adapting to potential changes is a complex process. The City of Austin must become more resilient to climate change, while striking a balance between infrastructure that is already in place, planning efforts that are underway, and constraints on resources.

To increase its climate resilience, the City must identify the specific vulnerabilities within our community. IPCC Chair Robert T. Watson defines vulnerability as "the extent to which a natural or social system is susceptible to sustaining damage from climate change." Accordingly, vulnerability is a function of:

the magnitude of climate change

+

the sensitivity of a system to changes in climate

+

the ability of the system to adapt to changes in climate

A detailed analysis of drainage, transportation, electric, and water infrastructure sensitivities to various climate change magnitude and risk scenarios should eventually be assessed. This analysis would include not only the City's current assets, but also those planned for the future and for the community as a whole.

Becoming more resilient to climate change will be an iterative process of responding to evolving changes in vulnerability, risk, demographics, and City infrastructure. All future City planning efforts should incorporate climate change impacts as a key consideration in order to effectively and efficiently manage resources, operations, assets, and infrastructure.

Climate Change Projections for Central Texas

The world's climate is changing as a result of human activities that release carbon dioxide and other heat-trapping gases into the atmosphere. Over the coming century, global temperatures, precipitation, and other important aspects of climate are expected to continue to change in response to both past and future emissions.

Research Methods

The climate projections referred to in this report were completed by Dr. Katharine Hayhoe, who is an associate professor in the Department of Political Science and Director of the Climate Science Center at Texas Tech University, which is part of the Department of the Interior's South-Central Climate Science Center. She is also the Founder and Chief Executive Officer of ATMOS Research, which provides relevant, state-of-the-art information on the effects of climate change to a broad range of non-profit, industry and government clients. Dr. Hayhoe's work has resulted in over 100 peer-reviewed papers, abstracts, and other publications, including the U.S. Global Change Research Program's *Second National Climate Assessment*; the U.S. National Academy of Science report *Climate Stabilization Targets: Emissions, Concentrations, and Impacts over Decades to Millennia*; and the upcoming *2014 Third National Climate Assessment*.

Climate change projections for Central Texas that are detailed in the tables and pages that follow are based on the following:

- Projections for the United States and the Great Plains region are based on the draft results reported in the upcoming *2014 Third National Climate Assessment*.
- Preliminary projections for Austin are based on two scenarios:

  Low = Low Emissions Scenario
  The Intergovernmental Panel on Climate Change lower Representative Concentration Pathway (RCP) 4.5 scenario, where global carbon emissions peak and then decline by end of century. 4.5 refers to the projected change in radiative forcing in units of watts per square meter. Radiative forcing is a measure of the magnitude of the human influence on the naturally-occurring greenhouse effect.

  High = High Emissions Scenario
  The Intergovernmental Panel on Climate Change higher Representative Concentration Pathway (RCP) 8.5 scenario, where continued dependence on fossil fuels results in an increase in carbon emissions throughout the century. 8.5 refers to the projected change in radiative forcing in units of watts per square meter. Radiative forcing is a measure of the magnitude of the human influence on the naturally-occurring greenhouse effect.

Future climate projections are uncertain for four main reasons:

1. **Natural variability**, which causes temperature, precipitation, and other aspects of climate to vary from year to year and even decade to decade. To address this, climate projections are averaged over 30-year timescales.

2. **Scientific uncertainty**, as it is still uncertain 1) exactly how much the Earth will warm in response to human emissions, and 2) global climate models cannot perfectly represent every aspect of Earth's climate. To address this, future projections are based on simulations from nine different climate models.
3. **Human scenario uncertainty**, as future climate change will occur largely in response to emissions from human activities that have not yet occurred. To address this, future projections use two different emission scenarios; one where global carbon emissions peak and then decline by the end of the century, and a second where continued dependence on fossil fuels continues to increase emissions through the end of the century.
4. **Local uncertainty**, which results from the many factors that interact to determine how the climate of one specific location, such as Austin, will respond to global-scale change over the coming century. To address this, global climate model simulations were downscaled to the Austin Camp Mabry weather station using the Asynchronous Regional Regression Model.

Temperature Projections

Over the coming century, climate change is expected to affect the United States and the state of Texas by increasing annual and seasonal temperatures. Projected increases in annual average temperatures by the end of the century across the South-Central Great Plains are between +5-6°F under the lower emissions scenario and +9-10°F under the higher scenario. The number of days per year where minimum and maximum temperatures exceed the historical hottest seven days of the year is also projected to increase, with proportionally greater increases for minimum temperature as compared to maximum, and for southeastern Texas as compared to the northwestern part of the state.

CLIMATE PROJECTIONS FOR AUSTIN				
	Current Average	**2011-2040**	**2041-2070**	**2071-2100**
Summer average high temp.	94°F	96°F (low) 97°F (high)	97.5°F (low) 100°F (high)	98°F (low) 103°F (high)
Number of cold winter nights per year (below 32°F)	15	11 (low) 11 (high)	8 (low) 6 (high	7 (low) 4 (high)
Number of very warm summer nights (low of 80°F)	0 (rare)	3 (low) 8 (high)	10 (low) 40 (high)	17 (low) 85 (high)
Number of hot summer days (over 100°F)	13	15 (low) 20 (high)	25 (low) 50 (high)	35 (low) 80 (high)
Number of very hot summer days (over 110°F)	0 (rare)	0 (low) 2 (high)	1 (low) 12 (high)	1 (low) 20 (high)

Precipitation Projections

As climate changes, precipitation patterns are also expected to change. In general, wetter areas (including most higher latitudes) are projected to become wetter, while drier areas (such as the U.S. Southwest) are projected to become drier. Situated as it is along the Gulf Coast between the Southeast and Southwest regions of the U.S., Texas has seen some increase across the wetter eastern half of the state, with little change to a slight decrease across the drier western half over the last century.

Projected future changes in precipitation depend strongly on season. In winter and spring, while the northern U.S. and Canada are projected to become much wetter, little change is expected across most of the central U.S. However, a decrease in precipitation throughout Central America may extend to southern Texas, particularly under the higher scenario. In summer, a slight decrease in precipitation is projected throughout the Great Plains, with no change projected for fall.

Despite little change in total precipitation, the nature of precipitation is expected to change. Heavy precipitation days have already increased across the Great Plains region. In the future, days per year that exceed the current wettest seven days of the year are projected to become more frequent across the eastern half of the state, while drought conditions in summer are likely to become more severe as global temperatures increase. A preliminary set of high-resolution climate projections downscaled to the Camp Mabry weather station suggest the following trends:

Precipitation Projections for Austin				
	Current Average	**2011-2040**	**2041-2070**	**2071-2100**
Annual average precipitation	32 in.	31 in. (low) 32 in. (high)	33 in. (low) 33 in. (high)	33 in. (low) 32 in. (high)
Number of dry days per year (no precipitation)	275	280 (low) 280 (high)	280 (low) 285 (high)	285 (low) 290 (high)
Number of days per year with more than 2 inches of rainfall	2	2.5 (low) 2.5 (high)	3 (low) 3 (high)	3 (low) 3 (high)
Maximum 5 day rainfall (inches)	6	7 in. (low) 7.5 in. (high)	8 in. (low) 8 in. (high)	8 in. (low) 8 in. (high)
Maximum consecutive dry days (no precipitation)	52	70 (low) 66 (high)	70 (low) 70 (high)	70 (low) 75 (high)

Additional Climate Data Needed

After analysis of Dr. Hayhoe's data, City departments have identified the following specific items that require further study to properly understand how climate change will affect operational and asset based thresholds:

- Climate models from weather stations to the West of Austin, over the Highland Lakes watershed
- Heat Index, heating degree days, and cooling degree days data
- Solar radiation, UV index, and days of sunshine data
- Hardiness zones for woody vegetation and grasses
- Projected changes in seasonal rainfall
- 100 and 500 year flood projections
- Soil moisture data
- Humidity data

Departmental Analyses

Detailed analyses of department-specific operational and asset management efforts that could be impacted by climate change are provided on the pages that follow. Nine departments have provided the following as part of this analysis:

- A summary of the department's mission and context as it relates to climate change
- Examples of recent extreme weather events and their impacts on the department
- A summary of climate stressors with related operational and asset-based climate thresholds
- An assessment of the potential future environmental, social, and economic impacts from climate change on departmental operations, asset management, and plans
- A summary of how climate resilience is integrated with existing departmental plans

Each department designated staff to work with the Office of Sustainability on this effort. Department Directors have been briefed on the analysis for their department and the overall content of this report, as well as on recommended actions going forward.

Transportation and Public Works

The Public Works Department (PWD) and the Austin Transportation Department (ATD) work together to provide safe, efficient, cost-effective, and sustainable transportation systems that include roadways, bikeways, walkways, bridges, and transit. Extreme weather events caused by climate change, as well as the fact that Austin's population is projected to double in the next 25 years, will have strong impacts on our ability to move people, goods, and services throughout the region. Planning efforts must include measures for our transportation system to become more resilient in the face of these impacts.

Recent Events and Impacts

Longer and hotter droughts cause clay soils to dry and shift, which can damage building foundations and road infrastructure. This kind of damage has led to broken loop detectors in pavement, which causes traffic lights to go into flash mode or out altogether. Currently, there are more than 1,000 traffic signals in Austin and approximately 750 of those have in-ground loop detectors – all of which are vulnerable to extreme weather. Hotter temperatures also affect employees who work outdoors such as signal crews, parking management staff, and construction workers; exposure to high temperatures can lead to dehydration, heat exhaustion, and heat stroke.

Extreme rain events can cause severe damage to roads, bridges, culverts, and buildings, as well as loss of life. The 2013 Halloween Flood washed out roads, making it difficult for residents trying to escape the rising waters and causing delayed response times for emergency crews attempting to help those in need. Major storm systems disrupt electrical service, causing traffic signals to go into flash mode or dark. In addition to putting drivers in danger, malfunctioning traffic lights may require the Austin Police Department to devote resources to directing traffic instead of helping with emergency response efforts.

Climate Stressors Correlated with Current Operational and Asset-based Climate Thresholds				
Climate stressors and thresholds	**Operations**	**Operation Climate Thresholds**	**Asset**	**Asset Climate Thresholds**
Increase in hot days during the summer	Construction crews need more breaks, causing reduced productivity and project delays. Construction involves night shifts to avoid extreme heat, creating conflicts with neighbors. Crossing guards restricted from working full shifts.	105°F to 129°F: crews must to drink 8 oz. of fluid every 50 minutes and take a 10 minute break in the shade. Temps ≥ 130°F: crews must drink 8 oz. of fluid every 30 minutes and take breaks in the shade.	Roads and building foundations prematurely fail due to extended periods of drought coupled with excessive precipitation in highly plastic soils.	Days over 100°F combined with no precipitation causes clay soils to shrink and impact infrastructure.
Increased intensity of precipitation	Shift of PWD resources from normal operations to assisting during flood events.	More than 1" of rain in a 24-hour period triggers staff to assist neighborhoods.	Flooded-out roads and damages to other critical infrastructure.	More than 1" of rain in 24-hours can wash out low roads and cause property damage.
Decrease in precipitation (drought)	Increase in calls for service to impacted infrastructure. Potential need to increase fleet and personnel.	Unknown.	Increased cost to deter construction site run-off when vegetation is unable to be installed or maintained.	Unknown.

Potential Future Impacts

When climate thresholds are exceeded, **ensuring access to the transportation network** may result in the following impacts:

- *Economic:* Loss of productivity and delays in construction timelines.
- *Environmental:* Loss of vegetation from drought combined with events of intense precipitation may increase flooding.
- *Social:* Increased flooding may harm vulnerable populations and isolate neighborhoods.

When extreme weather thresholds are exceeded, **protecting key transportation assets** may result in the following impacts:

- *Economic:* Increase in costs to maintain infrastructure.
- *Environmental:* Reduction in ecosystem services due to drought will mean greater dependence on structural solutions.
- *Social:* Reduced ability to provide services.

When climate thresholds are exceeded, **planning for transportation system demand** may result in the following impacts:

- *Economic:* Increase in costs if climate projections are not integrated into planning process.
- *Environmental:* Uncertain stability of landscape systems may increase infrastructure stressors.
- *Social:* Increased potential harm to community.

Climate Resilience Integration with Existing Plans		
Existing plans	**How plans currently address resilience**	**Additional efforts that could increase resilience**
FHWA Vulnerability Assessment	Identifies critical transportation routes most likely to be impacted by extreme weather events.	Ensure that transportation routes can recover from extreme weather events.
Alternative transportation infrastructure	Provides alternative transportation modes in the aftermath of extreme weather events.	Expand alternative transportation modes to ameliorate air quality.
Imagine Austin	Creates a plan for a compact and connected urban landscape.	Refine the Land Development Code to anticipate and address increased heat, drought, and flooding.

Austin Energy

Austin Energy is committed to delivering clean, affordable, and reliable energy, as well as excellent customer service to subscribers. Electricity used by Austin Energy customers comes from the interconnected grid that covers most of Texas and is managed by the Electric Reliability Council of Texas (ERCOT). All power plants in ERCOT operate in a coordinated way to maintain enough voltage on the grid so that all users have a reliable supply of electricity on demand. As part of that system Austin Energy:

- sells retail electricity directly to customers
- builds and maintains the electric service infrastructure to provide reliable electricity to its subscribers
- reduces or avoids electricity consumption and costs through services related to energy efficiency, building energy standards, local renewable energy incentives, and demand response
- generates and sells electricity to ERCOT for revenue, which reduces the amount of revenue that needs to be collected from customers

Austin's climate is projected to experience longer droughts and heat waves, which will primarily increase the cooling load required by homes and buildings; one way to mitigate the risk of load increases is to reduce the need for energy. Fortunately, many individuals, families and organizations are already taking steps to improve the energy efficiency of their homes and workplaces. Austin Energy supports these initiatives through its long-standing customer service programs including the goal of 800 megawatts of energy efficiency, rebates and incentives, technical support, and the Austin Energy Green Building (AEGB) program.

Recent Events

The ERCOT region's all-time record peak load occurred on August 3, 2011, when consumer demand hit 68,305 megawatts. Demand that summer peaked due to widespread high temperature extremes; the highest loads approached the amount of available electricity generation on the grid. Future temperature extremes throughout Texas might result in short-term generation capacity issues, which would then force ERCOT to implement rolling blackouts for all users throughout the grid.

Rolling blackouts did occur in 2011 due to cold weather. Extremely cold temperatures on February 2, 2011 led to higher than expected electricity load in the early morning hours and simultaneously caused several power plants in ERCOT to malfunction or be unavailable to meet demand. Many customers were without electricity for extended periods in extreme cold weather until the blackouts were lifted.

Climate Stressors Correlated with Current Operational and Asset-based Climate Thresholds				
Climate stressors and thresholds	**Operations**	**Operation Climate Thresholds**	**Asset**	**Asset Climate Thresholds**
Increase in hot days during the summer	Customer Disconnects are suspended. Austin Energy demand response programs are triggered when the ERCOT grid is stressed.	Disconnects are suspended when the heat index for the current day and forecasted for the following day is or will be 102°F. Power Partners thermostat cycling and Load Coop programs are initiated when ERCOT loads are approaching high.	Higher air temperatures result in higher cooling water temperatures in and out of thermal power plants. This can result in small efficiency losses and, if the discharge temperatures exceed regulatory limits, reduce unit output.	Discharge canal temperatures at Fayette Power Plant cannot exceed 113°F.
Increased intensity of precipitation	Increased service in response to downed power lines. Potential need to increase fleet and personnel. Austin Energy crews must manually operate Lady Bird Lake flood gates to prevent flooding.	Austin Energy staff are on call when heavy rains are expected or when LCRA releases upstream water.	Increased precipitation and extreme weather can bring down power lines or flood substations.	2" of rain in a 24-hour period washes out low-laying roads and can cause major property damage, which could affect the timeliness of power restoration activities.
Decreased in precipitation (drought)	Long periods of dry weather can affect trees near power lines, possibly increasing the amount of tree-caused outages.	Multiple days with little or no precipitation.	Drought can affect cooling reservoirs that must hold water to a certain level for pump intake in order to operate.	When the combined storage in the Highland Lakes falls below 600,000 acre-ft, LCRA mandates water customers curtail water diversion by a fixed %.

Potential Future Impacts

If climate change threatened our ability to **ensure continuous electricity delivery to critical facilities**, we might expect the following impacts:

- *Economic:* Major impacts to government, businesses and the local economy.
- *Environmental:* Increased air pollution from emergency generators or older generation units.
- *Social:* Major impacts on the ability to operate health and emergency services.

If climate change threatened our ability to **protect key electricity infrastructure assets from extreme weather**, we might expect the following impacts:

- *Economic:* Higher capital expenditures for premature replacement or reconstruction.
- *Environmental:* Spills and/or water contamination from over-heated or flooded equipment.
- *Social:* Higher rates to recover capital needs.

If climate change threatened our ability to **forecast electricity demand projections**, we might expect the following impacts:

- *Economic:* Inaccurate revenue and energy cost projections, as well as budget uncertainty.
- *Environmental:* Increased stress on water and cooling resources and a greater need for easily-dispatchable fossil-fuel resources.

Climate Resilience Integration with Existing Plans		
Existing plans	**How plans currently address resilience**	**Additional efforts that could increase resilience**
Efficiency, renewable energy, and demand response programs	Maintains safe indoor temperatures for vulnerable communities during extreme weather events.	Expand commercial and residential programs to further protect citizens from extreme weather events.
Drought contingency and water resource planning for power plants	Protects power plants from short term drought impacts.	Create a contingency plan that takes longer and hotter droughts into consideration.

Austin Water Utility

Austin Water delivers water and wastewater services for the City by drawing surface water from the Colorado River and returning treated wastewater to the river. Climate change has the potential to impact the supply and demand for water, as well as the conveyance and treatment of both water and wastewater.

Recent Events

Drought, heat, and demand have all impacted Austin Water in recent years. The ongoing drought has reduced inflows into LCRA-managed reservoirs so that continued demand has outpaced inflows and greatly reduced stored supplies. Increased evaporation from higher average temperatures has reduced reservoir supplies further. Reduced supply has triggered conservation measures in Austin and elsewhere throughout the Colorado River basin; the resulting changes in patterns of consumption by customers has required adaptation in treatment, operations, and financial divisions to continue to provide Austin Water's services in a sustainable manner.

Because wastewater collection relies primarily on gravity, wastewater facilities are often located in low areas subject to flooding. Extreme rain events like the 2013 Halloween Flood damaged and impeded access to some Austin Water wastewater facilities. In addition, floodwaters infiltrated wastewater flow, increasing inflows to the treatment facilities up to and beyond their limits and requiring some flows to bypass complete treatment.

Climate Stressors Correlated with Current Operational and Asset-based Climate Thresholds				
Climate stressors and thresholds	**Operations**	**Operation Climate Thresholds**	**Asset**	**Asset Climate Thresholds**
Increase in hot days during the summer	Reduced supplies and increased demand. Increased treatment needs.	Conservation triggers based on available supply and peak demands.	Air blowers at wastewater treatment plants can be impacted.	Blowers are set to shut off at excessively high temperatures.
Increased intensity of precipitation	Flooding events can disrupt wastewater collection and treatment.	Wastewater influent flows and volumes are dependent on local basin geography.	Flooding can impact pipelines.	Unknown.
Decrease in precipitation (drought)	Drought-motivated conservation can reduce demand for treatment (water may stay in system longer). Reduced Utility revenue.	Conservation triggers are based on available supply and peak demands.	Drought can impact pipelines.	Unknown.

Potential Future Impacts

When climate thresholds are exceeded, **ensuring continuous water delivery to critical facilities** may result in the following impacts:

- *Economic:* Reduced revenue.
- *Environmental:* Reduced ability to treat water and diminished water quality.
- *Social:* Water-dependent businesses and activities may be impacted.

When climate thresholds are exceeded, **protecting key water delivery infrastructure** may result in the following impacts:

- *Economic:* Raised costs for maintaining infrastructure.
- *Environmental:* Reduced ability to treat water and diminished water quality.
- *Social:* Disrupted service delivery to customers.

When climate thresholds are exceeded, **maximizing water efficiency and availability, and improving demand projections** may result in the following impacts:

- *Economic:* Acquiring new supplies of water may increase costs.
- *Environmental:* Projects to improve water availability could impair, or alternately, benefit environmental habitats.
- *Social:* Changing water services may change customer behavior and productivity.

Climate Resilience Integration with Existing Plans

Existing plans and programs at AWU at least partially address both acute and chronic potential impacts from future climate conditions. Flood and fire contingencies are currently addressed through emergency response and continuity of operations plans, including regional mutual aid programs like the Texas Water / Wastewater Agency Response Network (TXWARN). Impacts due to chronic heat and drought are currently being addressed through demand-side conservation programs and supply-side planning, both independent of and in coordination with the Lower Colorado River Authority (LCRA). A detailed utility-wide resiliency assessment will ensure that plans in place or being developed are responsive to the anticipated magnitude of changes in conditions and will help ensure that various plans are coordinated and complementary.

Watershed Protection and Parks and Recreation

The mission of the Parks and Recreation Department is to provide, protect and preserve a park system that promotes quality recreational, cultural and outdoor experiences for the Austin community. The mission of the Watershed Protection Department is to protect lives, property and the environment by reducing the impacts of flood, erosion and water pollution. Both missions are linked through the context of the environment and how Austin residents engage with it; accordingly, the evaluation of these departments' vulnerability to climate-related extreme events is presented jointly.

Recent Events

Recent heat waves and drought have directly impacted the environment, as well as how people engage with it. The combination of heat and drought have dropped water tables, killed vegetation, and caused trees to shed limbs. Extreme heat deters outdoor recreation, while drought curtails water recreation. Indoor recreation centers have seen an increase in use, resulting in increased costs to maintain outdoor spaces (e.g., replacing turfgrass, heat-related construction delays, tree replacement, etc.) as well as indoor spaces. Extreme heat and drought lead to lower participation in some outdoor programming, but an increased use of public pools, resulting in a rise in the associated maintenance costs.

Extreme rain events can take lives, destroy buildings and infrastructure, impede access to critical assets and disrupt recreation and tourism. The 2013 Halloween Flood required the repurposed use of the Dove Springs Recreation Center as a Disaster Assistance center for two weeks. Additionally, both Watershed Protection and Parks and Recreation staff were pulled from regular duties to assist at the Disaster Assistance Center and help affected residents. Flooding also disrupted the Austin City Limits Music Festival at Zilker Park, requiring that the final day of the festival be cancelled.

Climate Stressors Correlated with Current Operational and Asset-based Climate Thresholds				
Climate stressors and thresholds	**Operations**	**Operation Climate Thresholds**	**Asset**	**Asset Climate Thresholds**
Increase in hot days during the summer	Reduced field staff productivity. Vegetation die-off. Soil loss and more debris.	Frequent staff breaks are self-directed as needed.	Extreme heat impacts people, vegetation and soil.	No firm threshold, but changes in mean temperature affect people, plants and soil.
Increased intensity of precipitation	Large flood events overwhelm budgets and staffing capacity. Cancelled events.	Flood early warning system (FEWS) call back with 1 inch or greater precipitation forecasted.	Increased stress on storm sewer infrastructure can lead to other utility failures.	Unknown.
Decrease in precipitation (drought)	Low flow at Barton Springs reduces dissolved oxygen which threatens Salamander health.	Dissolved oxygen concentrations < 5 mg/L are of particular concern for endangered species.	Barton Springs, the Soul of Austin – an irreplaceable facility.	When flow is < 40 cubic feet per second, water quality is significantly impacted. At < 30 cubic feet per second, Salamander health is threatened.

Potential Future Impacts

If climate change threatened **areas susceptible to flooding**, we might expect the following impacts:

- *Economic:* Damage to the desirability of Austin for jobs, tourism and recreation because of vegetation loss, higher temperatures, and higher costs for City services. Debris-laden, intense floods cause greater damage to public and private structures.
- *Environmental:* Loss of vegetation from drought and intense precipitation may increase flooding depths and frequency.
- *Social:* Increases in flooding may harm the most vulnerable population and isolate low-income neighborhoods.

Watershed Protection authored a portion of the Corrective Action Report (CAP) in response to the 2013 Halloween Flood. Based on the CAP, there are 13 specific modeling, hardware, and communications-based improvements to the Flood Early Warning System (FEWS) that have already begun to be implemented. If climate change furthered threatened our ability to **protect key flood water gauges**, we might expect the following impacts:

- *Economic:* Increased costs for maintaining infrastructure as well as the Flood Early Warning System.
- *Environmental:* Additional debris loading may test the reliability of even reinforced or hardened flood monitoring equipment.
- *Social:* While the CAP will increase the reliability of flood gauges and equipment, additional debris loading and extreme weather may make it difficult to protect lives under all circumstances. The amount of rainfall that fell during the Halloween Flood and the location of that rainfall created a flood wave of such magnitude and speed along Onion Creek, any system would have been challenged to provide enough time for a complete dry weather evacuation.

If climate change threatened our ability to **analyze changing floodplain models to determine potential impacts on current and future development**, we might expect the following impacts:

- *Economic:* Floodplain models may challenge regulatory authorities to impose unforeseen conditions on future development projects.
- *Environmental:* An uncertain vegetation matrix will lead to uncertain modeling results.
- *Social:* Future models may expand the areas which are at risk for social disruption.

With an increasing likelihood of extreme weather events, the City of Austin is actively pursuing flood risk mitigation as one step toward climate resiliency. These efforts are in keeping with a statement by Fran McCarthy, an Emergency Management Policy analyst for the Congressional Research Service and author of From Global Warming, Natural Hazards and Emergency Management:

> **"Engaging in property acquisition as a positive initiative to deal with climate change as well as to reduce the impact of future disasters is a powerful and politically viable argument for each community leader."**

Prior to the Halloween Flood, the City had purchased over 300 flood-prone homes in the lower Onion Creek neighborhoods at a cost of more than $36 million. Since the flood, another 58 homes have been purchased and additional buyouts are planned. Altogether, the amount spent on buyouts alone approaches nearly $100 million to lower property risk and increase the safety of citizens.

Climate Resilience Integration with Existing Plans		
Existing plans	**How plans currently address resilience**	**Additional efforts that could increase resilience**
Flood Risk Mitigation planning	Asesses flood risk and enacts plans for flood mitigation.	Gain a better understanding of impacts resulting from longer and hotter droughts, interspersed with heavier precipitation.
Pre-flood design solutions	Plans buyouts to minimize future impacts to residents and businesses.	Place greater emphasis on pre-flood options that enhance resilience.
Flood Early Warning System	Increases agility of emergency response efforts.	Upgrade gauges and software.
Austin's Urban Forest Plan	Identifies and plans for tree health in light of water shortages.	Incorporate tree species that are better adapted to a new climate.
Green Roof and Heat Island Initiatives	Reduces overall temperature in urban areas.	Coordinate between green infrastructure strategies to further reduce the heat island effect.

Health and Human Services

Austin/Travis County Health and Human Services promotes a healthy community through the use of best practices and community partnerships. Having a healthy and vibrant community is one of the characteristics that distinguishes Austin and makes it a desirable place to live. However, a changing climate may impact the overall health of the community and put particularly vulnerable groups, such as the very old, very young, homeless, socially or economically disadvantaged and isolated populations, at greater risk. Tailoring preparedness and emergency response strategies to address the needs of our most vulnerable citizens will help decrease extreme weather impacts for Austin.

Recent Events

During heat waves and other weather-related emergencies, portions of the population might not be able to independently reach cooling stations, grocery stores, primary care, mental and behavioral health services, and emergency services. Lack of connectivity and access to services further isolates already at-risk populations. Drought and flooding increase the risk of poor water quality, as well as exposure to pathogens from contaminated drinking or surface water. Short-term flooding increases the risk of exposure to mosquito-borne diseases, while drought conditions bring wildlife to urban settings, increasing the risk of exposure to disease, fleas and ticks. Unfavorable meteorological conditions combined with air pollutants is conducive for ozone formation, which can affect lung function and trigger respiratory conditions such as asthma. As evidenced by the 2011 Bastrop Wildfires, exposure to particulate matter levels can also aggravate respiratory disease.

Austin must also be prepared to help other communities affected by extreme weather and climate change. Austin serves as the shelter hub for Galveston and should be prepared to provide short and long-term assistance to evacuees from tropical storms, floods, and hurricanes.

Climate Stressors Correlated with Current Operational and Asset-based Climate Thresholds		
Climate stressors and thresholds	**Impacts on vulnerable populations (age, income levels, or other social factors)**	**Thresholds**
Increase in hot days during the summer	Increased cases of allergic disease from elevated levels of pollens caused by more vigorous weed growth and longer pollen seasons. Threatened safety and availability of food and water supplies. Increased heat-related injuries or death. Increased number of poor air quality days from ground level ozone.	Unknown.
Increased intensity of precipitation	Changes in rates and trends of zoonotic diseases carried by animals or insects. Changes in rates and trends of diseases resulting from exposure to contaminated surface and/or drinking water.	Unknown.
Decreased in precipitation (drought)	Increased respiratory and cardiovascular illness and deaths caused by smoke from heat and drought-related wildfires, as well as changes in air pollution, particularly ground-level ozone exceeding EPA National Ambient Air Quality Standards.	Unknown.

Potential Future Impacts

When climate thresholds are exceeded, **vulnerable populations (due to age, income levels, or other social factors)** may be impacted by the following:

- *Vector-borne diseases:* Increasing incidences from mosquitos in a warmer and wetter climate.
- *Water- or air-borne diseases:* Increasing incidents of rodents coming closer to homes in search of water and spreading diseases to household pets and humans.
- *Poor air quality:* Increase in Ozone Action Days and higher levels of particulate matter, leading to asthma and other respiratory ailments.
- *Extreme heat:* With an increasing number of warm nights and the inability to cool down overnight, vulnerable communities are put at risk of overheating during a heat wave.
- *Access to food and potable water*: Safety and availability of food and water supplies will be threatened, resulting in increased costs.

Climate Resilience Integration with Existing Plans		
Existing plans	**How plans currently address resilience**	**Additional efforts that could increase resilience**
Disease surveillance	Tracks disease migration to mitigate impacts.	Additional study to model future disease scenarios.
Community Health Assessment and the Community Health Improvement Plan	Identifies vulnerable communities in relation to issues surrounding nutrition, exercise and isolation. Identifies actions to mitigate negative health effects.	Expand assessment and planning efforts to include climate change impacts that include vector, water and air borne disease.

Fire and Emergency Management

The Office of Homeland Security and Emergency Management (HSEM) coordinates city-wide responses to large-scale emergencies and disasters. This includes planning for preparedness activities, as well as the efforts associated with the response and recovery phases of a disaster. HSEM works jointly with the utilities and other public safety and health agencies to develop a comprehensive approach to threats that reduces risks, ensures the continuity of operations, and facilitates community recovery. For example, HSEM works with the Austin Fire Department (AFD) to protect lives and property through extensive fire prevention and safety education efforts. Based on climate change projections, the extreme heat, drought, and wildfires of the summer of 2011 will become less exceptional, resulting in changes to the way we plan for and respond to extreme weather events.

Recent Events

In 2011, Travis County experienced one of the worst droughts and heat waves on record, causing vegetation to die off and setting the stage for a very dangerous fire season. On September 4, 2011, a tropical depression made landfall in Louisiana, leaving Travis County on the dry side of the storm, but subject to high winds that resulted in six major fires that consumed nearly 7,000 acres and destroyed 57 homes. Bastrop County also suffered a massive wildfire that burned 32,000 acres and destroyed 1,696 residential and commercial structures, ultimately resulting in the third largest home loss fire in U.S. history. The wildfires necessitated evacuation of more than 5,000 people and resulted in severe economic and ecological impacts to the region.

Texas leads the nation in flood-related deaths and holds records for excessive rainfall rates in less than 48 hours. Austin lies in the heart of Flash Flood Alley and flooding is the most serious hazard for the area, posing a threat across the city year-round. An increase in precipitation, as seen during the 2013 Halloween Flood, will intensify the severity of inundation, potentially damaging infrastructure and causing loss of life. Flooding can also hamper the ability for emergency vehicles to serve the city.

Climate Stressors Correlated with Current Operational and Asset-based Climate Thresholds				
Climate stressors and thresholds	**Operations**	**Operation Climate Thresholds**	**Asset**	**Asset Climate Thresholds**
Increase in hot days during the summer	Increased need for cooling stations and public messaging, as well as suppressing wildfire fuels.	Heat Emergency Plan goes into effect when the National Weather Service issues a Heat Advisory or Excessive Heat Warning.	High temperatures increase flammability of homes and vegetation.	30 days over 100 °F combined with low humidity.
Increased intensity of precipitation	More staff and resources required to manage more intense or multiple events.	More than 1" of rain in 24-hours triggers staff to assist neighborhoods during the event.	Potential impacts to operational resources and facilities(i.e. the Fire Station at Onion Creek).	More than 1" of rain in a 24-hour period can wash out low-laying roads and can cause major property damage.
Decrease in precipitation	Potential need to increase fleet and personnel to respond to more calls.	60 days with little or no precipitation; National Fire Danger Ratings of very high and extreme.	Lack of available water for wildfires for areas not served by hydrants.	Consecutive days with little or no precipitation or Keetch Byram in excess of 575.

Potential Future Impacts

When climate thresholds are exceeded, **communication strategies for alerting affected communities in emergency situations** may result in the following impacts:

- *Economic:* Increased staffing and resources will be required to plan for and implement response actions.
- *Social:* Effectiveness in the ability to alert the public to threats.

When climate thresholds are exceeded, **ensuring continuity of governmental and emergency operations** may be impacted by the following factors:

- *Economic:* Personnel availability and infrastructure damage.
- *Social:* Increased need for health monitoring and responding to public concerns.

When climate thresholds are exceeded, **preparing for refugees coming to Austin due to catastrophic events and providing aid to displaced Austin residents** may be impacted by the following:

- *Economic:* The need to shift City resources to effectively respond to refugee management.
- *Environmental:* Increased waste proliferation resulting from limited and transient shelters.
- *Social impacts:* Short- and long-term housing availability.

Climate Resilience Integration with Existing Plans		
Existing plans	**How plans currently address resilience**	**Additional efforts that could increase resilience**
Emergency operations plan	Protects residents from extreme weather events.	Expand program to respond to more residents, especially in vulnerable communities.
Cooling and warming centers	Protects residents from extended hot weather events.	Expand planning to include hotter temperatures and longer heat durations.
Hazard mitigation plan	Protects vulnerable communities from harm.	Include mitigation of climate-related cascading hazards.
Community Wildfire Protection Plan	Expands community stakeholder groups to incorporate wildfire mitigation strategies.	Expand wildfire mitigation strategies to land use and building codes.
Comprehensive Wildfire Risk Assessment	Manages wildfire dangers in the region.	Conduct additional research to better understand future fire risks and response efforts.

Imagine Austin Comprehensive Plan

The City of Austin's comprehensive plan serves as a roadmap that unifies efforts for the betterment of the community. To realize the Imagine Austin vision, all City departments and programs must align with the plan's goals and priorities, all of which support climate resilience.

Climate Resilience Planning in Imagine Austin	
Priority Programs	**How implementation increases climate resilience**
Invest in a compact and connected Austin	Creates a more energy and water efficient community; less development in rural areas helps mitigate the depletion of natural systems.
Sustainably manage water resources	Provides an increasingly dependable and resilient water and wastewater systems.
Continue to grow Austin's economy by investing in our workforce, education systems, entrepreneurs, and local businesses	Develops a skilled workforce able to mitigate, respond and adapt to climate impacts and extreme weather events.
Use green infrastructure to protect environmentally sensitive areas and integrate nature into the city	Reduces the heat island effect; reduces stormwater amounts and velocity.
Grow and invest in Austin's creative economy	Provides a diverse employment base for shifting job markets.
Develop and maintain household affordability throughout Austin	Locates affordable housing near jobs, grocery stores, transit, and other community resources, increasing adaptive capacity.
Create a healthy Austin	Reduces vector and water-borne diseases and heat related stress.
Revise Austin's development regulations and processes to promote a compact and connected city	Creates infrastructure that is resilient to drought, heat, and flooding.

Conclusion

Climate change projections indicate that the extreme heat and flooding events of the last few years are likely to become the "new normal" in the next few decades. In the context of a rapidly growing regional population, this will put additional strain on City facilities and workers, making it challenging for City departments to maintain assets and services at current levels. Climate change is also likely to disproportionally impact our most vulnerable communities, as their ability to adapt to climate change is limited.

To proactively take steps as a best managed city and become more resilient to climate change, we must manage the risk of impacts to both new and existing capital investments. This may involve infrastructure design and material decisions that ensure adequate service despite climate change projections. It will also mean ensuring high levels of service to residents and the ability to effectively protect human life during extreme weather events.

It is also important to understand that some issues are out of the City's direct control such as grid-wide energy capacity, basin-wide water availability, regional food supply, and regional evacuees. In addition, some regional entities may not acknowledge climate change or recognize its risks. Climate variability also makes strategic planning a complex and ongoing process; there is a high degree of uncertainty in predicting the occurrence of when, where, and how strong extreme weather events will be. Although planning for uncertain weather may seem daunting, the City can act to ensure that departments and community members are resilient to the impacts of climate change.

Recommendations

1. **Develop more detailed climate projections.**

   Additional data is needed to better understand climate change impacts for Austin. The City should continue to work with climate researchers to develop more detailed climate projections for Central Texas. The results from this analysis should be incorporated into the capital planning process as well as department-specific planning activities.

2. **Conduct detailed vulnerability assessments.**

   Currently, Public Works, Transportation, and the Capital Area Metropolitan Planning Organization (CAMPO) are piloting a vulnerability assessment of the regional transportation infrastructure with Federal Highway Administration grant funding. The value of this grant project is $152,000 plus a considerable amount of staff time. Tasks in the vulnerability assessment include:

   - Gathering data on asset locations, characteristics, and climate sensitivities
   - Combining asset and climate projection information to identify vulnerabilities
   - Assigning a level of risk for climate impacts on assets

   The results from this study may serve as a framework for other departments to use in conducting vulnerability assessments, and should be evaluated at the project's conclusion. The City should also determine the cost, feasibility, and timeframe for conducting detailed vulnerability assessments for Austin Energy, Austin Water, Watershed Protection, Parks & Recreation, as well as the implications for public health and emergency preparedness. Grant funding opportunities should be identified and explored, and the City should also consider whether or not to include vulnerability assessment costs in future budget planning efforts.

3. **Integrate resilience strategies with current departmental planning efforts.**

   The City of Austin is already moving in the right direction with many planning and programmatic efforts underway that contribute to climate resilience. Other existing planning processes can integrate climate resilience by using the data presented in this report. Climate resilience should be included as part of Enterprise Risk Management plans, Business Continuity plans, long-term plans, and capital plans.

4. **Coordinate with regional partners.**

   Climate impacts do not start and stop at the City limits. Becoming more resilient will involve coordination with regional partner organizations, such as the Lower Colorado River Authority (LCRA), Electric Reliability Council of Texas (ERCOT), Capital Area Council of Governments (CAPCOG), Capital Area Metropolitan Planning Organization (CAMPO), Texas Department of Transportation (TXDOT), and Travis and other surrounding counties.

Becoming more climate resilient will be an iterative process of responding to evolving changes in vulnerability, risk, demographics, and City infrastructure. The work will be on-going and will need to be assessed on an on-going basis, using the most current projections and data.