



Update on City Actions Addressing Urban Heat

This report provides an update on recent City efforts to mitigate urban heat and proposes a path forward to create a Citywide Urban Heat Mitigation and Adaptation Plan.

THIS ITEM IS FOR DISCUSSION AND POSSIBLE ACTION.

Summary

Phoenix, a city in the heart of the Sonoran Desert, attracts new residents and visitors from across the U.S. with desert life as its signature. Unlike many other U.S. cities that only have a small percentage of homes with air conditioning, almost all dwellings in Phoenix have some form of mechanical cooling, making it better prepared for extreme heat events than many other cities. However, while we all are exposed to heat when we are outdoors, heat does not affect all residents equally - outdoor workers, people experiencing homelessness, and other vulnerable populations such as low-income residents living in poorly insulated homes, face the brunt of the impacts related to heat. Heat is responsible for more fatalities than most other climate hazards combined. Yet the invisible threat of heat often goes unnoticed by residents and visitors; it is like a silent storm.

Extreme heat events are not the only concern. Over the last 20 years, the average night-time temperature in Phoenix has risen by nine degrees as a result of the urban heat island, a phenomenon caused by adding increasing amounts of hardscape and concrete surfaces that capture and store heat during the day and release it more slowly in the evening hours than the surrounding desert. Research indicates that if cooler materials were used in infrastructure, while trees, shade and other forms of green infrastructure were added to the streetscape, urban heat island could be significantly mitigated. For example, a study conducted by Arizona State University (ASU) identified two neighborhoods in Phoenix just two miles apart that experienced a 13 degree average surface temperature difference during peak summer hours. It underscores that infrastructure can be a major determinant of temperatures that the community experiences.

Past Actions Related to Heat

Given its reputation as the hottest city in the nation, and its proximity to ASU, Phoenix is the epicenter of research related to heat. Hundreds of research projects conducted by ASU and other universities over the last decade form a library of evidence that could inform future action. In addition, Phoenix is home to many best practice actions such as the Heat Relief Network, which partners with 137 organizations to distribute water and operate cooling centers throughout the region, and the home weatherization program, where the Neighborhood Services Department works with utilities and others to invest millions of dollars each year in weatherizing homes of low-income residents. Other projects will likely become future best practices such as the comprehensive heat planning being done in the Edison-Eastlake Choice Neighborhood; where baseline heat measurements have been taken to compare against future development that will be optimized to create a model cool neighborhood.

Attachment A, Creating a Cooler Phoenix, is a report developed in collaboration with ASU that details both the causes and impacts of heat and introduces a strategy to address heat in Phoenix, while **Attachment B** provides a summary of 24 major programs undertaken by City departments in the last decade that model best practice approaches. Yet as the Creating a Cooler Phoenix report outlines, despite numerous past actions and potpourri of solutions, the City does not yet have an overarching plan to address extreme heat and urban heat island in the long term.

Staff Recommendation for the Path Forward

Over the past two years, a significant effort has been undertaken by ASU, Harvard University, City staff and other stakeholders to better understand the potential for heat mitigation in Phoenix. Accelerated by a \$100,000 grant from Bloomberg Philanthropies, a Heat-Ready Team was formed to pilot actions in the community, seek input from residents and businesses on what it means to be heat ready, and explore a framework by which cities could evaluate their heat preparedness using a yet-to-be-developed Heat-Ready Certification system.

The effort resulted in some remarkable findings: Harvard students researched the effect of heat on transit ridership including making recommendations for an updated transit ridership propensity model, and prototyped a "walkshed" tool. This "walkshed" tool considers zero-car households, proximity to schools, shopping, and transit to identify the most likely routes, or walkshed, that pedestrians would likely take in a given neighborhood. If expanded Citywide, this walkshed tool could help identify priority areas for investment in shade to create cool corridors throughout the City.

To culminate this effort, staff and ASU are committed to advancing the heat mitigation work by engaging the community, businesses, and other stakeholders in a holistic

planning process over the next two years to develop three key items:

- (a) An Urban Heat Mitigation and Adaptation Plan
- (b) A Heat-Ready Certification Model to be developed and piloted in Phoenix
- (c) A walkshed mapping tool to identify priority routes for infrastructure in vulnerable neighborhoods

These items would leverage past research and actions and be informed by existing plans and policies such as the Tree and Shade Master Plan, Complete Streets Ordinance and Policy, Transportation 2050, the Comprehensive Bicycle Master Plan, and the General Plan.

Previous Action

The item was also presented to the Water, Wastewater, Infrastructure and Sustainability Subcommittee on March 6, 2019.

Financial Impact

Staff would work to leverage existing City department budgets to fund various research efforts, community outreach, and heat-related pilot projects over the next two years, supplemented by grants and support from funders to be identified.

Responsible Department

This item is submitted by Deputy City Manager Karen Peters and the Office of Sustainability.

Attachment A

Creating a Cooler Phoenix

Strategy to Address Urban Heat

This report, co-authored by City of Phoenix staff and ASU is intended to serve as a starting resource for development of a comprehensive *Urban Heat Mitigation and Adaptation Plan* in the City of Phoenix by 2021.

Background on Urban Heat in Phoenix

As one of the hottest cities in the United States, Phoenix has a long history of adapting to climatic extreme heat and the urban heat island. Extreme heat is a consequence of the regional climate driven by global forces and increasing urbanization. The urban heat island results from heat being retained in the urban environment during the day and released slowly at night. Phoenix experiences some of the highest temperatures anywhere in the country. The all-time record is 122° F, set in 1990, and ten of the last 30 years have had temperatures reaching 118° F. Phoenix also experiences longer and warmer summers than most other places in the U.S. In 2016, 30 days exceeded 110° F, and the region averages nearly 100 days each year with temperatures over 100° F.

As hot as current conditions may seem, daytime and nighttime temperatures are increasing in Phoenix. Over the last 75 years, daily average temperatures have increased by about 5° F. More importantly, the number of days with maximum temperatures over 112° F, roughly the threshold that triggers certain emergency heat response measures, has increased from an average of 4 days per year to over 10 days per year and nighttime temperatures have increased almost 9° F. As further evidence of the urban heat island effect, the difference in temperature between rural areas and urban Phoenix increased from 5° F to 10° F.

These trends are likely to continue as we experience more impact from urban expansion and global climate change. Average temperatures in Arizona's urban areas increased at three times the rate of the Southwest during the 20th century. Modeling of the urban environment suggests that continued expansion of the region will increase the urban heat island and thereby increase average temperatures by as much as 4° F. To compound this, estimates of possible impacts of global warming on average temperatures over the next 50 years for the Phoenix region range from 3° F to 5° F. Estimates of future possible combined effect of expanded regional urbanization and climate change range from 1.8 to 10.8° F increase in the afternoon and 5.4 to 14.4° F at night by the end of the century.

Phoenix is already experiencing challenges from the impacts of extreme heat and future changes in heat could increase the impacts on residents and infrastructure.

Multi-Sector Impacts from Current and Projected Heat

Water - Over 50% of the water use in Phoenix is used outdoors, primarily for irrigation. The water required by plants to survive increases as temperatures increase, and compounds water supply issues in this region that has been experiencing drought conditions for the past twenty years. Recent research indicates that for each 1° F rise in nighttime temperature, water consumption increases by 1.4 -3.8%.

Energy - Air conditioning, the most effective tool in mitigating the health effects of extreme heat, requires additional energy as temperatures increase, and produces waste heat thus increasing the need for more air conditioning in a positive feedback loop. It is estimated that 5-10% of existing energy demand is used to compensate for the urban heat island effect. Increasing heat will not only increase the cost to cool but increases the vulnerability of the electrical infrastructure to failure and peak demand overload. Mechanical failures in transmission lines could increase almost 200% with a 1° C increase in average temperature.

Air Quality - Increasing heat can also affect air quality in two fundamental ways that are relevant for our region's long-standing challenges with ozone and particulate matter. Increased temperatures affect emissions of ozone precursors (e.g., organic vapors from gasoline tanks) as well as the chemical reactions that lead to ozone formation. Higher temperatures will also result in decreased soil moisture levels, which in turn will lead to increases in fugitive dust emissions and particulates. Elevated levels of either ozone or airborne particulates can result in increased rates of asthma hospitalization and other adverse effects to public health and healthcare systems.

Thermal Comfort - Increasing heat can make people feel more uncomfortable, decrease their quality of life, and lower their satisfaction with their neighborhood and city. Thermal comfort is a subjective measure affected by factors other than just heat, including behavior, perception, wind, humidity, and solar exposure. In 2017 the Central Arizona-Phoenix Long-term Ecological Research Project's Phoenix Area Social Survey asked people if, during last summer, were you ever too hot inside your home, and 38% answered yes. As extreme heat becomes more frequent and intense, achieving personal thermal comfort will become a greater challenge. The acceptable amount of time to be exposed to heat outdoors could be reduced for work, exercise, play, or walking or waiting for public transit. In some cases, increased exposure can lead to or exacerbate health issues, and in extreme cases, lead to fatal heat stroke and other causes of mortality that are linked to high temperatures, including heart attacks.

Health - Heat is the number one killer among natural hazard events in the United States and there are several factors that can affect the number of heat-related deaths, such as population growth, community cooling interventions, and the urban form. Heat does not affect all populations equally and research in Maricopa County has documented elevated risks for lower income households, isolated individuals, seniors, outdoor workers, and other vulnerable populations. The number and rate of heat-related deaths in Maricopa County has been highly variable from 2002 through 2018. However, the last three years

(2016-2018) have all had higher counts and rates than any other year in the period of record. Researchers have suggested that this recent increase may be attributable to reductions in social service programs that directly or indirectly protect people from heat. Beyond the 100 or more cases of heat-related deaths in the county each year, there are thousands of cases of heat-related illnesses that result in ambulance service calls, emergency department visits, overnight hospitalization, and other interactions with professional public safety and healthcare services. The clear correlation between heat-related mortality and morbidity and daily mean temperatures suggest that in the absence of additional interventions, projected warming for the region will pose additional health risks.

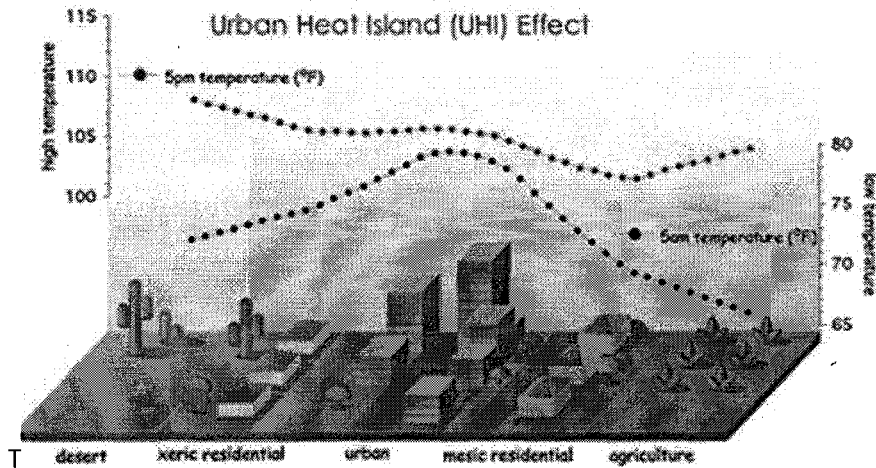
Economy - All these impacts can directly and indirectly affect the region's economy. Increases in the costs for water and energy limit the available funds to be spent on other needs. Heat impacts on comfort and health can affect labor productivity and costs, as hours that people can work outdoors shorten and hours lost to health problems increase. There are substantial healthcare costs associated with the thousands of cases of heat illness each year that require professional attention. Increasing heat will negatively impact people's lifestyles and they may choose to leave the region for some or all of the year rather than adapt. This may jeopardize future economic expansion as negative press will diminish the region's reputation. This issue of reputation can already be seen in national media stories about how hot Phoenix is and may become in the future.

The Dynamics of Urban Heat

There are several reasons why Phoenix is the hottest major city in the United States. The extreme heat that Phoenix experiences is a result of the regional climate and geography. Phoenix is located in subtropical latitudes and its location relative to the equator and the Pacific Ocean puts it in the Eastern Pacific subtropical high-pressure system which results in frequent weather patterns of high pressure with clear skies and dry air. The mountains in California trap the moisture coming from the Pacific making it drier in Arizona. Clear skies, high solar radiation, and dry air all contribute to high temperatures. These regional climate conditions will be impacted by changes in global climate patterns. Though there is uncertainty about the future of global climatic patterns, there is general agreement among climate scientists that the Southwest will become hotter and drier through the rest of this century.

The urban form of Phoenix also contributes to higher temperatures. As Phoenix has grown over the last several decades, many existing agricultural lands and deserts have been replaced with buildings, roadways, and parking lots that are built with concrete and asphalt. These urban materials have a high heat-storage capacity compared to the surrounding deserts and agricultural areas, absorbing more heat during the day and releasing back into the urban areas at night. Urban areas also generate waste heat through the heating and cooling of buildings, cars, and industry, thus compounding the problem.

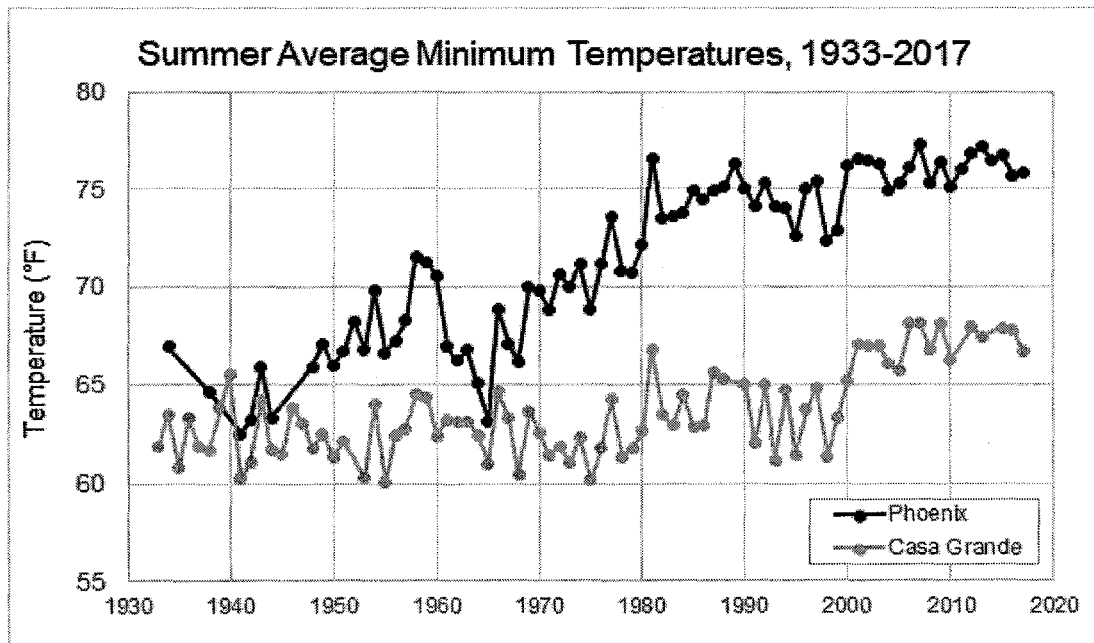
Figure 1: Urban Heat Island Effect



The result is that urban areas are as hot as deserts and hotter than agricultural lands during the day but cool off much slower than desert and agricultural areas at night. This effect is called the urban heat island (see figure 1).

Figure 2 compares the annual minimum temperature from 1950 to 2005 from Casa Grande National Monument, a rural area, with those for Sky Harbor Airport, an urban area. Both show an increase over time but the increase for Sky Harbor, 7.5°F is almost three times greater than Casa Grande's 2.3°F.

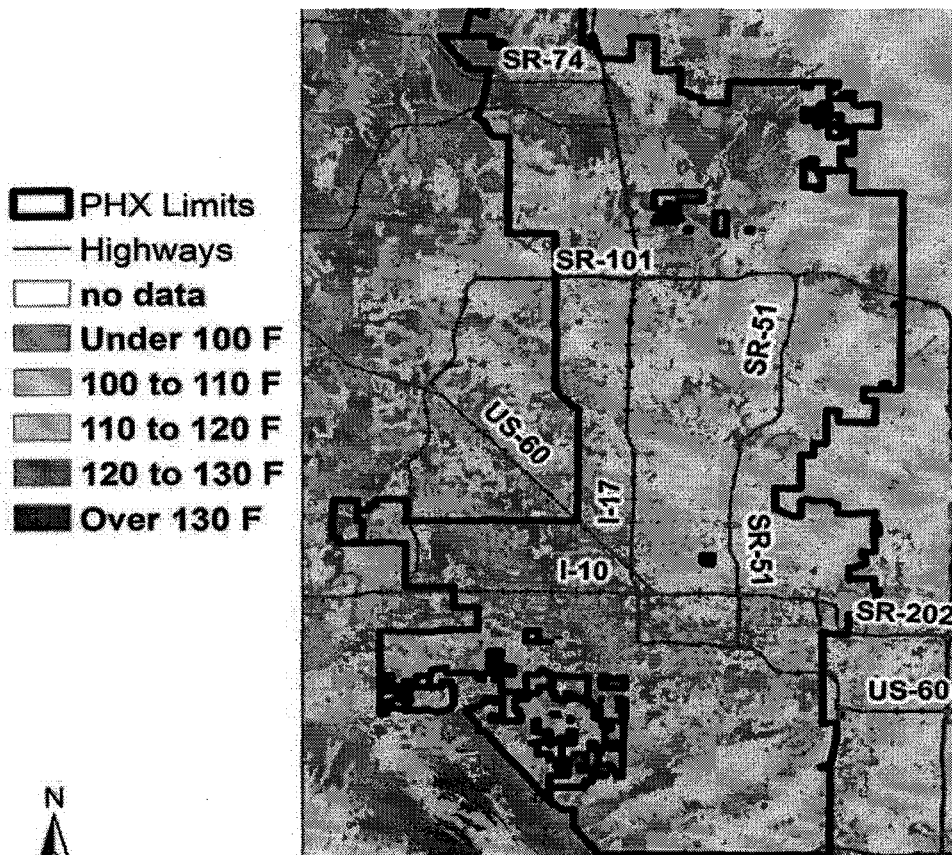
Figure 2: Summer Average Minimum Temperatures 1933 to 2017 Casa Grande and Phoenix, Arizona



The pathways between heat and its impact on comfort and human health can be complex and varied. How and when people are exposed to heat can be influenced by behavioral and demographic factors. When people are exposed to increasing heat, they may experience discomfort as a result of physiological changes such as elevated core temperature, sweating and dehydration, elevated heart rate, and impaired neurological function. Their ability to seek relief may depend on social and economic factors such as income and family support. The impact on health depends on many risk factors such as age, health status, gender, and metabolic workload.

Neither heat nor its impacts are uniform across the geography of Phoenix and there is not one “urban heat island” but, rather, many different microclimates within the city. Areas with less vegetation and more concrete or asphalt experience more intense urban heat. Thus, areas with industrial uses, dense office and commercial development, and higher density residential are typically hotter than areas with lower density development. Residential areas with less green landscaping will typically be hotter than areas with more grass and trees. Figure 2 is a heat map of Phoenix that shows how these patterns are dispersed across the city.

Figure 3: Estimated Surface Temperature in Phoenix at Noon June 26th, 2010



The impacts of heat are also not uniform across the population of Phoenix with some people, groups, and institutions more vulnerable to heat than others. The level of vulnerability is dependent upon exposure (weather conditions exacerbated by urban materials and vegetation), sensitivity (the extent to which people and systems can absorb impacts without suffering harm), and adaptive capacity (the ability to modify features or behaviors to cope with existing and anticipated stress). Exposure can be a factor of the weather or the conditions under which people live, work, and play. Sensitivity can be a factor of socio-economic conditions (such as the percentage of households living below the poverty level) and health conditions (such as diabetes). Adaptive capacity is a function of knowledge, attitudes and practices. These factors vary from institution to institution, neighborhood to neighborhood, and person to person.

Holistic Heat Management Framework Despite being a national leader in research and actions on urban heat, Phoenix, like most other cities, has not undertaken a holistic city-wide approach to addressing urban heat island and rising temperatures. On a global level, Phoenix and other cities are increasingly leading the way in developing actions to address climate-related hazards and climate change. In the Phoenix region, there is currently no single agency that has purview over the majority of the issues involved in mitigating and adapting to heat. Developing resilience to urban heat will require multiple city stakeholders, including other governmental agencies, non-governmental organizations, community groups, the private sector, and the scientific community, collaborating to share, plan, and implement strategies for heat mitigation and adaptation.

Phoenix has not been idle regarding heat mitigation and adaptation. It has been working with a wide range of agencies to partner on heat mitigation, adaptation and research projects. Key networks which city staff and partners are already embedded include the Maricopa County Bridging Climate Change and Public Health Initiative, the Urban Sustainability Directors' Network, the National Integrated Heat-Health Information System (convened by NOAA and the CDC), the Global Heat-Health Information Network (convened by the World Health Organization and World Meteorological Organization). Over the last decade Phoenix staff has been developing and implementing a wide range of heat mitigation and adaptation projects. These include tree and shade projects, cool roofs, heat relief, and neighborhood activities. The Appendix to this document list over 50 of these projects, several of which are featured in the Environmental Protection Agency's Community Heat Island Actions Database.

Arizona State University has been a leader in heat research and engagement for almost 30 years and has partnered with the City of Phoenix within many of these networks and the projects found in the Appendix. ASU has also been developing a HeatReady framework with the intent of providing cities and other institutions a guide and standard for developing heat mitigation and adaptation strategies. The HeatReady framework is being developed by researchers at Arizona State University who worked closely with city staff and community partners during the Bloomberg Mayors Challenge "Test, Learn, and Adapt" phase in which the city participated in summer 2018. HeatReady draws concepts from the highly successful "StormReady" program managed by NOAA and the National Weather Service. More than 2,000

communities across the United States are certified as StormReady; Phoenix was certified as StormReady in 2017. Through the Bloomberg Mayors Challenge, ASU researchers and city staff identified key elements to include in a city-based certification program focused on extreme heat that would parallel StormReady. HeatReady will offer cities tiered guidelines and recommendations by which they can recognize successful initiatives and identify opportunities to improve their portfolio and coordination of mitigation and adaptation activities.

Recommendation

To move forward it is recommended that Phoenix begin development of a systematic city-wide plan for addressing mitigation and adaptation for the urban heat island and rising temperatures. The scope of this Urban Heat Mitigation and Adaptation Plan should include a review of current and future trends, and the anticipated impacts of extreme heat and the urban heat island in Phoenix, goals for desired levels of comfort and health (and other outcomes) under extreme heat, strategies and policies for public, commercial, and private actions as well as ongoing monitoring (measurement) and evaluation.

Arizona State University has been engaged in heat research and engagement for almost 30 years, including the partnerships mentioned above. Based on this experience ASU has identified the following principles for heat mitigation and adaptation as applicable to development of the Phoenix Urban Heat Mitigation and Adaptation Plan.

- The effects of extreme heat and the Urban Heat Island can be addressed to maximize thermal comfort and cooling, and minimize energy and water use, especially within the urban core.
- The Urban Heat Island and extreme heat do not have a uniform impact across Phoenix and strategies to respond to its effects will vary from one location to another
- Prioritize cooling initiatives for:
 - The hottest areas of Phoenix
 - Vulnerable populations and areas with little shading and public cooling opportunities.
 - Enhanced shade throughout the city especially where thermal comfort is important such as high use public walking routes and transportation nodes.
 - Developing cool islands where people are concentrated.
 - City infrastructure projects in the design stage that could support cooling elements, such as buildings, streets, and landscaping.
 - Incorporate cooling guidelines into any zoning and design guidelines currently being revised.
- Implementing strategies to address the Urban Heat Island and extreme heat cannot be done solely by the city and the city alone. Broad public support is critical to success.

The process to develop this plan will likely take about two years to develop and adopt, including public participation during the development and public review before adoption. As the city develops its comprehensive heat mitigation and adaptation plan, it should continue its efforts to develop, promote, and enhance city-oriented projects, such as those in the Appendix. It should also continue to work with regional, national, and international partners to advance programs, policies, and initiatives beyond city boundaries. The city should also share its progress through these and other professional networks and participate in cross-organization working groups to learn best practices from other jurisdictions around the world.

Phoenix is well-positioned to serve as the initial case study for the HeatReady program, which will be a national, city-oriented initiative that facilitates knowledge exchange between cities and offers a set of evaluation and certification criteria. By working closely with ASU researchers in the development of Phoenix's comprehensive mitigation and adaptation plan, the city will have access to leading contemporary national and international insights regarding the components of effective urban and extreme heat management strategies.

Attachment B

Successful Past Projects and Actions

In the last decade, the City has developed and implemented over 50 successful urban heat island (UHI) mitigation projects. While combating the effects of UHI, these projects have led to a more united, vibrant, and healthy community within the Phoenix metropolitan area. In order to build on this momentum and foster future changes, it is necessary for Phoenix to identify the key strategies that will result in the greatest impact in heat mitigation, and then identify the best approach to implementing those strategies. A list of the most notable projects include:

Major Projects:

1. *Tree and Shade Master Plan*

Adopted by City Council in 2010, the plan seeks to double the urban tree canopy to 25% by 2030. The goal of the plan includes creating a healthier, more livable and prosperous city through strategic investment in the care and maintenance of the urban forest and engineered shade. By implementing the Plan, the City will fight the effects of the urban heat island while enriching the city and the lives of its residents.

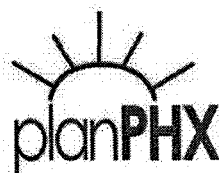
Addresses outcomes related to shade, cool pathways/walkability, and parks and natural systems.

Department(s): Parks and Recreation & the Office of Sustainability

2. *Plan PHX*

Lead by the Phoenix City Council, the project collaborates with residents about the future of Phoenix. As a result of thousands ideas from more than 150 meetings, a new vision and framework has been developed that is built around the promise of creating a Connected Oasis.

This new promise will serve as the guiding principle in the update of the Phoenix General Plan.



GENERAL PLAN 2015
A Blueprint for a Connected Oasis

Addresses outcomes related to complete streets, community health, parks and natural systems, and community outreach and education.

Department(s): Plan PHX Leadership Committee and Planning and Development

3. **Bicycle Master Plan:** The plan sets the course for the next 20 years for the development, growth and connectivity of bicycle facilities in Phoenix. Phoenix will become a Platinum-level Bicycle Friendly Community. It will be safe and easy to bike anywhere in the city. A well-connected infrastructure network will link people and places, making bicycling a preferred option for daily transportation, recreation, and healthy lifestyles. The plan provides new policies for bicycle facilities, traffic control practices, and proposals for facilities at destinations, such as parking or shower facilities. As a first step, the City implemented the GRIDBikes system in 2014—a bike share network along the light rail that has since been expanded to Tempe and Mesa. It includes over 800 bicycles but may expand to over 1000 bikes by 2020.



Addresses outcomes related to complete streets, community health and reducing GHG emissions.
Department(s): Street Transportation

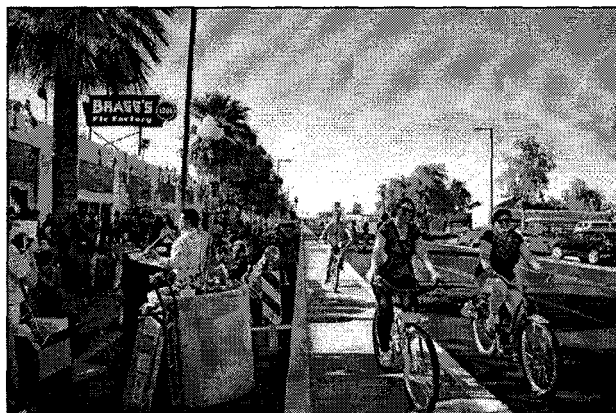
4. **Transportation 2050** Approved by Phoenix voters in 2015, Transportation2050 is a 35-year citywide transportation plan that aims to dramatically expand investment in Phoenix for bus service, light rail construction and street improvement. Additional emphasis has been placed on street needs from street maintenance to new pavement, bike lanes, sidewalks, and ADA accessibility to complement an increase in transit services. Transit plans also include the building of more than 200 new shade structures for bus riders during hotter months.



Addresses outcomes related to complete streets and shade.
Department(s): Public Transit and Street Transportation

5. **Complete Streets Program**

Established guiding principles and practices so that transportation improvements are planned, designed, constructed, operated, and maintained to develop an accessible, safe, reliable, efficient, integrated, convenient and connected multimodal transportation system. The system promotes active transportation and public health, and accommodates people of all ages and abilities.



Addresses outcomes related to complete streets, community health and cool pathways/walkability.

Department(s): Street Transportation

6. **Reinvent PHX**

A collaborative partnership between the city, the U.S. Department of Housing and Urban Development, Arizona State University, St. Luke's Health Initiatives and several other organizations. The team made a commitment to developing walkable, opportunity-rich communities connected to the light rail. As a result of this partnership, action plans have been created for districts along the light rail system to establish a community-based vision for the future. Additionally, the partnership identified investment strategies to improve the quality of life for all residents.



Addresses outcomes related to complete streets, cool pathways/walkability, community health, and community outreach and education.

Department(s): Planning and Development

7. **Walkable Urban Code (WU Code)**

As part of the Reinvent PHX project, a new urban and transit-oriented zoning code, the Walkable Urban (WU) Code, was adopted by City Council on July 1, 2015 (Ordinance G-6047). It improves walkability through a requirement for 75% shading in the walkable areas around the site. The Walkable Urban (WU) Code is Chapter 13 of the City of Phoenix Zoning Ordinance. To learn more view : [WU Code Handout](#)

Addresses outcomes related to complete streets, cool pathways/walkability, community health, and community outreach and education.

Department(s): Planning and Development

8. Cool Roofs Initiative

The implementation of the Phoenix Cool Roofs Initiative in 2012 further supports the goals of the Green Construction Code. The initiative coated 70,000 square feet of public roof tops with reflective materials and resulted in average 17% energy savings for the participating buildings.



Addresses outcomes related to resource efficient infrastructure.

Department(s): Public Works

9. Energize Phoenix

Funded by a \$25 million grant from the U.S. Department of Energy and the American Recovery and Reinvestment Act. The project was designed as a large-scale, three-year pilot program to provide energy efficiency upgrades in buildings along Phoenix's new Light Rail Corridor. The



program substantially exceeded the program's stated goals. Over 33 million square feet of commercial space was retrofitted/updated, as well as 2,014 square feet of residential space. The program helped stimulate economic growth by adding \$31 million to the local economy. Participants annual energy consumption was reduced by 135 million kilowatt-hour (kWh) translating into over \$12.5 million of annual energy cost avoidance for the community. Additionally, greenhouse gas emissions were reduced by 95,000 metric tons of carbon dioxide equivalent

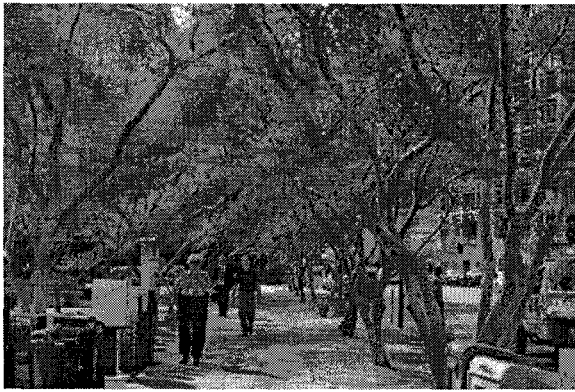
and the project payback period for total investment was a mere 4.5 years.

Addresses outcomes related to resource efficient infrastructure and reducing GHG emissions.

Department(s): Office of Environmental Programs

10. Third St. Shade/Downtown Urban Form Plan

Sponsored in 2008 by the Maricopa Association of Governments (MAG) Pedestrian Design



Assistance Program, the project aims at improving traffic circulation and mobility for pedestrians and bicyclists. Modifications include reducing the number of travel lanes, adding bicycle lanes on both sides of the street, landscaping enhancements, street lighting upgrades, sidewalk and ADA improvements, and safer street crossings for pedestrians.

Addresses outcomes related to shade, complete streets and cool pathways/walkability.

Department(s): Planning and Development

11. Let's Grow Phoenix Gardens

In 2012, the city received a \$100,000 grant from Cities of Service to implement the Let's Grow Phoenix Gardens initiative. The project addressed the lack of access to healthy foods for residents in public housing

communities. As part of the initiative to increase urban gardens, the city recruited volunteers to help transform dormant property, courtyards and land in three public housing facilities into vibrant garden spaces, which now provide a healthy source of food for low-income residents. The effort also combined educational



courses in cooking and nutrition curriculum in support of then Mayor Greg Stanton's priority to create access to healthier foods.

Addresses outcomes related to community health, parks and natural systems, and a vibrant food system.

Department(s): Office of Environmental Programs

12. Phoenix Brownfields to Healthfields

The City's Office of Environmental Programs was awarded a \$400,000 community-wide brownfields assessment grant from the U.S. Environmental Protection Agency. The goal of the



project includes removing hazardous substances and pollutants from identified brownfield properties and redeveloping these properties into uses that improve public health. The properties are being reused for healthcare facilities, clinics (permanent and mobile), healthy food outlets, supermarkets, temporary food retailers, mobile markets, urban agriculture, food hubs, community/school gardens, and farmer's markets.

Addresses outcomes related to a vibrant food system and community health.

Department(s): Office of Environmental Programs

13. Rio Salado Habitat Restoration Project

The area stretches along five miles of the Salt River just south of Downtown Phoenix. The site was once used for dumping and is now a lush riparian corridor. The habitats vary from wetland ponds to mesquite bosque to cottonwood/willow forest. The area is frequented by bird watchers who have identified over 200 species of birds (and counting...) as well as hikers, bicyclists, joggers, and even horseback riders.



Addresses outcomes related to parks and natural systems and resource efficient infrastructure.

Department(s): Parks and Recreation

14. Phoenix Mountain Preserve and Adaptive Management Plan

At more than 16,000 acres, South Mountain Park/Reserve is one of the largest municipally operated parks in the country. The park faces numerous challenges from increased use, expanding adjacent development, and a growing network of potentially unsafe and unsustainable non-designated trails. The South Mountain Trails Master Plan was developed as a planning and implementation tool to address these problems. In addition to this strategy, the city is launching a roadmap of infrastructure improvements expected to be completed over the next 5 years, prior to the park's centennial in 2024.



Addresses outcomes related to park and natural systems and community health.

Department(s): Parks and Recreation

15. Aviation Land Reuse Strategy

Phoenix Sky Harbor International Airport has acquired noise-impacted land as part of its Community Noise Reduction Program. The strategy includes approximately 750 voluntarily-acquired parcels. The airport has contracted with a consultant team which will assist in recommending compatible land uses or the area and appropriate redevelopment strategies consistent with airport and community goals. The reuse options will provide economic and community benefits to the airport and the local community. As part of the strategy, the airport and consultant team will provide a market analysis and community outreach to promote public engagement. This process will set short and long-term goals addressing growth of the area to balance the priorities of residents, businesses, and stakeholders.

Addresses outcomes related to community health.

Department(s): Aviation



16. Del Rio Area Brownfields Plan

The project has been funded through a grant from the U.S. Environmental Protection Agency and developed by the City of Phoenix Office of Environmental Programs, in partnership with the



Planning and Development Department. The plan helps guide the redevelopment of brownfield sites within the area, direct the assessment and cleanup of sites, and identify resources available to assist with redevelopment. The plan focuses on the Del Rio Area, which is located within the South

Mountain Village and within one mile of the downtown Phoenix area.

Addresses outcomes related to community health.

Department(s): Office of Environmental Programs

17. Heat Relief Network and "We're Cool" Campaign

A partnership between the Maricopa Association of Governments (MAG), municipalities, nonprofit organizations and faith-based communities that provides refuge from the Arizona heat for those in need. Donation-stocked hydration stations are activated to provide additional aid. The network also supports online posts including community news bulletins, tips for staying cool, weather reports, and signs of heat exhaustion.



Addresses outcomes related to extreme heat emergency and disaster readiness, community health, and community outreach and education.

Department(s): Human Services, Neighborhood Services, City Manager's Office/Volunteer Phoenix, Emergency Management

18. Resilient PHX

Phoenix's Chief Service Officer, Michael Hammett, and the Resilient PHX AmeriCorps VISTA team organize extensive volunteer-based outreach efforts that canvas vulnerable neighborhoods and transit stops to educate citizens on the availability of vital resources to prevent heat-related illnesses.

Addresses outcomes related to extreme heat emergency and disaster readiness, community health, and community outreach and education.

Department(s): City Manager's Office/Volunteer Phoenix, Emergency Management

19. Violence Impact Project – West Phoenix Revitalization

A project that serves as a culmination of a city initiative and the ongoing expansion of Grand Canyon University. The project focuses on a section of the Black Canyon Corridor in which it aims to revitalize neighborhoods and reduce crime. In order to accomplish this goal, multiple city departments have united to address homelessness, drug crimes, prostitution, and mismanaged apartment complexes and businesses.

Addresses outcomes related to community outreach and education and community health.

Department(s): Police

20. Choice Neighborhoods Initiative

The \$1.5 million Choice Neighborhoods Planning and Action Grant from the U.S. Department of Housing and Urban Development (HUD) led to an eventual \$30M grant to implement the project.



The initiative will transform distressed neighborhoods and public housing into mixed-income neighborhoods linking housing improvements with schools, public assets, transportation, and access to jobs. The project has three primary goals including, replacing distressed public housing with high-quality mixed-income housing that is well managed and fulfills the needs of neighborhood residents; improving educational

outcomes and the intergenerational mobility for youth with services and supports delivered directly to youth and their families; and creating conditions necessary for public and private reinvestment in distressed neighborhoods to offer assets (i.e. good schools) that are important to families' choices about their community.

Addresses outcomes related to community outreach and education and community health.

Department(s): Housing

21. Tres Rios Environmental Restoration

The project involves the rehabilitation of nearly 700 acres in and around the Salt River. The project creates a synergistic relationship between the renewed wetlands and the nearby wastewater treatment facility. The reclaimed water from the wastewater treatment facility is pumped across the street to the wetlands, where the plants and animals naturally filter the water before it is discharged back into the Salt River. The wetlands are now home to more than 150 different species of birds and animals which are attracted to the lush cottonwood groves, willows, and mesquites that border the reed-lined ponds.



Addresses outcomes related to parks and natural systems and community health.

Department(s): Water Services

22. Park and Storm Drain Infrastructure

Following the massive 100-year storm that swept through the Valley in 2014, the city has initiated numerous recovery efforts to improve its stormwater retention and flood control infrastructure. Since the storm, the city has completed approximately \$7.5 million of work to restore and improve stormwater drainage along roadways in the South Mountain and Laveen areas, which bore the brunt of the rainfall. Plans have also been finalized to add to the \$66 million of storm water control projects completed in the area in the past 20 years. Plans include work to improve drainage along rights of way, clear and improve stormwater corridors, and begin the construction of the largest stormwater retention basin in the area (36 acres).

Addresses outcomes related to extreme heat emergency response and disaster readiness.

Department(s): Public Works

23. Alternative Fuel for City Buses and City Vehicle Fleet

The city operates one of the largest alternative fuel fleets in the nation with approximately 2,900 vehicles using CNG, LNG, ethanol flex-fuel, or electric hybrid technology. After a successful pilot program in 2007, the city began using a blend of 80 percent diesel and 20 percent biodiesel (B20) in the non-transit vehicle fleets and diesel equipment. The city owns flex-fuel vehicles that are capable of using a blend of 85 percent ethanol (E-85) and has invested in the construction of four E-85 compatible fuel tanks to fuel approximately 500 vehicles.



Addresses outcomes related to reducing GHG emissions.

Department(s): Public Transit

Minor Projects:

1. *Taylor Mall*

A joint project between the city and Arizona State University that utilized low impact development practices to increase retention and minimize storm water runoff. Curb cuts were used to allow storm water from the street to drain into retention areas and bio swales between the sidewalk and the curb. Additionally, the project used permeable pavers to pave on-street parking spaces and sidewalks, and permeable recycled-glass paving was added to bus stops.

Addresses outcomes related to shade, resource efficient infrastructure and community outreach and education.

Department(s): Streets Transportation

2. *Love Your Block Phoenix*

A mini-grant program that engages with Phoenix community members to help revitalize their neighborhoods. The program is funded by Cities for Service and is led by the Mayor's Office, City Manager's Office Volunteer Phoenix Program and Neighborhood Services Department. In June 2015, the City was awarded with two AmeriCorps VISTA members for three years and \$30,000 to plan and implement the mini-grant program in low to moderate income neighborhoods over a three-year period. Each year, five community groups are awarded \$1,000 to implement the proposed changes in their neighborhoods.



Addresses outcomes related to shade, cool pathways/walkability, parks and natural systems, and community outreach and education.

Department(s): City Manager's Office, Mayor's Office/Volunteer Phoenix, Neighborhood Services

3. *Urban Phoenix Tree Planting Project*

Funded by the Love Your Block mini-grant program, the project has planted trees in downtown Phoenix, with more planting projects scheduled. The project aims to raise awareness around the



value of trees planted, increase the walkability and livability of downtown Phoenix, and become another step towards reaching the goal of 25% shade canopy coverage for the city in the Phoenix Tree and Shade Master Plan. The plan aims to increase the shade canopy coverage for Phoenix through strategic investment in care and maintenance of the urban forest and engineered shade.

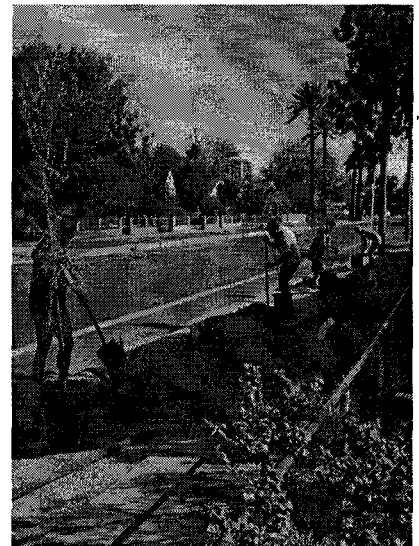
Credit: Alyssa Hagerbrant

Addresses outcomes related to shade, cool paths/walkability, parks and natural systems, and community outreach and education.

Department(s): Street Transportation, Neighborhood Services, Parks and Recreation, City Manager's Office/Volunteer Phoenix

4. *Triangle Neighborhood Tree Planting :*

In November 2016, the Resilience AmeriCorps and Love Your Block teams, funded by Cities of Service, supported the planting of 33 trees in the Triangle Neighborhood of Downtown Phoenix. The neighborhood had been identified as a heat island. The project aligned with the City's broader goals of increasing the tree canopy of the entire city. In addition, the lead resident volunteer coordinated with property owners to receive a free tree if they agreed to water and care for it. ASU Professor and State Climatologist Dr. Selover installed heat temperature sensors to measure surface temperature changes of the project over time. The group has also been funded for an additional 5-7 trees to be planted in Fall 2017. This project also led to the development of a Community Tree Shade Blueprint to serve as a guide for resident driven tree planting projects in Phoenix.



Addresses outcomes related to shade, cool pathways/walkability, parks and natural systems, and community outreach and education.

Department(s): City Manager's Office/Volunteer Phoenix

5. *Burton Barr Library*

A canopy system of 42 slanted solar panels that shade 84 parking spaces. The panels benefit the library in the form of low-cost energy, with each panel was installed at Burton Barr Central Library in 2011 producing enough energy to power 0.6 homes. The Energy Efficiency Conservation Block Grant from the American Recovery and Reinvestment Act funded the \$1.3 million project.

Addresses outcomes related to shade, resource efficient infrastructure, and reducing GHGs.

Department(s): Library, Public Works

6. *City Hall Parking Garage and Washington St. Parking Garage*

Two solar arrays provide 32% (1.18 mW) of the parking garages' electricity needs.

Addresses outcomes related to shade, resource efficient infrastructure, and reducing GHGs.

Department(s): Public Transit, Public Works, Convention Center

7. *Ahwatukee Foothills Park-and-Ride*

A partnership between Salt River Project (SRP) and the City to install solar panels on covered parking structures at the park-and-ride facility. The project cost \$1 million to install and produces 102 kW.

Addresses outcomes related to shade, resource efficient infrastructure, and reducing GHGs.

Department(s): Public Transit

8. *People United Fight Back Neighborhood*

Love Your Block funded a beautification project near 24th St. and Broadway that included the planting of more than 100 shrubs to help mitigate the heat island effect. This project leveraged additional support from HandsOn Greater Phoenix to complete phase two of the project focusing on tree shade. The project took place in late 2017 and early 2018 via \$15,000 in funding.



Addresses outcomes related to shade and parks and natural systems.

Department(s): City Manager's Office/Volunteer Phoenix

9. Curb Cut/Tree Shade

Resilient PHX is leading a curb-cut /tree shade demonstration project along Grand Avenue. This project will serve as a demonstration of how residents can create rain water mitigation systems and tree shade. Street Transportation is providing support on this project.

Addresses outcomes related to shade, cool pathways/walkability, parks and natural systems, and community outreach and education.

Department(s): City Manager's Office/Volunteer Phoenix, Street Transportation

10. Civic Space Park

This sustainable multi-use space boasts many unique characteristics. The park's benches and decking are made from recycled materials, the concrete and pavers are pervious reducing heat reflection and runoff, and solar panels create shade while producing 75Kw of electricity. Once the trees have reached maturity, they are expected to shade 70% of the park space.



Addresses outcomes related to shade, resource efficient infrastructure and reducing GHG emissions.

Department(s): Parks and Recreation

11. Sonoran Preserve Master Plan

The plan establishes the goal of acquiring land to maintain species diversity and ecological processes, while providing a recreational resource. A total of 9,100 acres has been acquired so far.

Addresses outcomes related to parks and natural systems.

Department(s): Parks and Recreation

12. City of Phoenix Green Business Leader Program

Recognizes and promotes businesses that volunteer to operate in a more environmentally responsible manner through waste diversion. The goal of the program is for the participants to agree to a three-year commitment to offer recycling services and to properly separate recycles from trash. A Zero Waste team is available to provide presentations, training, and audits to ensure program success.



Addresses outcomes related to community outreach and education and reducing GHG emissions. **Department(s):** Public Works

13. WaterSmart Workshops

Provides residents with landscape and conservation workshops which are designed to help teach citizens how to use water wisely while enhancing their lives and the planet.

Addresses outcomes related to community outreach and education.

Department(s): Water Services

14. SustainPHX Literacy Project

A program that is designed to educate employees and residents, particularly youth, about the importance of sustainable living. The program is run by the Phoenix Green Team, an interdepartmental team that embraces sustainability and strives to weave sustainability into city culture through community engagement, activities, programs, education and awareness. As part of the program the Team worked together to create a description for the student sustainability officer position for which a senior at Phoenix's Bioscience High School was elected. The student is the first student sustainability officer elected to an Arizona Student Council.



Addresses outcomes related to community outreach and education.

Department(s): Sustainability

15. Internal Safety Standards

The Employee Safety Manual provides internal standards and safety guidelines for City employees to enable them to recognize signs of heat exhaustion and be educated on hydration recommendations should they be needed.

Addresses outcomes related to community outreach and education.

Department(s): Human Resources, Planning and Development

16. Public Water Conservation – “Water Use It Wisely”

A partnership between the Arizona Department of Water Resources, Salt River Project (SRP) and several cities within Maricopa County. Provides information and workshops geared toward water efficient landscaping and reducing residents' overall water consumption.

Addresses outcomes related community outreach and education

Department(s): Water Services

17. Incentivized Transit Use for City Employees

City of Phoenix employees receive free or discounted bus and light rail fares. This employee benefit reduces congestion during daily commutes as well as emissions from single- occupant vehicles.

Addresses outcomes related to reducing GHG emissions.

Department(s): Public Transit

18. Express Bus Routes

The Express Route is a weekday commuter service operated by Valley Metro. The route runs to and from downtown Phoenix from other cities in the Valley bringing passengers from the suburbs into the downtown corridor.



Addresses outcomes related to reducing GHG emissions.

Department(s): Public Transit

19. Trip Reduction Program

The result of a state statute passed by the Arizona Legislature in 1988 to comply with federal air quality standards. Maricopa County adopted an ordinance to ensure compliance. The program reduces air pollution and traffic congestion by reducing drive-alone trips and miles to the work site. Employers and schools with 50 or more employees or driving age students in Maricopa County are required to participate. The city's program includes carpool parking subsidies, free bus/light rail passes for employees, emergency ride home cab vouchers, telecommuting, bicycle facilities, and other incentives.

Addresses outcomes related to reducing GHG emissions and community health.

Department(s): Office of Environmental Programs











20. Mandated Carpool at Police Academy

The Phoenix Regional Policy Academy requires new recruits to carpool to and from the academy. During their first week, recruits are instructed to find others in their class who live in close proximity to them and begin carpooling. It is not uncommon to have more than two recruits carpool.

Addresses outcomes related reducing GHG emissions.

Department(s): Phoenix Police Department

A. Outcomes of mitigation strategies

<p>Shade</p> 	<p>Vibrant Food System</p> 
<p>Complete Streets</p> 	<p>Extreme Heat Response and Disaster Readiness</p> 
<p>Cool Pathways/Walkability</p> 	<p>Community Outreach and Education</p> 
<p>Resource Efficient Infrastructure</p> 	<p>Community Health</p> 
<p>Parks and Natural Systems</p> 	<p>Reduce GHGs</p> 

Outcome Descriptions

Shade



Phoenix has set an ambitious goal of reaching 25% tree and shade canopy for the entire city by 2030. This goal works in tandem with efforts being implemented to mitigate the growing effects of urban heat island. Projects that support the strategic planting of desert-adapted trees, shrubs and community gardens enable the city to better reach this goal—whether they are an increase in the number and size and trees or structured shade positioned over sidewalks and transit stops. City efforts to increase the tree and shade canopy will lead to increased community health and walkability.



Complete Streets

Changes in Phoenix residents' way of living calls for a shift away from more traditional methods of transportation toward more multi-modal ones. Phoenicians are found to be incorporating more active types of transportation into their daily lives (i.e. walking or cycling), leading to a need for safe and well planned neighborhoods that best serve the needs of their communities. Increased use of the public transit system reduces harmful vehicle emissions and traffic congestion during peak commuting hours. Projects that support interconnected healthy communities may focus on increasing walkability via shaded pathways, safe and connected bike lanes, and easy access to a number of public transit options.



Cool Pathways/Walkability

While many citizens still rely on their personal vehicles as their primary mode of transportation, many more find themselves walking to access public transit stops, biking, or simply walking to closer destinations. Heat exhaustion and other heat related illnesses are likely to arise from pathways that do not offer shade or cooler ambient air temperatures. Cool pathways for these commuters are essential, especially during hot summer months. Projects that support cool pathways and increased walkability include the installation of shade structures along sidewalks and at transit stops, increased canopy cover from trees and man-made structures, and use of specialized materials that do not retain heat in the way traditional materials do.



Resource Efficient Infrastructure

Many UHI mitigation techniques are rooted in resource efficient infrastructure requirements. Traditional building designs have been found to exacerbate the urban heat island effects, leading to high ambient air temperatures around buildings. Resource efficient infrastructure is encouraged through legislative actions such as green building codes, community service projects, and certification programs such as LEED.



Parks and Natural Systems

Research has recently highlighted the connection between community health and access to green spaces. While the formation of such spaces might appear challenging in a desert environment, there are numerous ways in which to incorporate sustainable parks and green spaces. Project opportunities range from large to small – riparian habitat restoration to community garden. Incorporating natural systems not only reduces ambient air temperatures, it also supports healthy activities and hobbies such as biking, birding, and access to nutritious foods.



Vibrant Food System

Community gardens have the potential to address numerous problems within urban spaces. The gardens provide residents with access to green spaces as well as healthy foods. Phoenix is actively working to eliminate food deserts through these projects such as this, while also supporting the health of the community. Urban community gardens are popping up in vacant dirt lots contributing to a more vibrant food network.



Extreme Heat Response and Disaster Readiness

To quickly and effectively address problems arising from extreme conditions, the city must have cohesive plans and resources in place. Multi-pronged strategies will be heat essential and include public outreach in the form of community bulletins, safety tips, and refuge and/or hydration stations.



Community Outreach and Education

Educating and engaging with the public increases the city's ability to combat climate concerns. Workshops and tutorials on topics such as planting trees and residential water conservation relay valuable skills and knowledge, while also bringing about voluntary changes within the community. Today's youth will be tomorrow's decision makers. As such, valley youth should be educated on the problems facing the city and the best ways in which to address them. Engaging students in the decision making process early on will equip them for future decision making and problem solving.



Community Health

Community health is an outcome around which all others revolve. Each project is designed to address urban heat island effects with an overarching goal being a healthy, thriving and sustainable community.

However, not all Phoenix communities possess the adequate resources to reach this goal. Many require the assistance of the city, community volunteers and non-profit organizations. Projects that support collaboration and community health include community gardens, remediation of brownfields, and the installation of parks and recreational areas.

Reduce GHGs



As the fifth largest city in the nation, Phoenix has been faced with the challenge of reducing its greenhouse gas emissions (GHGs) amid continued rapid growth. There are numerous ways that the city can address this problem, many of which the city is already pursuing. These projects include use of alternative fuel methods and public transit options, installation of solar panels of city rooftops, and construction of LEED certified buildings.