COMMITTEE MEMBERS

Alan Journet	Southern Oregon Climate Action Network
Christina Medina	Pacific Power Energy
Cody Scoggins	Medford Water Commission
Greg Jones	Abaela Wines
Josh Lebombard	Oregon Department of Land Conservation and Development
Julie Smitherman	Medford Water Commission
Marty Main	Small Woodland Services
Rianna Koppel	True South Solar
Ryan Battleson	Oregon Department of Fish and Wildlife
Ryan Sandler	National Oceanic and Atmospheric Administration
Shavron Haynes	Jackson County Water Master
Steve Vincent	Avista Natural Gas
Stuart Warren	Oregon Land Development and Conservation Commission
Mike Zarosinski	City Council Member
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CITY STAFF

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Globally, the world has reached a point from which it is not possible to avoid the impacts of climate change. Although potential future impacts of climate change vary from mdoel to model, as global climate emissions continue to climb, more severe climate impacts are generally thought to be a likely scenario.

The United States is home to millions of unique biome's that will all be impacted by climate change differently, making the need to develop adaptation and resiliency plans at the local level exceptionally important. While no plan can comprehensively address all the ways in which climate change will impact humans and our built and natural environments, this plan has focused on four key areas that the City of Medford can strategically address to effectively mitigate the effects of climate change.

Our process for developing the Climate Adaptation and Resiliency Plan is to first identify potential city-wide vulnerabilities. The vulnerabilities report relies on an existing body of research to identify how natural systems in the Rogue Valley may change, and the corresponding impacts of those changes on the regional economy, built environment, public health, and community. While we are no longer able to stop the effects of climate change, strategically working to improve resiliency and adaptation can help mitigate the effects of climate change, protecting quality of life. Research to understand our vulnerabilities will be ongoing, as new data becomes available.

The second part of this plan will identify key strategies for improving resiliency and adaptation. The Medford Planning Department will work closely with the Climate Adaptation and Resiliency Plan Committee and stakeholders to identify and develop climate change solutions. Any meaningful response, while led by the City of Medford, must be supported by an array of stakeholders to succeed. Regional opportunities to partner in addressing concerns related to climate change will be explored and pursued wherever possible.

HOW TO USE THIS DOCUMENT

This report on *Vulnerabilities* is an introductory document to identify ways that the City of Medford may be impacted by climate change. It should be used to guide research and support policy, regulation, and program development to improve resiliency and adaptation.

This document was created by Medford city staff with guidance from the Climate Change Adaptation and Resiliency Plan Steering Committee, composed of local subject area experts, business owners, and advocates. With a focus on adaptation and resiliency, this group developed goals and actions to guide city intiaitives for a more resilient future.

1

COMMUNITY MEMBERS ARE ENGAGED AND EMPOWERED TO CONTRIBUTE TO CLIMATE ADAPTATION AND RESILIENCE IN A WAY THAT IS BROADLY INCLUSIVE AND TRANSPARENT.

- Inclusive and accessible information about climate change adaptation and resiliency.
- Improved community understanding of incentive programs to reduce water and energy use among renting and owning households and commercial enterprises.
- Greater awareness of green jobs programs and greater connection between workers in vulnerable sectors to career learning opportunities.

2

POLICY ADVOCACY AND REGIONAL PLANNING EFFORTS RELATED TO CLIMATE CHANGE ARE PROACTIVE AND COORDINATED TO ACHIEVE GREATER RESILLIENCY AT ALL SCALES, FROM RESIDENT TO REGION.

- Support regional efforts to reduce impacts of climate change.
- Support state and federal legislation that address the effects of climate change on city operations and residents and businesses located within the City.

3

LOCAL POLICY PROMOTES A MORE RESILIENT BUILT AND NATURAL ENVIRONMENT AND LCOAL ECONOMY. THE COSTS AND BENEFITS OF RESILIENCY ARE SHARED EQUITABLY.

- Citry policies (regualtions, investments, etc.) achieve more equitable outcomes that deliberately consider disparate impacts of climate change on different communities, particulary the most vulnerable members of our community
- Resillient community that is prepared for natural disasters at the neighborhood level.
- Support local businesses and entrepeneurial efforts that address the effects of climate change and reduce climate vulnerabilities.
- Promote resiliency in the built environment.
- Protect natural systems and wildlife habitat from climate change impacts.
- Prepare for abrupt population change.
- Reduce water and energy demand.
- Mitigate Urban Heat Island effects.

See Part II of the CCARP for a full list of community visions, goals, and actions.

Future climate projections are created by combining historic climate data, observed real-time environmental change, and measurements of greenhouse gas emissions into complex models that attempt to predict future climate conditions. While these models are based on the best available science, they cannot consider every variable that may interact to make future climate outcomes more or less extreme.

The Representative Concentration Pathway (RCP)[1] models different climate futures based on the volume of greenhouse gases emitted in the years to come. This model is used by the International Panel on Climate Change (IPCC)[2] and the State of Oregon to guide planning and preparedness efforts. The State of Oregon in their Fifth Climate Assessment (2021)[3] have used RCP2.5, an intermediate scenario assuming that emissions will peak around 2040 then decline, and RCP8.5, which assumes that emissions will continue to rise throughout the 21st century.

The City of Medford has not created any unique data or reports for this plan, but has collected findings from: The State of Oregon's Fifth Climate Assessment (2021)[2]; Climate Change Vulnerability and Adaptation in Southwest Oregon (2022)[4] developed by the USDA and U.S. Forest Service; Climate Change Vulnerability and Adaptation in South-Central Oregon (2019)[5] developed by the USDA and US. Forest Service; and Climate Wise Rogue River Basin (2008)[6] prepared by the Resource Innovation Group, Geos Institute, USDA Forest Service, and the Pacific Northwest Research Station.

The consensus among these reports is that the Rogue River region will experience hotter and drier conditions and shifts in precipitation, with more precipitation falling as rain (particularly during winter months) and declining snowpack. These changes will have profound impacts on the local environment and economies as droughts intensify, wildfire risk increases, water and air quality declines, and our natural ecosystems deteriorate. The degree to which these events impact quality of life in the City of Medford depends on our regional approach to emission reductions, adaptation, and resiliency.

ACUTE CLIMATE CHANGE

Refers to weather events like wildfire that immediately effect the environment. The Internal Displacement Monitoring Center[7] estimates that in 2020 alone, 1,714,000 persons were internally displaced in the United States from extreme weather events. Locally, the 2020 Almeda Fire[8] destroyed 2,700 structures, immediately displacing approximately 3,000 residents, many of whom are still experiencing housing insecurity.

SLOW ONSET CLIMATE CHANGE

Refers to the risks and related impacts of gradual shifts in climate, like drought and the loss of biodiversity. Locally, slow-onset climate change required the Federal Bureau of Reclamations to reduce water allotments for agriculture in the Klamath Basin[9] in an attempt to save endangered fish species. The impact has been reduced crop yields, lost fishing and subsistence opportunities, lost revenues associated with outdoor tourism and recreation, and rising social tensions.[10]

TEMPERATURE

The Fifth Oregon Climate Assessment (2021)[2] reports that Oregon's' annual average temperature increased by about 2.2^0 (F), per century since 1895. If there is no significant reduction in emissions, temperature in Oregon is projected to increase an average of 5^0 (F) by 2050 and 8.2^0 (F) by 2080. Summer temperatures may be as much as 15^0 (F) hotter than the baseline temperature by 2080. High heat events will become more frequent and intense, as the annual number of days over 90^0 (F) continues to increase. Heatwaves like the 2021 event impacting the Pacific Northwest will become more routine. By the end of the century, the number of days over 100^0 annually, may exceed 40.

Increasing temperatures are driving climate change, impacting weather patterns, growing seasons, and the species we currently think of as indigenous to our region. According to Climate Change Vulnerability and Adaptation in Southwest Oregon 2022 report[3], "average annual temperature wihtn the SWOAP assessment area has already increased by 0.6 C (PRISM) to 1.5 C since 1895." This is consistent with historic temperature data collected for Medford since 1911.

Projections by the USGS[11] suggest that by mid-century, Medfords' climate will more closely resemble that currently experienced by Redding, California with a July average high of 96.8^0 and January average low of 38^0. By 2100, the Rogue Valley may more closely resemble the Bakersfield, California region with a July average high of 100^0F and January low of 36^{0F}.

HISTORICAL AVERAGE

The historical average helps establish a baseline from which to measure change. NASA's Goddard Institute for Space Studies, the National Oceanic and Atmospheric Administrations National Climactic Data Center and the UK Meteorological Office's Hadley Center all began taking consistent and reliable temperature measurements in 1880. Historic average temperatures is not something communities can return to, but something communities can use to identify trends and associated climate consequences. "Rather than thinking of our future in terms of some historic 'normal' or 'average' condition we need to think in terms of the trends and what those trends indicate the future is likely to bring."[12]

DEGREE DAYS

Degree days are based on the assumption that when the outside temperatures is 65^0 F, we don't need heating or cooling to be comfortable. Degree days are the difference between the daily temperature mean and 65^0 F.[13] This concept is most used to track energy use and estimate related heating and cooling demands in various climate change scenarios. As the Rogue Valley Region continues to warm, the number of heating days will decrease and cooling days will increase. Community members employed in land-based sectors or that are housing-insecure will be most impacted. This presents challenges and opportunities for the city to equitably coordinate and incentivize increased access to air conditioning.

PRECIPITATION & SNOWPACK

As temperatures rise, the region will get more rain than snow. Extreme downpours will become more frequent, but on average, precipitation levels will remain the same. The City of Medford will likely see more winter precipitation and drier springs, creating conditions for exceptionally dry summers. Shifting water availability will effect soil moisture impacting both wild and cultivated plant species and increasing fuel loads in wildfire risk areas.[4, 5, 6]

SNOWPACK

Snowpack may reduce by as much as 75% from the baseline by 2040, and another 75% from 2040 to 2080, practically eradicating any snowpack in the Rogue River Basin.[3, 6] As snowpack decreases, lower flows and higher water temperatures are expected. This will negatively impact native aquatic species and ecosystems that rely on them. Dissolved oxygen levels are expected to decrease, creating conditions where disease can flourish. Shifts in the timing of stream flows may trigger earlier emergence of aquatic insects and shift salmon spawning and migration times, in turn shifting the availability of primary food sources for migratory species, impacting those dependent upon them for nourishment.[4]

WILDFIRE

Across the West, wildfires are occurring with more frequency and intensity. Fire suppression policies, land management practices, and climate change in combination have created dryer forests with greater fuel loads. As drought seasons become longer and more water is received as precipitation rather than snow, wildfire risk too will continue to grow.[4, 5]

ECOSYSTEM

The distribution of ecosystems around the world is largely determined by two variables: average annual temperature and precipitation. When these variables are modified, the survival of biomes and the species of which they are composed may be undermined. While some species populations are at risk of decline from altered food availability, competition, predator-prey dynamics, and availability of key habitat features, others will grow.[4, 6] Some insect species will emerge earlier and in greater numbers. Unlike mammals, insects, amphibians, and plants are dependent on external ambient temperatures. Warming leads to increased metabolic rate, rapid growth, and population growth in some endothermic species, while others will be unable to thrive in this region. One pest species that we can expect to boom in population is the

Bark Beetle, whom burrows under the bark of coniferous trees, negatively impacting the health of the tree and sometimes killing it. The proliferation of this insect will in turn have an ecological effect on our forests, contributing to increased fuel loads and wildfire risk, in turn endangering habitat and the wellness of keystone species.[3]

DROUGHT

METEOROLOGIAL DROUGHT

A lack of precipitation or an evaporative demand that exceeds precipitation.

HYDROLOGICAL DROUGHT

When a prolongued meteorological drought effects surface or subsurface water supply, such as a streamflow, reservoir, and lake levels.

AGRICULTURAL DROUGHT

When a meteorological and hydrological drought impacts agricultural production.

SOCIOECONOMIC DROUGHT

When economic and social institutions are impacted by drought.

Between 2000 and 2020, an average of 37% of Oregon experienced drought of moderate intensity, and 7% experienced extreme drought conditions. As precipitation patterns shift durations of drought will become more extreme and more frequent. As droughts occur, water quality is also impacted, affecting aquatic species and those that rely on them for nutrition.[3]

WATER QUANTITY	WATER QUALITY	PUBLIC HEALTH	ASSOCIATED OUTCOMES
INCREASED WATER TEMPERATURE	WATER BORNE DISEASES	VECTOR BORNE DISEASES	REDUCED FOOD SECURITY
DECREASED WATER AVAILABILITY	IMPACTS ON WATER CHEMISTRY	RESPIRATORY HEALTH IMPACTS	REDUCED/ FAILED CROP YIELDS
REDUCED AIR QUALITY FROM PARTICULATE MATTER	HARMFUL ALGAE BLOOMS	RESPIRATORY HEALTH IMPACTS	ECONOMIC LOSSES
		MENTAL HEALTH IMPACTS	IMPACTED BIODIVERSITY
		WEAKENED IMMUNE SYSTEM	INCREASED CARBON EMISSIONS
			BURDENED PUBLIC AND SOCIAL INSTITUTIONS

In 2018, Business Oregon[14] reported that the most competitive traded sector industries in Jackson and Josephine counties were: e-commerce, forestry and wood products, wholesale trade and logistics, agriculture, food and beverages, and tourism. Specific regional advantages included the production of wood products, business support services, preserved fruits and vegetables, aerospace products, and cannabis crop farming.

A 2022 report from the Oregon Employment Department[15] projects the following occupational growth over the next decade: Food preparation and Serving Related (24.5%), Property Management (22.7%), Personal Care and Services (20.7%), and Healthcare Support (18.7). The Southern Oregon Regional Economic Development Inc. identified four strategic growth areas[16] based on employment trends (2018): healthcare, natural resources, accommodations and food service, and specialty agriculture.

REGIONALLY STRATEGIC GROWTH AREAS

HEALTHCARE

In 2018 approximately 24,614 residents were employed in the healthcare sector regionally. In 2019 Asante announced plans to open a $64 million dollar outpatient cancer center in Medford, indicating a growing market and employment sector. Major healthcare companies in the region include Asante Health Systems and Providence Health and Services.

NATURAL RESOURCES

The Rogue Valley Region appreciates a legacy cluster of forestry and nonmetal mining. In 2018, local forestry and wood products were one of the most competitive traded sector industries, with employment concentrations twice was large as the U.S. average. Fishing and outdoor tourism remain major draws to the region.

TOURISM

Major drivers of tourism include regional cultural events, outdoor recreation, specialty food production, and both amateur and competitive sports. Tourism benefits a range of industries, generating an estimated $11.8 billion dollars annually and directly employing 12,350 residents, (2018). While some tourism attractions are already being impacted by climate change, namely decreased air quality from wildfires, other generators of tourism, like premier sports facility attractions, are growing.

SPECIALTY AGRICULTURE

Derived from six sectors, farms and ranches, specialty foods and ingredients, wineries, farm management and labor services, packaged fruits and vegetables, and agricultural services. The region is also recognized statewide for our competitive production of wine grapes and cannabis. Specialty agriculture is also a major driver of regional tourism.

WINE INDUSTRY

The first Oregon vineyard was cultivated in the Rogue Valley and the first winery opened here in 1873, by Peter Britt.[17] As an internationally recognized wine region encompassing several river valleys and supporting more than 70 grape varietals, the wine industry is a major tourism draw. Climate change may prompt vintners to compress the growing season to avoid fruit damage from frost, extreme heat, and wildfire smoke.[18]

Extreme heat and drought may impact vine health and create favorable conditions for pests. The use of pesticides and fungicides may increase as a result of increased pest populations and shifts in precipitation patterns. As climate change progresses, some varietals may no longer be viable in the Rogue Valley and the fermentation process itself may be compromised by increased chemical hazards and vulnerabilities to microbial contamination and fungal growth.[5, 19, 20]

ORCHARD INDUSTRY

The Pacific Northwest is the leading producer of U.S. tree fruits. For 2016, the region produced approximately 66% of the total U.S. apple crop, 75% of the pear crop, and 82% of the cherry crop.[21] In Jackson County, pears represent the largest edible crop at approximately 6,851 acres.[22] The majority of this acreage is located in the Rogue Valley.

The orchard industry will be impacted by inadequate chill hours (the Bartlett Pear requires 800 chill hours)[23], impairing development of fruit buds making trees vulnerable to pest and disease and may create a mismatch of timing of flowering and pollination, reducing yield. Extreme heat days can create sunburn in crops and alter fruit firmness, synthesis of sugars, organic acids, and antioxidant compounds.[22]

FORESTRY & WOOD PRODUCTS

Working forests contribute $12 billion dollars annually to Oregon's economy and supports over 58,000 jobs. In the Rogue Valley, approximately 5,605 people are employed in the sector - namely in support activities for forestry and wood production and manufacturing. As average seasonal temperatures continue to increase, trees will be more vulnerable to pests and disease. Dryer soil conditions will contribute to wildfire frequency and intensity, impacting timber yields and sector growth. Certain species of trees may become less viable and need to be replaced by species better suited to the region's changing climate. At the same time, demand for forest products for construction may increase as wood products gain appeal as alternatives to other materials that may be more impacted by climate change, less available as resource availability constricts, or produce greater emissions.

CITY FINANCES

As a municipal organization providing an extensive array of services to residents, visitors, and businesses, climate change will impose additional operational costs for the City. Climate imposed financial liabilities will emanate from the higher cost of operating and maintaining infrastructure that is vulnerable to climate change impacts. At the same time, climate vulnerabilities in the local economy also increase risks to the stability of City revenue sources. The Transient Lodging Tax, for example, may be negatively influenced by wildfire smoke.

TOURISM

Local tourism is driven by outdoor recreation opportunities, arts and cultural events, and specialty food production. For the year 2018 in Jackson County, the following sectors were the top beneficiaries of tourism spending: food service ($142.2 million accommodations ($105.5 million), retail sales ($58.9 million), local transportation and gas ($56.5 million), and entertainment and recreation ($55.2 million).[24]

Outdoor recreation opportunities are central to Rogue Valley tourism branding. Traditionally, the most popular tourism season is summer. However, climate change will make summers in the Rogue Valley less hospitable, with increasing temperatures and continued impacts from wildfires. The COVID-19 pandemic provided a glimpse of what the regional economy may look like without robust summer tourism. Winter outdoor recreation businesses too may be increasingly challenged as more precipitation falls as rain and not snow.

Although large parts of the local tourism industry may be negatively impacted by climate change, some tourism businesses may benefit. Such is the case with sport fishing on the Rogue River. While fishing for salmon and steelhead in many other rivers in northern California and the Pacific Northwest suffers from low river flows attributed to depleted snowpack and severe drought, the Rogue River has remained a robust fishery - at least for the time being. This has drawn more international attention to sport fishing in the Rogue River, benefiting local guides and industries that support those recreational activities.

The built environment contributes significantly to greenhouse gas emissions, but is itself also affected by and vulnerable to the effects of climate change. It is vulnerable to acute and slow-onset climate events. Extreme temperatures, increasing storm intensities, and events like wildfire all threaten the integrity of our buildings and infrastructure.

This section of the CCARP examines vulnerabilities of the built environment in Medford and throughout this region to changing environmental factors attributed to climate change. Much of the research in this field focuses on the effects of increased precipitation, which directly contributes to catastrophic riverine flooding. Other frequently discussed built environment impacts pertain to sea level rise. In Medford and the Rogue Valley region, increasing frequency and severity of extreme heat events and their many consequences are probably the greatest threat to the built environment.

The built environment includes many kinds of human made structures that range in size as much as they range in function. This report addresses those we are most familiar with - our homes - as well as the infrastructure upon which modern human life relies. It examines building systems themselves (equipment, materials, and construction technologies) and structures in the broader context in which the built environment is located.

BUILDING SYSTEMS

INDOOR CLIMATE CONTROL

A study on indoor air quality by the US EPA in the late 1980s found that on average Americans spend 90% of their day indoors.[25] It is hardly surprising that indoor climate management and control has become a ubiquitous feature of modern residential, commercial, and industrial buildings. In a warming climate with more extreme hot weather, cooling interior spaces is no longer a luxury or modern comfort, but an essential building system for basic wellbeing and physical health (particularly for individuals and groups who are more susceptible to heat related illness). A report published by the International Energy Agency notes that, due to a number of factors, "Between 1990 and 2016, annual sales of ACs nearly quadrupled to 135 million units." The report goes on to note that under current policy conditions and trends in consumer behavior, the "Soaring AC ownership [will drive] overall electricity demand to unprecedented levels", accounting for 40% of total growth in residential energy consumption.[26]

As discussed above, climate change in this region will result in more days when cooling building interiors will be required, and fewer days when heating building interiors will be required. This shift may render older HVAC systems inadequate or even obsolete in the face of changing consumer needs. Even the most efficient HVAC systems will not be immune to power disruptions caused by extreme demand for electricity during hot weather. It is, ironically, HVAC systems in the first place that generate such high demand for electricity during such weather events, putting electric generation and distribution infrastructure at ever increasing risk at times when it is needed the most. Under current conditions, global demand for electricity for space cooling will grow significantly by 2050, representing almost a quarter of total electricity used currently (MIT Technology Review 2020).

Cooling technology has progressed at a glacial pace, and despite modest advances in efficiency remains relatively unchanged from its invention in 1902. This compounds urban heat island effect (discussed below), because cooling technologies emit heat into their surrounding environment thus creating a "classic feedback loop" of ever higher localized temperatures. Fortunately, improving the efficiency of space cooling, through policy and technology, can significantly reduce peak energy demand from space cooling, increasing energy resiliency while reducing GHG emissions and Urban Heat Island effect.[27]

BUILDING MATERIALS

As stated in the introduction, modern human life has existed within a relatively stable and narrow climate band for thousands of years. Modern building technologies have evolved in response to a set of fairly predictable environmental loads, allowing architects, engineers, and materials scientists to develop building materials and construction methods that ensure structural integrity and building systems performance over a relatively long functional life.

But with a changing climate, these assumptions may no longer be valid. More frequent, severe storms will impact building envelope systems and materials in ways that may exceed design parameters.[28] Paint, exterior cladding, and common roofing materials may degrade faster under these conditions. Asphaltic shingles, for example, are susceptible to extreme heat and high wind events, both of which will become more common as climate change advances. Many of the most ubiquitous building materials in our community, structural steel and concrete, will be increasingly vulnerable to conditions that stress these materials to the point of failure.[29]

A warming climate will also increase habitat for certain insects (such as termites), as shorter, milder winters reduce ground freezing which constrains growth of insect populations. Buildings with wood cladding and structural components could experience more problems with infestations that compromise these wood building materials.[30]

In neighborhoods built within or even within close proximity to a Wildland Urban Interface, buildings may not be adapted to meet increased needs for fire safety. Building design, construction method, site design, and property management may need to be adjusted to address increased wildfire risk.

Climate change has already affected the supply chain for building materials. Severe storms and wildfires have placed additional demand on building materials supplies, just as climate change exerts pressure on key natural resources that are essential to modern building technologies. Global supply chains, furthermore, will be increasingly disrupted by climate change-influenced supply chain disruptions.

URBAN HEAT ISLAND EFFECT

As mentioned throughout this report, extreme heat events will be the most prevalent, and serious climate change impact, experienced locally. But extreme heat affects different kinds of places differently. Places that are more urban experience more extreme heat than rural places due to the way that the built environment has been developed over time. Air temperatures during extreme heat events in communities with a greater density of buildings, roads, and other heat absorbing land cover can soar to 20 degrees hotter than rural lands at their peripheries.[31] Research published recently in a brief by Climate Central assessed Urban Heat Island (UHI) effect in 159 cities throughout the United States. The study assessed "the potential difference in average temperature the city compared to its less developed surroundings."[32] Although some of the nation's largest cities had the highest urban heat island intensities (i.e. the largest relative differences between urban and rural environments), Bend, Oregon had the 14th highest index score, suggesting that smaller cities outside of large metropolitan areas (like Medford) can experience severe UHI.

Multiple variables can influence the severity of UHI in a particular place. These include:

- Surface reflectivity. As anyone with a car with black upholstery knows, dark colors absorb more infrared radiation that may be stored and then released over time—even after the surface is no longer exposed to sunlight. Asphalt paving and dark-colored roofing surfaces, for example, tend to reflect less solar radiation back into space and may hold that radiation as heat which is then released through night time hours when lighter-color surfaces are cooling.[33]

- Urban geometry or morphology. The shape of cities, from the height of buildings to the width of streets, influences the way air moves through the built environment and heat is dissipated. The design of buildings, the extent and orientation of building surfaces, can increase or reduce the amount of heat stored and dispersed into surrounding space and the amount of shading that creates cooling.

- Presence of vegetation. Plants absorb heat and cause surrounding air to cool through evapotranspiration. This effect in addition to shade can reduce peak summer temperatures by 2-9 degrees Fahrenheit.[34]

- Until a study is undertaken in Medford, it will be difficult to know the extent of UHI effect here and the way it uniquely affects different parts of this community. That said, a growing body of research has identified an array of negative impacts that are consistent across different communities including

- Degraded air quality. Higher temperatures enable chemical reactions that create ground level ozone, which contributes to a range of respiratory illnesses including asthma. Increased electrical energy loads increase the need for power generation, most of which is still produced by fossil fuel combustion that emits sulfur dioxide, nitrogen oxides, particulate matter, carbon monoxide, and mercury.

- Elevated urban temperatures increase demand for electricity by 5 to 10%, placing additional stress on electricity generation and distribution systems and increasing the risk of systemic failure (e.g. brownouts, blackouts, etc.). A study found that UHI effect accounted for up to 15% of electricity used for cooling in Los Angeles.

- Public health. UHI exacerbates extreme heat events, which are responsible for more deaths annually than all other natural hazards combined. Heat related health conditions and death are suffered disproportionately by vulnerable populations, particularly by the elderly, low income households, and those with disabilities.[35]

PARKS AND GREENSPACE

Urban parks are often viewed as an effective means of increasing community resiliency in the face of a changing climate. Most significantly, greenspace and urban tree canopy can mitigate the effects of extreme heat events and Urban Heat Island effect. Parks, street trees, privately owned green space (yards), and green roofs or facades can actually create the opposite of UHIs: a "Park Cool Island" or PCI. Even small parks with trees and other vegetation can have significant cooling effects on surrounding urbanized development on their peripheries.[36] Distributed throughout a community in a way that provides equitable access to all members of a community, regardless of socioeconomic status, parks can deliver relief from the effects of climate change in a number of different ways.

At the same time, parks are themselves vulnerable to the effects of climate change. As summer temperatures increase and periods of drought become more frequent and intensive, species currently thought of as native or adapted to the climate regime that has existed for hundreds of years will experience additional environmental stress. Research on the effects of climate change on urban plantings has identified a variety of potential impacts on trees including increased frequency of periods of waterlogging and flooding; drought; advances in bud burst; increased risk of frost damage to young leaf tissue; and insufficient periods of cold to allow bud vernalization and breaking seed dormancy.[37] Changes in plant physiology caused by climate change can also make trees more vulnerable to pathogens and herbivorous insects. At the same time, climate change will allow pests and pathogens to extend their geographical range.[38]

Even with their many benefits, parks and other urban greenspace also pose risks to the urban built environment when considered in the context of climate change impacts. Locally, the Almeda Fire demonstrated the seriousness of this risk: a relatively unmanaged natural riparian corridor conveyed a devastating wildland fire through the communities of Talent, Phoenix, and unincorporated Jackson County. The City of Medford, which has invested more than $1M to riparian habitat restoration and fuels reduction over the last seven years, developed a wildfire management for the Bear Creek Greenway as a result of that catastrophic event.

PUBLIC INFRASTRUCTURE

The lifestyle we are able to enjoy now has largely been made possible through the development of modern public infrastructure systems. These systems are also critical to the viability of our economy. Each type of infrastructure is vulnerable to unique climatic conditions, but most systems are also vulnerable due to interdependencies on other urban systems.[39] Disruption of electric power, for example, affects nearly all other infrastructure including water, sanitary sewer, and transportation systems. The consequences of severe climate events, like other natural hazards, can "cascade" as impacts to one type of infrastructure radiate outward affecting other systems.

This section of the report examines the potential impact of climate change on many different types of urban infrastructure systems, focusing on several that are most likely to be impacted and are of great significance.

DRINKING WATER

With more frequent, severe drought, the availability of a reliable source of safe drinking water is of great concern. The City of Medford acquires its drinking water from a regional water utility. The Medford Water Commission (MWC) operates and maintains the system that delivers drinking water to the City of Medford and White City. The cities of Ashland, Eagle Point, Jacksonville, Phoenix, and Talent are served on a wholesale basis. Additionally, two domestic water districts purchase water from the Commission as needed. The MWC derives water from Big Butte Springs and the Rogue River, as a supplemental source when demand exceeds the springs' supply.

Big Butte Springs is a groundwater source replenished by rainfall and snowpack. Water supply is influenced by high temperatures increasing evapotranspiration rates, meteorological drought, wildfire affecting the Big Butte Springs watershed, landslides, and extreme flooding effecting one or more treatment facility, or power outages. The Rogue River water supply is most influenced by snowpack.

The Medford Water Commission's water rights are senior in priority to many users in the Rogue River Basin. Under this legal agreement, Medford's water allotments can only be curtailed by drought conditions affecting our primary water source. Diversions from the Rogue River are limited, but in more recent years, decreased flows at the Big Butte Springs have required MWC to rely more heavily on this secondary source. Reliance will likely continue, as population increases and climate change continues.

Plans to address future supply shortages and water quality is ongoing and efforts to minimize these challenges include the development of the Rogue Valley Water Supply Resiliency Project, a ten-year plan to safeguard the Valley's drinking water against droughts, earthquakes, and increased demand; and the Water Management and Conservation Plan (2017), a guide to the development and implementation of water management and conservation programs and policies to ensure water resources to meet future needs.

In the City of Medford, a number of properties continue to use wells as a drinking water source. Many of these wells are shallow, drawing from perched aquafers with relatively little storage capacity that require regular recharge from precipitation. As droughts become more frequent and severe, and precipitation events become less frequent but more intense, recharge will decline placing more wells at risk of failure. As this occurs, property owners may turn to the Medford Water Commission for service.

<u>ELECTRICAL POWER</u>

Aside from municipal drinking water, electric power may be one of the most vulnerable essential infrastructure systems that is directly and indirectly impacted by climate change. Power outages resulting from extreme weather events are very disruptive for and costly to businesses and individuals alike.

Despite its importance nationally, our electricity infrastructure is ageing, becoming ever more susceptible to severe weather events. Wildfires represent a significant threat to transmission lines, but they can also create atmospheric conditions that cause transmissions lines to fail. Precautionary measures to avoid causing wildfires during high wind, high heat conditions may lead to proactive shutdowns or "brownouts" of transmission lines.

Electrical power generation is also vulnerable to drought that is caused and/or exacerbated by a warming climate. Coal fired power plants, which require massive inputs of freshwater for steam generation and cooling, no longer operate in Oregon. But hydroelectric generation is entirely dependent on sufficient flows through dams. The Bonneville Power Administration and Pacific Power use hydroelectric power generation extensively throughout Oregon, including within the Rogue, Klamath, and Umpqua river basins. Reduced flows caused by drought will pose challenges to the reliability of this emission-free source of electricity.

<u>STORMWATER</u>

Urban stormwater management will be affected by climate change in several ways. First, although our region will likely continue to receive the same amount of precipitation annually, precipitation events will likely become more and more concentrated with relatively fewer more intense storms. Those events will occur with greater frequency during winter months, where warmer temperatures at higher elevations in the hills around Medford will cause an increase in the amount of precipitation falling as rain instead of snow, which, coupled with an increase in storm intensity, may lead to higher flows and more frequent flooding in area creeks (such as Bear Creek).

This shift to fewer more intense storms poses challenges for infrastructure built to withstand the effects of a different precipitation pattern. High intensity storms are more likely to cause street and property flooding where infrastructure is not designed to collect such a high volume of water falling during a short period of time. Likewise, existing bridges and culverts that are not designed to handle these events may be undersized, create hazardous flooding conditions at road crossings, and be more likely to sustain damage and become compromised over time.

WASTEWATER TREATMENT

Wastewater management will be affected by climate change in several ways. A study of climate change impacts on wastewater management in California identified the following impacts that are most likely to be applicable locally:

- Lower stream flows raise instream temperatures, placing additional stress on aquatic ecosystems, adding potential further complications and expense to the cost of regulatory compliance;
- Increasing numbers of intense precipitation events and flooding that may damage wastewater treatment facilities and require additional capacity in the case of combined stormwater-sanitary sewer systems;
- Improved water conservation, particularly sudden reductions in municipal water consumption, can negatively affect wastewater treatment operations.[40]

ROADS

Extreme heat events that are becoming more frequent and more severe can damage road surfaces and undermine their long term durability. Both impacts have immediate public safety and longer term operations and maintenance implications. Concrete roads are susceptible to buckling as large slabs of concrete expand into abutting slabs. Asphalt is also vulnerable to the effects of high temperatures because it, unlike concrete, is “viscoelastic” and becomes less rigid and more fluid at higher temperatures.[41]

Responses to this problem include engineering roads and bridges to survive changing operational conditions. In this region that probably means designing roads and bridges that can withstand more extreme heat events. It also means considering recovery from catastrophic failures. Infrastructure cannot be designed to address every contingency. Good planning for those situations can prepare a community so that recovery occurs as quickly as possible and disruptions are kept to a minimum.

Climate change in the Rogue Valley has a direct impact on public health as water quality degrades, seasonal water availability shifts, days of poor or hazardous air quality increase, and extreme heat days become more regular. These events, in addition to general environmental degradation and biodiversity loss, will impact where people choose to live, visit, and recreate. Vulnerable populations and frontline communities are at particular risk of severe climate-related illness and death, though everyone may experience negative impacts to health and quality of life.

WATER QUALITY & DROUGHT

Regional water quality will be impacted by slow-onset climate change. As temperatures rise, the Rogue Valley Region can expect to receive more precipitation in the form of rainfall as snowfall declines. As water availability shifts, seasonal streamflow will be lower and waters warmer than what is currently and historically customary. As shallow waters warm, pest population and associated diseases, like mosquitoes and the West Nile Virus that they carry, will increase. Bacteria, virus, and waterborne parasites will also flourish in our waterways, increasing vector-borne illness wherever people digest or bathe in open and untreated waterbodies.[1, 2, 3]

The loss of regional water quality and availability may eradicate cooling options for lower income and unhoused populations, like traditional swimming areas. During drought events, surcharges may be implemented to improve conservation, contributing to increased living costs as households turn to home-cooling options, like temporary outdoor pools and air conditioning, burdening low-income community members.

Decreasing water quality will impact aquatic species populations, affecting households that participate in subsistence lifestyles to any degree. Fish populations, impacted by both warming waters and pathogens will further decline, affecting human populations as well as other species that both directly and indirectly rely on fish for nutrition.

MENTAL HEALTH

Both acute and slow-onset climate change has been found to impact mental health and wellness. Following acute weather events, individuals may experience the effects of trauma, increased stress, and depression as households may mourn the loss of life, assets, and experience displacement.[42] The indirect effects of slow-onset climate change, like drought, can contribute to increased stress and anxiety, depression, exacerbate existing mental health issues, and in extreme scenarios increase rates of suicide.[43] Studies show these outcomes are more predominant in rural and agricultural communities.[44] [45] [46] [47]

EXTREME HEAT DAYS

Extreme heat events are becoming more common in the U.S., especially during summer months. For many climates, cooling infrastructure in private residences does not exist; and outdoor cooling areas - like pools, may be inequitably placed and generally unable to meet demand, making extreme heat events particularly dangerous for youth, elders, and vulnerable populations. The *Fifth Oregon Climate Assessment*[1] predicts that without any adaptation, excess heatwave-related deaths will increase by an average of 422% by 2031-2080, relative to 1971-2020.

Though the City of Medford is accustomed to high summer temperatures, extreme heat events will become more commonplace. Prolonged exposure to extreme heat can cause heat exhaustion, heat cramps, heat stroke, and death, as well as exacerbate preexisting chronic conditions such as respiratory and cardiovascular diseases.[48] Heat-related illness occurs when a person's body is no longer able to properly regulate temperature, causing vital organ damage. Though heat-related illnesses can effect anyone, it is most common among young children, elders, and individuals with underlying conditions; and disproportionately affects unhoused and low income households lacking access to cooling systems; and workers in land-based sectors, like farming and construction..

In 2021, a week-long heatwave set new high temperature records for many communities in the Pacific Northwest. Over the period of that week, there was an increase of 600 deaths across Washington and Oregon - three times what was expected.[49] [50]The City of Medford experienced a high temperature of 115^0 during this event, 14^0 above the normal mean maximum temperature.[51] Events like this will become more frequent, posing potentially dire risks for vulnerable households.

URBAN HEAT ISLAND

The Urban Heat Island (UHI) effect occurs when solar energy is absorbed and stored in pavements leading to an increase in surface temperatures, as well as the surrounding air temperature.[52] People of color and low income households are particularly vulnerable to the urban heat island impacts, with one study finding that "the average person of color lives in a census tract with higher SUHI [summer urban heat island] intensity than non-Hispanic whites [...] A similar pattern emerges for people living in households below the poverty line relative to those at more than two times the poverty line."[53] Though the City of Medford does not have existing data on UHI temperatures nor what neighborhoods are most impacted by this phenomena, it's widely accepted that any urban area with substantial dark paving is subject to UHI. Those neighborhoods with less tree canopy are more likely to be impacted.

PEST POPULATION INCREASE

Environmental changes, like warming waters, increased daily temperatures, and reduced snowpack creates favorable conditions for pest species like mosquitoes, ticks, and bark beetles. The public health danger of increasing pest populations includes increased disease, like the West Nile Virus and Lyme, and exacerbated hazardous climate conditions. The bark beetle, for instance, contributes to increased wildfire risk by weakening tree systems, creating additional fuel loads.[4]

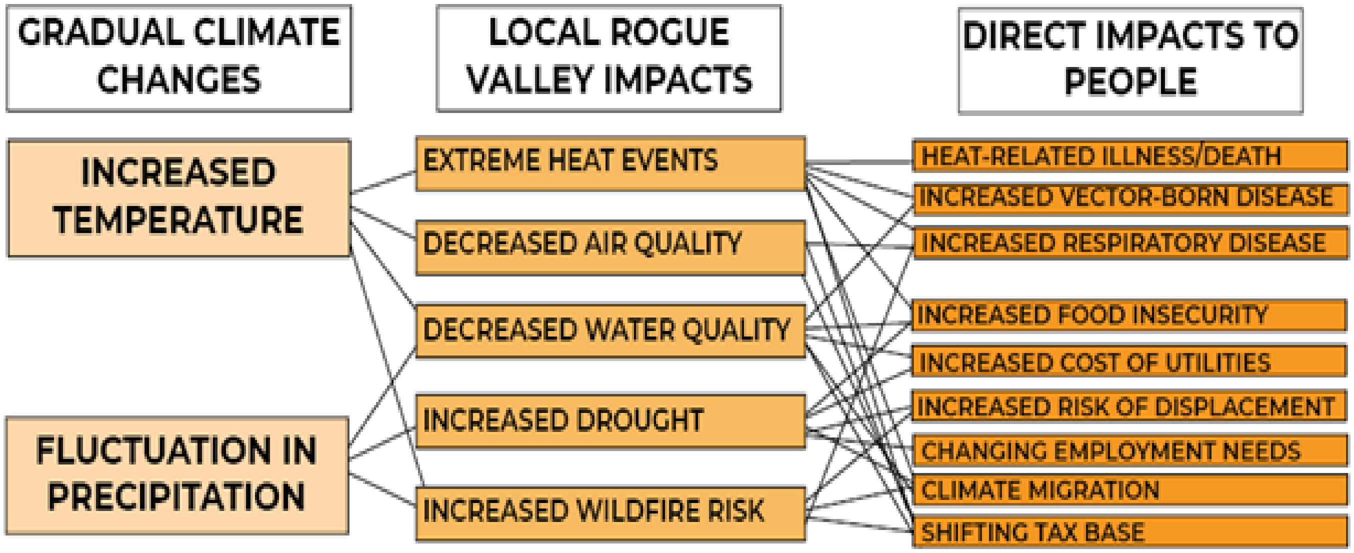
AIR QUALITY

In the state of Oregon, 90% of air pollution is produced from daily activities that involve aerosols that release toxic chemicals like household paints, and activities that use fossil fuels. The single largest source of air pollution statewide is the automobile, with industry accounting for less than 10% of pollution.[54] As the center of large geographical region, Medford faces additional challenges in reducing air pollutants as daily trip generations originate from surrounding communities as well as local community members.

The Rogue Valley is predisposed to stagnant air days that accumulate and trap pollution.[55] The location of the I5 corridor and high volume of daily trips generated creates challenges for maintaining healthy air quality standards. Climate change will further impact air quality, as wildfire becomes more common in summer and autumn months; high heat days increase the amount of ozone pollution and air conditioners generate additional particulate matter; and drought conditions increase the amount of particulate matter in the form of dust.

Poor air quality days impact individuals with respiratory and underlying health conditions, but also make the likelihood of developing such conditions more likely. Prolonged exposure to even low to moderate particulate matter is associates with increased risk of death.[56] Among pollution-related deaths in the United States, poor air quality is the direct cause of half, with environmental-based workers that spend significant time outdoors, housing-insecure populations, elders, and individuals with underlying conditions at significantly greater risk.[57]

Data from the Oregon Department of Environmental Quality[58] shows the impact of increasing frequency and intensity of wildfire on air quality in the City of Medford, with "an 8.7 fold increase in days impacted per year" from poor air quality, between 2013 and 2022. For reference, "Medford had one hazardous [air quality index] day between 1985 and 2012, and four from 2013 to 2022." In 2022 alone, the region experienced more than 6 hazardous air quality days indicating a trend of higher poor air quality days from wildfire.



Climate change directly impacts the quality of life for all residents in the Rogue Valley. As in many places, however, the burden of these changes is not borne equally. As increased temperatures and shifts in water availability strain our natural and built systems, vulnerable households and frontline communities are most at risk for negative health outcomes and displacement. However, the degree to which Medford experiences the impacts of climate change depends on how vigorously we pursue climate adaptation and resiliency solutions for our community now.

Maintaining a high quality of life and expanding opportunities for Medford community members should be a central priority for any climate adaptation and resiliency programs. Understanding historical and contemporary barriers to access and resiliency in our city is key to shaping any meaningful response to climate change.

VULNERABLE HOUSEHOLDS

Households less able to respond to external changes for financial or physical reasons are referred to as vulnerable populations. Community Resilience Estimates[59] considers the following factors: poverty, single or zero caregiver, household crowding, communication barrier defined as households where no one has received a high school diploma or non-native English speaking households, elders, instances of unemployment over a 12 month period, disability, no health insurance, no vehicle access, no broadband internet access. Any one of these factors makes a community less resilient.

FRONTLINE COMMUNITIES

Ecotrust[60] defines frontline communities as those "that experience 'first and worst' the consequences of climate change. These are communities of color and low-income, whose neighborhoods often lack basic infrastructure to support them and who will be increasingly vulnerable as our climate deteriorates." Frontline communities may also refer to those households that rely on land-based relationships for subsistence or employment, or work with polluting agents, as they are more exposed to the direct health and economic impacts of climate change.

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CLIMATE CHANGE AND INEQUITY

Equity, unlike equality, acknowledges the imbalance of our social systems. At the local government, unequal investment of public goods and application historically of racist policies have kept some households from accumulating wealth, creating the inequitable conditions we see today. For these reasons, the burden of acute and slow-onset climate change unfairly weighs on our vulnerable households and frontline communities.

Households and communities that lack investment are less resilient and adaptive to the impacts of climate change, and also more likely to be exposed to the associated risks. For example, a neighborhood that has not received significant investment may provide naturally affordable housing for vulnerable households. The neighborhood may lack tree canopy and maintained green space and the majority of housing may not offer air conditioning. As a result, extreme heat events may unequally impact the neighborhood, and exacerbate existing negative public health outcomes.

The Matthew Effect[61] is a guiding hypothesis that "pre-disaster inequity is exacerbated by differentials in disaster impacts and institutional and social responses." This is to say that vulnerabilities that make a household less able to respond to acute or slow-onset climate change becomes worse following a disaster. This exacerbated inequity may be fueled further by the redevelopment opportunities created by disaster events. As redevelopment occurs, permanent displacement will take place where there is unequal access to resources.

CLIMATE MIGRATION IN THE ROGUE VALLEY

The Rogue Valley Region is at risk of experiencing shifts in population from slow-onset climate change and acute events like wildfire. Climate migration occurs on a gradient, where some households may be forced to relocate, like in an emergency event, while other households may choose to relocate because of decreased air quality from seasonal wildfires or the effects of extended droughts. Environmentally-based livelihoods are most vulnerable to the impacts of climate change, and regions where these sectors are dominant, are at greater risk of experiencing negative population change.

The City of Medford should model planning for two scenarios, population growth and potential population loss. While there is not yet a methodology to project internal climate migration and location choice, anecdotal evidence suggests that the Rogue River Valley is already a destination for households fleeing climate events, like wildfire in Northern California. This anecdote is corroborated by early research that shows climate refugees generally relocate to nearby communities with similar characteristics but where the perception of hazard risk is less.

In 2020, Oregon wildfires destroyed more than 5,000 homes, causing $1.15 billion dollars in damages. The 2020 Almeda Fire alone destroyed 2,482 residential properties (Jackson County Damage Assessment Dashboard), many housing low income and vulnerable populations. Studies of other acute disasters show that vulnerable households are not only more exposed to the risks of natural disasters, but recover more slowly and are less able to return to the communities they fled - as supported by the Matthew Effect hypothesis.

SUDDEN POPULATION CHANGE

Sudden population change[62] would occur as a result of an acute weather event like wildfire. In a scenario like this, the City of Medford would experience increased competition for resources like housing and social services; and increased strain on public resources like open space and public schools. Possible planning scenarios should include acute sudden population influx and associated needs, and possible acute population loss in the event that a natural hazard event directly impacts the City of Medford.

GRADUAL POPULATION CHANGE

Slow-onset climate change[62] may lead to population growth as households may perceive the climate risk of Medford may be less than that of surrounding communities. However, as livability decreases in the Rogue Valley as a result of environmental degradation, public health, and the associated impacts of climate change on local and surrounding economies - population may be expected to decrease. Outcomes from this scenario may include tax-burdened households, loss of property values, loss of tax base, and disinvestment.

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