IRVINE

CLIMATE ACTION AND ADAPTATION PLAN

APRIL 2025

Draft

CITY OF IRVINE
1971

CLIMATE ACTION AND ADAPTATION PLAN

Join Irvine in creating a ***climate-smart City*** for the future.

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NOTE:

This Climate Action and Adaptation Plan (CAAP) articulates broad policy objectives to achieve equitable climate action. The CAAP does not approve, fund, or authorize implementation of any specific projects. Each implementation project will be reviewed and approved over time and follow protocols and best practices for adoption, which may require additional public review, review by City decision-makers, and/or environmental review under the California Environmental Quality Act. As a result of those reviews, there may be alternatives and mitigation measures developed that may be implemented as well.

ACKNOWLEDGEMENTS

Irvine City Council

Mayor
Larry Agran

Vice Mayor
James Mai

Councilmember
Melinda Liu

Councilmember
William Go

Councilmember
Mike Carroll

Councilmember
Kathleen Treseder

Irvine Sustainability Commission

Chair
Kev Abazajian

Vice Chair
Steve Allison

Commissioner
Ted Hsieh

Commissioner
Christine Knowland

Commissioner
Alex Mohajer

Commissioner
Ron Scolesdang

Irvine City Staff

City Manager
Oliver C. Chi

Director of Public Works
Sean Crumby

Acting Director of Public Works & Sustainability
Luis Estevez

Manager of Sustainability
Melissa P. You

Energy & Outreach Administrator
Selene Lawrence Delafontaine

Sustainability Policy Administrator
Ryan Tenney

Climate Analyst
Joslyn Fritz

Ascent Environmental, Inc.

Atlas Planning Solutions

Iteris, Inc.

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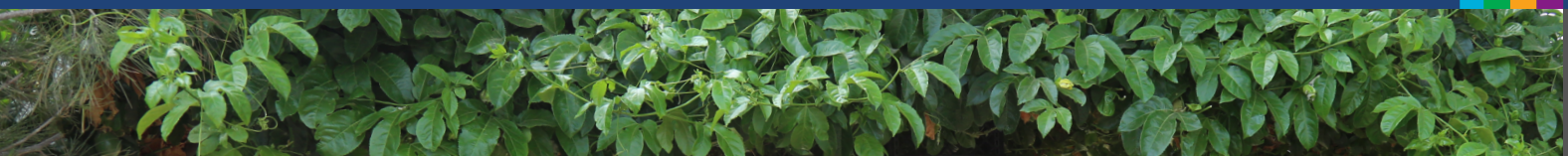

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EXECUTIVE SUMMARY

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Climate Action and Adaptation Plan

Executive Summary

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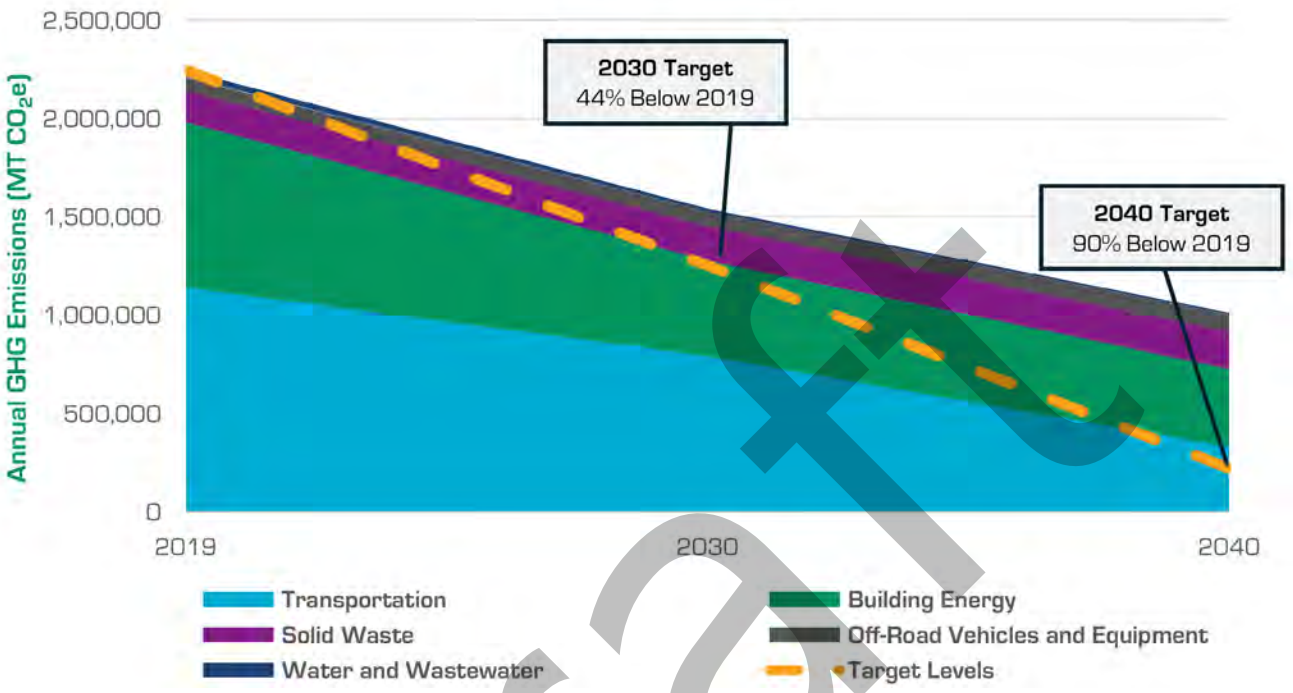
The City of Irvine (City) is taking steps to address the urgent challenges posed by climate change through this Climate Action and Adaptation Plan (CAAP). The CAAP demonstrates the City's commitment to creating a sustainable and resilient future for all community members. This plan is informed by robust technical analyses, comprehensive community engagement, recent legislation, and best practices in climate action planning. Successful implementation of the CAAP will result in meaningful greenhouse gas (GHG) emissions reductions, increased community resilience, and equitable outcomes for Irvine's diverse communities.

The foundation of the CAAP is built upon the City's communitywide GHG emissions profile. Using 2019 as the baseline year, the City's total GHG emissions were estimated at 2,247,593 metric tons of carbon dioxide equivalent ($MTCO_2e$), spread across five different sectors. The largest contributors to the citywide emissions, in descending order, were transportation, building energy, and solid waste. As a result of existing State regulations and programs, the City is expected to experience significant decreases in GHG emissions through the 2030 and 2040 target periods, despite continuous population and economic growth. However, the City is aiming for even more ambitious GHG reductions caused by local actions and implementation measures. As such, the City has established GHG reduction targets of: **(1) 44% below 2019 emissions levels by 2030; and (2) 90% below 2019 emissions levels by 2040.** While the City's 2030 target is aligned with the State's 2030 target established by Senate Bill (SB) 32, the 2040 target was directed by the City and is more ambitious than the State's 2045 target established by Assembly Bill (AB) 1279. These targets, along with the City's communitywide GHG emissions inventory and forecast by sector, are presented in **Figure ES** below.

FIGURE ES COMMUNITYWIDE GHG EMISSIONS FORECAST AND TARGETS



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To make progress towards the established GHG emissions reduction targets, the City has developed a pathway for reducing GHG emissions, which includes a suite of strategies organized into six different sectors: (1) Transportation and Land Use; (2) Building Energy; (3) Off-Road Vehicles and Equipment; (4) Solid Waste; (5) Water and Wastewater; and (6) Resilience, Green Economy, and Carbon Sequestration, which are all presented in detail in **Chapter 3**. The City has already begun implementing these strategies, and by continuing to do so, the City can ultimately achieve its climate vision of building a sustainable community that can thrive in the face of climate change. In addition to the GHG reduction strategies, the CAAP includes high-level strategies and actions designed to allow the City to adapt to the direct and indirect challenges resulting from and/or exacerbated by climate change. These strategies and actions are organized into six distinct sections, which are detailed in **Chapter 4**: (1) citywide; (2) extreme heat; (3) drought; (4) wildfire; (5) flooding; and (6) liquefaction/landslide. Each of these sections represent the primary climate change hazards that the City is potentially exposed to as a result of climate change, with the exception of "citywide," which represents cross-cutting strategies and actions that would bolster the City's capacity to address all existing and future climate change hazard events.

The CAAP serves as a comprehensive roadmap for the City to reduce its GHG emissions and adapt to climate change, thereby resulting in a more sustainable and resilient community and enhancing the quality of life for all community members. This effort builds upon existing initiatives, sets ambitious GHG reduction targets informed by and built upon State goals, and outlines a clear path forward. Regular monitoring and updates will ensure the plan remains adaptable to new challenges and opportunities, while continuing to serve Irvine's diverse and growing community.

The CAAP's adaptation strategies are organized into six distinct sections:

1) Citywide

2) Extreme Heat

3) Drought

4) Wildfire

5) Flooding

6) Liquefaction/Landslide

The CAAP's GHG reduction strategies are organized into six different sectors:

1) Transportation and Land Use

2) Building Energy

3) Off-Road Vehicles and Equipment

4) Solid Waste

5) Water and Wastewater

6) Resilience

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INTRODUCTION

Chapter One
Introduction

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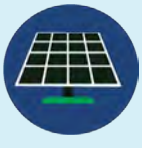
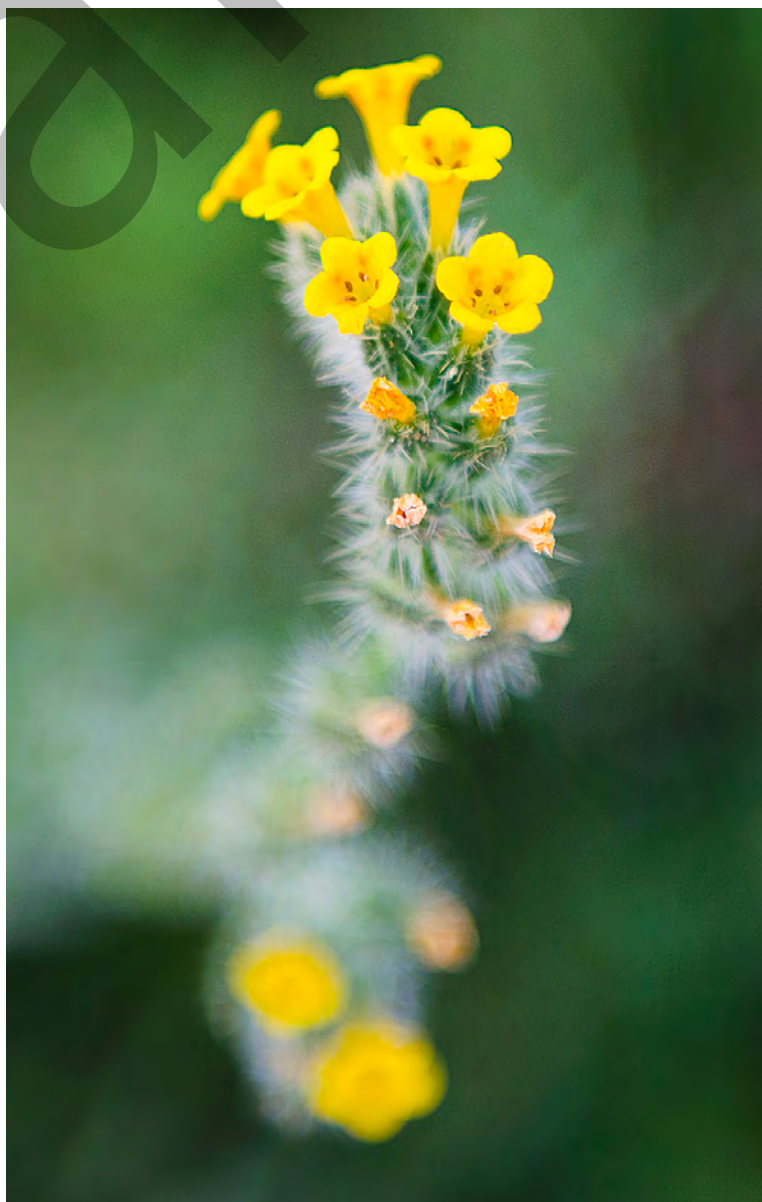
The City of Irvine (City) was incorporated in 1971 and is renowned as one of the country's premier master-planned communities. Centrally located in the heart of Orange County, and with a current population of approximately 315,000 residents spread across 66 square miles, the City exemplifies thoughtful urban planning with an extensive network of bike trails, meticulously designed villages, thriving business districts, vast open space, and an award-winning parks system. The City's Mediterranean climate, featuring warm summers and mild winters with cooling coastal influences, has historically been one of its most attractive features. However, like cities across California and around the world, Irvine faces unprecedented challenges from climate change. As centers of population, economic activity, and infrastructure, cities are both significant contributors to climate change and increasingly vulnerable to its effects. Locally, these effects may include prolonged heat waves, extended drought periods, increased frequency or severity of storm events, and heightened wildfire risk due to more suitable conditions for wildfire ignition and spread. These effects have already begun to negatively affect the City and communities throughout the region, with wide-ranging impacts on public health, infrastructure, transportation, local economies, and natural resources.



The City recognizes both the enormity of the challenges imposed by the climate change issue and the unique opportunity cities have in promoting long-term sustainability and resilience in the face of climate change. The City has committed to building a climate-safe future through numerous initiatives, and this Climate Action and Adaptation Plan (CAAP) represents the next ambitious step in the City's climate leadership. To effectively reduce greenhouse gas (GHG) emissions—which are heat-trapping gases that cause climate change—the City recognizes the need for transformational action across multiple sectors, including fundamentally rethinking how people travel, how energy is generated and used, how waste is managed, and how infrastructure is designed. The CAAP provides a strategic roadmap for this transformation. Beyond reducing emissions, the CAAP is also aimed at adapting to the impacts of climate change and bolstering community resilience. By reducing GHG emissions and adapting to climate change, the CAAP will help facilitate a resilient and reduced-carbon future

Through implementation of this plan, the City will work to ensure that the benefits of climate action reach all members of the community. Climate change continues to disproportionately impact vulnerable and historically disadvantaged communities, who are often the first to experience its consequences and the last to experience the benefits of societal action. The City will work to ensure that every community member has access to cleaner air, affordable clean energy, sustainable transportation options, and healthier neighborhoods. Equity and inclusion are at the heart of this CAAP, as a result a resilient and reduced-carbon future will be pursued in an equitable and inclusive manner.



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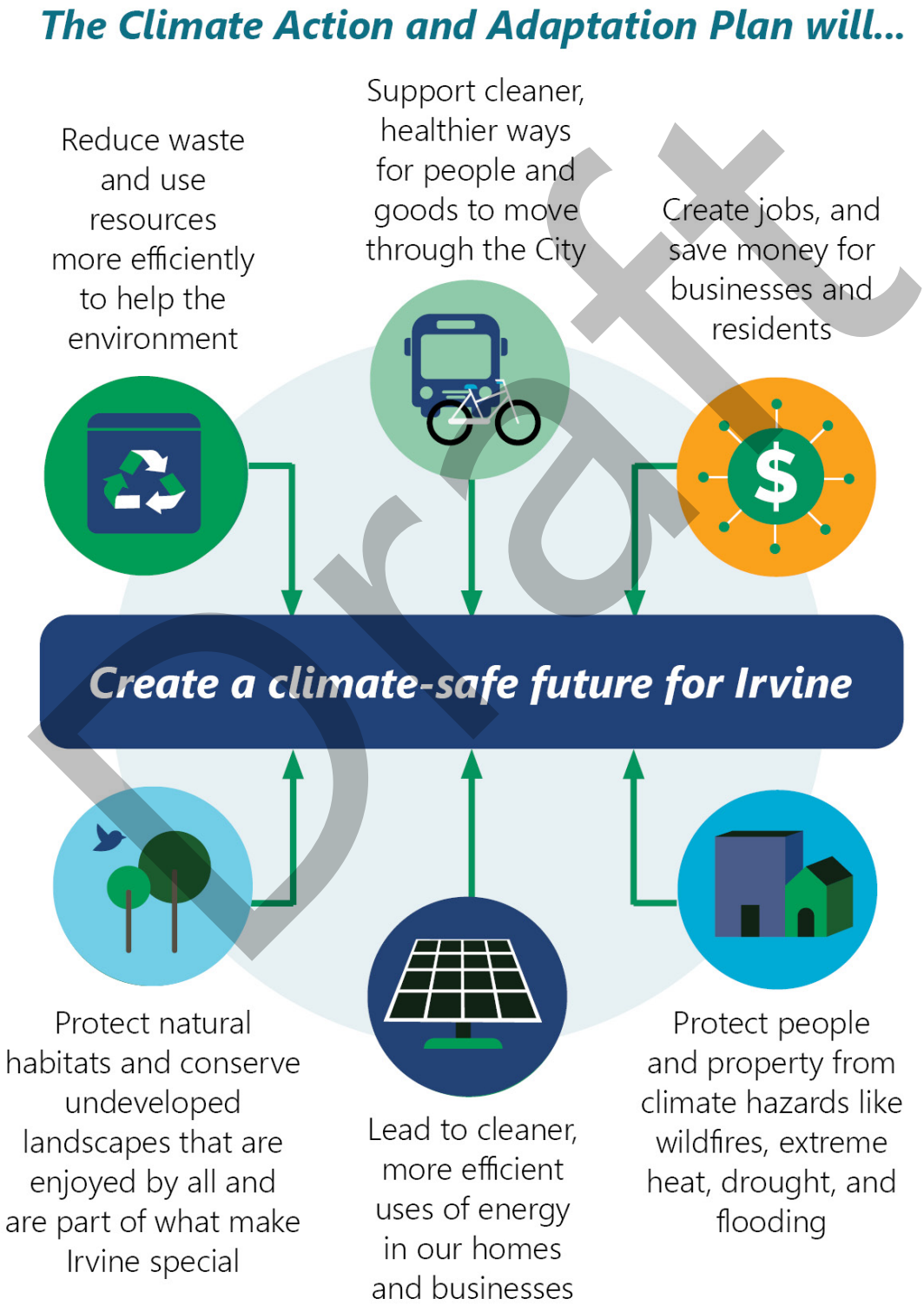
PLAN PURPOSE

The CAAP will serve as a roadmap for the City to reduce GHG emissions and adapt to climate change. It is also driven by a vision for a climate-safe future as shown **Figure 1** below.

FIGURE 1 CLIMATE-SAFE FUTURE



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Irvine's climate vision includes the following elements and outcomes.

CLEAN AND CONNECTED COMMUNITY

- Every community is walkable, bikeable, and connected to schools and services.
- Access to zero-emission charging and fueling infrastructure is not a barrier to new vehicle technologies.
- Higher-density housing in key areas reduces housing and transportation costs.
- Public transit and micro-mobility options are widely available.

EFFICIENT AND DECARBONIZED BUILDINGS

- Most energy consumed in the City is from carbon-free sources and affordable.
- New buildings are future-proof, with all electric components and renewable energy generation and storage.
- Community members are able to upgrade older and inefficient homes to reduce energy bills.
- The energy grid is efficient and resilient.

ZERO-WASTE COMMUNITY

- Every community member has the knowledge and access to receptacles for proper recycling and diversion of waste.
- Infrastructure supports high rates of construction and demolition waste recycling and reuse.
- Consumers can recycle and reuse more packaging and products.

CLEAN AND RENEWABLE EQUIPMENT

- All small engines are replaced with battery-electric options, reducing air and noise pollution.
- Infrastructure supports the use of electricity and renewable fuels for larger construction equipment.
- Irvine is an incubator and early adopter of new zero-emission technology.

WATER EFFICIENCY AND SECURITY

- Water consumption communitywide is reduced, even with community growth.
- Water sources are primarily local and secure.

GREEN, RESILIENT, AND PROSPEROUS COMMUNITY

- An extensive urban canopy provides shading and other benefits to all neighborhoods and communities.
- A green technology hub is established and thriving in Irvine.
- New buildings are made with low-carbon materials.

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ENGAGING THE COMMUNITY

The City is committed to comprehensive community engagement. In the context of climate planning, engagement can raise awareness of climate change, inform community members and other stakeholders about the planning process, and provide meaningful opportunities for feedback and to influence plan development. Addressing climate change locally relies on community buy-in and participation. Recognizing this, the City conducted extensive community engagement over a three-year period to inform the development of this CAAP, using both direct and indirect outreach methods to ensure broad participation across the City's diverse communities. **Figure 2** summarizes the extensive engagement and outreach that was conducted throughout the CAAP development process.

Direct outreach and engagement consisted of the City hosting community workshops where community members had opportunities to participate in online surveys available in multiple languages, along with interactive polling sessions during presentations. Indirect CAAP outreach efforts consisted of social media campaigns across multiple platforms, email communications, and community events. The feedback received through these engagement efforts revealed strong community interest in transportation-related strategies and actions, particularly focused on active transportation infrastructure and public transit improvements. Beyond transportation, the community showed strong support for initiatives pertaining to solid waste reduction, building energy efficiency, and water conservation. While outreach and engagement will be ongoing throughout the plan's implementation, the comprehensive feedback thus far has shaped this CAAP to not only address climate challenges, but also align with community values and priorities.

In an effort to solicit feedback from all community members, online surveys were available in eight threshold languages besides English:

1 Chinese (simplified)
2 Chinese (traditional)
3 Spanish
4 Japanese
5 Korean
6 Vietnamese
7 Farsi
8 Arabic

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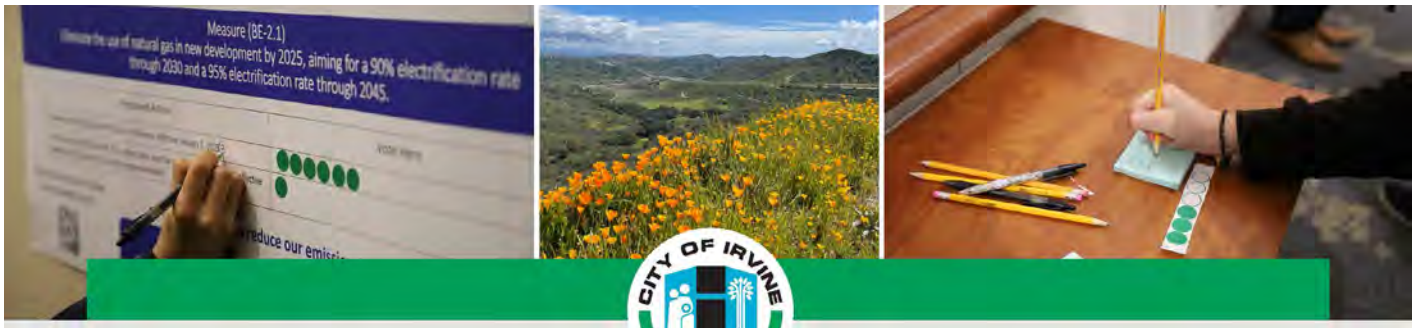
FIGURE 2 CLIMATE ACTION AND ADAPTION PLAN OUTREACH



IRVINE

CLIMATE ACTION AND ADAPTATION PLAN

Since 2021, the City of Irvine has been engaging with the community on the Climate Action and Adaptation Plan (CAAP). Over the course of this extensive outreach phase, City staff has used a wide range of strategies and outlets to promote the CAAP.

Direct Outreach

3,900 community members directly engaged

- **30** workshops & presentations
- **326** feedback votes at workshops
- **590** attendees at public events
- survey recieved **3,298** views online
- respondents gave **8,854** comments & opinions
- **4** internal stakeholder meetings
- **5** sector-based external stakeholder meetings
- **150** HOA groups contacted

Indirect Outreach

197,575 community members reached indirectly

- **71** social media posts
- **161,274** individuals reached
- **2,822** engagements on posts
- **3,236** visits to CAAP webpages
- **9** CAAP emails sent
- **33,065** CAAP email recipients
- **57** clicks on CAAP content

Visit *cityofirvine.org/climate* to learn more.

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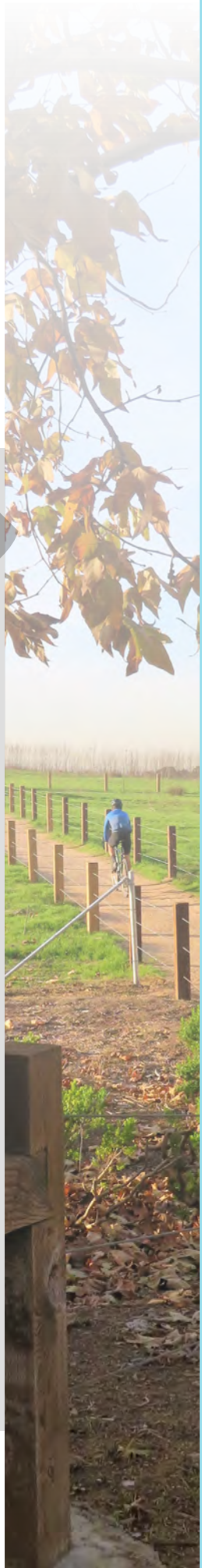
ACHIEVES RESOLUTION

In 2021, the City Council established its policy and set foundational goals regarding climate change when it adopted Resolution No. 21-50—A Resolution of the City Council of the City of Irvine, California, Addressing Climate Change in Irvine's Environment, Values, and Energy Sources—otherwise known as the ACHIEVES Resolution. Resolution 21-50 formally acknowledges the growing threat of climate change to the environment and human well-being, including future generations of Irvine residents, and memorializes the City's commitment to sustainability, resilience, and environmental protection. The primary objectives of Resolution 21-50 are summarized below.

- Achieve a zero-carbon local economy based on the most recent climate science.
- Ensure environmental, economic, and social justice in climate actions by actively seeking input from community stakeholders and protecting vulnerable communities.
- Consider developing and/or implementing new codes, standards, and incentives with a goal that all new and existing buildings in the City's jurisdiction become energy efficient and zero carbon.
- Plan, permit, and invest in transportation measures that reduce vehicle miles traveled and GHG emissions.
- Strive to use 100% renewable energy in City operations and to offer 100% renewable electricity to residents and businesses.
- Plan, permit, and build critical energy infrastructure, including electric vehicle charging networks, distribution grid upgrades to enable electrification of heating and transport, microgrids, and/or renewable fuel transport and storage systems, each to the extent practicable.
- Develop an innovation toolkit for carbon-free energy technologies by supporting research, design, development, and early market deployment of new carbon-free energy sources, batteries, and other energy storage technologies.
- Protect and promote the health and safety of residents through climate adaptation.
- Implement actions that prepare residents for a changing climate and build resilience among populations at greatest risk from climate hazards.
- Support local businesses in addressing climate change and building a sustainable innovation economy that provides goods and services necessary for achieving climate goals.



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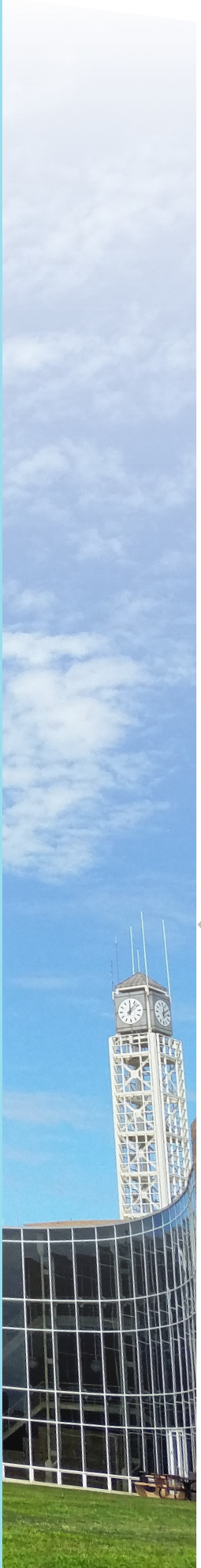

LOCAL CLIMATE-RELATED EFFORTS

In addition to the CAAP, the City has been engaged in an array of other climate-related programs and planning efforts, demonstrating its commitment to addressing climate change and promoting sustainability and resilience. The CAAP will ultimately serve as the City's roadmap for climate action, but continuing and expanding implementation of other local climate-related plans and programs will contribute to the City's broader climate goals. **Figure 3** below shows some of the notable plans and programs from recent years.

COLLABORATION AND PARTNERSHIPS

As shown in **Figure 4**, the City works with partners in the regional community, across the state, and around the globe, as tackling the threat of climate change requires collective action beyond its own efforts. The City must promote and facilitate collaboration between public, private, and nonprofit organizations, and engage with the community.

STATE CLIMATE LEGISLATION

The State has taken several legislative steps to reduce GHG emissions and build resilience to climate change impacts, which provide policy direction and context for this CAAP. **Figure 5** below summarizes three important pieces of legislation aimed at reducing GHG emissions across California, which this CAAP is directly informed by and aligned with.

In addition to its legislative actions, the State has also addressed climate change through guidance to and collaboration with local and regional governments. Most notably, the Climate Change Scoping Plan (Scoping Plan), developed by the California Air Resources Board (CARB), serves as the State's sector-by-sector roadmap for reducing GHG emissions in line with codified GHG emissions reduction targets and serves as an important guidance document for local governments in reducing their local emissions. The most recent iteration of the Scoping Plan—developed in 2022—outlines a technologically feasible, cost-effective, and equity-focused path to achieve the GHG reduction and carbon neutrality targets established in AB 1279. Separately, the California Adaptation Planning Guide (APG), developed by the California Governor's Office of Emergency Services (Cal OES), serves as California's official climate change adaptation planning guidance document intended for use by local governments. These documents, in addition to the remaining spectrum of climate-related efforts led by the State, underscore the importance of addressing climate change at all levels of government.

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FIGURE 3 TIMELINE OF LOCAL CLIMATE EFFORTS

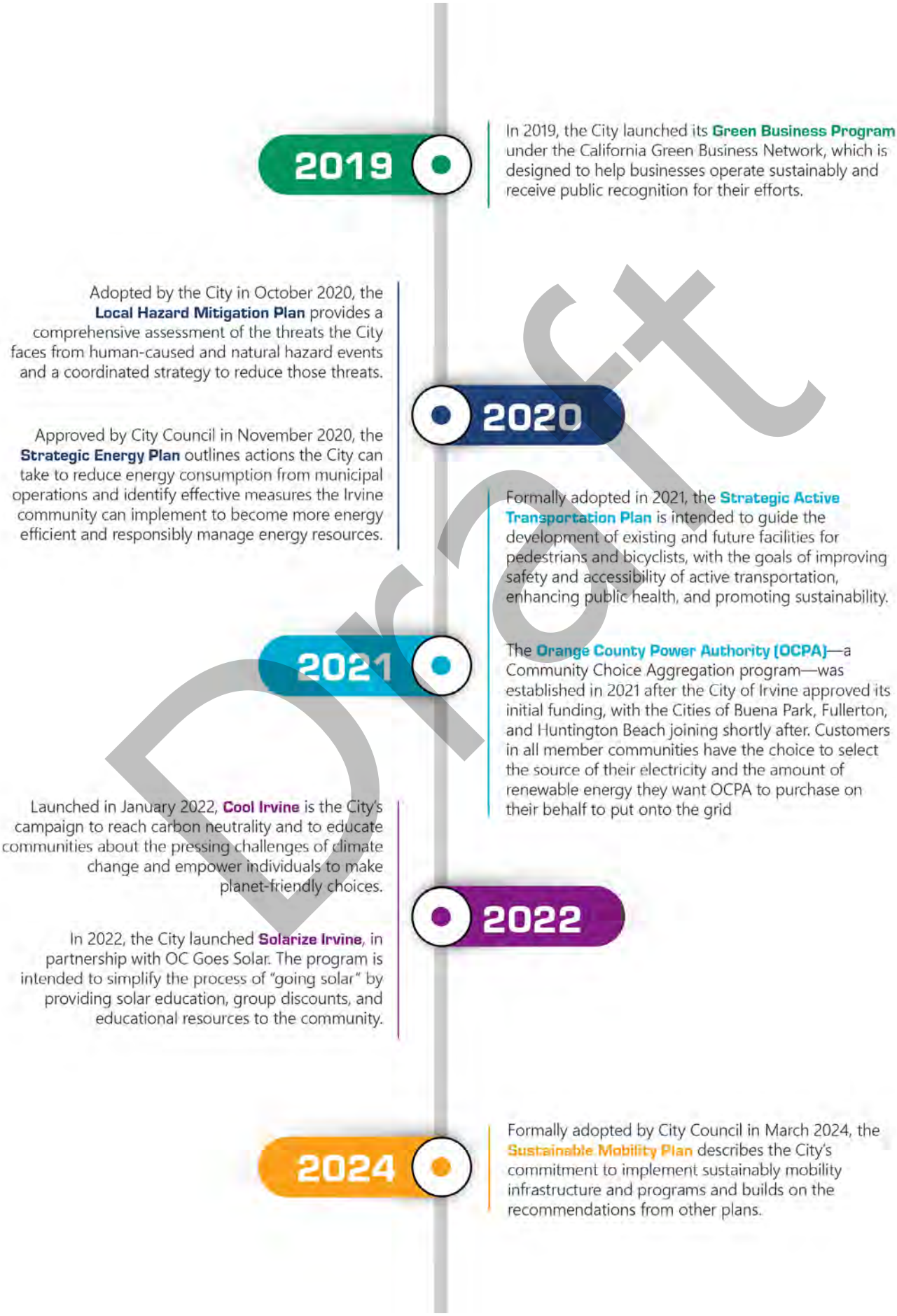

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FIGURE 4 PARTNERSHIPS

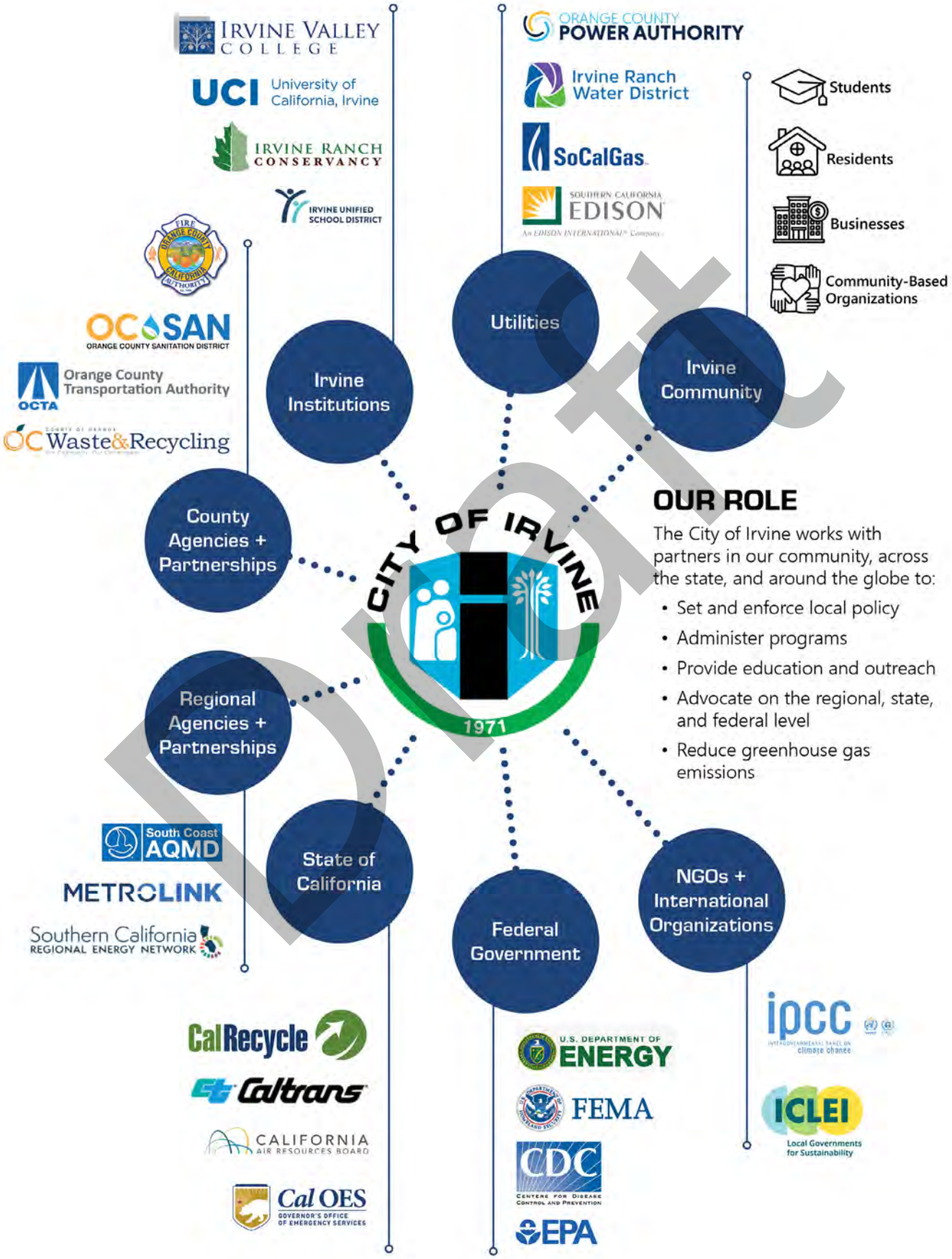

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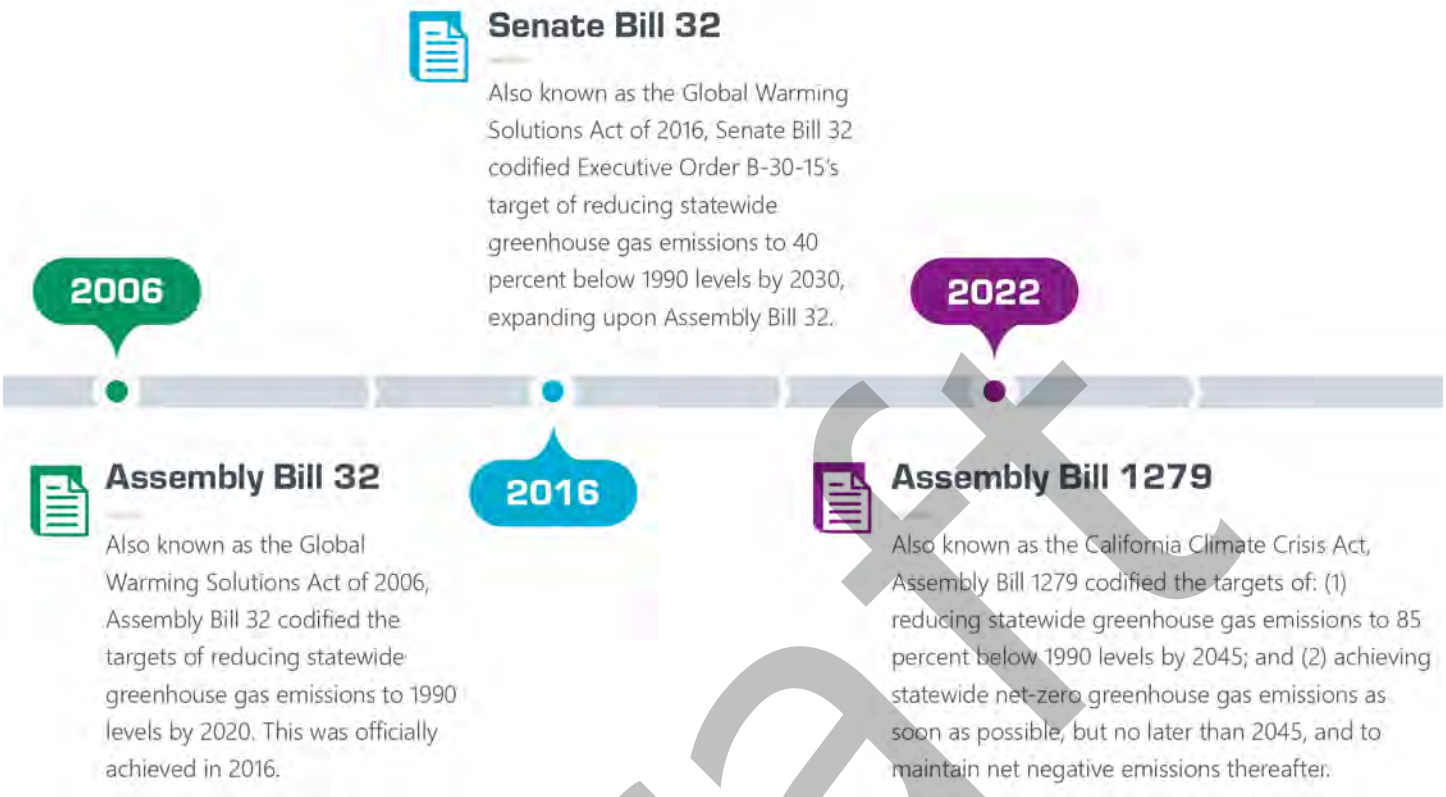
FIGURE 5 LEGISLATION TIMELINE



EARTH DAY COMMUNITY EVENTS

Each year in April, the City, like many other communities, celebrates Earth Day. While Earth Day is only one day, the City hosts a variety of community events and offers opportunities to learn how to reduce their carbon footprint all month long in honor of Earth Day. Some of the past events and opportunities included:

- Utensils and Condiments Drive: In partnership with Second Harvest Food Bank of Orange County, the City collected sealed, unused takeout utensil packs and unopened condiment packets, where donations could be dropped off at multiple locations throughout the city.
- Induction Cooking Workshop: The City hosted a free induction cooking workshop featuring local award-winning chef Katie Chin, who demonstrated how to make various ethnically-diverse dishes on an all-electric induction cooktop. The workshop included discussion on the benefits of switching from a gas range to an all-electric cooktop.
- Free Compost Giveaway Event: In partnership with Tierra Verda Industries, the City offered three free 20-pound bags of compost to residents. Volunteers were on-site to place compost bags in people's vehicles.
- Open Space Celebration: Partnering with the Irvine Ranch Conservancy and the Irvine Company, the City hosted an open space celebration at the Quail Hill Trailhead. Attendees were treated to a free pancake breakfast, family-fun activities, and a hike of the 1.8-mile Quail Hill Loop Trail.

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UNDERSTANDING IRVINE'S CLIMATE CHALLENGE

Chapter Two
Understanding Irvine's Climate Challenge

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Climate change is seen as not only a threat, but an opportunity to transition the way our cities, businesses, and homes operate to build a healthy community and resilient economy. There are two primary components to addressing climate change: (1) reducing GHG emissions and (2) adapting to hazards that are worsened by evolving weather patterns. The CAAP addresses both components, with many of the strategies to reduce GHG emissions having adaptation co-benefits, such as reliability of essential services. Similarly, adaptation strategies may achieve local GHG reductions. Combined, the climate action and adaptation strategies set a framework for a climate ready and resilient Irvine.

This chapter presents the background on climate change for the GHG reduction and adaptation strategies that will be described in detail later in the CAAP. It starts with an overview of the science that explains climate change at the global level, then narrows its focus to local influences and effects. This includes a deeper look at how GHG emissions influence our climate, and how they are generated in Irvine. It also discusses the impacts of climate change, some of which are already being experienced.

THE PHYSICAL BASIS OF CLIMATE

The physical basis behind Earth's climate is rooted in the greenhouse effect, a natural process that insulates the Earth and helps regulate its temperature through the presence of GHGs in the atmosphere. These naturally occurring gases, which consist mainly of water vapor, carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O), act as effective global insulators. They essentially act as layers of a blanket in the atmosphere that keep the energy from the sun near Earth's surface and allow for temperatures that are conducive to life, as demonstrated in **Figure 6**. Without the greenhouse effect, Earth would be cold and unsuitable for human life.

Human activities, also referred to as anthropogenic activities, have created an abundance of GHGs in our atmosphere that can be directly related to the increased use of fossil fuels in industry and daily life. The increases in GHGs act as further insulation in the atmosphere, trapping additional heat near Earth's surface that previously would have escaped into space (see the figure below). This phenomenon is known as climate change and is the primary driver behind more extreme weather patterns, the rapid melting of the polar ice caps, rising sea levels, and other effects that impact people, infrastructure, and natural systems.

FIGURE 6 THE GREENHOUSE EFFECT

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A CHANGING CLIMATE

Climate change is intensifying worldwide, with rising temperatures, and more frequent extreme weather events like heatwaves, floods, and droughts, as highlighted in the most recent scientific reviews from the Intergovernmental Panel on Climate Change. These changes are disproportionately affecting vulnerable regions, with implications for biodiversity, food security, and human health, demanding urgent global action to mitigate and adapt to these impacts. While climate change can manifest in many ways across the world, **Table 1**, presents various climate indicators and a description of the historic and future projected trends in California.

Table 1 Statewide Climate Indicators

Climate Indicator	Historic Trend	Future Trend
Temperature	Warming (last 100+ years)	Warming
Snowpack	Declining (last 60+ years)	Declining
Intensity of Heavy Precipitation Events	No significant trends (last 100+ years)	Increasing
Frequency of Drought	No significant trends (last 100+ years)	Increasing
Sea Level	Rising (last 100+ years)	Rising
Area Burned by Wildfire	Increasing (last 30+ years)	Increasing

Notes: The "Future Trends" associated with each "Climate Indicator" presented in this table are all based on Medium-High to Very High confidence, per California's Fourth Climate Change Assessment: Statewide Summary Report, which was published in January 2019.

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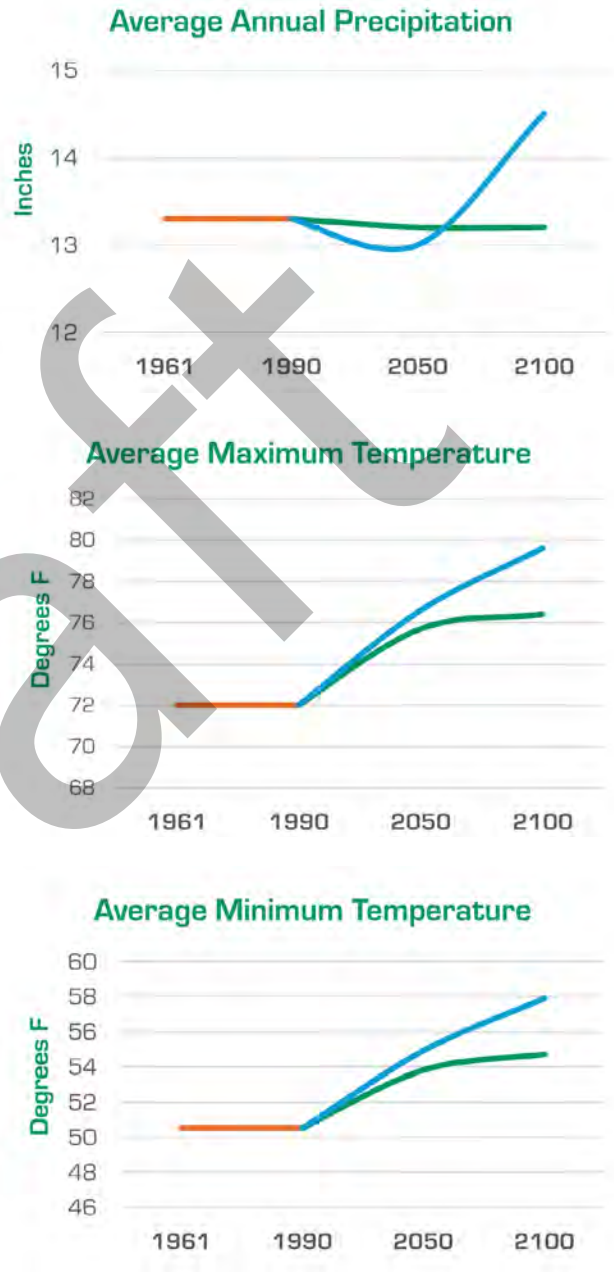
CLIMATE CHANGE IN IRVINE

The primary direct effects of climate change that are expected in Irvine are increased temperatures and higher variability in precipitation patterns, including both more intense heavy rainfall and more severe and extended periods of drought. **Figure 7** demonstrates the projected shifts in precipitation and temperature as experienced in Irvine through the end of the 21st century. The scenarios include a medium emissions scenario, where global GHG emissions stabilize by midcentury, and a high emission scenario, where GHG emissions continue to increase globally through the end of the century. These projections are based on global climate models that have been validated with recent and historical temperature and precipitation trends.

Increased temperature and more intense and variable precipitation have cascading indirect effects that are considered climate hazards. The five main climate hazards anticipated for Irvine are: extreme heat events, wildfire, drought, flooding, and liquefaction and landslides. These hazards could negatively affect the people, infrastructure, natural resources, and economy of Irvine. The core of climate adaptation as a concept is to build communities that are more resilient these hazards. Additional details on the five main climate hazards for Irvine can be found in **Table 2**.

FIGURE 7 DIRECT EFFECTS OF CLIMATE CHANGE UNDER VARIOUS SCENARIOS



Source: Ascent 2023.

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Table 2 Five Primary Climate Change Hazards Expected to Impact Irvine

Hazard	Description	Local Climate Impacts
Extreme Heat Events	Extreme heat events are a period when temperatures are abnormally high relative to a location's normal temperature range and are one of the leading weather-related causes of death in the United States. Extreme heat days and warm nights both contribute to heat exposure, with warm nights preventing relief from exposure during extreme heat days.	More conservative estimates show that by mid-century, the number of extreme heat days and warm nights experienced each year are expected to increase by 100% and 500%, respectively.
Drought	Warmer temperatures contribute to more frequent and intense droughts, leading to a decline in and faster melting of winter snowpack, greater rates of evaporation, and drier soils. These conditions decrease the amount of snowmelt runoff that determines California's water supply. Droughts could result in water supply shortages and over extraction of water from natural reservoirs.	Average annual precipitation levels are not expected to change significantly; however, the potential for increased periods of below-average precipitation and snowpack accumulation are increasing.
Wildfire	Climate change will result in changes in precipitation patterns, increased temperature, and drought conditions. Wetter months may lead to increased vegetative growth while following periods of drought will allow for the vegetative growth to dry up creating greater amounts of fuel for fires. Santa Ana wind events create strong and extremely dry winds that have caused some of the region's most damaging wildfires.	California may experience an increase in wildfires and burned area by the mid-century, under a high emissions scenario. Overall, burned area is projected to increase over 60% for Santa Ana winds driven fires and over 75% for non-Santa Ana fires.
Flooding	Increases in temperature and precipitation can lead to extreme precipitation events that can cause flooding. Both inland flooding, where rainfall amounts exceed the ability of water to be absorbed into soil or carried away by draining, and flash flooding from short periods of intense rainfall are hazards present in Irvine.	Changes in the intensity and duration of precipitation events causing heavy rainfall, thunderstorms, and hail are expected. Areas of Irvine already experience flooding during heavy rainfall events may see the intensity and duration of events increase due to climate change; however, the frequency is not expected to increase substantially.
Liquefaction and Landslide	Liquefaction and landslides are unique climate hazards as they are exacerbated by increases in heavy rainfall and flooding. Liquefaction is generally a seismic event that can be extremely destructive in areas susceptible to it. Landslides occur when soil on slopes becomes destabilized, typically associated with heavy rains and exacerbated by recently burned terrain.	Increases in wildfire frequency could influence increased landslides during heavy precipitation events. Areas in the northern portion of Irvine that are already subject to liquefaction are unlikely to have significantly increased probability of such events; however, liquefaction events can be highly destructive when they do occur.

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Fabric of the Community

Situated at the foothills of the Santa Ana Mountains to the east, the San Joaquin Hills to the west and south, and the low-lying flatlands of central Orange County to the north, Irvine has a diverse geographic setting. Located approximately five miles south of the City of Santa Ana (Orange County Seat), Irvine is in a key job center for both Orange County and Southern California.

Irvine provides the educational, employment, recreational, and cultural opportunities of a large city and, since its incorporation in 1971, has grown to include strong, diverse residential and business communities while committing to the preservation of one-third of Irvine as open space, per the City Charter. At 53 years old, Irvine is a relatively young city that consists of 30 distinct villages that are characterized by their own neighborhood parks, schools, and commercial centers. Irvine is still growing and continuing its history of master planning through redevelopment of underutilized commercial and industrial uses.

As of 2023, Irvine had a population of approximately 315,000 and is expected to have 327,700 residents by the year 2045. Household incomes are generally higher in Irvine than in Orange County as a whole, with 56% of households in the City having incomes above median. Even with a greater median household income, compared with the region, a larger percentage of residents rent their home.

Vulnerable Populations

Climate change disproportionately affects those with existing disadvantages. Low-income communities and communities of color often live in areas with heightened exposure to environmental hazards, such as higher temperatures and worse air quality. These communities also have fewer financial resources to adapt to these hazards. For instance, low-income populations are already disproportionately burdened by energy bills and may reduce air conditioning usage out of concerns about cost. People with chronic medical conditions are often more physiologically susceptible to negative health impacts from extreme heat and poor air quality, and those with mobility issues are particularly at risk. Many of the above risk factors are often present in older adults, who are more likely to have a limited income, chronic health conditions, and mobility limitations, and are more likely to experience social isolation.[1]

Factors such as age, physical and mental condition, socioeconomic status, access to key services, and other factors affect the ability of people to prepare for and protect themselves and their property from a climate-related event. Even though hazard events may impact all parts of the City with equal severity, individuals may experience the effects differently.

[1] Hall, Alex, Neil Berg, Katharine Reich. (University of California, Los Angeles). 2018. Los Angeles Summary Report. California's Fourth Climate Change Assessment. Publication number: SUM-CCCA4-2018-007.

How much of Irvine's population is vulnerable?

- **12.3%** of Irvine households contain at least one **person with a disability.**
- **13.1%** of households had an income that was considered below the **poverty level**.
- **12.6%** of population over **65 years of age**.

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Vulnerability Assessment Results

As a key step of development of the CAAP, the City conducted a vulnerability assessment to understand how specific climate hazards will impact the City's essential services, infrastructure, and vulnerable populations, combined with an assessment of the City's adaptive capacity. As discussed above, there are a variety of climate hazards that can impact Irvine, and they affect populations and infrastructure in diverse ways.

The City, its supporting agencies, and countywide organizations have already taken steps to build resilience and protect sensitive populations and assets from hazards. The term "adaptive capacity" characterizes Irvine's current capability to cope with the projected impacts from climate hazards to vulnerable populations and assets, determined through a review of existing plans and programs. The combination of impacts and adaptive capacity provides an assessment of climate hazard vulnerabilities, that demonstrate focus areas where additional policies may be needed as part of a climate adaptation framework.

Climate hazard vulnerabilities can be characterized as scores between 1 and 5, based on the impact of a hazard and the adaptive capacity for mitigating the hazard. A score of 5 indicates that potential impacts are high and adaptive capacity is low. A score of 1 indicates that potential impacts are limited, and adaptive capacity is high. **Table 3** provides an overview of the Climate Hazard Vulnerability Scores for key climate hazards.

Extreme heat events, drought, and wildfire present the highest impact risks to the City, including to essential infrastructure and vulnerable populations. Liquefaction may be one of the most infrequent and improbable indirect climate hazards; however, it has potential to be most impactful, with limited adaptive capacity.

Table 3 Statewide Climate Indicators

Community Elements	Extreme Heat Events	Drought	Wildfire	Flooding	Liquefaction	Landslide
Essential Facilities	2	4	4	1	4	1
Transportation Systems	3	1	2	3	5	2
Lifeline Utility Systems	4	4	4	3	4	3
Hazardous Materials	3	4	4	1	4	2
Economy	3	3	3	1	2	1
Natural Resource Areas	5	5	5	1	3	1
Vulnerable Populations	5	2	4	1	3	1

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A complete climate vulnerability assessment for the City of Irvine can be found in Appendix B. The vulnerability assessment includes more information on analysis methods and results, and the regulatory drivers for climate adaptation planning.

IRVINE'S GREENHOUSE GAS PROFILE

The driver of climate change and its impacts are GHG emissions that are generated by everyday human activities. The City of Irvine has a population of approximately 315,000 with an average of 270,000 daily workers that all use vehicles, consume energy, and generate waste that cause direct and indirect GHG emissions. For the purpose of the CAAP, the City has developed an inventory of annual GHG emissions within the City's boundary. This GHG inventory presents data on how and where GHG emissions are generated, providing valuable insight into the actions the City and community members can take to reduce their climate contributions.

The policies presented later in this CAAP are expected to reduce future GHG emissions. As such, the City has used the GHG inventory and projections on growth in population, jobs, and vehicle travel to estimate future GHG emissions, known as a GHG emissions forecast. This forecast allows the City to understand how local, state, and federal policies and regulations will contribute to reducing local GHG emissions and allow for the City to establish future reduction targets that are ambitious but achievable. Additional details on the GHG analysis presented here can be found in Appendices C and D.

Greenhouse Gas Inventory

The first step in a community's climate action planning process is to develop a GHG emissions inventory, which is a snapshot of the GHG emissions associated with sources and activities within its jurisdiction in a given year. The purpose of an inventory is to:

- Establish a baseline against which future emissions levels and future reduction targets can be measured;
- Understand the sectors and sources generating GHG emissions and their relative contribution to total emissions; and
- Monitor progress towards achievement of GHG reduction targets.

In 2019, the City conducted a GHG emissions inventory. It measured (1) the total emissions generated from communitywide activities within the City of Irvine, known as the communitywide GHG inventory, and (2) the contribution of the City's government operations, known as the government operations GHG inventory.

The communitywide GHG inventory, presented in **Figure 8**, shows:

- The contribution of fuel consumed in vehicles is large, comprising approximately 50% of total communitywide GHG emissions.
- Energy used in buildings also contributes 37% of the communitywide GHG emissions, but through community collaboration there are significant opportunities for reduction.

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FIGURE 8 COMMUNITYWIDE GHG INVENTORY FOR 2019

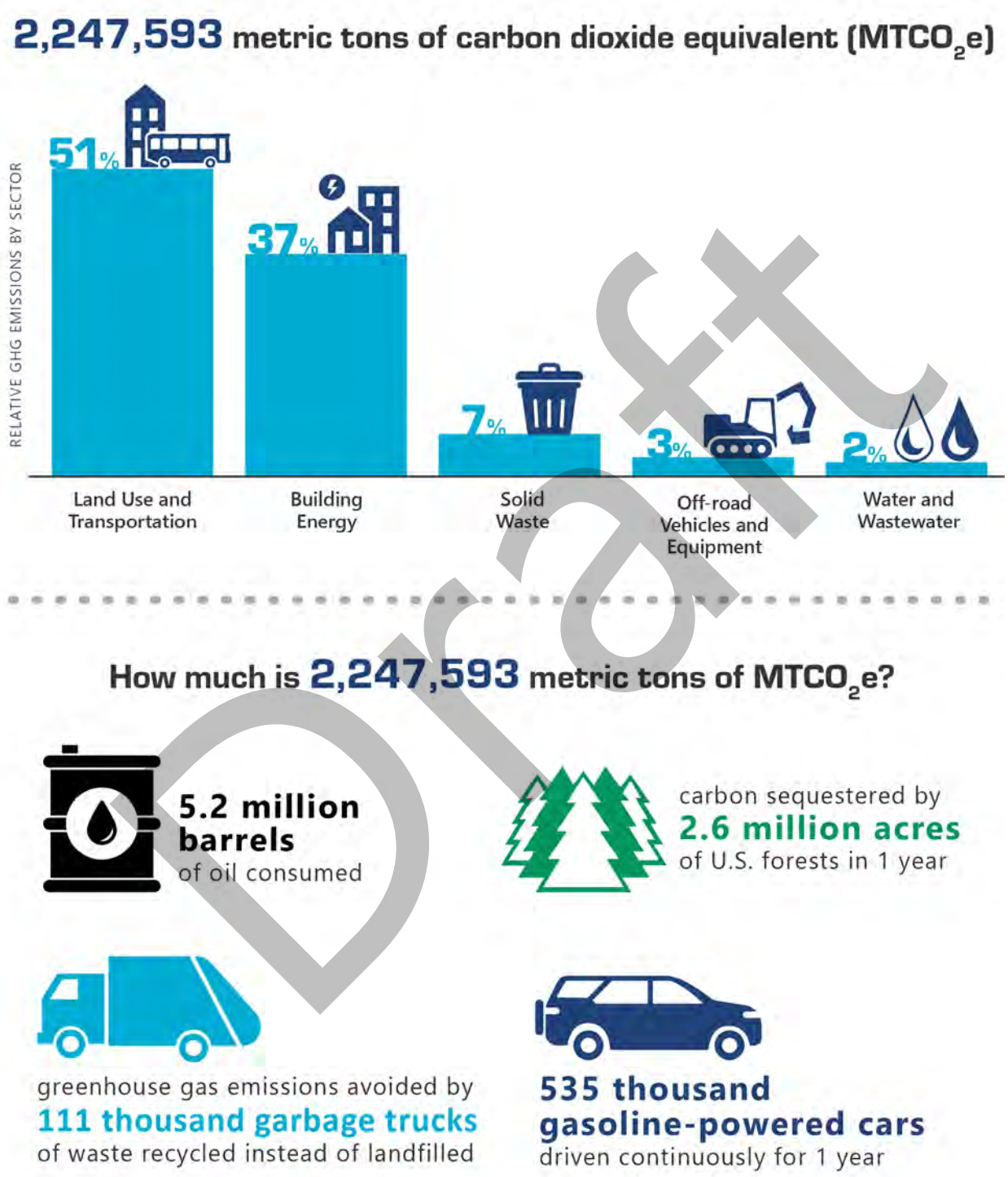

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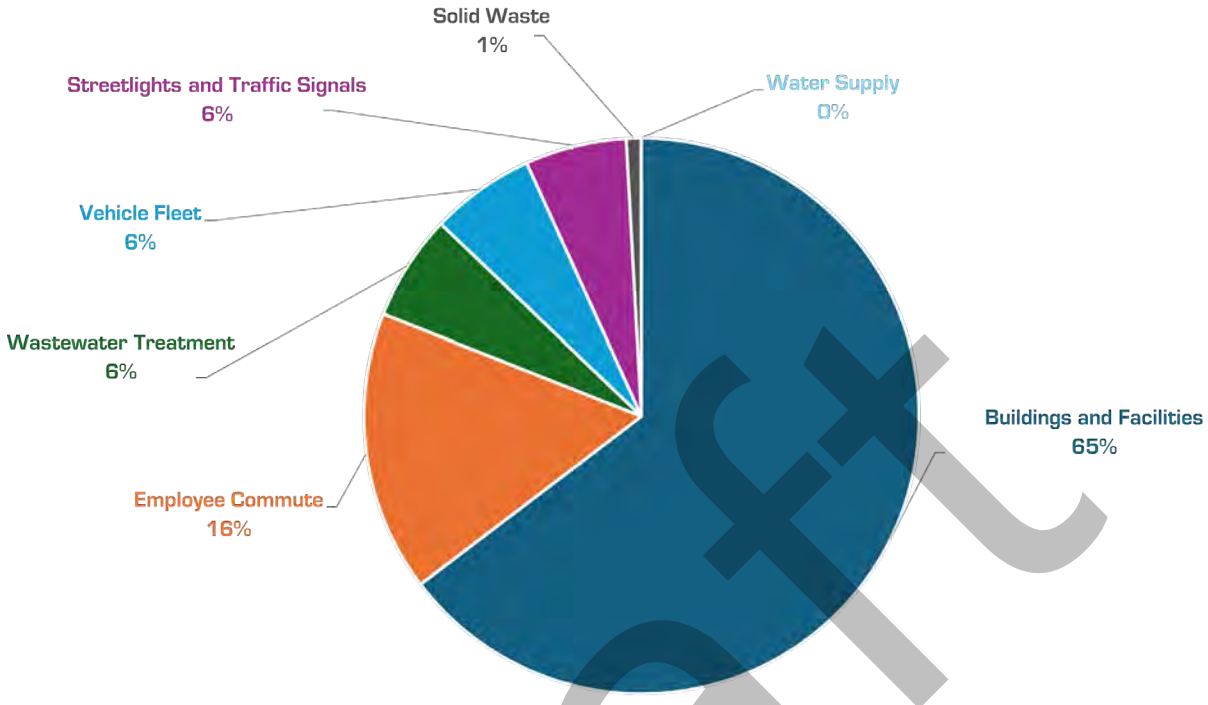
FIGURE 9 GOVERNMENT OPERATIONS GHG INVENTORY FOR 2019



The government operations GHG inventory is presented in the pie chart in Figure 9, displaying how buildings and facilities are by far the largest GHG emissions sources for government operations. An important aspect of the government operations GHG inventory is the ability for the City to exert direct control over these GHG emissions sources and lead by example.

The GHG emissions inventory presented in this section is intended to provide a high-level overview of the purpose for conducting an inventory, and scale of various GHG emissions sources and activities. Chapter 3 provides more detail on each GHG emissions source in the context of levers for reducing emissions.

Greenhouse Gas Forecast and Targets

This CAAP identifies policies and strategies that will reduce future GHG emissions to bring citywide total emissions below a target level. Viewing how population and economic growth, changing land use patterns, and State and federal regulations will affect GHG emissions in the future provides a perspective on where the City and community can focus climate action efforts – and ultimately what level of GHG reductions can be achieved.

Communitywide GHG emissions in the City are expected to decline through 2030 and 2040, as a result of State regulations and programs, even while population and economic growth is expected to continue. Regulations such as Advanced Clean Cars II, which regulates

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statewide tailpipe emissions, and Renewables Portfolio Standards that set requirements for renewable and GHG-free electricity, are expected to reduce local GHG emissions significantly. Even with these reductions from State actions, the City is aiming for more aggressive GHG reduction targets.

To realize a future low-carbon economy, the City is establishing GHG reduction targets that align with those of the State. The State is shifting its economy to a low-carbon future, and the City of Irvine intends to be a leader in this transition. With adoption of the ACHEIVES Resolution and the statewide targets set by SB 32 and AB 1279, the following local GHG reduction targets have been established:

- 44% reduction in emissions below 2019 levels by 2030
- 90% reduction in emissions below 2019 levels by 2040

The chart in **Figure 10** provides an overview of future communitywide GHG emissions for the City for the years 2030 and 2040, after the expected impacts of currently adopted State and federal regulations. Also shown is how the City's GHG reduction targets compare to future expected GHG emissions levels, and the GHG emissions gap that will need to be bridged to meet the targets, with the policy and programs in this CAAP. More details on how GHG emissions forecasts and targets were developed can be found in Appendices D and E.

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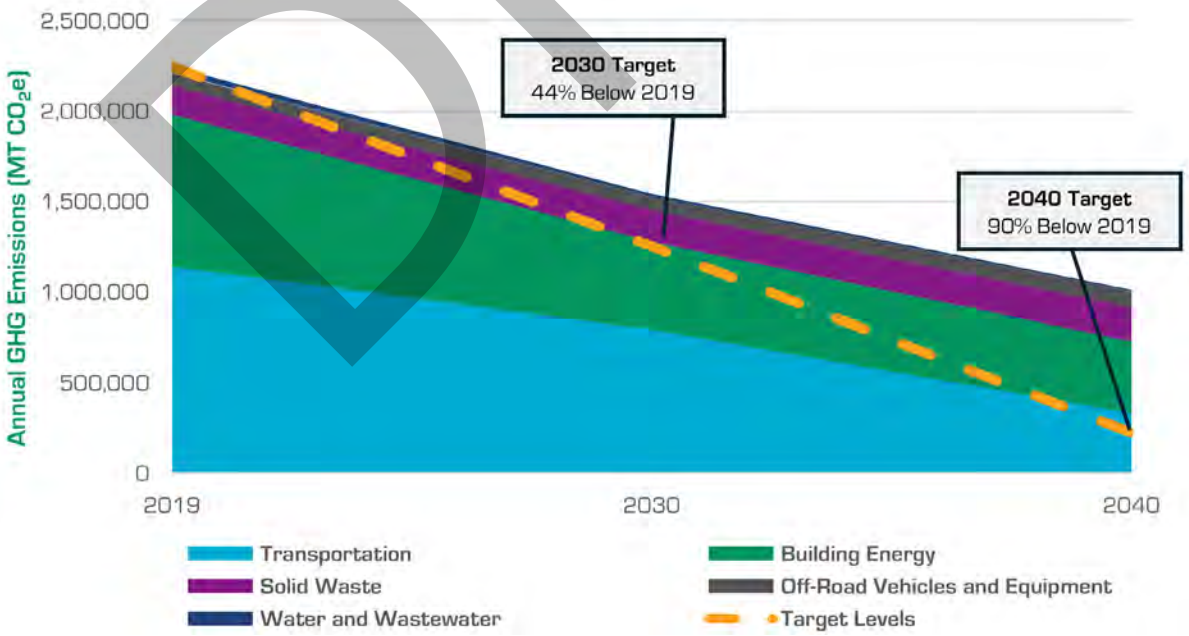
FIGURE 10 COMMUNITYWIDE GHG EMISSIONS FORECAST AND TARGETS



ADDRESSING CLIMATE CHANGE

Understanding the local effects and hazards resulting from climate change, and the local contributions of GHG emissions that cause them, provides a basis for developing a policy strategy to address the challenges and opportunities for the City. Addressing climate change requires an integrated approach that targets both its sources and impacts. Targeting its sources by reducing the anthropogenic flow of heat-trapping GHGs into the atmosphere is known as climate action, or climate change mitigation. Targeting its impacts is known as climate change adaptation and involves efforts that are intended to reduce risk and build resilience to climate change. **Figure 11** illustrates this integrated approach to climate change mitigation and adaptation. Although climate change mitigation and adaptation can often be separate planning efforts, it is important to consider both components in climate action planning, which this CAAP does.

The remainder of the CAAP provides details on the approaches the City can take to address climate change, including strategies for reducing local GHG emissions and addressing the impacts of climate change.

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Clean Lawn Equipment

In January 2024, the State banned the sale of new small off-road engine-powered garden equipment, such as leaf blowers, lawn mowers, string trimmers, hedge trimmers, and small chainsaws. This statewide sales ban will result in the eventual phasing out of this equipment. However, in consideration of the health, safety, and welfare of residents and visitors, the City is expediting this process through the adoption of Ordinance No. 23-25, which enacted a phased-out approach on the use of this equipment beginning on July 1, 2024, while also updating its noise regulations.

To assist residents with the transition to zero-emission equipment, the City has partnered with the South Coast Air Quality Management District (SCAQMD) to offer residential lawn and garden equipment rebates. Each household can receive up to three rebates over the lifetime of the program, for different pieces of equipment. Additionally, as part of this transition and consistent with the City's sustainability commitment, residents must recycle their gas-powered equipment by taking it to a certified scrapper or dismantler on the approved SCAQMD list prior to applying for the rebate. Further, for residents who are customers, the Orange County Power Authority (OCPA) offers discounted equipment at their online marketplace.

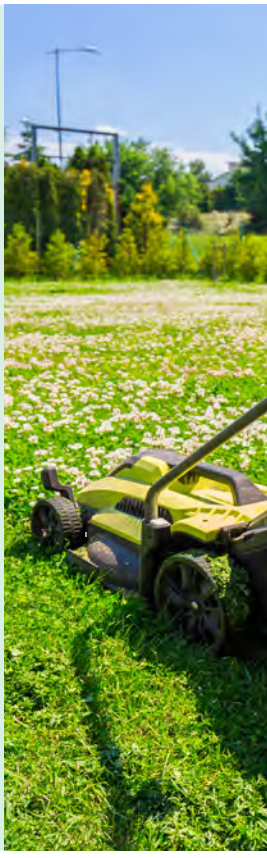
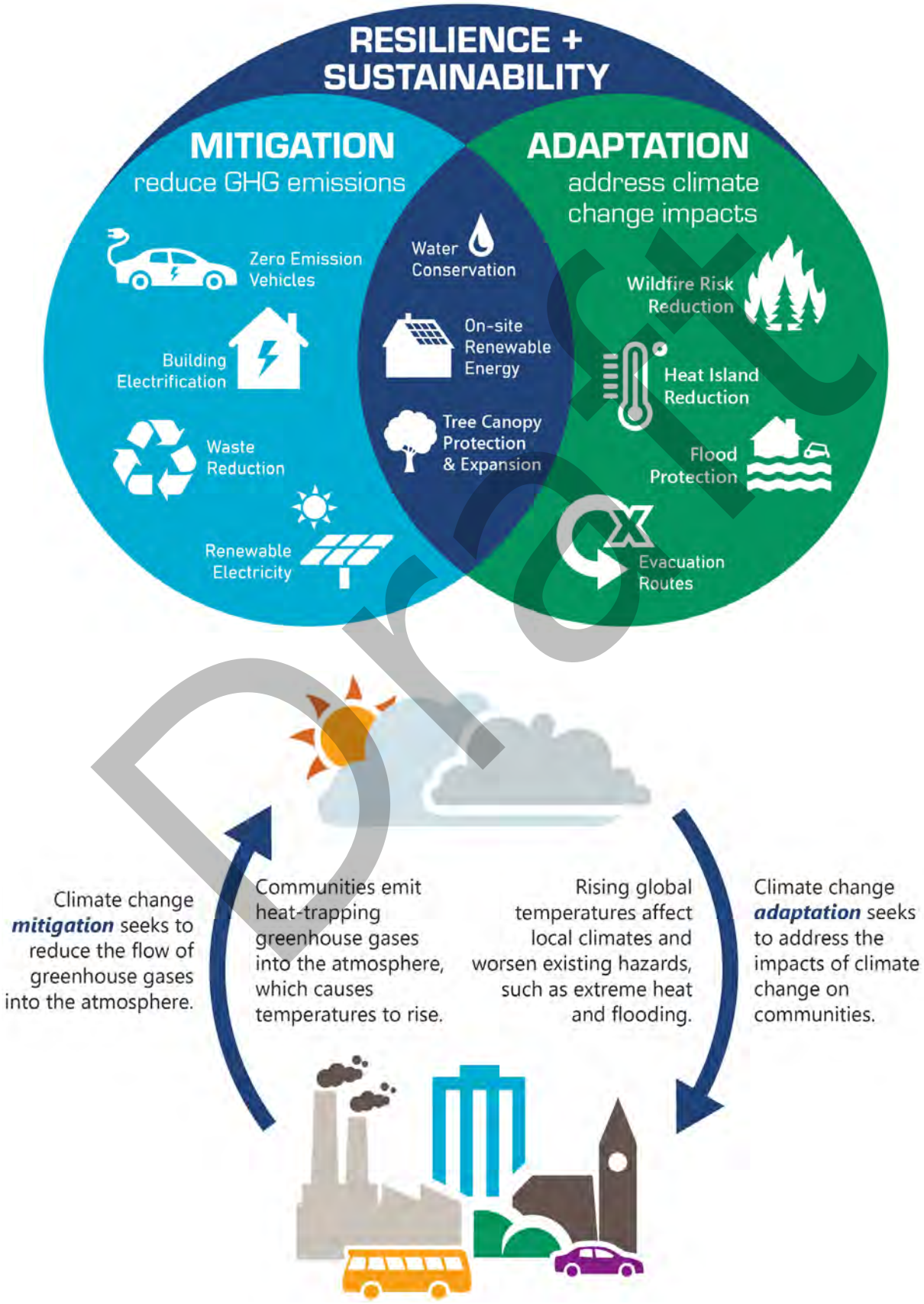


FIGURE 11 CLIMATE CHANGE MITIGATION AND ADAPTATION PLANNING



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PATHWAY TO A LOW-CARBON ECONOMY

Chapter Three
Pathway to a Low-Carbon Economy

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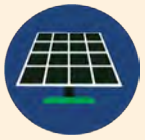
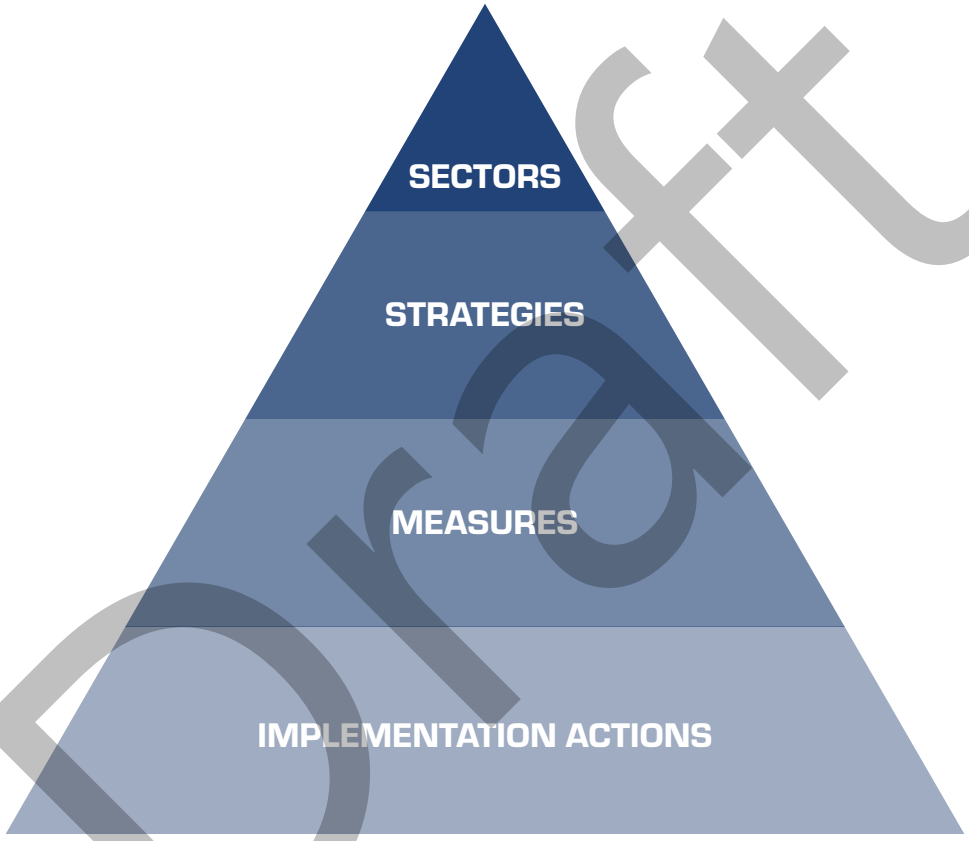
California is the world's largest economy that has committed to a zero-carbon future, and the City is committed to providing its residents, workers, and businesses the resources to thrive in a low-carbon economy. A progressive strategy must start now, such that new growth, redevelopment projects, and infrastructure upgrades are well-equipped to support sustainable travel modes and technologies. The following chapter outlines the City's pathway towards deep GHG reductions.



PATHWAY FRAMEWORK

With extensive stakeholder input, the City has developed a pathway for reducing communitywide and government operations GHG emissions to meet target levels. The success of the CAAP relies on participation from everyone: City government, property owners, businesses, and individuals, along with support from other levels of government.

The City's pathway addresses each of the key GHG emissions sectors identified in the 2019 communitywide GHG emissions inventory, with a suite of strategies that will be prioritized and implemented over time. Under each strategy, there are several measures that will be implemented to achieve specific objectives. The City has also identified implementation actions that establish clear steps to be taken in order to achieve the objectives of measures.



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Effective implementation of the CAAP measures will rely on public participation and partnerships with public agencies, non-profits, and private interests. The City has identified how actions within the City's authority and actions of external partners intersect to create more effective and comprehensive GHG reduction programs. This chapter provides a summary of these actions for each GHG reduction measure; with additional detail on implementation available in Chapter 4 and in Appendix G.

GREENHOUSE GAS STRATEGIES

EMISSIONS SECTOR	STRATEGIES
TRANSPORTATION AND LAND USE (TR)	TR-1: Sustainable Transportation & Land Use Planning TR-2: Low- and Zero-Emission Vehicles TR-3: Transit System Improvement TR-4: Active Transportation TR-5: Transportation Demand Management TR-6: Vehicle Idling TR-7: Parking
BUILDING ENERGY (BE)	BE-1: Building Energy & Electrification BE-2: Low Carbon Development BE-3: Clean Energy BE-4: Energy Education and Awareness
SOLID WASTE (SW)	SW-1: Zero Waste SW-2: Landfill Emissions
OFF-ROAD VEHICLES AND EQUIPMENT (OR)	OR-1: Electrification & Clean Alternatives
WATER AND WASTEWATER (W)	W-1: Water Conservation W-2: Recycled Water
RESILIENCE, GREEN ECONOMY, AND CARBON SEQUESTRATION (MS)	MS-1: Urban Forestry & Open Space MS-2: Urban Heat Island Reduction MS-3: Green Infrastructure MS-4: Green Business & Jobs MS-5: Carbon Sequestration & Embodied Emissions

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CO-BENEFITS

While the CAAP is primarily geared toward reducing GHG emissions and adapting to climate change, implementation of the strategies will also result in an array of "co-benefits" beyond climate change mitigation and adaptation. The co-benefits identified in this CAAP, along with a short description of each, are provided below.

Benefit to Renters: Provides cost savings, such as lower energy bills or increased access to public transit. 53% of households in Irvine are renters.

Equity: Enhances equity through improved quality of life and access to resources and opportunities for underserved communities. This can be realized in many ways, including improving procedural equity or ensuring that benefits of policies are experienced by all community members.

Air Pollution Prevention: Minimizes local or regional criteria pollutant emissions at the location of implementation. While air pollution is generally considered a regional-scale challenge, reduction in fossil fuel consumption can support the City's overall contribution of air pollutants as well as more localized challenges, such as toxic air contaminants and indoor air quality.

Health and Wellbeing: Improves public health and/or general quality of life through policies that support clean and active communities. Examples may include policies that support the ability to comfortably use active transportation to reach key destinations or improved indoor air quality.

Reliability: Increases reliability of the electrical grid, transit systems, emergency response, and other essential services. An example may be that increasing onsite renewable energy and battery storage can reduce stain on the electrical grid during peak hours.

Prioritized by Community: Community members noted certain measures as high priority during the public engagement process.

Job Development: Maximizes the creation of quality jobs through policies that support local workforce development and attract green industries to Irvine.

Resource Preservation: Helps to preserve and enhance green space, prime habitat, and biodiversity in Irvine. This ensures that local ecosystem services are maintained, such as stormwater and air filtration through vegetation, and that Irvine residents and visitors can continue to experience natural Southern California habitats.

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Each strategy included in this CAAP has one or more of these co-benefits associated with it, and each co-benefit is classified with a unique icon, which can be found with the description above. However, it should be noted that there are additional co-benefits beyond those that are listed here that will culminate as a result of successful CAAP implementation, such as community cost savings and reduced traffic and congestion, among many others. While these additional co-benefits are equally important, the co-benefits included above were elevated as part of the community engagement process.

GREENHOUSE GAS REDUCTION STRATEGIES

The GHG reduction strategies of the CAAP are focused on GHG sources the City has direct control or significant influence over. Many of the strategies will require voluntary participation; however, the City can influence the carbon footprint of essential services, new growth and redevelopment, and how land use patterns intersect with mobility options. The City intends to implement programs that provide support for residents and businesses to take action and reduce barriers to more sustainable practices.

In the following pages, the City's strategies for reducing GHG emissions are laid out in detail, including each measure, measure co-benefits, and GHG reduction potential. With successful implementation of the GHG reduction strategies, it is expected that GHG emissions would be reduced to levels that would achieve the City's GHG reduction targets outlined in Chapter 2. Additional details on the GHG reduction potential of combined strategies, and methods used to estimate GHG reduction potential, can be found in Appendix F.

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Switch is On

The City has partnered with the State to launch "Switch is On," a campaign that supports Californians throughout the journey of home electrification. Swapping out gas-powered appliances for electric appliances is one of the most effective and important actions one can take for a better energy future, and is essential to help Irvine meet its climate goals.

Switch is On is the first campaign of its kind — not only in California, but in the U.S. as a whole. The City is proud to help lead the charge to go electric, as home electrification is integral to reducing emissions. When appliances use electricity instead of gas, we rely on an increasingly renewable energy supply. On a sunny day, California is powered by as much as 94% renewables and the majority of the State's overall power mix is composed of non-fossil fuels. Electric appliances are also safer, more efficient, better performing, and can lead to more savings compared to their gas counterparts.

As part of the Switch is On campaign, Irvine residents can meet with one-on-one advisors, find vetted contractors, access shortcuts to incentive programs and rebates, and learn about more ways to support climate action efforts on a grassroots level.

HOW TO READ SECTOR SNAPSHOTS

Sector Description

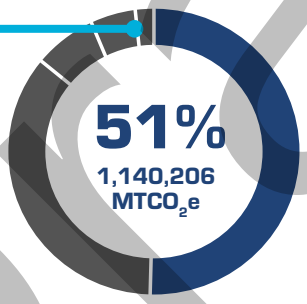
TRANSPORTATION AND LAND USE

The largest and most challenging GHG emissions sector to address is transportation and land use, which has been driven by decades of auto-centric development patterns. While the City has one of the more compact development patterns of Orange County cities, the need for personal automobiles to perform daily functions is ingrained in both the culture and landscape. It is the City's obligation to continue and expand the development of walkable, livable neighborhood; while supporting infrastructure to enable zero-emission modes of transportation.

Sector Emissions (2019)

Sector Emissions

Total emissions and relative contribution to total in 2019 community GHG emissions inventory.



Total Emissions from the Transportation and Land Use Sector in 2019

Sector Statistics

Sector Statistics

Relevant and recent statistics about the sector.

1,017 public EV chargers in 2024

11.8% of all registered vehicles in Irvine are EVs

2.9B annual vehicle miles traveled

888.7 total bike lane and bike path miles

Irvine's Vision for a Clean and Connected Community

Sector Vision

- Every community is walkable, bikeable, and connected to schools and services.
- Access to zero-emission charging and fueling infrastructure is not a barrier to new vehicle technologies.
- Higher-density housing in key areas reduces housing and transportation costs.
- Public transit and micro-mobility options are widely available.

Sector Future GHG Emissions

Figure showing how sector GHG emissions are expected to change with the influence of State regulations, and implementation of the CAAP for the years 2030 and 2040.

Future GHG Emissions with CAAP Strategies

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HOW TO READ STRATEGY OVERVIEWS

TR-1 Sustainable Transportation and Land Use Planning

Strategy Description

Expanded low- and zero-emission vehicle (ZEV) purchase options and charging infrastructure nearly eliminate tail-pipe GHG emissions.

CO-BENEFITS

Benefit to Renters

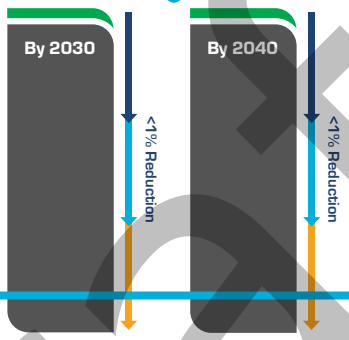
Air Pollution Prevention

Health and Wellbeing

Prioritized by Community

Strategy Co-benefits

GHG REDUCTION POTENTIAL



Strategy GHG Reduction Potential

Relative to the total reductions from implementation of the CAAP for the years 2030 and 2040.

MEASURES TO REALIZE TR-1

	BUILDS UPON	ACHIEVED THROUGH	
		City Action	Community Support
TR-1.1 Increase high-density, transit-oriented development along primary corridors to reduce time spent traveling.	City of Irvine 2021-2029 Housing Element	Encourage a mix of commercial and residential uses in all areas of the City, and increased housing density in key areas	Build Accessory Dwelling Units (ADUs) on private property
TR-1.2 Create car-free areas to reduce vehicle use and promote pedestrian use.	CicloIrvine open streets events	Facilitate safe and walkable experiences, including pedestrian malls and car-free zones	Choose walking to reach destinations and explore local businesses

Summary of Actions

for implementation of GHG reduction measures.

Existing City Initiatives

GHG Reduction Measures

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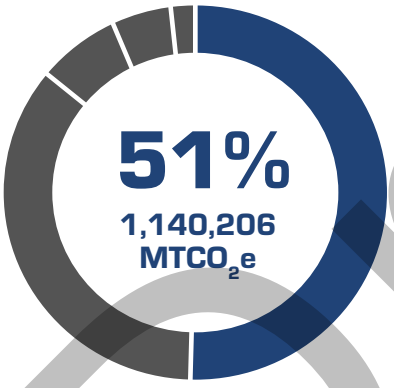
TRANSPORTATION AND LAND USE

The largest and most challenging GHG emissions sector to address is transportation and land use, which has been driven by decades of auto-centric development patterns. While the City has one of the more compact development patterns of Orange County cities, the need for personal automobiles to perform daily functions is ingrained in both the culture and landscape. It is the City's obligation to continue and expand the development of walkable, livable neighborhood, while supporting infrastructure to enable zero-emission modes of transportation.

Sector Emissions (2019)



Total Emissions from the Transportation and Land Use Sector in 2019

Sector Statistics

1,017 public EV chargers in 2024

11.8% of all registered vehicles in Irvine are EVs

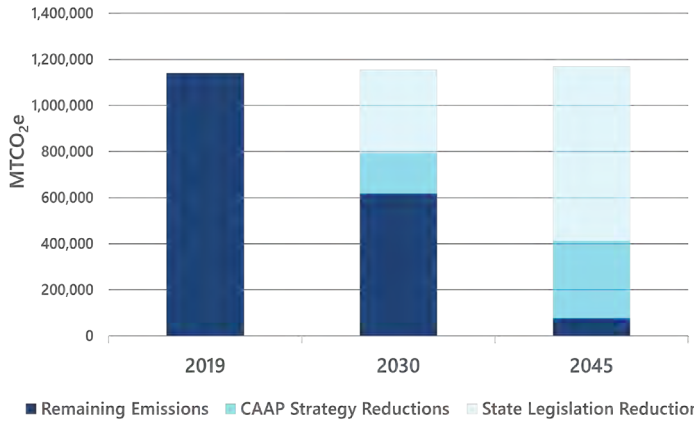
2.9B annual vehicle miles traveled

399.7 total bike lane and bike path miles

Irvine's Vision for a Clean and Connected Community

- Every community is walkable, bikeable, and connected to schools and services.
- Access to zero-emission charging and fueling infrastructure is not a barrier to new vehicle technologies.
- Higher-density housing in key areas reduces housing and transportation costs.
- Public transit and micro-mobility options are widely available.

Future GHG Emissions with CAAP Strategies



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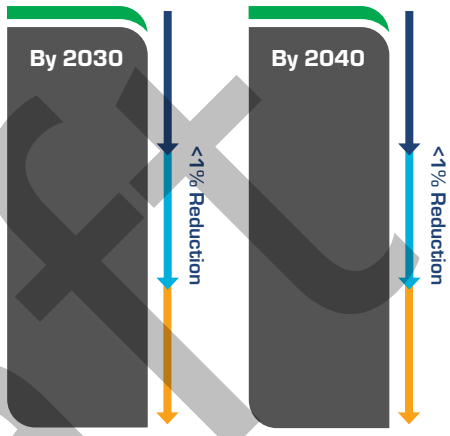
TR-1 Sustainable Transportation and Land Use Planning

Land use planning that supports increased housing near mobility options and walkable experiences to reduce GHG emissions from vehicle travel.

CO-BENEFITS

- Benefit to Renters
- Air Pollution Prevention
- Health and Wellbeing
- Prioritized by Community

GHG REDUCTION POTENTIAL



MEASURES TO REALIZE TR-1

BUILDS UPON	ACHIEVED THROUGH	
	City Action	Community Support
TR-1.1 Increase high-density, transit-oriented development along primary corridors to reduce time spent traveling	City of Irvine 2021-2029 Housing Element	Encourage a mix of commercial and residential uses in all areas of the City, and increased housing density in key areas	Build Accessory Dwelling Units (ADUs) on private property
TR-1.2 Create car-free areas to reduce vehicle use and promote pedestrian use	CicloIrvine open streets events	Facilitate safe and walkable experiences, including pedestrian malls and car-free zones	Choose walking to reach destinations and explore local businesses

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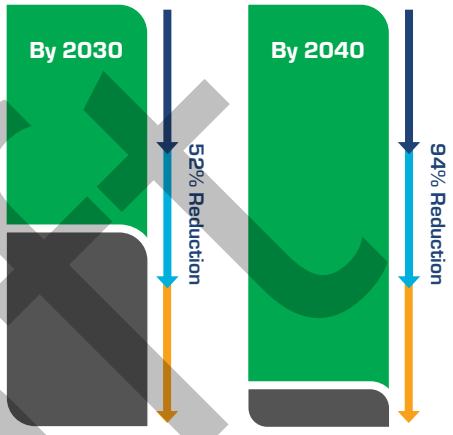
TR-2 Low- and Zero-Emission Vehicles

Expanded low- and zero-emission vehicle (ZEV) purchase options and charging infrastructure nearly eliminate tailpipe GHG emissions.

CO-BENEFITS

- Benefit to Renters
- Air Pollution Prevention
- Health and Wellbeing

GHG REDUCTION POTENTIAL



MEASURES TO REALIZE TR-2

	BUILDS UPON	ACHIEVED THROUGH	
		City Action	Community Support
TR-2.1 Increase electric vehicle (EV) charging infrastructure	EVCS permitting available online through City's website	Direct installations of EV chargers and supporting installations on private property	Follow EV charging installation permitting requirements
TR-2.2 Increase EV and low-carbon vehicle adoption through incentives and awareness of existing federal, state, and regional incentives/tax credits	EV charger installation rebates shared through the City's website and external communications	Replace City fleet vehicles with ZEVs and share information on available incentives and tax credits	Support a regional EV collaborative to share lessons learned and best practices, and track metrics
TR-2.3 Support EVs in new development by increasing the number of chargers required	EV chargers required as part of 2022 CALGreen building standards code	Require that new development installs EV chargers consistent with CALGreen Code Tier 2 Voluntary Measures	No actions identified
TR-2.4 Reduce the use of fossil fuel-powered vehicles	2022 City of Irvine Zero-Emission Vehicles Transition Plan	Implement the 2022 Zero-Emissions Vehicle Transition Plan for widespread EV adoption	Utilize e-bikes and other modes of electric micro-mobility

Draft

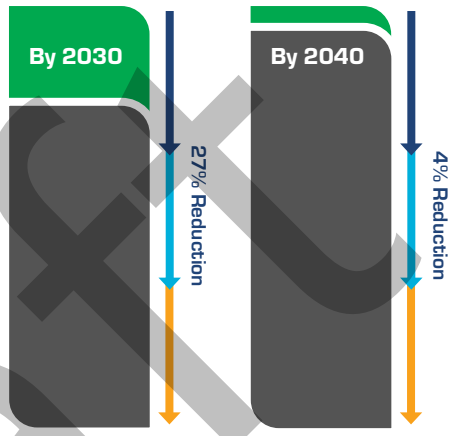
TR-3 Transit System Improvement

Increased accessibility and improved infrastructure for public transit reduces single-occupancy vehicle trips and enables more low-cost and low-carbon mobility options.

CO-BENEFITS

- Equity
- Air Pollution Prevention
- Reliability

GHG REDUCTION POTENTIAL



MEASURES TO REALIZE TR-3

		BUILDS UPON	ACHIEVED THROUGH	
			City Action	Community Support
TR-3.1	Enhance and expand transit facilities and infrastructure to access a broader ridership	Upgrades completed to transit facilities including shading and real-time transit information available at stations and through the PassioGo app	Work with public transit agencies to evaluate and implement measures to improve transit infrastructure and first-last mile services	Partner with regional transit agencies to expand services offered and frequency
TR-3.2	Increase transit ridership through incentives and more frequent, connected transit lines	In-progress Irvine Transit Vision Study evaluates priorities and pilot projects for increasing ridership	Implement transit supportive treatments on transit routes and offer ridership incentives	Continue to partner with OCTA and TNC to expand first-mile/last-mile options
TR-3.3	Implement an on-demand microtransit system, transporting residents from curb to curb (e.g., OC Flex or LA County Micro)	Irvine CONNECT provides free shuttle service for community members	Consider deployment of on-demand ZEV shuttle services and partnership opportunities	Partner with OCTA or private entities to provide more on-demand services

Draft

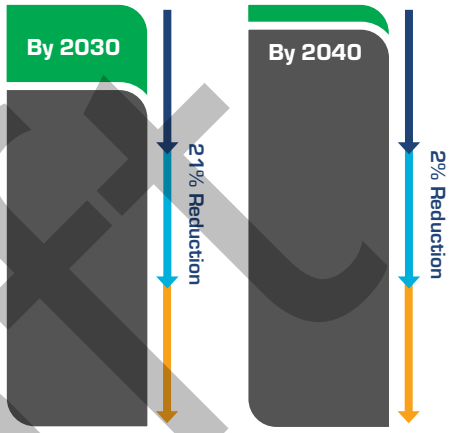
TR-4 Active Transportation

Expanded active transportation infrastructure, including protected bike lanes and improved sidewalks, supports healthy and connected communities that are not completely reliant on vehicles to meet basic needs.

CO-BENEFITS

- Equity
- Air Pollution Prevention
- Health and Wellbeing
- Prioritized by Community

GHG REDUCTION POTENTIAL



MEASURES TO REALIZE TR-4

	BUILDS UPON	ACHIEVED THROUGH	
		City Action	Community Support
TR-4.1 Develop more protected bikeways	113.2 miles of existing off-street bikeway trails	Prioritize development of protected bike lanes and closure of trail network gaps	Continue to use and advocate for protected bike lanes
TR-4.2 Expand bicycling and walking options through infrastructure improvements	Implementation of City of Irvine 2020 Strategic Active Transportation Plan	Develop a citywide Mobility Plan and Pedestrian Design Guidelines	Continue working with Irvine Unified School District to build on the Suggested Routes to School Program
TR-4.3 Develop more accessible and safer pedestrian infrastructure	Implementation of City of Irvine 2020 Strategic Active Transportation Plan	Implement pedestrian safety improvements, such as high-visibility crosswalks	Choose walking and biking to reach destinations when possible
TR-4.4 Implement a community bikeshare program	Bikeshare programs prior to 2020 pandemic	Continue efforts to develop a bikeshare program, and consider an e-bike or scooter share	Support and use community bikeshare offerings

Draft

TR-5 Transportation Demand Management

Enabling more options for commuting to work and school will be a collaborative effort between employers, the City, and transit providers to reduce single occupancy vehicle trips.

CO-BENEFITS

Air Pollution Prevention

Job Development

GHG REDUCTION POTENTIAL

NO QUANTIFIED GHG REDUCTIONS

MEASURES TO REALIZE TR-5	BUILDS UPON	ACHIEVED THROUGH	
		City Action	Community Support
TR-5.1 Reduce vehicle miles traveled (VMT) from local businesses through employee rideshare and transit incentive services such as Spectrumotion	The Spectrumotion public/private partnership for TDM	Require large employers to offer commute trip reduction programs and employee parking cash-outs	Utilize employer offered and local services for alternative commute options
TR-5.2 Increase implementation of transportation demand management (TDM) strategies such as high-occupancy vehicle (HOV) lanes or reduced transit fares for students to reduce vehicle emissions	Free transit passes available for Irvine Valley College students and reduced fare for other area colleges	Measures TR-3.1 through TR-3.3	Utilize transit options and access incentives

Draft

TR-6 Vehicle Idling

Increased use of electric and plug-in hybrid electric vehicles eliminates emissions generated by engine idling.

CO-BENEFITS

Air Pollution Prevention

Health and Wellbeing

GHG REDUCTION POTENTIAL

NO QUANTIFIED GHG REDUCTIONS

MEASURES TO REALIZE TR-6		BUILDS UPON	ACHIEVED THROUGH	
			City Action	Community Support
TR-6.1	Reduce vehicle idling through education and adoption of EVs and plug-in hybrid electric vehicles (PHEV)	2022 City of Irvine Zero-Emission Vehicles Transition Plan	Measures TR-2.1 through TR-2.4	Purchase EV and low-carbon vehicles; take advantage of incentives and tax credit

Draft

TR-7 Parking

Reassess the value of parking so it is not prioritized over alternative mobility options and housing costs.

CO-BENEFITS

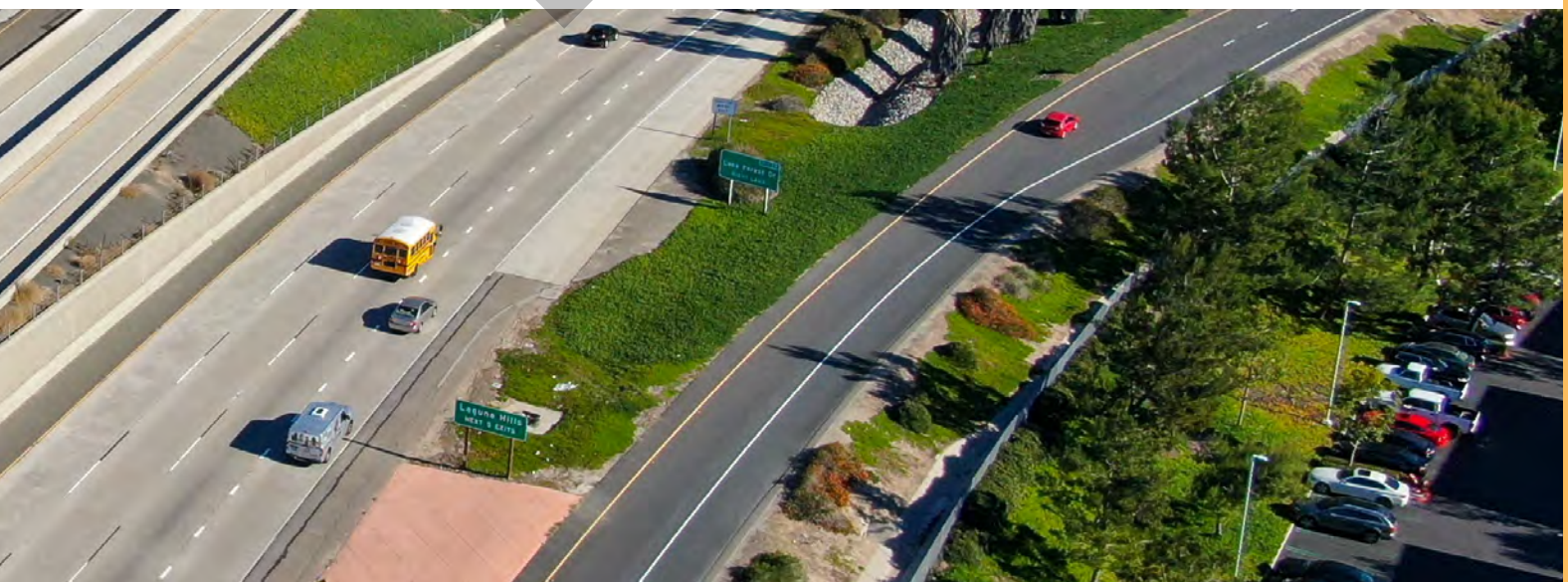
Air Pollution Prevention

Health and Wellbeing

GHG REDUCTION POTENTIAL

NO QUANTIFIED GHG REDUCTIONS

MEASURES TO REALIZE TR-7	BUILDS UPON	ACHIEVED THROUGH	
		City Action	Community Support
TR-7.1 Reduce the amount of parking to meet the needs of residents, workers, and visitors in a way that is consistent with the City's sustainability goals	No City initiatives started	Explore pilot program to reduce parking minimums in areas of high-density residential and residential mixed use located in areas within ½ mile of high quality transit station and/or high quality fixed transit stop	Walk, bike, and take public transit to key destinations
TR-7.2 Implement fees for parking in high-traffic areas	TDM programs, such as Spectrumotion, and public transit infrastructure	Assess the feasibility of pricing on- street parking in the City in high-traffic areas, such as business districts	Walk, bike, and take public transit to key destinations

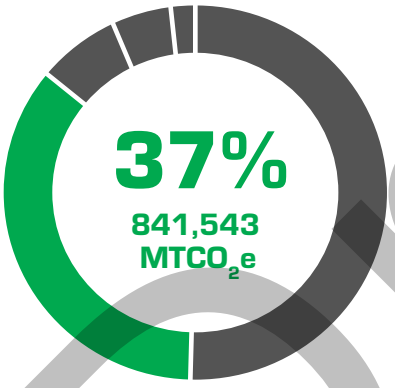


Draft

BUILDING ENERGY

The energy used to generate electricity, heat and cool homes and businesses, and provide the convenience of modern life generates GHG emissions. The City has already made substantial progress in reducing building emissions by establishing the Orange County Power Authority (OCPA), offering expanded renewable energy options. Decarbonizing buildings is a collective effort that relies on choices the City and community members make on how buildings are designed and maintained, and the sources of purchased electricity.

Sector Emissions (2019)



Total Emissions from the Building Energy Sector in 2019

Sector Statistics

100% carbon-free energy sources supplied by OCPA in 2022

48% of citywide natural gas use is from commercial and industrial buildings

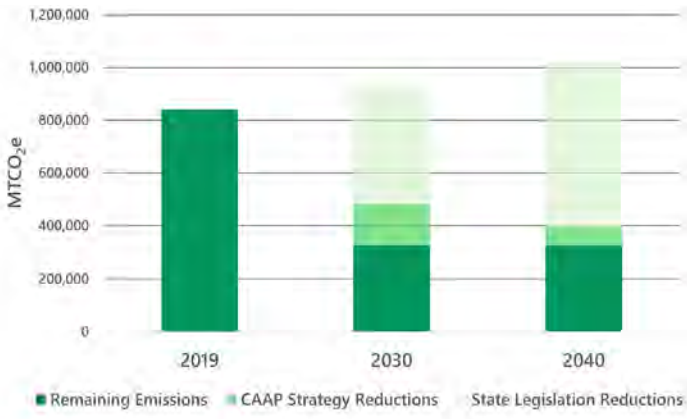
97K existing residential units as of 2020

49% of existing residential units built before 1992

Irvine's Vision for Efficient and Decarbonized Buildings

- Most energy consumed in the City is from carbon-free sources and is affordable.
- New buildings are future-proof, with all-electric components and renewable energy generation and storage.
- Community members are able to upgrade and renovate older and inefficient homes to reduce energy bills.
- The energy grid is efficient and resilient, and community facilities serve as microgrids.

Future GHG Emissions with CAAP Strategies



Draft

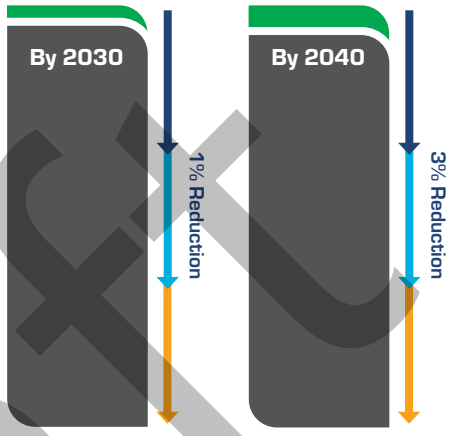
BE-1 Building Energy and Electrification

The existing stock of buildings will be energy efficient and fueled primarily by renewable electricity.

CO-BENEFITS

- Benefit to Renters
- Air Pollution Prevention
- Health and Wellbeing
- Prioritized by Community

GHG REDUCTION POTENTIAL



MEASURES TO REALIZE BE-1

	BUILDS UPON	ACHIEVED THROUGH	
		City Action	Community Support
BE-1.1 Facilitate energy audits for existing buildings to identify energy efficiency retrofit and electrification opportunities	City of Irvine 2021-2029 Housing Element	Encourage a mix of commercial and residential uses in all areas of the City, and increased housing density in key areas	Build Accessory Dwelling Units (ADUs) on private property
BE-1.2 Retrofit existing residential buildings (single family, and multi-family less than 20,000 square feet) to improve energy efficiency and facilitate fuel switching	10 facilities have been retrofitted with heat pumps to date	Regular interval energy audits at City facilities	Choose walking to reach destinations and explore local businesses
BE-1.3 Retrofit existing multi-family (20,000 square feet and larger) and nonresidential buildings to improve energy efficiency and facilitate fuel switching	Renters Sustainability Toolkit available to all renters in Irvine	Pilot an all-electric retrofit of the City of Irvine Community Center and develop a building benchmarking program	Participate in energy efficiency programs and report building energy through ENERGYSTAR portfolio manager
BE-1.4 Reduce plug loads in existing buildings	Energy efficiency rebates shared on the City's website	Facilitate the adoption of peak load reducing technologies, such as building energy management systems	Optimize building efficiency for peak load reduction and costs savings

Draft

BE-2 Low-Carbon Development

New buildings are designed to be future proof, with all-electric equipment where feasible.

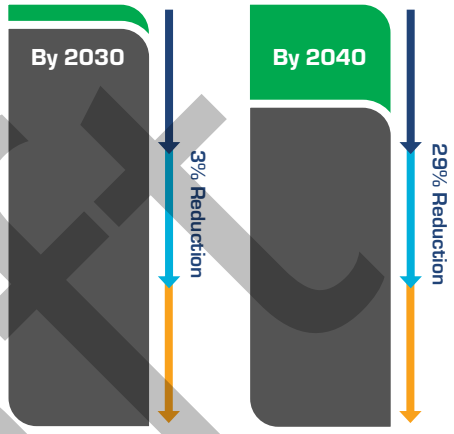
CO-BENEFITS

Prioritized by Community

Air Pollution Prevention

Health and Wellbeing

GHG REDUCTION POTENTIAL



MEASURES TO REALIZE BE-2

	BUILDS UPON	ACHIEVED THROUGH	
		City Action	Community Support
BE-2.1 Eliminate the use of natural gas in new development	Current California Energy Code efficiency standards and Electrify Irvine	Adopt a building electrification ordinance, in accordance with legal requirements	Partnerships with SoCalREN, utilities, other cities, and the private sector to develop effective strategies for electrification
BE-2.2 Implement and enforce REACH building codes and Green Building Standards	Current California Energy Code efficiency standards and Electrify Irvine	See Measure BE-2.1	No actions identified
BE-2.3 Eliminate fossil fuel-powered backup energy sources by 2028	No ongoing City initiatives	See Measure BE-1.3	Purchase zero-emissions back-up power sources (such as batteries)
BE-2.4 Require smart grid technologies to include two-way communication and control capabilities between buildings and the electric grid	2022 City of Irvine Distributed Energy Resources (DER) Implementation Plan	Integrate smart grid technologies into City facilities; starting with one or more pilot projects identified in the DER Implementation Plan	Expand use of SCE smart grid programs

Draft

MEASURES TO REALIZE BE-2	BUILDS UPON	ACHIEVED THROUGH	
		City Action	Community Support
BE-2.5 Facilitate net zero energy projects	10 facilities have been retrofitted with heat pumps to date	All new City facilities will be zero-emission by 2030, and all existing facilities zero-emission by 2035	Access rebates and incentives to improve efficiency of homes/ businesses and switch to electric equipment
BE-2.6 Reduce high-global warming potential (GWP) refrigerants	No ongoing City initiatives started	Partner with OCPA and SCE to implement a natural refrigerant incentive program	Purchase low-GWP refrigerants and equipment that supports their use

Draft

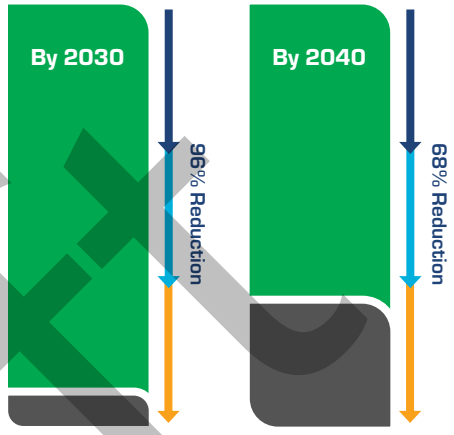
BE-3 Clean Energy

The existing stock of buildings will be energy efficient and fueled primarily by renewable electricity.

CO-BENEFITS

- Benefits to Renters
- Prioritized by Community
- Health and Wellbeing

GHG REDUCTION POTENTIAL



MEASURES TO REALIZE BE-3

	BUILDS UPON	ACHIEVED THROUGH	
		City Action	Community Support
BE-3.1 Enroll 100% of communitywide accounts in 100% renewable/zero-carbon option from OCPA	OCPA delivers electricity with 100% carbon-free and 100% renewable options at competitive rates	Conduct outreach to increase awareness of OCPA's carbon-free electricity supply and encourage retention at 100% renewable service level	Enroll in OCPA and opt for higher renewable service levels when possible
BE-3.2 Increase renewable energy installations in existing buildings	Solarize Irvine and the 2022 City of Irvine Distributed Energy Resources (DER) Implementation Plan	Continue the Solarize Irvine program to provide access to group discounts and information about solar and battery storage; and implement the DER Implementation Plan	Develop regional partnerships to expand and share solar installation incentives
BE-3.3 Increase renewable energy in new development	Current California Energy Code efficiency standards	Require that new buildings install sufficient onsite renewables to meet total energy consumption, and newly built parking structures have solar generation capabilities	Utilize Solarize Irvine resources to install solar and battery storage
BE-3.4 Develop innovative approaches to energy generation, distribution, and storage	2022 City of Irvine Distributed Energy Resources (DER) Implementation Plan	Evaluate opportunities to expand battery storage capacity, through building reach codes and micro-grid/DER projects	Partner with internal City divisions and external public service facilities to develop renewable microgrids

Draft

BE-4 Energy Education and Awareness

All community members can access rebates, incentives, and educational materials for saving money with energy upgrades.

CO-BENEFITS

Benefits to Renters

Prioritized by Community

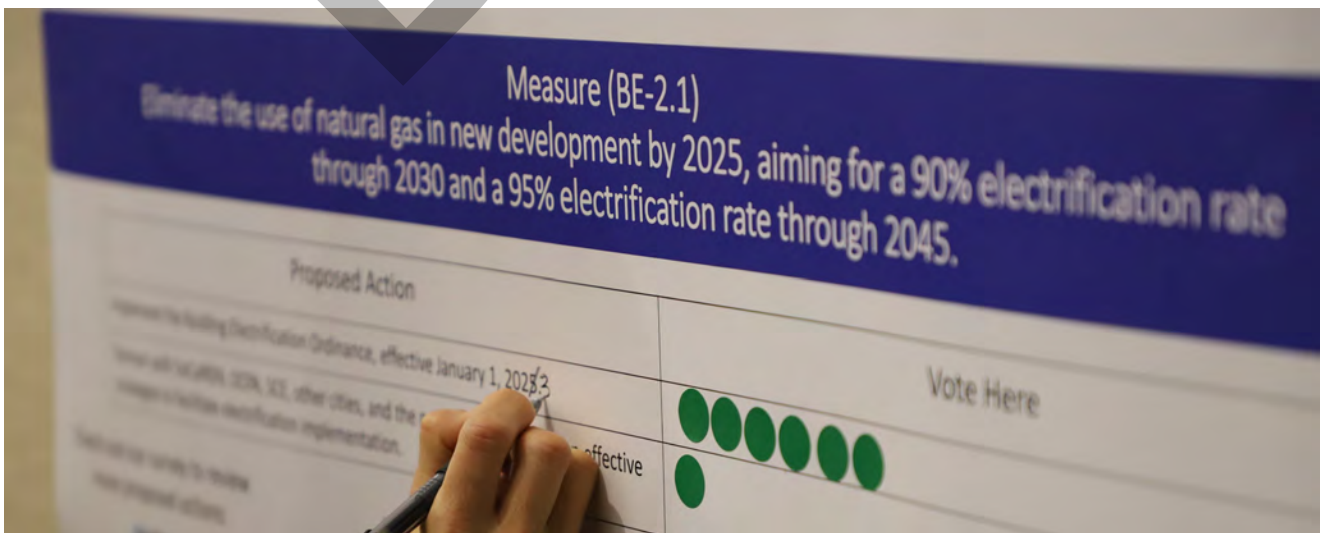
Health and Wellbeing

GHG REDUCTION POTENTIAL

NO QUANTIFIED GHG REDUCTIONS

MEASURES TO REALIZE BE-4

	BUILDS UPON	ACHIEVED THROUGH	
		City Action	Community Support
BE-4.1 Strengthen community awareness of energy efficiency, energy conservation, electrification, and clean energy	Electrify Irvine, Irvine Green Business Program, and Solarize Irvine	Develop and implement a comprehensive outreach and education campaign to support transition to carbon-free buildings	Leverage the Green Business network to share energy efficiency examples and resources and provide information on clean energy incentives

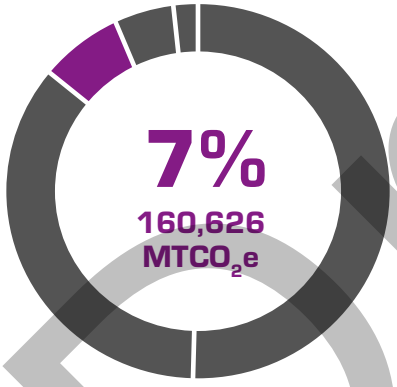


Draft

SOLID WASTE

The ability to reduce waste, recycle, and reuse materials can reduce GHG emissions by avoiding decomposing waste and processing activities at landfills. The City will supply the means for appropriate disposal and recycling of waste, which includes providing access to the right facilities, waste management, and education programs. The City has already made significant progress ensuring all have access to recycling and organics disposal, and that the infrastructure exists such that both food and non-food materials can be recovered. However, programs will need to be expanded, and public-private partnerships and new technologies will need to be explored, to achieve a true zero-waste future.

Sector Emissions (2019)



Total Emissions from the Solid Waste Sector in 2019

Sector Statistics

5.9 pounds of waste are generated each day by the average Irvine resident

341,845 tons of waste disposed communitywide in 2022[1]

[1] CalRecycle. 2024. Jurisdiction Diversion/Disposal Rate Summary, City of Irvine. Available: https://www2.calrecycle.ca.gov/LGCentral/DiversionProgram/JurisdictionDiversionPost2006

Irvine's Vision for a Zero-Waste Community

- Every community member has the knowledge and access to receptacles for proper recycling and diversion of waste.
- Infrastructure supports high rates of construction and demolition waste recycling and reuse.
- Consumers can recycle and reuse more packaging and products.

Future GHG Emissions with CAAP Strategies

Draft

SW-1 Zero Waste

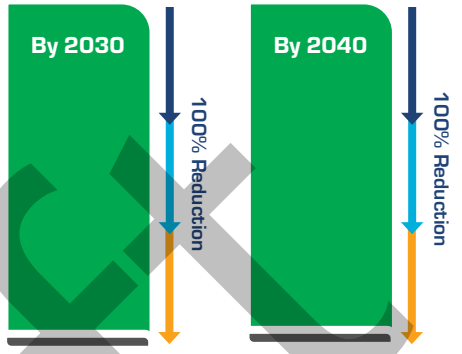
The disposal of organic waste in landfills is eliminated and the ability to recycle, reduce, and reuse is expanded.

CO-BENEFITS

Prioritized by Community

Resource Preservation

GHG REDUCTION POTENTIAL



MEASURES TO REALIZE SW-1

	BUILDS UPON	ACHIEVED THROUGH	
		City Action	Community Support
SW-1.1 Eliminate the disposal of organic solid waste in landfills to reduce methane emissions	Organics diversion requirements for residential and commercial generators	Continued enforcement of organics collection requirements under SB 1383	Partnerships with schools, waste haulers, and food recovery organizations
SW-1.2 Increase recycling and the diversion of other inorganic solid waste through the expansion of public recycling bins	Zero Waste Program and educational materials about recycling on City website	Educate community members on recyclable and compostable materials, and require recoverable materials at events	Partnerships with waste haulers to expand diversion of solid waste
SW-1.3 Reduce the generation of waste from residents and businesses through waste-reduction measures such as single-use plastic restrictions and bans	Developed the Single-use Plastics Alternatives Guidelines	Continue education on single-use requirements and consider a single-use plastic ban	Continued compliance with single-use requirements
SW-1.4 Reduce the generation of construction and demolition waste	2007 Construction and Demolition (C&D) Debris Recycling and Reuse Ordinance (Ordinance No 07-18)	Adopt a comprehensive construction and demolition ordinance to reach a 75% diversion rate	Continued compliance with C&D requirements
SW-1.5 Facilitate repair and reuse of consumer products	No City initiatives started	Evaluate the feasibility of reuse facilities and partnerships to develop "fix-it clinics" support for repair and reuse	Repair and reuse materials and products

Draft

SW-2 Landfill Emissions

Explore innovative solutions for reducing waste sent to landfill.

CO-BENEFITS

Prioritized by Community

Job Development

GHG REDUCTION POTENTIAL

NO QUANTIFIED GHG REDUCTIONS

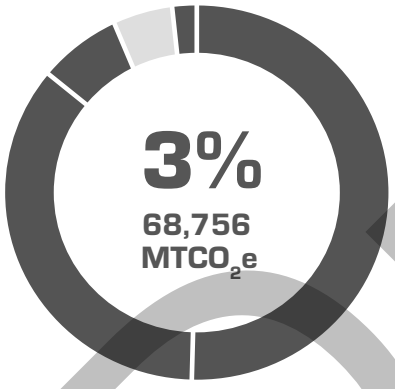
MEASURES TO REALIZE SW-2	BUILDS UPON	ACHIEVED THROUGH	
		City Action	Community Support
SW-2.1 Dispose waste at innovative facilities such as waste-to-energy and reuse facilities	No City initiatives started	Evaluate the feasibility of reuse and waste-to-energy facilities (See SW-1.5 and SW-2.2)	No actions identified
SW-2.2 Support waste-to-energy facilities that turn trash into fuel	No City initiatives started	Establish a local facility that can process organic waste to create energy or hydrogen	Partnership with OC Sanitation District, OC Waste & Recycling, or others
SW-2.3 Engage with waste-related policy making	No City initiatives started	Advocate for state legislative actions that reduce emissions from solid waste	No actions identified

Draft

OFF-ROAD VEHICLES AND EQUIPMENT

Off-road vehicles and equipment can be fueled by electricity and renewable fuels to reduce their GHG emissions contribution. Smaller equipment and generators can be replaced with battery-electric options, whereas larger equipment is expected to be available in the future as active market innovations progress. The City is currently supporting the State's Green Lawn Care Law by transitioning from small, gas-powered landscape equipment to electric. The City will continue to support the transition to zero-emission technology and provide resources to community members.

Sector Emissions (2019)



Total Emissions from the Off-Road Vehicles and Equiment Sector in 2019

Sector Statistics

13 active construction projects in Irvine in 2024[2]

2 public renewable diesel fueling stations in Irvine in 2024[3]

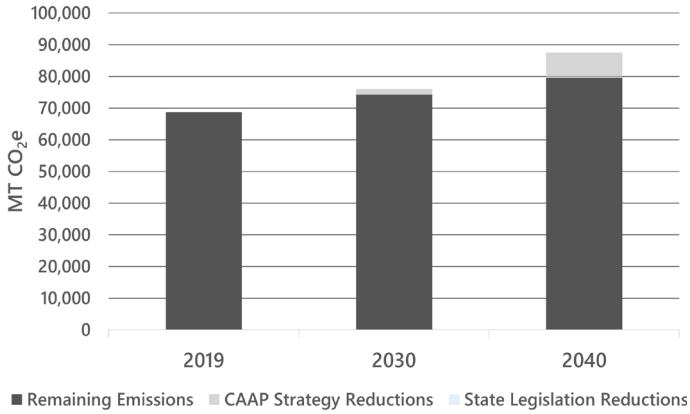
[2] https://storymaps.arcgis.com/stories/8ffb0dc939244b5f908e3d6f7a8a15f4

[3] https://afdc.energy.gov/stations#/find/nearest?fuel=RD&location=irvine

Irvine's Vision for Clean and Renewable Equipment

- All small engines are replaced with battery-electric options, reducing air and noise pollution.
- Infrastructure supports the use of electricity and renewable fuels for larger construction equipment.
- Irvine is an incubator and early adopter of new zero-emission technology.

Future GHG Emissions with CAAP Strategies



Draft

OR-1 Electrification and Clean Alternatives

All off-road equipment and vehicles have options and infrastructure for zero-emission technology.

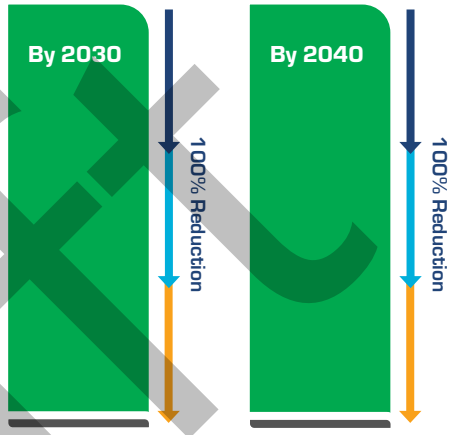
CO-BENEFITS

Air Pollution Prevention

Health and Wellbeing

Prioritized by Community

GHG REDUCTION POTENTIAL



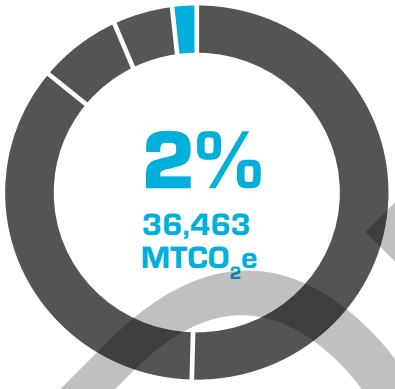
MEASURES TO REALIZE OR-1	BUILDS UPON	ACHIEVED THROUGH	
		City Action	Community Support
OR-1.1 Reduce emissions from landscaping equipment such as leaf blowers by supporting a transition to electric equipment	2023 Gas-powered Lawn Equipment Ban (Ordinance No 23-25)	Provide and promote incentives for the transition to electric-powered equipment	Switch out gas-powered equipment with electric equipment
OR-1.2 Reduce emissions from construction equipment by supporting transition to electric equipment	No City initiatives started	Require use of low-carbon fuels, Tier 4 equipment, and battery electric generators at construction sites	Consider low-carbon technology for construction projects

Draft

WATER AND WASTEWATER

The water we use and wastewater we generate result in indirect GHG emissions from the electricity required for pumping, conveyance, and treatment, as well as some emissions from processes at wastewater treatment plants. These essential services can be decarbonized by using renewable energy to power processes, reducing water consumption, and shifting to sustainable supplies of water. While water is a small contributor to communitywide GHG emissions, it is a valuable resource with supplies fluctuating year after year due to climate conditions. As such, reduction of water consumption is key to ensuring water security for all of Irvine as our climate and precipitation patterns change.

Sector Emissions (2019)



Total Emissions from the Water and Wastewater Sector in 2019

Sector Statistics

80% of Irvine Ranch Water District's water sources are locally-based

22,924 M gallons of water delivered in 2020 by Irvine Ranch Water District

35% of total water deliveries in Irvine were recycled water in 2022

Irvine's Vision for Water Efficiency and Security

- Communitywide water consumption is reduced, despite community growth.
- Water sources are local, sustainable, and secure.

Future GHG Emissions with CAAP Strategies

Draft

W-1 Water Conservation

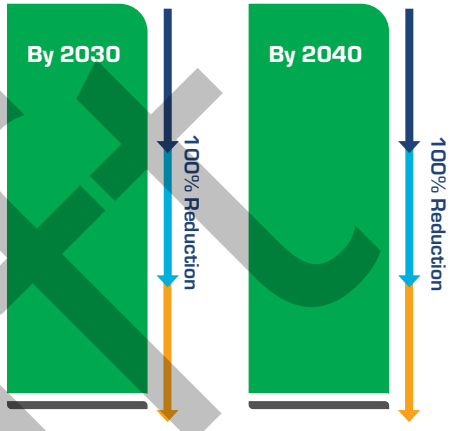
Water efficient fixtures, equipment and landscaping are prioritized to reduce per capita water consumption.

CO-BENEFITS

Benefits to Renters

Reliability

GHG REDUCTION POTENTIAL



MEASURES TO REALIZE W-1

		BUILDS UPON	ACHIEVED THROUGH	
			City Action	Community Support
W-1.1	Reduce water consumption in buildings through conservation campaigns and water efficiency measures	Cool Irvine shares information about water conservation programs	Require that ultra-low flow water fixtures be installed in all buildings, and establish a water use benchmarking program for buildings over 20,000 square feet	Partner with Irvine Ranch Water District and others to promote water conservation incentives
W-1.2	Reduce water consumption for irrigation and landscaping by encouraging drought tolerant/low-water use landscaping practices	2015 Model Water Efficient Landscaping Ordinance	Continue to reduce water demand at City-managed and owned properties by using low-water use landscaping, recycled water, and upgrading irrigation systems	Continue to Partner with IRWD to promote landscape water conservation programs

Draft

W-2 Recycled Water

Recycled water infrastructure in the City is expanded to offset water imports and groundwater pumping.

CO-BENEFITS

Benefits to Renters

Reliability

GHG REDUCTION POTENTIAL

NO QUANTIFIED GHG REDUCTIONS

MEASURES TO REALIZE W-2

		BUILDS UPON	ACHIEVED THROUGH	
			City Action	Community Support
W-2.1	Increase the use of recycled water	Dual-plumbing requirements for new non-residential development	Encourage onsite greywater reuse and rainwater harvesting for landscaping	Collaborate with IRWD to develop greywater readiness policies for residential construction

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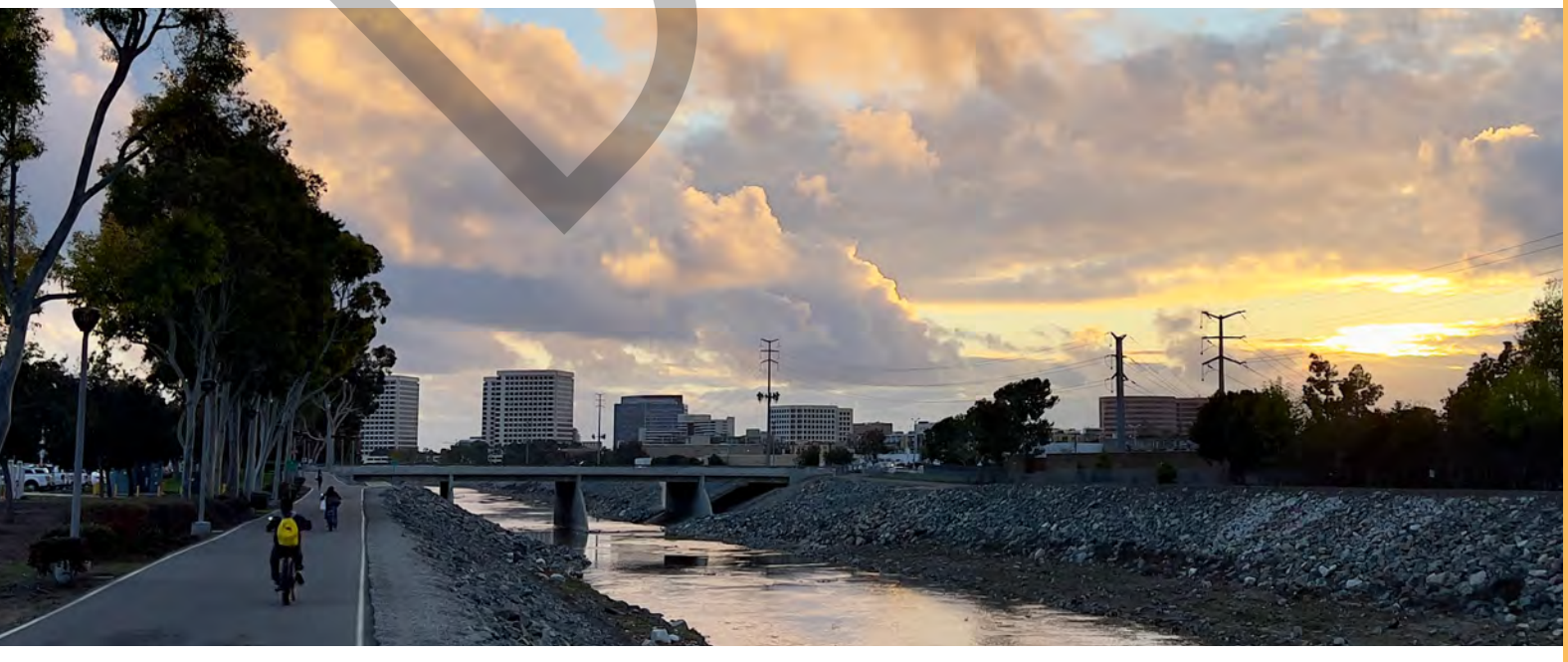


RESILIENCE, GREEN ECONOMY, AND CARBON SEQUESTRATION

The City can enact policies that help reduce GHG emissions by supporting the transition to a green economy and provide additional community benefits. Planting and maintaining healthy trees and preserving open space provide valuable ecosystem services to the community, such as reducing the urban heat island effect and providing natural habitat, while at the same time sequestering atmospheric carbon. Urban greening, or expanding green infrastructure, also achieves these goals, and reduces flooding and preserves soils. Additionally, the City plans to leverage the growing low-carbon economy to support high-quality jobs in emerging markets and green technologies.

Sector Statistics

550,000 trees in Irvine

30+ years as a Tree City USA

55 local businesses participating in Irvine Green Business Program

Irvine's Vision for a Green, Resilient, and Prosperous Community

- An extensive urban canopy provides shading and other benefits to all neighborhoods and communities.
- A green technology hub is established and thriving in Irvine.
- New buildings are made with low-carbon materials.

Resilience, Green Economy, and Carbon Sequestration are not directly reflected in the City's GHG emissions inventory and forecast, but provide a net GHG benefit and community benefits.

Draft

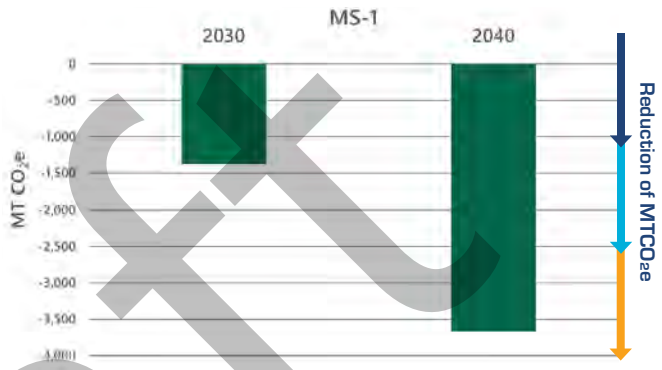
MS-1 Urban Forestry and Open Space

The urban forest will be expanded, and open space preserved to enhance carbon sequestration value and shading in key areas of the City.

CO-BENEFITS

- Benefit to Renters
- Equity
- Resource Preservation
- Health and Wellbeing
- Prioritized by Community

CARBON SEQUESTIATION POTENITAL



MEASURES TO REALIZE MS-1

	BUILDS UPON	ACHIEVED THROUGH	
		City Action	Community Support
MS-1.1 Protect and enhance native trees and vegetation	In development: 30-year Urban Forest Master Plan	Develop a strategy to increase and preserve the urban forest, including programs for free trees for low-income communities	Partner with local non-profit organizations to support tree planting events
MS-1.2 Expand and protect City parks and open spaces	City of Irvine 2017 Parks Master Plan	Invest in enhancing community parks and access to parks, and support creation of community gardens	No actions identified

Draft

MS-2 Urban Heat Island Reduction

Expand the use of high albedo materials to reduce both night and daytime temperatures during extreme heat events, thereby reducing energy consumption.

CO-BENEFITS

Benefits to Renters

Health and Wellbeing

GHG REDUCTION POTENTIAL

NO QUANTIFIED GHG REDUCTIONS

MEASURES TO REALIZE MS-2		BUILDS UPON	ACHIEVED THROUGH	
			City Action	Community Support
MS-2.1	Reduce the urban heat island effect with urban forestry, shade structures, and cool roofs to conserve energy	2024 Cool Pavements Pilot for treatments on San Juan and San Leon in Irvine	Expand the Cool Pavements Pilot Program, and require high-albedo materials in new development	No actions identified

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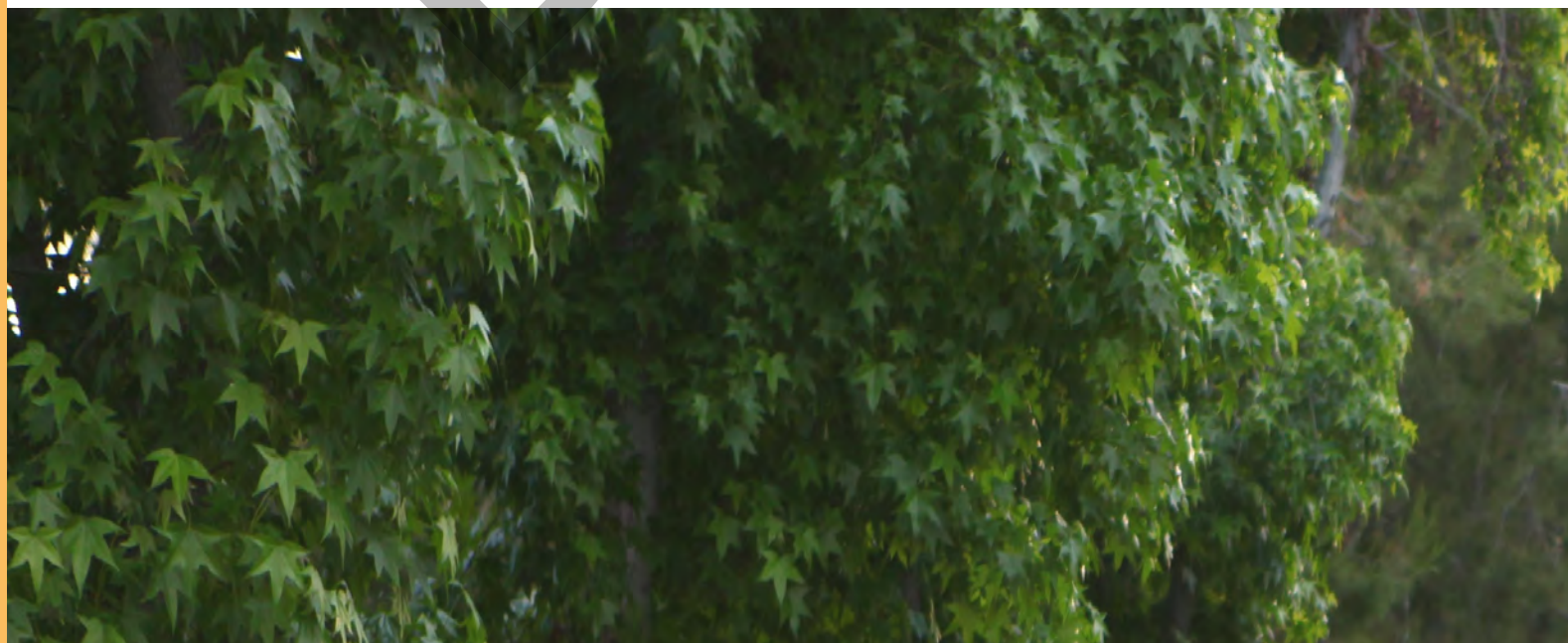

MS-3 Green Infrastructure

Leverage opportunities to increase urban greening and green infrastructure to increase wellbeing while preserving biodiversity.

CO-BENEFITS

Health and Wellbeing

Reliability

GHG REDUCTION POTENTIAL

NO QUANTIFIED GHG REDUCTIONS

MEASURES TO REALIZE MS-3

		BUILDS UPON	ACHIEVED THROUGH	
			City Action	Community Support
MS-3.1	Increase the use of green infrastructure	No City initiatives started	Fund and implement a green infrastructure program for civic resources, and develop guidelines for private initiatives	No actions identified

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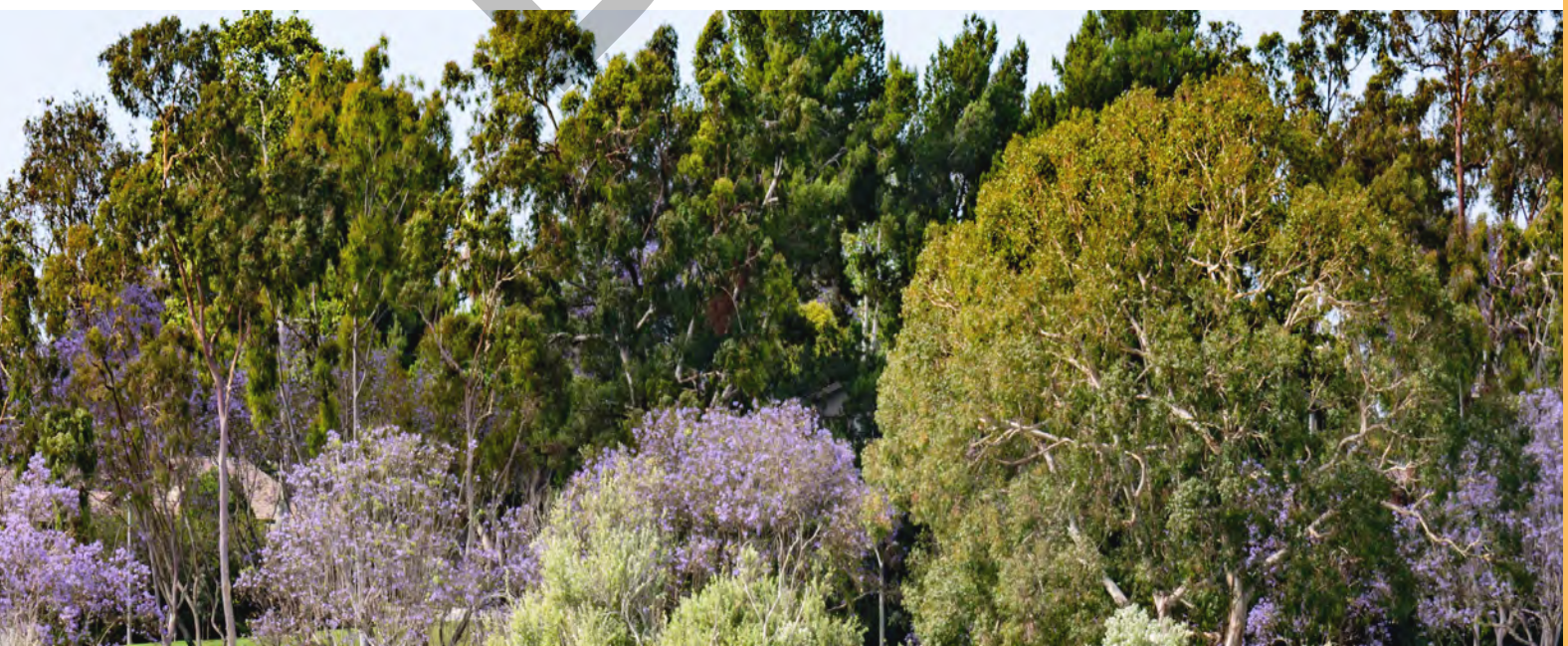

MS-4 Green Business and Jobs

The low-carbon economy provides expansion of employment and business opportunities in emerging markets and technologies.

CO-BENEFITS

Job Development

GHG REDUCTION POTENTIAL

NO QUANTIFIED GHG REDUCTIONS

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MEASURES TO REALIZE MS-4		BUILDS UPON	ACHIEVED THROUGH	
			City Action	Community Support
MS-4.1	Incentivize and promote eco-friendly operations, habits, and business practices through programs such as the Green Business Program	The City continues to invest in and grow its Green Business Program	Expand the City's Green Business Program and support carbon capture and sequestration deployment in Irvine	Partner with local educational institutions and private sector partners to develop a clean technologies industry hub
MS-4.2	Support the creation of green jobs and businesses in the City	The City continues to work with SCE and OCPA on contractor training on electrification and energy efficiency	Spur the local green economy by incentivizing green industries to centralize in Irvine, and supporting education in emerging green technologies	Work with local partners to provide energy workforce training opportunities

MS-5 Carbon Sequestration and Embodied Emissions

Healthy soils support increased carbon removals within the City, and low-carbon building materials support global GHG reductions.

CO-BENEFITS

Resource Preservation

GHG REDUCTION POTENTIAL

NO QUANTIFIED GHG REDUCTIONS

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MEASURES TO REALIZE MS-5		BUILDS UPON	ACHIEVED THROUGH	
			City Action	Community Support
MS-5.1	Increase soil carbon content to mitigate greenhouse gases and increase climate resilience	The existing use of a "soil health first" approach to landscaping on City property	Promote awareness of the State's Healthy Soils Initiative and tips for residents and businesses to increase soil carbon content	Continue partnership with UCI to support local carbon sequestration, wildfire prevention, and other nature-based solutions
MS-5.2	Use low- carbon and carbon sequestering construction materials in new development	No City initiatives started	Adopt a building code requiring use of low-carbon materials for new construction	No actions identified

ADAPTING TO CLIMATE CHANGE

Chapter Four
Adapting to Climate Change

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Preparing Irvine for the impacts of climate change requires significant investment in time and resources across the community, while considering local businesses, public health, emergency services, critical infrastructure, and natural resources. As the City continues to combat climate change through reducing local GHG emissions, it must also adapt and prepare for the impacts of climate change and bolster the resilience of its communities to climate hazards. As such, while being informed by the vulnerability assessment prepared as part of this CAAP (which is summarized in Chapter 2 and can be found in Appendix B), the City has prepared a suite of adaptation strategies to complement the GHG reduction strategies presented in Chapter 3.

GUIDING PRINCIPLES

Irvine is dedicated to protecting and promoting the health and safety of its residents and community through its adaptation actions. The City will implement actions that can both prepare residents for a changing climate and build resilience for populations at greatest risk of climate hazards. The development of adaptation strategies and actions was guided by the following principles and considerations:

- **Planning and Collaboration:** The complexity and interconnectedness of climate change requires a significant investment in community engagement and education to increase awareness and resilience. Programs that educate and inform residents, visitors, businesses, and local decision-makers can empower individuals to take actions to reduce risk for themselves. Programs that seek to bring community members together can create lasting connectivity among neighbors who can plan for safety in times of crisis. In addition, land use, geography, and transportation network infrastructure necessitate comprehensive and multi-jurisdictional adaptation approaches and solutions in partnership with local, regional, and State entities.

- **Healthy Communities:** Climate change hazards affect the health of residents, workers, and visitors in Irvine. Impacts include respiratory impacts from wildfire smoke, heat-related illnesses, increasing allergies and asthma, food-borne and water-borne illnesses, and mental health impacts from extreme events. Changes in the frequency and severity of storms, floods, heat waves, wildfires, and other extreme events create stress on healthcare systems, employees, and infrastructure. Maintaining and improving physical and mental health should be a top priority.

- **Climate Equity:** Climate change does not affect all community members equally. Climate change hazards can disproportionately affect vulnerable populations that may have a more challenging time responding to hazardous events due to age, language barriers, income, housing, or other characteristics. Accounting for the specific needs of those most vulnerable to climate change hazards is paramount.

- **Emergency Preparedness:** Emergency preparedness requires proactive planning, established protocols, effective communication, and reliable and clear sources of information available through multiple channels. To minimize the impact of potential disasters, the City will play a key role in making sure residents and visitors have the correct information about what to do and where to go in the event of a disaster. Individuals also have a responsibility and should stay informed, prepare emergency kits, and take additional precautions to minimize risk to themselves and their loved ones.

- **Resilient Buildings:** Irvine's built environment includes a mix of residential and non-residential buildings, including master-planned communities and neighborhoods of single- and multi-family homes, along with commercial and industrial buildings. Upgrades to business and residential structures to reduce risk can be coupled with efforts to increase energy efficiency and reduce greenhouse gas emissions, contributing to the long-term resilience and sustainability of the City's building stock.

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- **Resilient Infrastructure:** The implementation and management of Irvine's infrastructure will determine how well it can protect residents and mitigate future climate and extreme weather impacts. As the City does not directly own or operate all the critical infrastructure (e.g., electricity, water, telecommunications) within its boundaries, it must work directly with those companies, agencies, and organizations to enhance the resilience of those systems. Continuous investment in transportation infrastructure may be needed to facilitate mobility throughout the City in both everyday life and in an emergency.
- **Resilient Ecosystems:** Natural systems provide valuable functions to both residents and visitors in the form of ecosystem services (e.g., water storage) in the watershed and open space. Natural lands and open space are increasingly affected by climate change and will need to be adaptively managed to continue providing societal benefits.

The City's approach to climate change adaptation is organized into six sections which each consist of a set of strategies and actions: (1) citywide; (2) extreme heat; (3) drought; (4) wildfire; (5) flooding; and (6) liquefaction/landslide. Each of these sections represent the primary climate change hazards that the City is exposed to, with the exception of "citywide," which represents cross-cutting strategies and actions that would bolster the City's capacity to address all climate change hazard events. Successful implementation of these strategies and actions will complement other adaptation and resilience planning efforts, such as the City's Local Hazard Mitigation Plan and General Plan Safety Element.

The CAAP's adaptation strategies and actions are organized into six different sections:

- **Citywide**
- **Extreme Heat**
- **Drought**
- **Wildfire**
- **Flooding**
- **Liquefaction/Landslide**

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CITYWIDE (CW)

CW-1: Prioritize climate change planning

- Continue to update the climate vulnerability assessment and Local Hazard Mitigation Plan as required to comprehensively plan for current and future natural and human-caused hazards within the City.
- Integrate climate science and projected climate-related impacts in all City planning documents, policies, programs, and ordinances as they are reviewed or updated.

CW-2: Collaborate with local, regional, State, and Federal partners to support social and economic resilience

- Establish relationships with FEMA and CDC in preparation for extreme weather events or natural disasters.
- Coordinate with surrounding municipalities and Orange County to enhance evacuation and emergency management protocols, agreements, and processes.
- Provide residents, businesses, and neighborhood organizations with evacuation procedures and shelter-in-place guidelines to grow community resilience.
- Coordinate with regional healthcare facilities to ensure effective care for all City residents and regional travelers during an emergency.

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CW-3: Strengthen community resilience through collaboration and education

- Collaborate with local community organizations to develop a climate change education outreach program that identifies gaps in community resilience planning and engages vulnerable community members.
- Expand participation in the Irvine Community Emergency Response Team (CERT) program for residents and businesses.
- Evaluate and enhance existing preparedness and evacuation programs (e.g., Prepare Irvine, AlertOC) to better educate, inform, and engage the public about emergency preparedness in the case of a disaster.
- Identify gaps in current communication pathways with vulnerable community members during planned (e.g., Public Safety Power Shutoff events) or unplanned power outages.

CW-4: Collaborate with local businesses on economic and community resilience

- Collaborate with local businesses and organizations to conduct regular workplace emergency preparedness drills.
- Develop agreements with hotels to designate them as Red Cross facilities in case of an emergency.

CW-5: Collaborate with school districts to develop emergency preparedness programs

- Continue agreements with local school districts to ensure that school facilities can function as evacuation sites during major emergencies.
- Identify opportunities to use school facilities as evacuation centers, cooling centers, and charging stations, during extreme heat or weather events.

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CW-6: Coordinate with regional and local transportation and transit agencies to ensure continued access and movement in the event of an emergency

- Coordinate with regional and state transportation agencies to assess the vulnerability of transportation infrastructure to hazardous climate-related events.

CW-7: Coordinate with regional utilities to enhance the preparedness, protection, and resilience of water, energy, and telecommunications infrastructure

- Coordinate with regional utilities to assess the vulnerability of critical infrastructure to hazardous climate-related events.

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EXTREME HEAT (EH)

EH-1: Prepare the community for extreme heat events

- Work with regional and local health agencies to evaluate extreme heat warning thresholds and protocols and incorporate enhanced extreme heat preparedness into local operations.
- Establish a City-wide Heat Alert Program (HAP) when weather forecasts predict heat waves or extreme heat days.
- Educate vulnerable community members (e.g., aging, elderly, ill) and their caregivers to detect signs and symptoms of, and to prevent heat-related illness. Emphasize the importance of immediate medical assistance for heat-related illnesses.

EH-2: Develop facilities and resources to reduce the effects of extreme heat events

- Expand the number of publicly operated cooling centers based on the needs of vulnerable populations.
- Collaborate with local businesses and institutions to provide a "Cool Zone" area network (i.e., cooling centers).
- Develop a tree and shade master plan with a particular focus on climate-resilient tree species.

Draft

DROUGHT (D)

D-1: Collaborate with agency partners to prepare for future drought conditions

- Continue to support and participate in the development of a regional and local drought contingency plan.
- Collaborate with federal, State, and local agencies and organizations to explore alternative sources (e.g., desalination) and improve capacity.

D-2: Develop and implement Citywide efforts to reduce water usage

- Promote nature-based methods and best practices (e.g., bioswales, natural ground cover) through the City's stormwater program.
- Update "Division 7 - Sustainability in Landscaping" of the Irvine Municipal Code of Ordinances and the Master Streetscape & Landscape Design Manual to reflect the latest advances in best practices in landscape design that reduce water use within the City.

D-3: Promote community water conservation measures

- Support regional partners in education and outreach efforts focused on water conservation measures (e.g., water reuse, water use, and irrigation efficiency) for City residents.
- Encourage drought tolerant/low-water use native landscaping, and low-flow water fixtures, and apply daytime watering restrictions on properties throughout the City to reduce water consumption.

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WILDFIRE (WF)

WF-1: Collaborate with regional partners to reduce the impacts of wildfire

- Routinely participate in the update of the Orange County Community Wildfire Preparedness Plan for areas within the Very High, High, and Moderate Fire Hazard Severity Zones.
- Continue to promote and implement the Orange County Vegetation Management program to reduce wildfire risk.
- Coordinate with regional partners to explore and deploy fire detection cameras as part of a wildfire monitoring network.

WF-2: Implement actions to reduce flammable materials in wildfire zones

- Remove highly flammable vegetation in Very High, High, and Moderate Fire Hazard Severity Zones and replant with fire-adapted specimens.
- Replant bare or disturbed hillside areas after wildfires to reduce erosion that may lead to landslides.

WF-3: Educate the community about wildfire for improved public safety and resilience

- Work with Orange County Fire Authority on home preparedness assessments to assist more residents in understanding and addressing their wildfire risk.
- Expand the fire hazard prevention awareness campaign to residents in the High and Very High Fire Hazard Severity Zones.
- Support regional partners (e.g., Orange County Fire Authority's Ready, Set, Go Program) in their efforts to educate residents about defensible space, vegetation management, and home hardening efforts.

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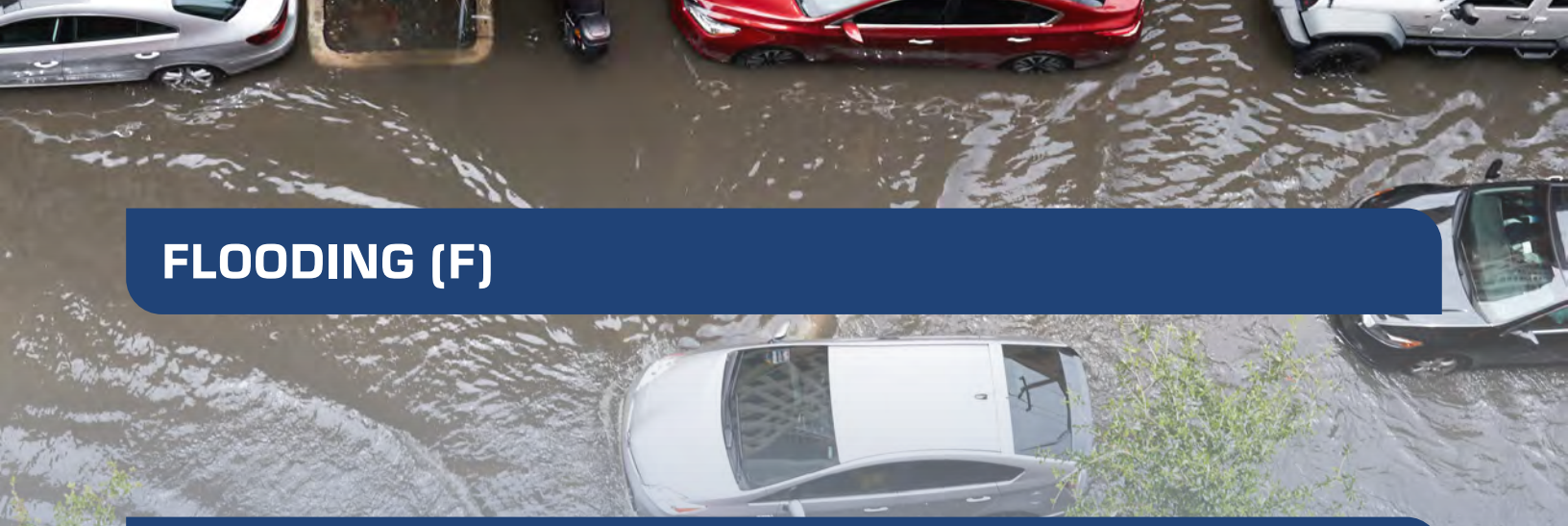

FLOODING (F)

F-1: Coordinate with relevant agencies to better plan and prepare emergency services required for flooding events

- Monitor stormwater management infrastructure and identify changes in flooding patterns and locations related to changing climatic conditions.

F-2: Develop or update long-term public works plans for critical facilities to address current and future flood risks

- Require that future transportation infrastructure projects consider current and future flood risk and align the projected lifespan of the project with the best available science.
- Explore and implement Low Impact Development standards for new development to reduce the amount of stormwater runoff.

F-3: Educate the community about wildfire for improved public safety and resilience

- Implement a public outreach program to increase public awareness of flooding, stormwater management, and drought management issues and techniques for residents to mitigate those challenges on their property.
- Partner with Orange County Public Works to proactively disseminate information from the "H_2OC Stormwater Program" to educate home and small business owners on regulations and highlight the role that engaged residents can play in assisting with community-based stormwater management.

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F-4: Ensure resilience and long-term functionality of stormwater and sewer systems

- Update the City's Master Plan of Drainage regularly to incorporate new data and/or address emerging issues.
- Conduct comprehensive visual and functional test monitoring and asset condition assessments. Model potential impacts on utility infrastructure under future flooding scenarios.
- Conduct frequent cleanings of storm drain intakes, especially before and during the rainy season.

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LIQUEFACTION / LANDSLIDE (L)

L-1: Coordinate with local and regional partners to prepare and respond to liquefaction and landslide events

- Coordinate with Irvine Ranch Water District on subsidence monitoring in areas of active groundwater extraction and work with water utilities to develop strategies based on the amount and severity of subsidence occurring.
- Coordinate with Irvine Ranch Water District and Orange County Water District on emergency water storage and distribution following a liquefaction or landslide event.
- Coordinate with Caltrans and Orange County Transit Authority for inspection and maintenance of primary evacuation routes.

L-2: Educate the community about liquefaction or landslide events for improved public safety and resilience

- Provide information to community groups and businesses about how to prepare for and recover from a liquefaction or landslide event.
- Promote retrofits of key community facilities not owned by the City.

WF-3: Design facilities to be resilient to a liquefaction or landslide event

- To the extent feasible, construct all new and significantly retrofitted City-owned facilities to remain operational in the event of a major liquefaction or landslide event.
- In coordination with Caltrans, update facilities condition assessments for bridges along evacuation routes to identify bridges that need seismic retrofitting.

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Irvine Shares the Way

"Irvine Shares the Way" is a broad-based campaign and initiative to improve the safety of everyone in Irvine, whether they are walking, bicycling, or driving. Through educational materials, safety workshops, and other events and opportunities, the campaign will help raise awareness of traffic laws and remind residents how they can reduce the chances of a collisions when they are walking, bicycling, and driving.

Since the inception of Irvine Shares the Way, the City has led a suite of related projects and programs to help promote safety, regardless of what mode of transportation one is using. These projects and programs include, but are not limited to:

- Suggested Routes to Schools: Suggested Routes to School (SRTS) is a nationwide program that aims to create safer conditions around schools and encourages students, parents, and school staff to walk, bike, or roll to school. The City, in partnership with Irvine Unified School District, Tustin Unified School District, and local public schools, is continuing the development of SRTS throughout Irvine.
- Irvine CONNECT: Shuttle Service Pilot Program: As a new shuttle service free to the public, available until 8 PM on weekdays and 10 PM on weekends, Irvine CONNECT makes it easier to get around the city with stops at parks, schools, hospitals, and shopping centers. This program was first identified in the City's Transit Vision.
- South Yale Corridor Improvements Project: The South Yale Corridor Improvements Project will evaluate the south segment of Yale Avenue in the city, between the I-405 Freeway and University Drive. The project aims to better utilize the available roadway space to best serve community needs such as safety, access to neighborhoods and the school, and connections to nearby parks and trails.

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Chapter Five
Implementing the Plan

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The CAAP is a vision for a low-carbon future in Irvine, identifying near-term actions and long-term policy direction for climate protection and resilience. Implementation of the CAAP measures and actions is expected to occur and evolve, over the next 15 years. It will be an iterative and collaborative process that requires continued investigation into policy options and ongoing engagement with stakeholders and community members. The City will prioritize transparency in implementation, tracking and publicly reporting data on the successes and challenges encountered. This data tracking, along with shifts in technologies and regulatory changes, will allow the CAAP to evolve, and the City will regularly consider how the CAAP can be updated to meet the community vision for a sustainable Irvine.

The following chapter provides an overview of how the CAAP is implemented, including information on implementation actions, how the community is included in this process, financial aspects of the CAAP, and implementation monitoring and reporting.

IMPLEMENTATION ACTIONS

Chapter 3 outlines a suite of GHG reduction strategies and measures and includes a summary of the implementation actions that can facilitate achievement of identified strategies and measures. These actions are where the work happens, and includes both actions by the City and actions by the community that support the CAAP's goals.

Additional details on potential implementation actions for the GHG reduction measures can be found in Appendix G. It should be noted that the CAAP itself does not approve, fund, or authorize implementation any specific project. Each implementation project will be reviewed and approved using City procedures and best practices for approval. The City will use its project approval processes to determine which specific implementation projects may require additional public review, review by City decision makers, and/or review under the California Environmental Quality Act.

FLEXIBILITY IN EXECUTION

Achieving the GHG reduction targets of the CAAP requires transformative changes in energy systems and transportation networks, and similar changes in other sectors. The CAAP serves as a policy document to begin charting a pathway towards deep GHG reductions. The City will be faced with multiple decision points along the way as implementation of the measures and actions occurs. To be effective, these decisions will need to be informed by additional analysis as necessary, stakeholder engagement, and funding commitments. This thoughtful and well-informed approach to implementation will requireflexibility in how the intentions of measure and actions are met.

The implementation actions identified for CAAP strategies and measures acknowledge that additional consideration will be needed to ensure community benefits and GHG reductions are maximized, while costs are minimized. Policy impacts and funding mechanisms will need to be analyzed. Partnerships will need to be created, expanded, and transformed. New technologies will need to be considered and evaluated. Implementation of the CAAP will need to be assessed and reassessed continually, meaning the policies outlined in the current version of the CAAP may need to be adjusted for effective execution.

COMMUNITYWIDE COLLABORATION

The CAAP is a community vision that requires collective action and collaboration. The goals can be achieved with a high level of support and commitment from all. The City will take

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action to prepare for the impacts of climate change and reduce local GHG contributions; however, the implementation of policies and programs will require that community members continue to provide input and make the changes necessary to realize the CAAP's vision. These types of actions can vary widely, including individuals taking advantage of energy efficiency rebates, businesses and homeowners conforming with new regulations and building codes, and entities engaging in partnerships with the City. Many of the actions that will need to be taken by community members can be beneficial regardless of GHG impact, providing cost savings and a clean and resilient community. Similarly, partnerships between the City and businesses, investors, public agencies, and non-profit groups can help advance mutual interests; expanding the capacity of the City for implementation and developing programs and solutions that work collectively and collaboratively to achieve the CAAP's vision. Appendix G includes identification of key external partnerships for implementation action.

The CAAP is built on an extensive community engagement process; its continued success is dependent on community members, groups, and organizations continuing to stay involved even after adoption. As implementation of the CAAP occurs, continued input from community members will be sought to ensure the appropriate direction is maintained and that there is buy-in for actions community members will need to take. The steps towards achieving a resilient and low-carbon economy will be nuanced and detailed, and continued engagement will be necessary as both the City and community members learn more about the impacts and outcomes of specific policies and programs. Important decisions will need to be made each year as CAAP implementation occurs, and these will be most successful with input from an informed and engaged community.

IMPLEMENTATION COSTS AND FUNDING

Implementation of the CAAP will require administrative action and capital improvements by the City that incur upfront costs. These costs will come in the form of increased staff time for program administration, capital costs for buildings and transportation infrastructure, and other costs such as incentives, services, or subsidies. While some costs associated with CAAP implementation constitute new expenditures, many can be reduced, paid back, or eliminated completely through various funding mechanisms. Importantly, failing to make these investments in the near-term will likely create greater costs in the future. Broadly, costs of inaction fall into two categories:

Economic costs: Direct losses to gross domestic product due to climate-related risks and impacts, and;

Social costs: Indirect costs incurred due to negative climate-related impacts on people and/or their environments.

Reducing local emissions and preparing for climate hazards now will limit future economic impacts, such as increased energy and health care costs.

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FIGURE 12 COSTS OF INACTION

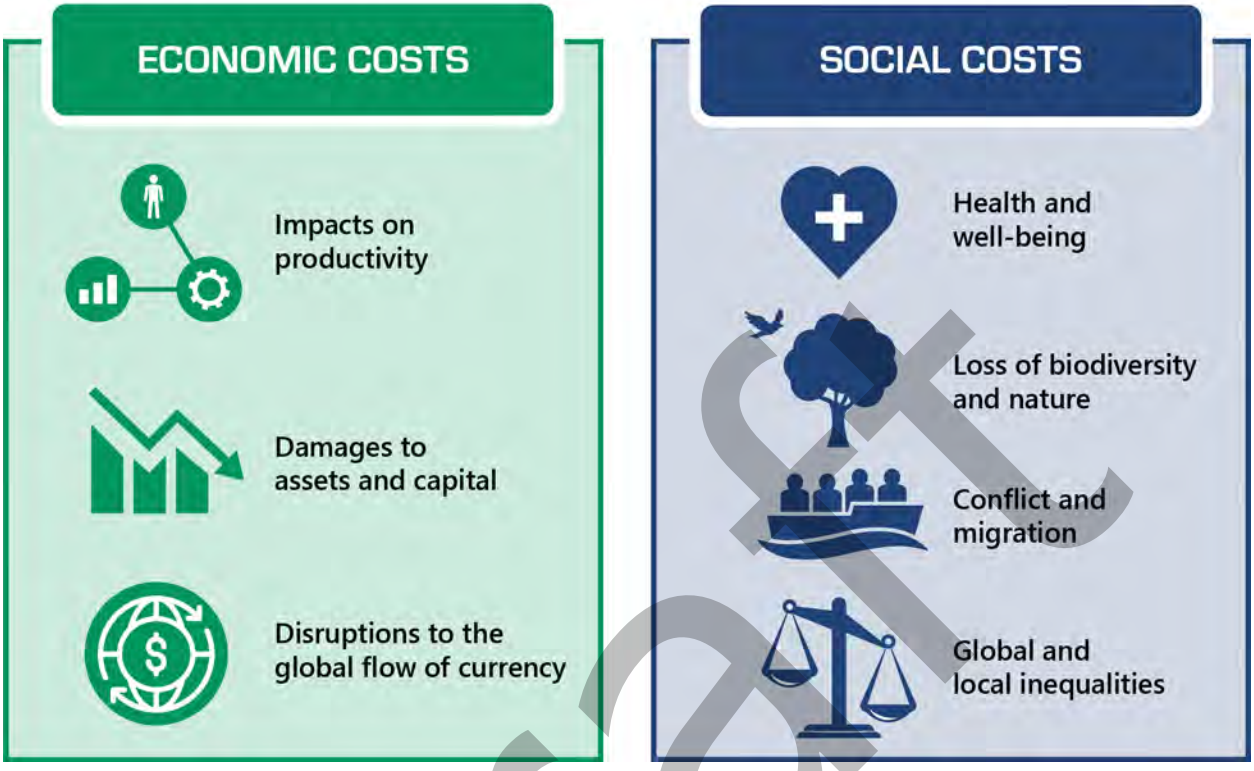
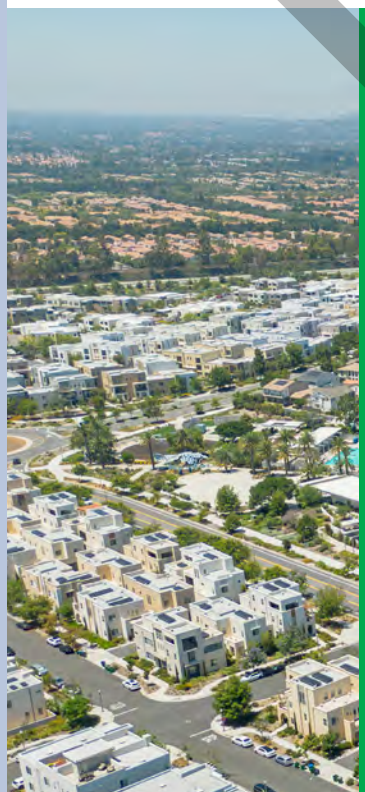


Figure Source: Climate Policy Institute 2024.

As the CAAP is implemented, the City will investigate the costs of programs and policies and how they can be funded through external sources, such as grants, or funding mechanisms such as enterprise funds that are self-sustaining. The goal will be to minimize general fund allocations where possible and prioritize innovative funding solutions.



One Irvine Program

One Irvine is a neighborhood revitalization program that connects Irvine residents with community-strengthening resources and with each other. The program enhances neighborhood conditions and facilitates specific improvement projects in collaboration with residents. With a comprehensive focus, various components of the program promote sustainability and resilience outcomes. For example, One Irvine offers a free DIY Sustainable Resources for Renters Toolkit, which can help renters within the city take charge of their own environmental impacts and make tangible changes within their living spaces. The toolkit contains items such as faucet aerators, LED lightbulbs, water-efficient showerheads, and more. Additionally, One Irvine also offers green home grants. These grants offer owners of single-family homes and condominiums built in or before 1975 up to $1,500 for sustainability upgrades, such as electric dryers, electric vehicle chargers, smart irrigation controllers, induction cooktop stoves, and home battery storage systems, among many more eligible upgrades.

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TYPES OF COSTS AND FUNDING MECHANISMS

Implementation Costs:

- **Personnel costs:** for the salary and benefits of staff required for measure implementation. Some measures may be able to be implemented within current capacities, however, others will require either fractional or full-time employee commitments.
- **Capital costs:** for physical assets and equipment with a useful life of five years or more, such as electric vehicles and chargers, and building renovations.
- **Other costs:** include any other non-capital expenses that are required for measure implementation. This may include incentives, trees, transit subsidy programs, and consultant fees.

Funding Mechanisms:

- **External funding sources:** government or private funding programs like grants, loans, tax credits, or rebates
- **City's General Fund:** primary financial account used to manage the City's core services and operations including public safety, health, administrative services, etc. The general fund is primarily financed through revenues from local taxes (such as property taxes and sales taxes), fees for services, state and federal aid, and other miscellaneous sources. General funds can be allocated as needed to meet community needs and priorities.
- **Enterprise funds:** self-sustaining funds that are restricted for specific uses, such as development impact fees and revolving loan funds.

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IMPLEMENTATION COST ESTIMATES

An implementation cost analysis is in process and will be incorporated into this section at a later date.

MONITORING PROGRESS

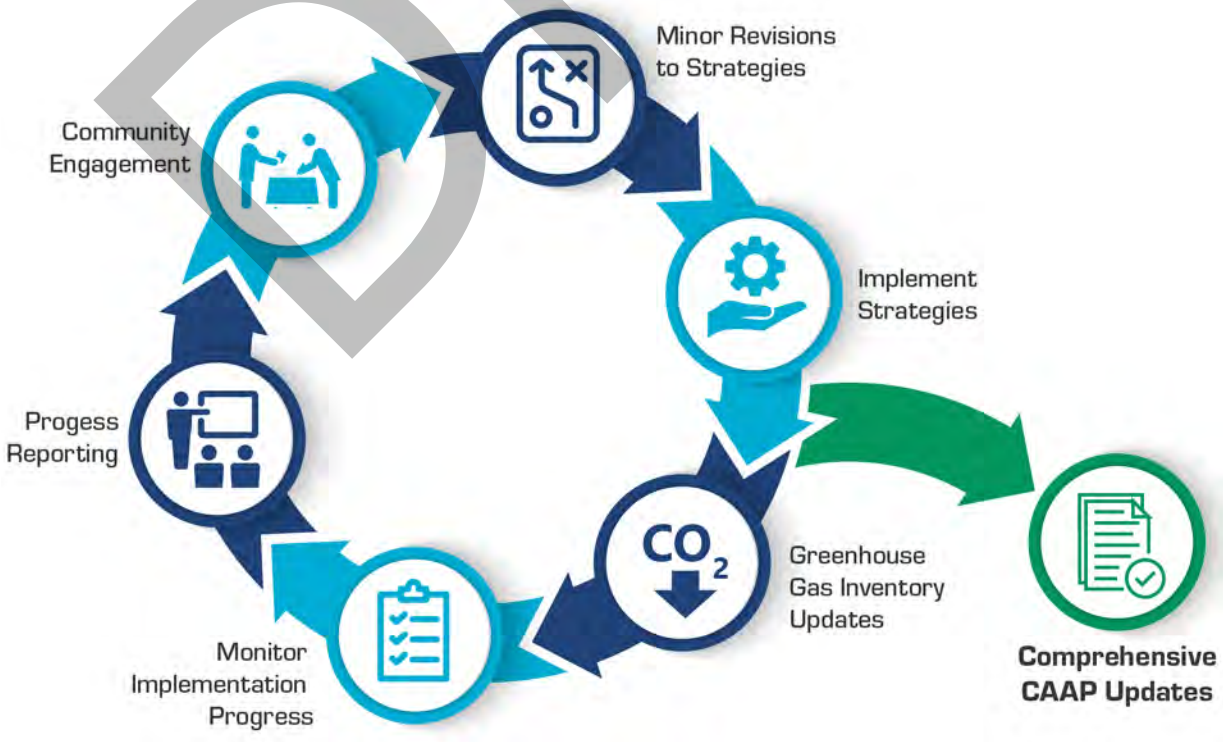
The success of the CAAP and the City's GHG reduction targets will need to be monitored regularly to ensure that time and energy is being focused on effective measures and that intended results are being achieved. The City will regularly collect data to both quantitatively and qualitatively measure the success of the GHG reduction measures and adaptation strategies. The three key data types the City will be reviewing include implementation status, performance monitoring, and GHG inventories.

Implementation status: The City will qualitatively track the status of each GHG reduction measure and adaptation strategies and any identified actions. This will include categorizations such as "not started", "awaiting funding", and "completed".

- **Strategy and measure performance:** As GHG reduction measures and adaptation strategies are implemented, the City will identify quantitative performance standards to measure implementation success.
- **GHG inventories:** GHG inventory updates will be conducted such that longer-term trends in GHG emissions can be identified.

The speed and scale of the transition the CAAP proposes will require close monitoring of progress in many forms, such that success and obstacles can be identified and addressed swiftly and effectively.

FIGURE 13 MONITORING AND REPORTING



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REGULAR REPORTING

The essential role the community plays in CAAP implementation requires that the City is transparent in its successes and challenges. The City will publish reports that disclose implementation and monitoring data for the CAAP as data are available, including implementation status, strategy and measure performance, and relevant GHG emissions trends identified through GHG inventories. These monitoring reports will also include near-term upcoming CAAP implementation priorities, such that decision makers and stakeholders can be informed of the next steps and potential funding needs. Transparency in the CAAP implementation process is critical to maintain community support and accountability.

FUTURE CAAP UPDATES

The CAAP intends to transform Irvine's role in addressing climate pollutant inputs and hazard impacts. This will happen with the backdrop of a dynamic environment where technology and policy solutions are evolving rapidly, and the City and community will need to be nimble to stay at the forefront. As such, the City intends to reevaluate the CAAP on a regular basis. The City will consider the data obtained from monitoring progress, new technologies, and changes to the regulatory framework to develop additional or modified GHG reduction and adaptation strategies.

The City will continually evaluate the need for targeted updates to the CAAP and its strategies and plan for more comprehensive updates. Generally, modifications to how policies are framed or implemented based on funding availability or encountered challenges will be assessed with monitoring reports. An example may be that a building code considered in the CAAP is superseded, and an option becomes available that achieves higher GHG reductions with reduced costs. Given the speed of the evolution of technology and legislation in California, the City will need to reevaluate the impacts of State and federal legislation, policy options, and availability of various low carbon technologies. Comprehensive CAAP updates may occur when changes are necessitated due to major changes in legislation, City growth projections, or other components of the framework that supports the technical basis of the CAAP or the strategies for reducing GHG emissions.

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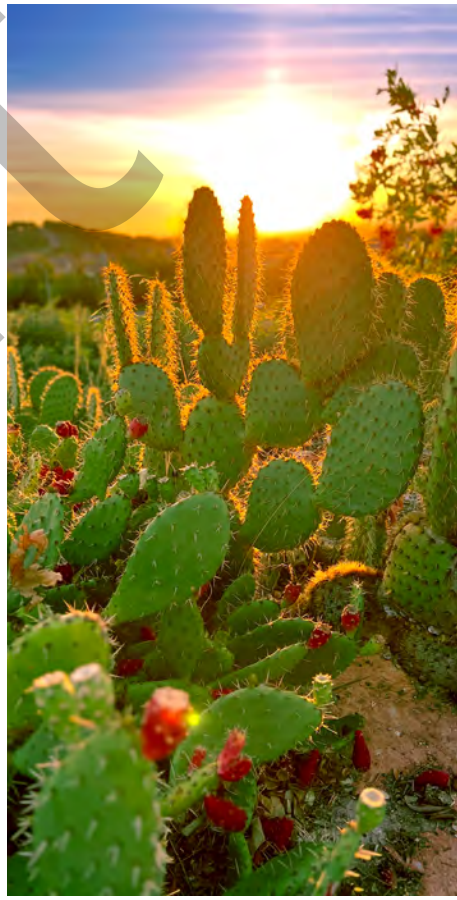
FLITWAY
FLITWAY

IRVINE SHUTTLE



COMPOST
GIVEAWAY

APPENDIX A

Community Engagement Summary.

IRVINE CLIMATE ACTION AND ADAPTATION PLAN

IRVINE CLIMATE ACTION AND ADAPTATION PLAN

Since 2021, the City of Irvine has been engaging with the community on the Climate Action and Adaptation Plan (CAAP). Over the course of this extensive outreach phase, City staff has used a wide range of strategies and outlets to promote the CAAP.

Direct Outreach

3,818
community members directly engaged

- **28** workshops & presentations
- **326** feedback votes at workshops
- **570** attendees at public events

survey recieved **3,298** views online

respondents gave **8,854** comments & opinions

- **3** internal stakeholder meetings
- **5** sector-based external stakeholder meetings
- **150** HOA groups contacted

Indirect Outreach

132,799
community members reached indirectly

- **62** social media posts
- **93,938** individuals reached
- **2,436** engagements on posts

3,077
visits to CAAP webpages

- **8** CAAP emails sent
- **26,585** CAAP email recipients
- **27** clicks on CAAP content

Visit *cityofirvine.org/climate* to learn more.

Community Engagement Summary

Prepared by City of Irvine Staff

April 2025

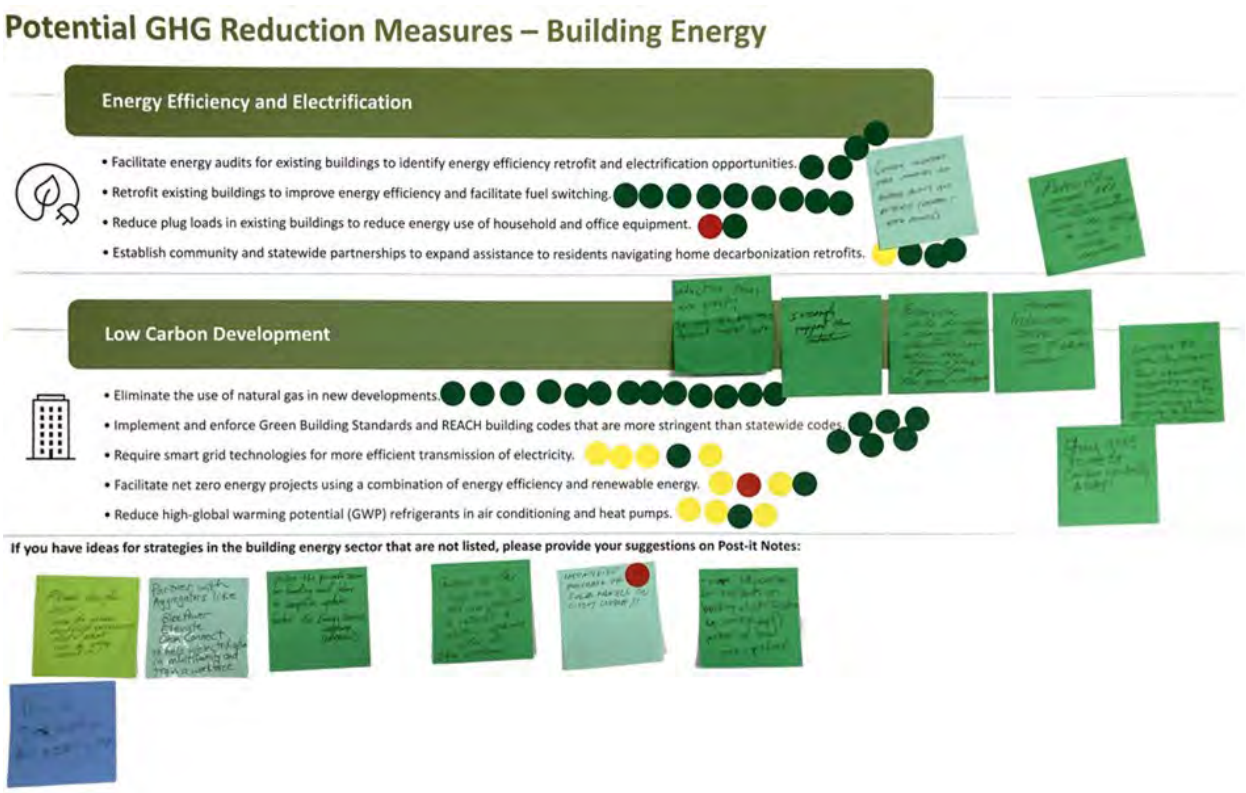
Introduction

The City of Irvine has been developing the Climate Action and Adaptation Plan (CAAP) over the course of nearly two and a half years. A significant part of the development of Irvine's CAAP has been public outreach. Public opinion is a critical part of a City's Climate Action Plan, and can greatly impact the decisions, actions, and goals that a city may want to take. Including Irvine's diverse set of stakeholders in the CAAP development will ensure an equitable development process that supports Irvine from the very root of the community. The City of Irvine has made a concerted effort to reach out to the public in as many ways as possible. This outreach has consisted of CAAP presentations, publicly accessible surveys, and other in-person, online, media and events.

Direct Outreach

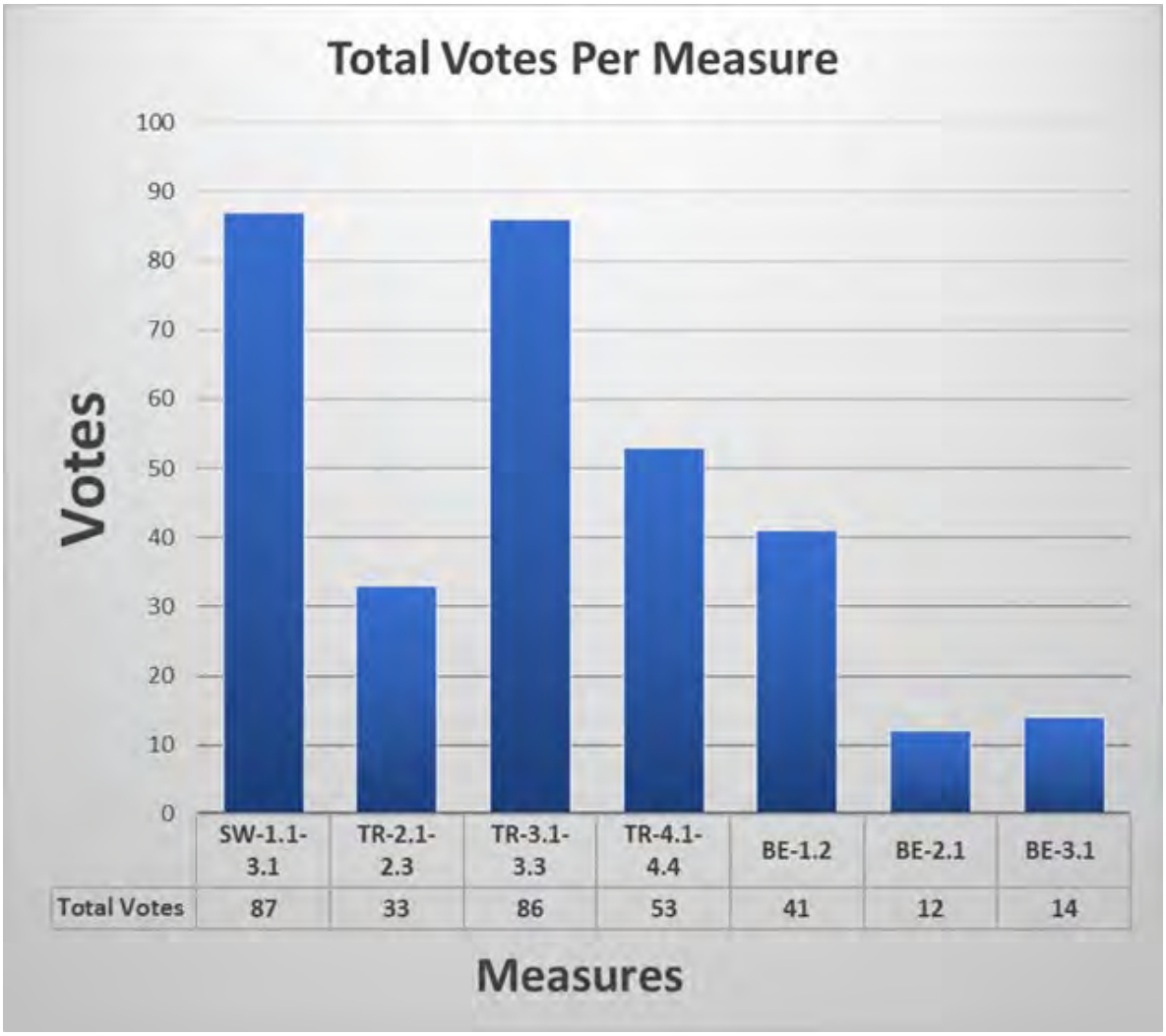
CAAP Workshops

City of Irvine staff held two in-person public workshops on draft CAAP measures. At these meetings, posterboards outlined all draft measures per emissions category. Members of the public were able to vote and provide feedback on each individual measure via colored stickers and comments cards. There was a total of 326 votes collected using this method. The measure with the most total votes was Measure SW-1.1-3.1 which follows as "Reduce waste generation and increase the diversion of waste from landfills, diverting 80% of all waste by 2030 and 90% by 2045." This measure had a total of 87 votes across the associated actions. The most voted on action had 19 votes in support of adopting an ordinance banning the use and distribution of polystyrene-foam and single-use plastics; an action that the City is currently working towards.



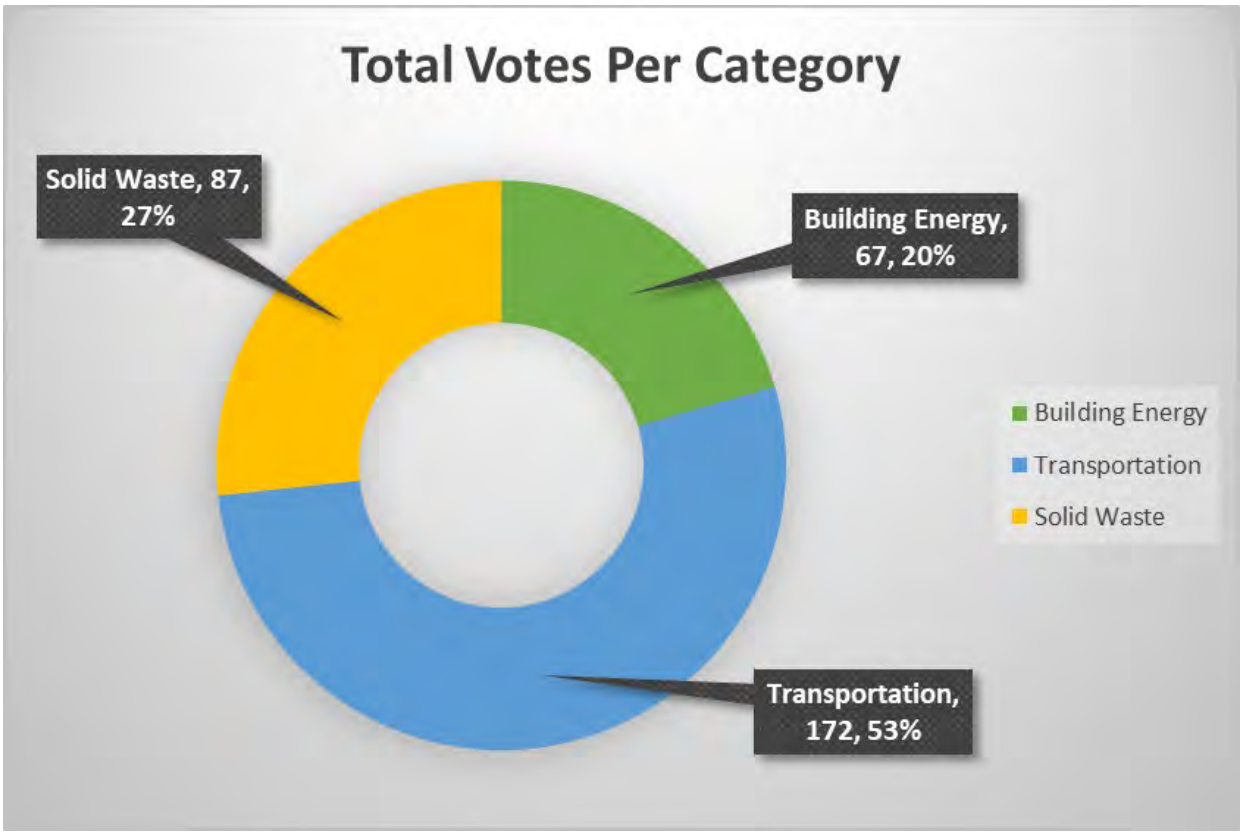
Public Workshop Posterboard

The measure with the second highest number of total votes was Measure TR-3.1-3.3 which follows as "Enhance and expand transit lines and infrastructure, reducing vehicle miles traveled (VMT) by 7.5% by 2030 and by 15% by 2045." This measure received 86 total votes. The most overall voted actions were related to expanding public transit connectivity Transportation- related measures also received the most comments from members of the public when engaging with the CAAP.



Public Workshop Vote Results

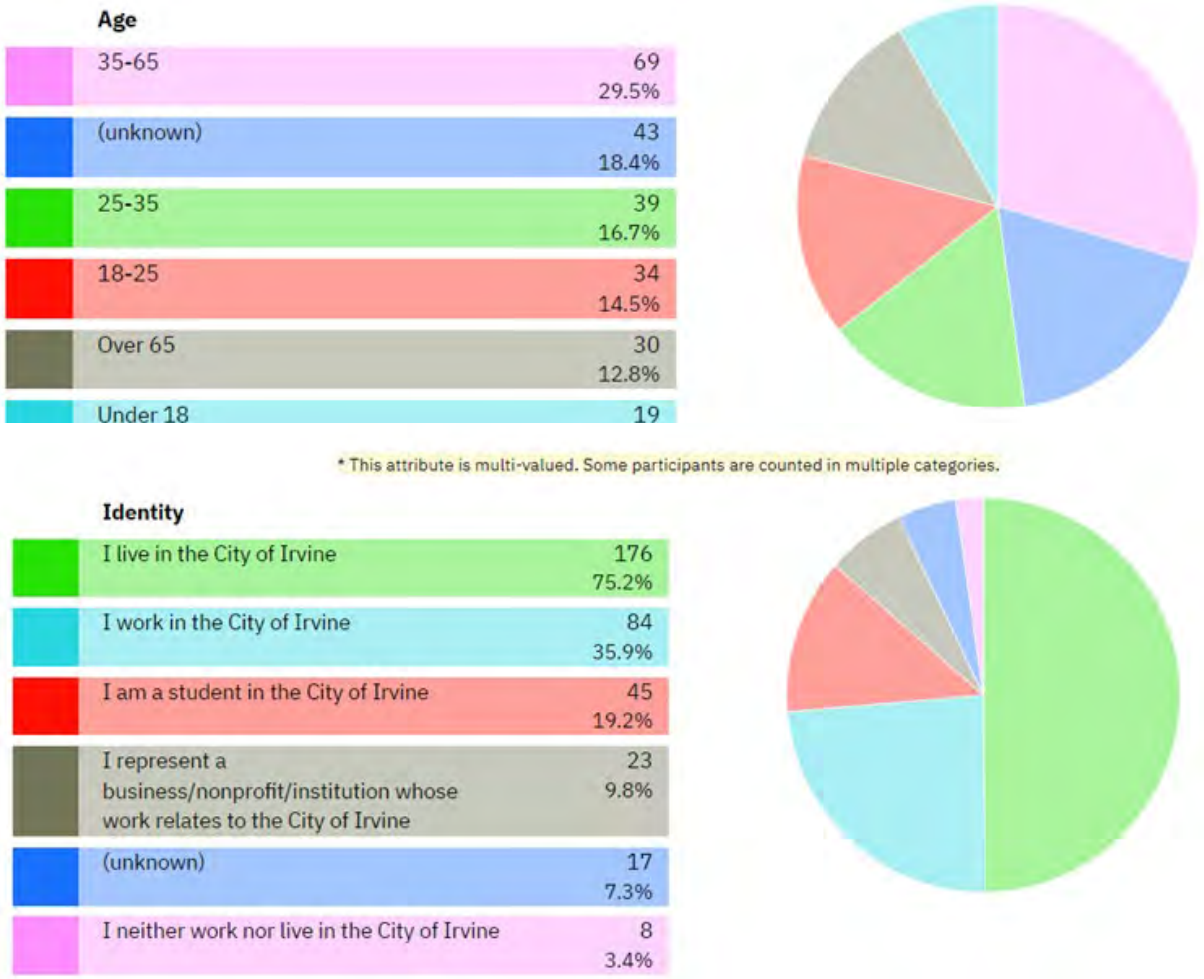
To summarize, the public provided the most supportive feedback on Transportation and Solid Waste measures. Transportation measures accounted for 53% of the votes from the public at both workshops. Solid Waste accounted for 27% of the votes. Building Energy measures accounted for 20% of the votes.



Public Workshop Votes Summary

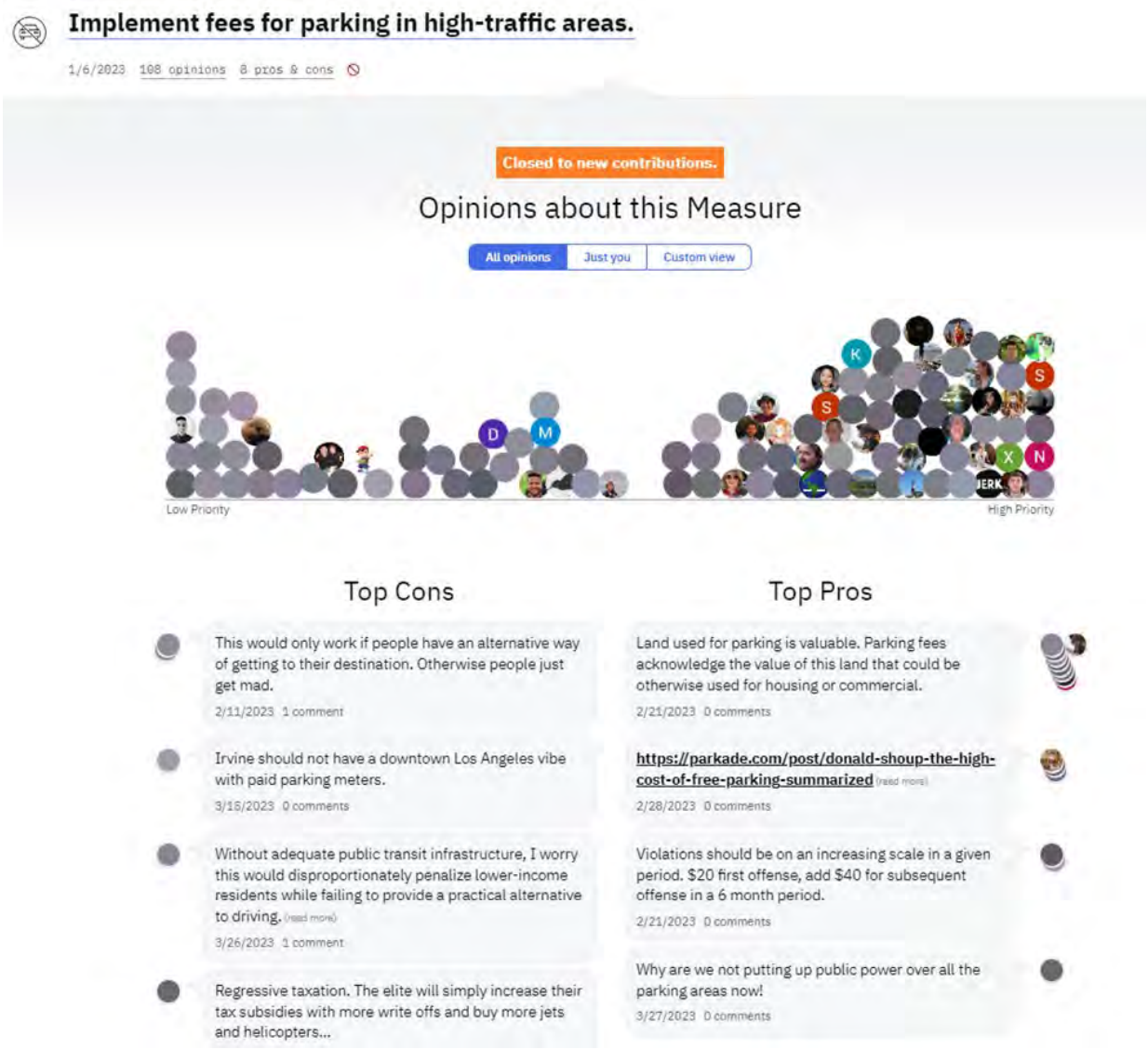
Consider.it Survey Results

The City also launched an online survey listing all the draft measures and actions in the CAAP. This survey produced the largest sum of feedback from all of the City's outreach. The survey was translated into the City's eight threshold languages, including Simplified Chinese, Traditional Chinese, Arabic, Vietnamese, Japanese, Korean, and Spanish. The survey was created in order to provide a space where the public can freely view, comment, and support the proposed measures and actions that were proposed in the CAAP. This survey was open throughout the 2023 calendar year and garnered 3,298 views and 8,854 total opinions from more than 230 unique registered users.

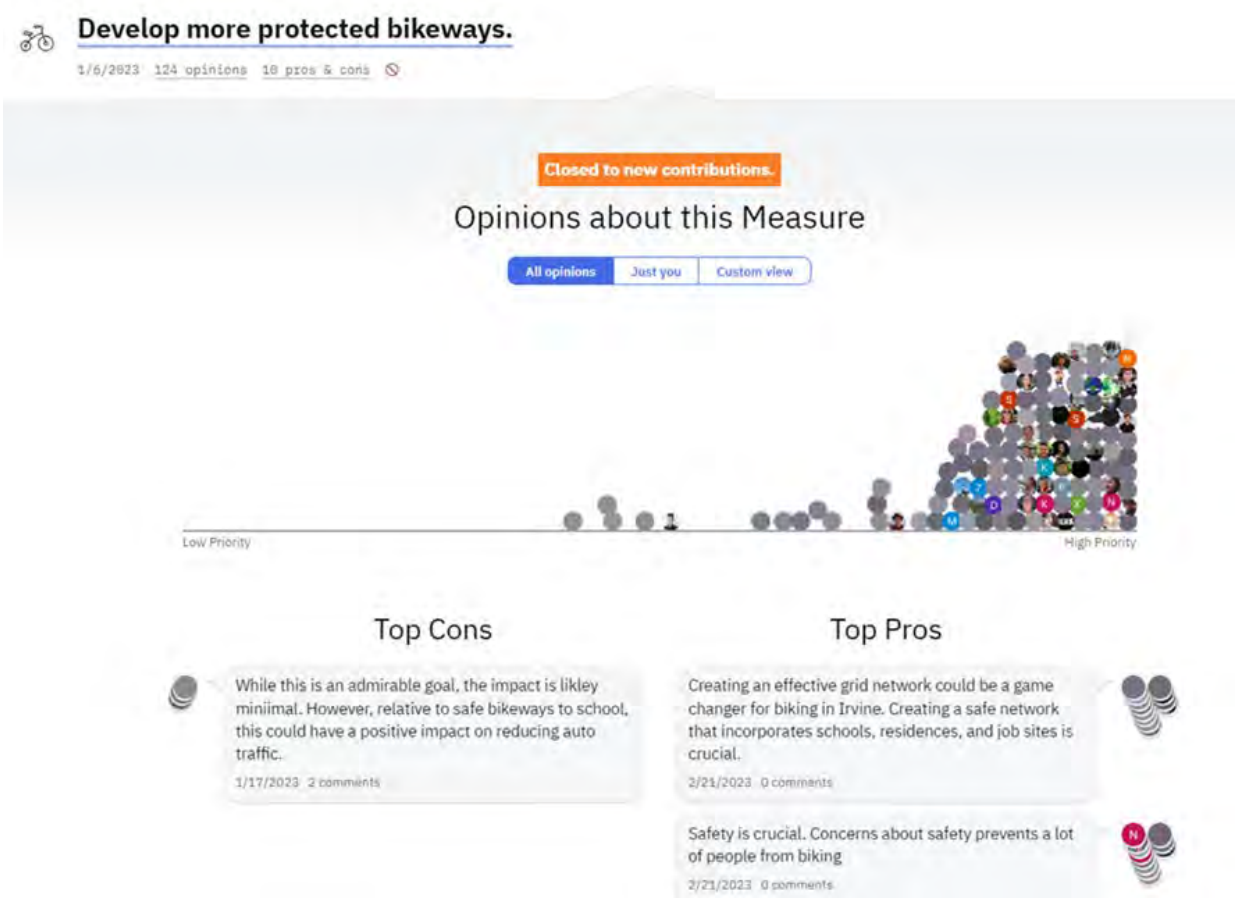


Consider.it Survey Responses by Age and Identity

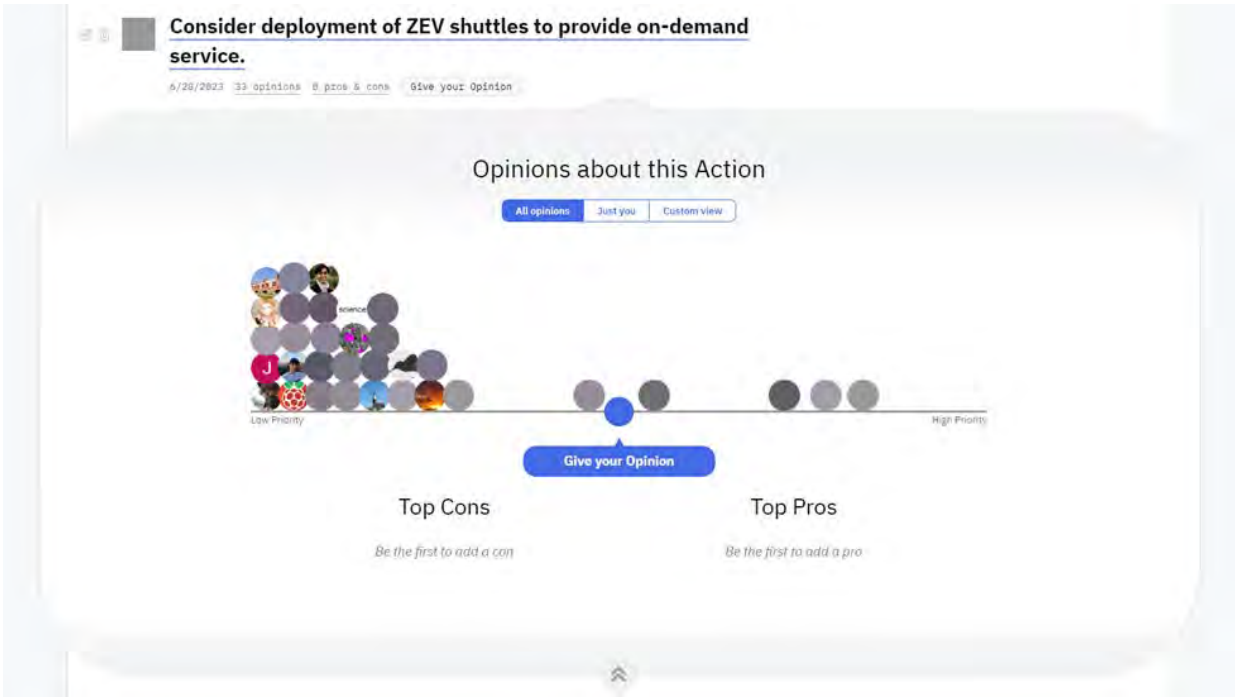
In addition to registering opinions, the survey also allowed for unique comments and suggestions from the community to be posed, and for others to vote and comment on the community proposals.



Consider.it Survey Opinions – Implement Fees for Parking in High Traffic Areas

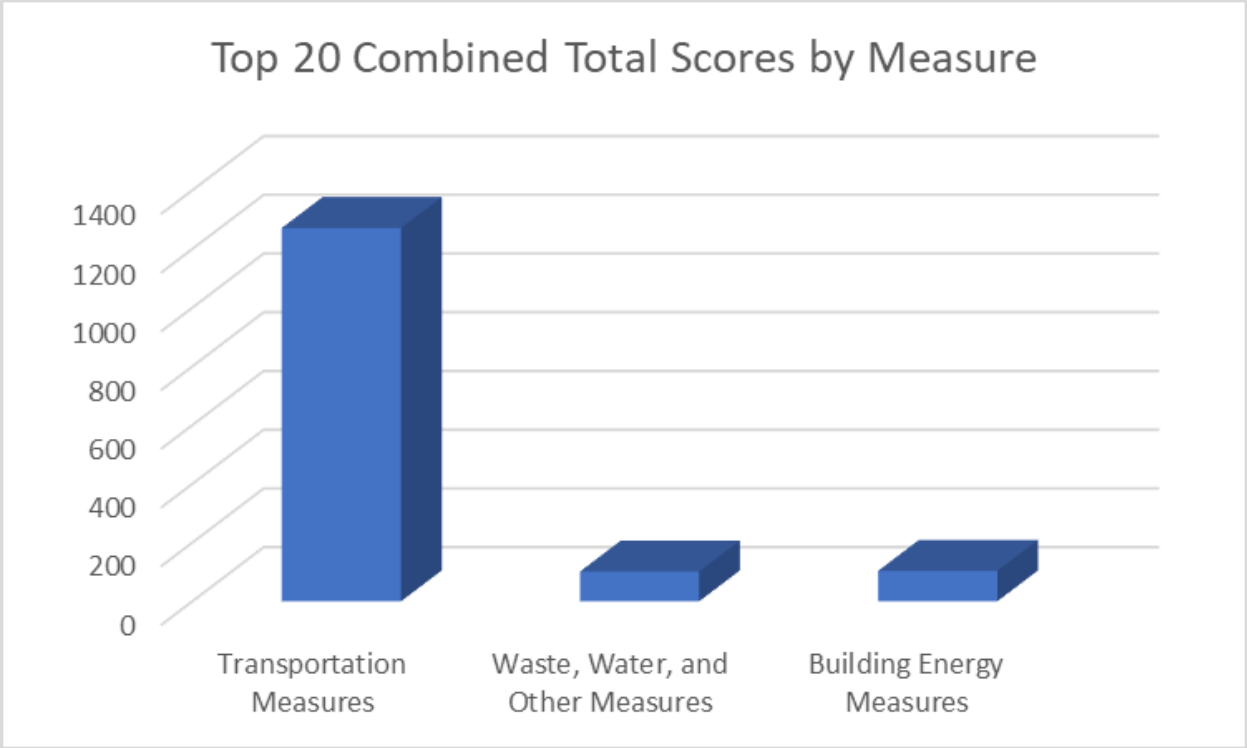


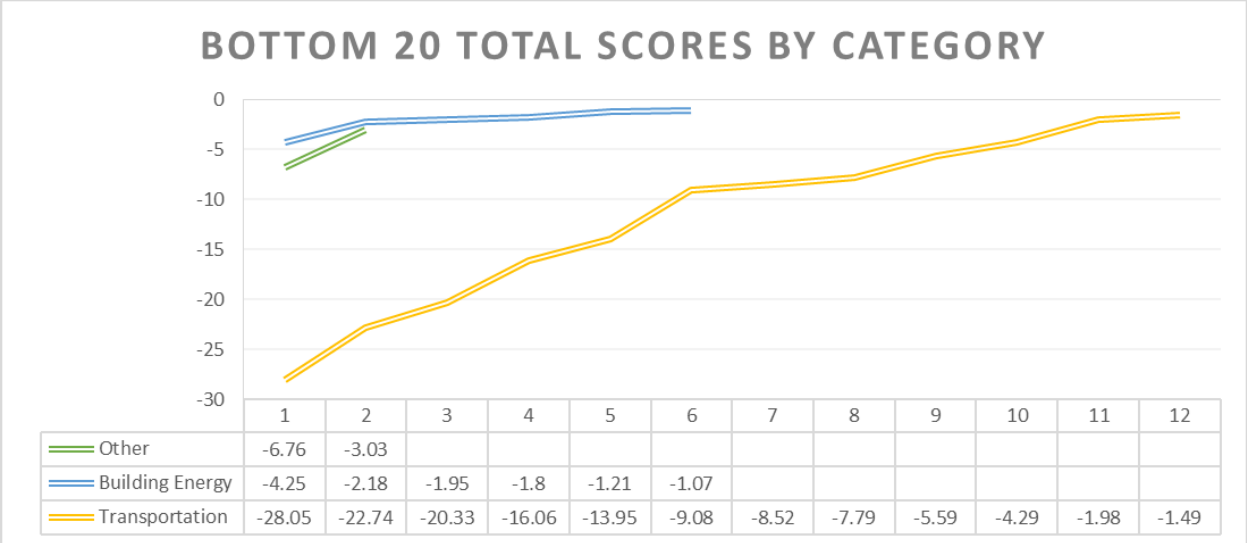
Consider.it Survey Opinions – Develop More Protected Bikeways



Consider.it Survey Opinions – Consider Deployment of ZEV Shuttles

Out of the top 20 measures with the highest Total Scores, 16 of them were in the Transportation category. What this means is that the community engaged primarily in transportation measures, and also rated these measures with a high degree of priority. The top 3 highest Total Score proposals were specifically related to Active Transportation with the highest Total Score of 108 in support of the measure “Develop more protected bikeways” with the second highest Total Score being 104 for ”expanding bicycle and walking options”, and the third highest being 102 for ”safer and more accessible pedestrian infrastructure”.

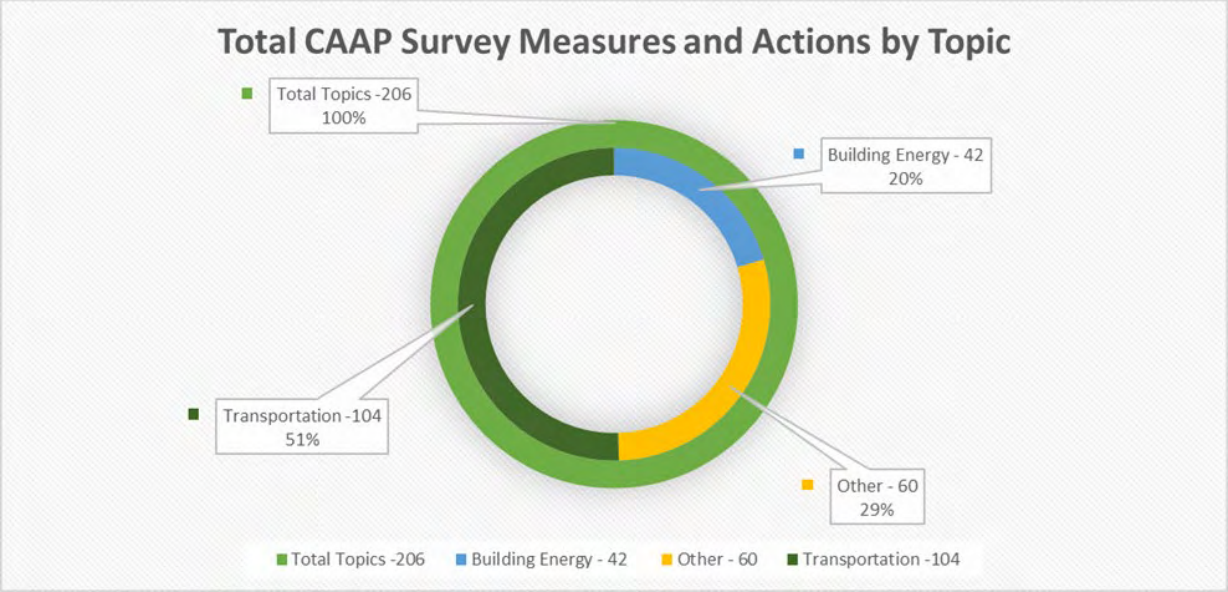




	1	2	3	4	5	6	7	8	9	10	11	12
Other	-6.76	-3.03										
Building Energy	-4.25	-2.18	-1.95	-1.8	-1.21	-1.07						
Transportation	-28.05	-22.74	-20.33	-16.06	-13.95	-9.08	-8.52	-7.79	-5.59	-4.29	-1.98	-1.49

Consider.it Survey - Measures Scores by Category

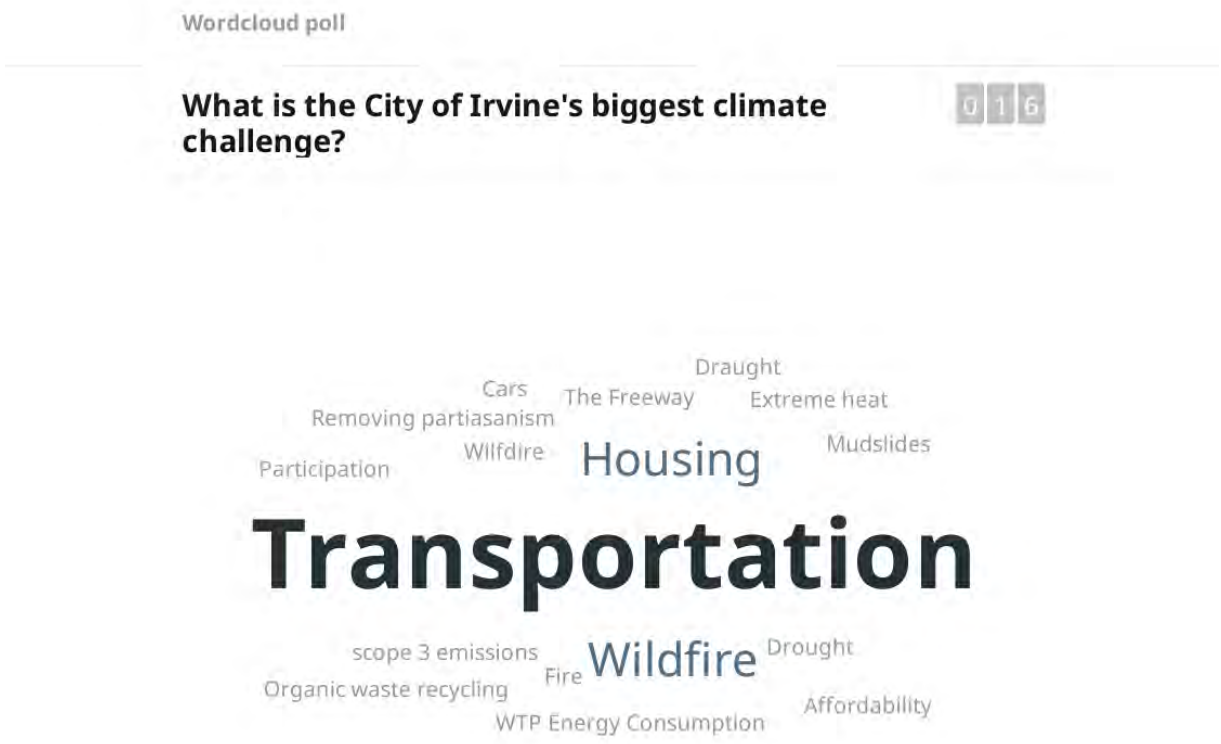
With responses to over 200 proposed measures and actions, there were some noteworthy trends. In terms of Building Energy, the public supported energy retrofit opportunities for current buildings as well as incentivizing the use of renewable energy sources in new constructions. For Waste, Water, and Other topics, the public supported an increase in recycled water in addition to incorporating more drought tolerant landscapes utilizing native vegetation. However, the public was by far the most engaged with Transportation topics. The Transportation topics that received the most attention were related to making safer and more accessible bike and pedestrian infrastructure, connected to useful locations.



Consider.it Survey - Total CAAP Measures and Actions by Topic

Slido CAAP Responses

Another method of outreach that City Staff utilized was an active poll and word cloud exercise used in virtual and in-person presentations. This poll populates responses and displays them in real in time for the audience to see. This method was meant not only to collect direct public comments, but also to spark up a dialogue that encouraged community members to engage with and ask questions. The three questions that were included in the Slido polls were: What is the City of Irvine's biggest climate challenge, What is the City of Irvine's biggest strength in addressing the climate crisis, and What is your vision for a Climate-Smart Irvine. The answers were displayed as a word cloud, where the same response would grow in proportion to the amount of support from members of the audience. Due to the nature of these broad questions, the answers varied significantly. Below are a few examples of these kinds of word clouds, and the various responses that were given.



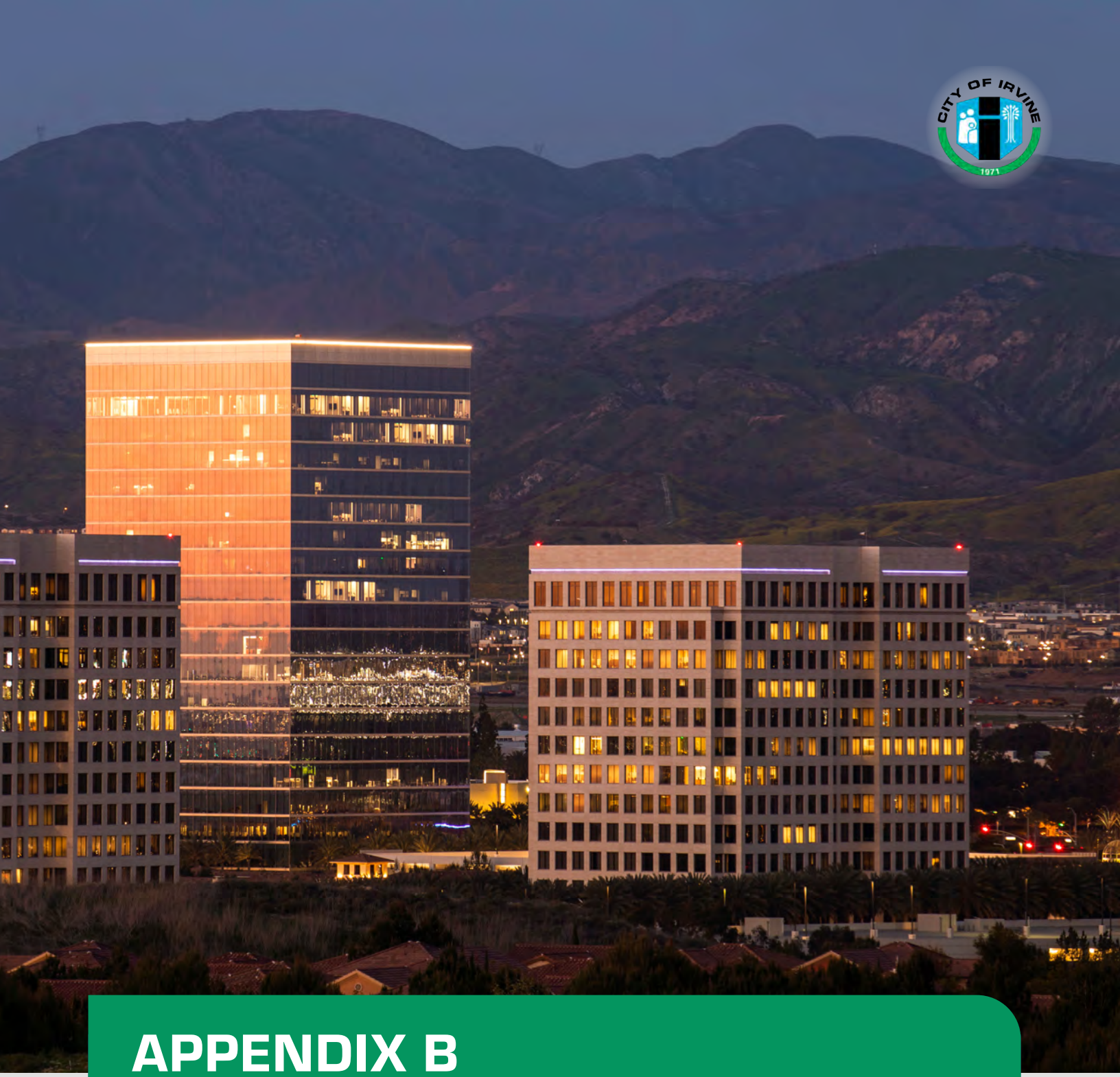
Slido Responses Wordcloud – What is the City of Irvine's biggest climate challenge?

Slido Responses Wordcloud – What is the City of Irvine's biggest strength in addressing climate crisis?

Slido Responses Wordcloud – What is your vision for a Climate-Smart Irvine?

Indirect Outreach

Apart from direct in-person and virtual engagement, City Staff attempted to reach all Irvine residents though indirect methods such as social media posts, email blasts, and tabling at community events. Through these broader efforts, the City reached over 190,000 community members.



APPENDIX B

Vulnerability Assessment.

IRVINE CLIMATE ACTION AND ADAPTATION PLAN

CITY OF IRVINE

CLIMATE VULNERABILITY ASSESSMENT

February 2023

ORGANIZATION

This document includes the following chapters:

Chapter 1- Introduction

This chapter describes climate adaptation planning and the applicable State requirements as they relate to this Vulnerability Assessment and Adaptation Framework.

Chapter 2 – Community Profile

This chapter provides a description of the City's general environment and demographics. Special emphasis is made to reveal disadvantaged communities and vulnerable populations.

Chapter 3 – Vulnerability Assessment

This chapter includes forecasts of each of the five climate-related hazards. It also maps where those hazards are most likely to affect the City of Irvine and which areas are most vulnerable to these changes.

This chapter evaluates the City's current capacity to address the five climate-related hazards. This includes an assessment of the City's current policies and programs and how they address the ability to respond to hazard events.

Chapter 4 – Adaptation Framework: Recommendations to Improve Resilience

This chapter includes potential strategies and policy recommendations to increase the City's ability to adapt to hazards and meet the needs of its vulnerable communities.

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ACRONYMS

ACS = United States Census American Community Survey

APG 2.0 = California Adaptation Planning Guide 2.0

CEC = California Energy Commission

CAL FIRE = California Department of Forestry and Fire Protection

CF = Critical Facilities

CNRA = California Natural Resources Agency

CalOES = California Office of Emergency Services

CoSMoS = Coastal Storm Modeling System

FEMA = Federal Emergency Management Act

FHSZ = Fire Hazard Severity Zones

FOC = Facilities of Concern

IRWD = Irvine Ranch Water District

LHMP = Local Hazard Mitigation Plan

MWD = Metropolitan Water District

NOAA = National Oceanic and Atmospheric Administration

OCFA = Orange County Fire Authority

OCTA = Orange County Transportation Authority

OCWD = Orange County Water District

OEHHA = California Office of Environmental Health Hazard Assessment

OPC = Ocean Protection Council

OPR = Office of Planning & Research

SCAG = Southern California Association of Governments

USGS = United States Geological Service

UHI = Urban Heat Island

UHIE = Urban Heat Island Effect

UHII = Urban Heat Island Index

UWMP = Urban Water Management Plan

VHFHSZ = Very High Fire Hazard Severity Zones

CHAPTER 1. INTRODUCTION

According to the State of California's Legislative Analyst's Office:

> *"Addressing the widespread impacts of climate change represents a significant challenge for the state. A changing climate presents California with five key climate hazards: (1) higher temperatures and extreme heat events, (2) more severe wildfires, (3) more frequent and intense droughts, (4) flooding due to extreme precipitation events, and (5) coastal flooding and erosion from sea-level rise. These hazards will threaten public health, safety, and well-being—including from life-threatening events, damage to public and private property and infrastructure, and impaired natural resources."*[1]

To address the potential impacts from these hazardous events on the community, the City of Irvine is expanding upon their climate action and hazard mitigation planning efforts to focus on climate change adaptation by understanding the community's vulnerabilities to climate hazards and explore strategies to reduce the vulnerability to projected climate change effects, increase the local capacity to adapt, and build resilience.

This vulnerability assessment and adaptation framework follow goals outlined in the City of Irvine's Safety Element and Local Hazard Mitigation Plan (LHMP) that correspond with climate adaptation planning, specifically:

Safety Element (2015)

"Minimize the danger to life and property from manmade and natural hazards, including fire hazards, flood hazards, non-seismic geologic hazards and air hazards."

City of Irvine Local Hazard Mitigation Plan (2020)

The City's Local Hazard Mitigation Plan (LHMP) was developed to broadly increase resilience in Irvine. The following key goals were developed for the City's LHMP:

- Protect against threats from natural hazards to life, injury, and property damage for Irvine residents and visitors.
- Increase public awareness of potential hazard events.
- Preserve critical services and functions by protecting key facilities and infrastructure.
- Protect natural systems from current and future hazard conditions.
- Coordinate mitigation activities among City departments, neighboring jurisdictions, and with federal agencies, and
- Prepare for long-term change in hazard regimes.

The purpose of this effort is to expand upon the City's previous work to provide more detail regarding community assets and vulnerable population impacted by climate change and lays the groundwork to form policies and programs to support climate resilience.

---

[1] Legislative Analyst's Office (LAO). 2022. Budget and Policy Post. Climate Change Impacts Across California Crosscutting Issues. April 5, 2022. https://lao.ca.gov/Publications/Report/4575. Accessed April 11, 2022.

Regulatory Drivers and Guidance for Climate Adaptation Planning

The report includes a Vulnerability Assessment and Adaptation Framework, which could be incorporated into the City's General Plan Safety Element, in compliance with SB 379, Government Code section 65302(g)(4)[2] and the Office of Planning & Research's (OPR) General Plan Guidelines.

According to SB 379, general plan safety elements must address climate change vulnerability, adaptation strategies, and emergency response strategies. SB 379 states:

> *"This bill would, upon the next revision of a local hazard mitigation plan on or after January 1, 2017, or, if the local jurisdiction has not adopted a local hazard mitigation plan, beginning on or before January 1, 2022, require the safety element to be reviewed and updated as necessary to address climate adaptation and resiliency strategies applicable to that city or county. The bill would require the update to include a set of goals, policies, and objectives based on a vulnerability assessment, identifying the risks that climate change poses to the local jurisdiction and the geographic areas at risk from climate change impacts, and specified information from federal, state, regional, and local agencies."*

As specified in Government Code section 65302(g)(4)(A) vulnerability assessments must identify the risks that climate change poses to the local jurisdiction and the geographic areas at risk from climate change impacts, utilizing federal, state, regional, and local climate vulnerability documentation such as APG 2.0 and the Cal-Adapt climate tool created by the California Energy Commission (CEC) and University of California, Berkeley Geospatial Innovation Facility. Other sources of information include data from local agencies regarding their adaptive capacity and historical data on natural events and hazards. Per Government Code section 65302(g)(4)(B), adaptation policies, goals, and objectives are to be developed based on findings from the vulnerability assessment. Additionally, Government Code section 65302(g)(4)(C) requires jurisdictions to create a set of feasible implementation measures to reduce climate change impacts on new or proposed land uses.

Assembly Bill 162 (2007)

Assembly Bill 162 requires that, upon the next revision of the housing element on or after January 1, 2009, cities and counties address flood hazards and safety in the land use, conservation, safety, and housing elements of their general plans.

Senate Bill 1241 (2012)

Senate Bill 1241 revised the safety element requirements to require all cities and counties whose planning area is within the state responsibility area (SRA) or very high fire hazard severity zones (VHFHSZs), as defined by CAL FIRE, to address and incorporate specific information regarding wildfire hazards and risk, and policies and programs to address and reduce unreasonable risks associated with wildfire. Upon the next revision of the housing element on or after January 1, 2014, the bill requires those cities and counties to review and update the safety element to consider the advice in the Office of Planning and Research's most recent publication of "Fire Hazard Planning, General Plan Technical Advice Series" as well as: information regarding fire hazards, a set of goals, policies, and objectives

[2] SB 379 was enacted to integrate climate change adaptation into California's general plan process.

based on identified fire hazards, and a set of feasible implementation measures designed to carry out those goals, policies, and objectives.

Senate Bill 1035 (2018)

Senate Bill 1035 requires regular updates to the safety element chapter of the general plan. New information regarding flood and fire hazards must be included and climate change adaptation and resilience must be addressed as part of the update. After 2022, safety elements must be updated upon each revision of the housing element or local hazard mitigation plan, but no less often than once every 8 years. Housing element revisions are typically on 4–8-year cycles and LHMP revisions are on 5-year cycles.

Senate Bill 99 (2019)

Senate Bill 99 requires that, upon the next revision of the housing element on or after January 1, 2020, the safety element must be updated to include information identifying residential developments in hazard areas that do not have at least two emergency evacuation routes (i.e., points of ingress and egress).

Senate Bill 747 (2019)

Senate Bill 747 requires that, upon the next revision of a LHMP on or after January 1, 2022, or beginning on or before January 1, 2022, if a local jurisdiction has not adopted a LHMP, the safety element must be reviewed and updated as necessary to identify evacuation routes and their capacity, safety, and viability under a range of emergency scenarios. If a LHMP, emergency operations plan, or other document that fulfills commensurate goals and objectives, a local agency may use that information in the safety element to comply with this requirement by summarizing and incorporating by reference such a plan or other document into the safety element.

Consistent with Government Code 65302(g)(4)(A), the following vulnerability assessment and adaptation framework also takes guidance from:

California's Fourth Climate Assessment (2018)

California Natural Resources Agency (CNRA), OPR, and CEC prepared California's Fourth Climate Assessment in 2018. The Climate Assessment was designed to presents findings in the context of existing climate science, including strategies to adapt to climate impacts and key research gaps needed to spur additional progress on safeguarding California from climate change.

Safeguarding California Plan (2018)

CNRA released an update to the Safeguarding California Plan in 2018, providing a roadmap for State government action to build climate resiliency. The Safeguarding California Plan presents overarching strategies and outlines ongoing actions and cost-effective and achievable next steps to make California more resilient to climate change.

Ocean Protection Council State Sea Level Rise Guidance (2018)

Between 2017 and 2018, the Ocean Protection Council (OPC) released two reports that update their understanding of sea level rise science and best practices for planning and addressing anticipated

impacts. The reports synthesize recent evolving research on sea level rise science and provides higher level recommendations for how to plan for and address sea level rise impacts, notably including a set of projections recommended for use in planning, permitting, investment, and other decisions.[3]

California Adaptation Planning Guide (2020)

The California Office of Emergency Services (Cal OES) released the second version of the Adaptation Planning Guide in 2020 - APG 2.0 - which includes updated guidance, an increased focus on equity and outreach, and best practices. The APG is designed to help local government, regional entities, and climate organizations incorporate best practices and current science and research into their adaptation plans.[4]

LOCAL AND REGIONAL CLIMATE PLANNING

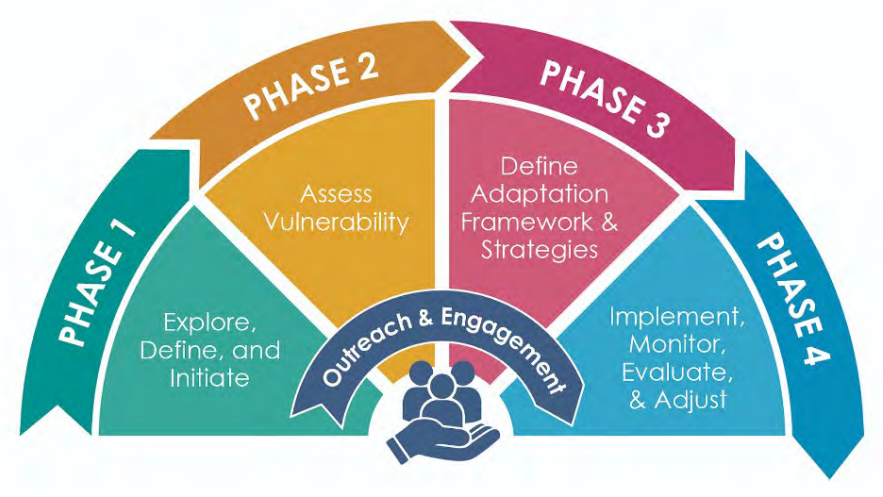
This vulnerability assessment and adaptation framework also draws upon existing efforts in the region to address climate change. These documents include, but are not limited to:

- City of Irvine General Plan Safety Element (Amended 2015)
- City of Irvine Local Hazard Mitigation Plan (2020)
- California Department of Transportation (Caltrans) Climate Change Vulnerability Assessment District 12 Technical Report (2019)
- Southern California Adaptation Planning Guide (APG) (2020)
- Southern California Association of Governments (SCAG) Climate South California Climate Adaptation Framework SB379 Compliance Curriculum for Local Jurisdictions (2021)
- Southern California Association of Governments (SCAG) Climate Risk & Vulnerability Assessment Tool for SB 379 Safety Element Updates
- Office of Planning and Research Defining Vulnerable Communities in the Context of Climate Adaptation (2018)

Methodology and Planning Process

The APG 2.0 provides a four-step process that communities can use to plan for climate change. The APG is designed to be flexible and guide communities in adaptation planning.

[3] Ocean Protection Council (OPC). 2018. State of California Sea-Level Rise Guidance: 2018 Update.
[4] California Governor's Office of Emergency Services (Cal OES). California Adaptation Planning Guide. June 2020.



Source: California Governor's Office of Emergency Services, 2020.

Phases of the Adaptation Planning Process include:

- Phase 1, Explore, Define, and Initiate:

  This phase includes scoping the process and project, such as identifying the potential climate change effects and important physical, social, and natural assets in the community.

- Phase 2, Assess Vulnerability:

  This phase includes analysis of exposure to, sensitivity of, and adaptive capacity to respond to climate effect to determine physical and social vulnerability.

- Phase 3, Define Adaptation Framework and Strategies:

  This phase focuses on creating an adaptation framework and developing adaptation strategies based on the results of the vulnerability assessment. The adaptation strategies are the community's potential response to the vulnerability assessment.

- Phase 4, Implement, Monitor, Evaluate, and Adjust:

  In this phase, the adaptation framework is implemented, consistently monitored, and evaluated, and adjusted based on continual learning, feedback, and/or triggers.

The purpose of this report is to document Step 1 through Step 3. The vulnerability assessment and development of adaptation measures follows the approach recommended by APG 2.0.

The vulnerability assessment identifies projected climate change exposures for the city at mid- to late-century timeframes. In addition to identifying the City's exposure to the effects of climate change, the vulnerability assessment evaluates the sensitivity of key population groups and major community elements to climate change and associated hazards.

CHAPTER 2. COMMUNITY PROFILE

The City of Irvine is located in southern Orange County, adjacent to the cities of Newport Beach, Lake Forest, Tustin, Santa Ana, Laguna Hills, Laguna Woods, and Laguna Beach. Situated at the foothills of the Santa Ana Mountains to the east, the San Joaquin Hills to the west and south, and the low-lying flatlands of central Orange County to the north, the City has a diverse geographic setting. Located approximately five miles south of the City of Santa Ana (Orange County Seat), the City is in a key job center for both Orange County and southern California.[5]

According to the US Census American Community Survey (ACS), in 2019 the City of Irvine had a population of almost 263,000. **Table 2-1: Demographics** displays the demographics in the City of Irvine and Orange County from 2019[6]. As shown in the table, the median household income for City residents is 13 percent greater than that for the region. Even with a greater median household income, compared with the region, a larger percentage of residences rent their home, and more are living below the poverty level. The number of households with a person living with a disability is 37 percent less for Irvine residences as compared to Orange County.

Table 2-1: Demographics

	Irvine	Orange County
Total Population[1]	262,665	3,168,044
Percent of residents that are children (less than 10 years)[2]	10.4%	11.7%
Percent of households that have people 65+ years[1]	20.6%	29.8%
Percentage of households with at least one person living with a disability[1]	12.3%	19.6%
Median age[2]	34.0	36.2
Total households[1]	94,490	1,037,492
Median household income[2]	$113,097	$97,972
Percent of rental households[2]	48.7%	40.7%
Percent of household income below poverty level[1]	13.1%	9.9%

Note: Percentage values rounded to nearest tenth decimal.
Source: US Census Bureau, ACS 2015 - 2019[1], US Census Bureau 2010 Summary File 1, ESRI Forecasts 2021[2]

Vulnerable Communities

Compared to the region, the City's population age distribution skews slightly younger than the region. (**See Table 2-2: Age Distribution Comparison**). This may be partially due to the large educational institution population. 12.6 percent of the population is aged 65 years and older, although 20.6 percent of Irvine households have a resident that is aged 65 years and older.

[5] City of Irvine. 2015a. General Plan Safety Element.
[6] Data for vulnerable populations was extracted from a combination of US Census Bureau American Community Survey 2015 – 2019 estimates and ESRI's Business Analyst 2021 forecasts. Data sources have been noted in each demographic table.

Table 2-2: Age Distribution Comparison

	Irvine	Orange County
Under 5	5.1%	5.7%
5 - 14	13.0%	12.4%
15 - 24	15.7%	12.9%
25 - 34	17.0%	15.1%
35 - 44	14.5%	13.3%
45 - 54	12.7%	12.7%
55 - 64	11.4%	12.3%
Over 65	12.6%	15.6%

Note: Percentage values rounded to nearest tenth decimal.
Source: US Census Bureau 2010 Summary File 1, ESRI Forecasts 2021.

In California, those persons of retirement age (i.e., 65 years and older) are expected to grow more than twice as fast as the total population and this growth will vary by region. This means that people are living longer, and the number of older persons is increasing. This trend is also evident in Irvine, where the percent of the population aged 65 years and older grew by 43 percent from 2010 to 2021.

The racial and ethnic composition of a population may affect housing needs because of cultural preferences associated with different racial/ethnic groups. Cultural influences may reflect preference for a specific type of housing and household structure. Research has shown that number and share of Americans living in multigenerational family households have continued to rise. In 2016, a record 64 million people, or 20 percent of the U.S. population, lived with multiple generations under one roof. The Asian and Hispanic populations are more likely than whites to live in multigenerational family households.[7]

Table 2-3: Race and Ethnicity shows that, according to the 2015-2019 ACS, the ethnic distribution of the Irvine's population was predominantly White, not Hispanic or Latino, and Asian Alone with each group representing approximately 44 percent of the population. Approximately 11.6 percent of the city's population was of Hispanic origin. While Orange County has larger percentage of the population identifying as White, not Hispanic or Latino (55.6 percent), it also has a much larger share of the population identifying as Hispanic or Latino origin (34.2 percent).

Table 2-3: Race and Ethnicity

	Irvine	Orange County
White Alone (Not Hispanic or Latino)	44.7%	55.6%
Black Alone (Not Hispanic or Latino)	2.2%	1.9%
American Indian Alone (Not Hispanic or Latino)	0.2%	0.6%
Asian Alone (Not Hispanic or Latino)	43.6%	21.9%
Pacific Islander Alone (Not Hispanic or Latino)	0.2%	0.3%
Some Other Race Alone (Not Hispanic or Latino)	3.1%	14.8%
Two or More Races (Not Hispanic or Latino)	6.0%	4.9%
Hispanic Origin (Any Race)	11.6%	34.2%

Note: Percentage values rounded to nearest tenth decimal.

Source: US Census Bureau 2010 Summary File 1, ESRI Forecasts 2021.

[7] Cohn, D'Vera and Jeffrey S. Passel. 2018. *A record 64 million Americans live in multigenerational households.* Pew Research Center. April 5, 2018. https://www.pewresearch.org/fact-tank/2018/04/05/a-record-64-million-americans-live-in-multigenerational-households. Accessed April 28, 2022.

The Irvine community is diverse with multiple languages spoken. As shown in **Table 2-4: English Proficiency and Languages Spoken at Home Among Residents 5 Years and Older - Irvine**, the majority of residents aged 5 years and older are fluent in English. However, over 16,000 residents or about 6.5 percent of the population are not fluent in English. In response, the City implements programs intended to communicate information to the diverse community of residents and workers with different backgrounds. The City of Irvine's website offers translation for 81 languages to provide information for the diverse community members.[8] The Irvine Police Department's Policy 345 provides guidance to members when communicating with individuals with limited English proficiency (LEP) to reasonably ensure that LEP individuals have meaningful access to law enforcement services, programs, and activities, while not imposing undue burdens on its members.[9]

Table 2-4: English Proficiency and Languages Spoken at Home Among Residents 5 Years and Older - Irvine

	Number of Speakers	Percent Not Fluent in English
English Only	122,128	-
Spanish	15,502	5.9%
Indo-European Languages	27,602	9.7%
Asian and Pacific Island Languages	74,197	15.9%
Other Languages	7,094	13.2%

Note: Percentage values rounded to nearest tenth decimal.

Source: US Census Bureau, American Community Survey 2015 - 2019, ESRI 2022

2.1 VULNERABLE POPULATIONS

Climate change disproportionately affects those with existing disadvantages. Low-income communities and communities of color often live in areas with conditions that expose them to more severe hazards, such as higher temperatures and worse air quality. These communities also have fewer financial resources to adapt to these hazards. For instance, low-income populations are already disproportionately burdened by energy bills and may reduce air conditioning usage out of concerns about cost. People with chronic medical conditions are often more physiologically susceptible to negative health impacts from extreme heat and poor air quality, and those with mobility issues are particularly at risk. Many of the above risk factors are often present in older adults, who are more likely to have a limited income, chronic health conditions, and mobility limitations, and are more likely to experience social isolation.[10]

Factors such as age, physical and mental condition, socioeconomic status, access to key services, and other factors affect the ability of people to prepare for and protect themselves and their property from a climate-related event. Even though hazard events may impact all parts of the city with equal severity, individuals may experience the effects differently.

[8] City of Irvine. 2022a. Home Page. https://www.cityofirvine.org/. Accessed May 3, 2022.

[9] City or Irvine. n.d. Policy 345. Limited English Proficiency Services.

[10] Hall, Alex, Neil Berg, Katharine Reich. (University of California, Los Angeles). 2018. Los Angeles Summary Report. California's Fourth Climate Change Assessment. Publication number: SUM-CCCA4-2018-007.

Disadvantaged Communities

According to the California Office of Environmental Health Hazard Assessment (OEHHA) a community is considered disadvantaged based on its pollution burden and sensitive populations. OEHHA provides the CalEnviroScreen tool to evaluate and map disadvantaged communities. The dataset helps identify California communities that are most affected by specific sources of pollution, and where people are often especially vulnerable to pollution's effects. The dataset uses environmental, health, and socioeconomic information to produce scores for every census tract in the state that are mapped using a scale based on the pollution burden of the location. The higher the percentage, the greater the burden and the higher likelihood of environmental justice concerns.

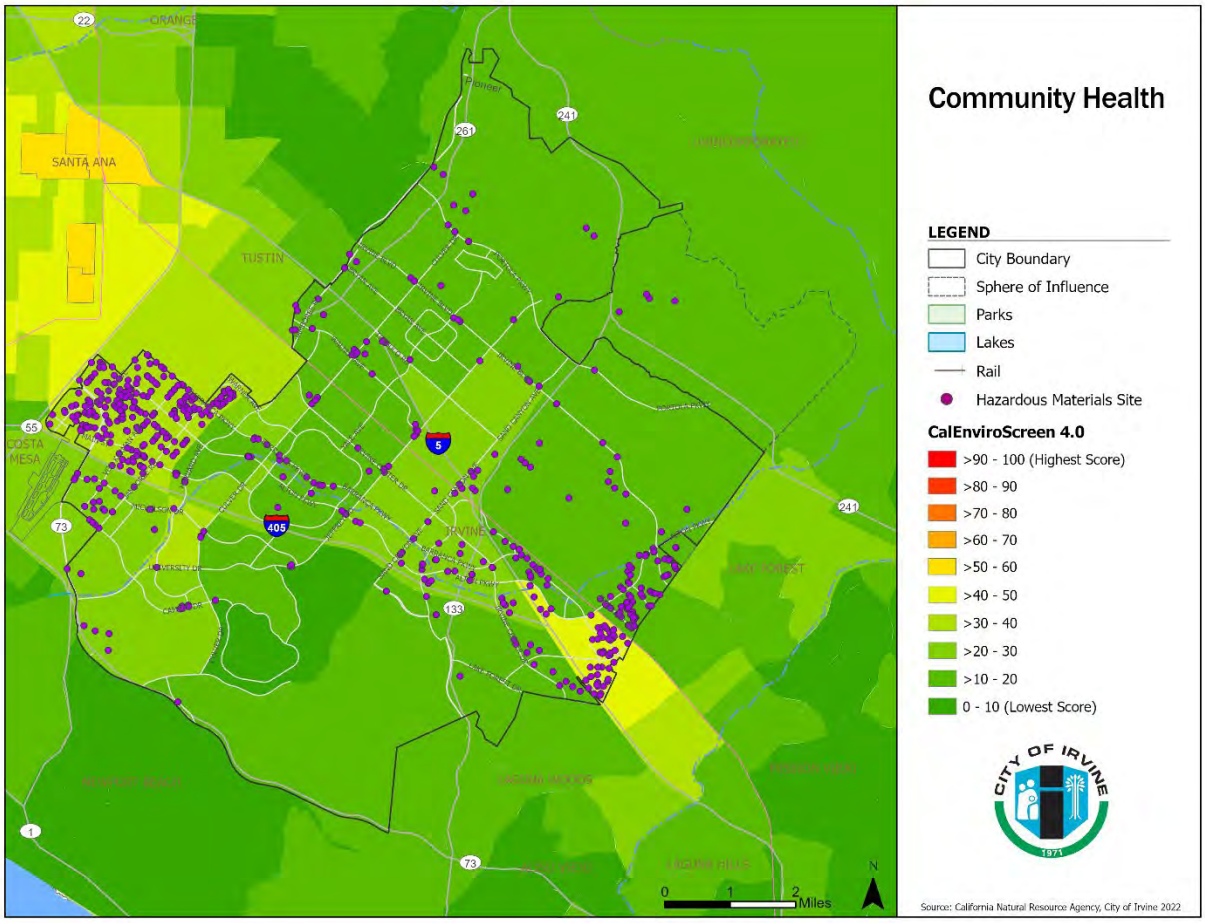
CalEnviroScreen calculates scores for two groups of indicators: Pollution Burden (e.g., PM2.5 concentrations, diesel PM emissions, adjacency to solid waste sites) and Population Characteristics (e.g., asthma emergency department visits, linguistic isolation, low-income households). Figure 2-1: CalEnviroScreen 4.0 shows the combined Pollution Burden scores, which is made up of indicators from the Exposures and Environmental Effects components of the CalEnviroScreen model. Pollution Burden represents the potential exposures to pollutants and the adverse environmental conditions caused by pollution. Compared to all census tracts in the state, those tracts in Irvine are all in the bottom half, meaning the population of Irvine has lower pollution burden compared to other areas in the state. As a result, OEHHA does not identify any census tract in the City as containing disadvantaged communities.

While the City does not have state-defined disadvantaged communities, the City still has populations that are vulnerable to climate hazard events. Each section covering a different climate hazard within the Vulnerability Assessment contains an analysis of social sensitivity using the following criteria to assess the potential impact to vulnerable populations:

- Disability status: Persons with disabilities may often have reduced mobility and experience difficulties living independently. As a result, they may have little or no ability to prepare for and mitigate hazard conditions without assistance from others. An estimated 12.3 percent of Irvine households contain at least one person with a disability.
- Income levels: Lower-income households are less likely to have the financial resources to implement mitigation activities on their residences. They may also struggle with having the necessary time to find and access educational resources discussing hazard mitigation strategies. Furthermore, lower-income households are less likely to be able to afford moving to areas that are safer or less at risk of being impacted by a hazard. The national poverty limit standard for the U.S. for a four-person family is an income of $26,200 or less. In Irvine, between 2015 and 2019, an estimated 13.1 percent of households had an income that was considered below the poverty level. An estimated, 2.6 percent of households received food stamps or qualified for the Supplemental Nutrition Assistance Program (SNAP).[11]
- Seniors (individuals at least 65 years of age): Seniors are more likely to have reduced mobility, physical and/or mental disabilities, and lower income levels, all of which may decrease their ability to prepare for and mitigate a hazard event.

[11] United States Census Bureau (US Census). 2010. 2010 Summary File 1, ESRI Forecasts 2021. Accessed May 5, 2022.

Figure 2-1: CalEnviroScreen 4.0



Homeless Population

The homeless are highly susceptible to impacts from direct and indirect climate effects including extreme heat events, air pollution from wildfires, and precipitation-driven or coastal flooding. Throughout Orange County, homelessness has become a substantial issue. Previous factors contributing to the rise in people experiencing homelessness included the general lack of housing affordable to lower-income people, increases in the number of people whose incomes fall below the poverty level, reductions in public subsidies, the de-institutionalization of those with mental illness, and increasing substance abuse issues. The increase in the number of layoffs and the loss of employment during the COVID-19 pandemic have likely contributed to an increase in this population because these effects resulted in the inability to afford housing. The impact of the COVID-19 on homelessness in Orange County will likely continue when eviction moratoriums are lifted, which could result in a further increase in people experiencing homelessness. According to the SCAG pre-certified data, 130 individuals are experiencing homelessness in Irvine, with three individuals (2 percent) who are sheltered and 127 individuals (or 98 percent) who are unsheltered.[12]

[12] City of Irvine. 2021a. 6th Cycle 2021-2029 Housing Element – Second Draft. November 19, 2021.

In Orange County, homelessness is addressed regionally by the Orange County Continuum of Care (COC), an umbrella organization that brings together government agencies and community-based nonprofit organizations in a coordinated effort to meet the urgent needs of people experiencing homelessness or that are in imminent danger of experiencing homelessness. The County of Orange Health Care Agency is the collaborative applicant, and 2-1-1 OC is the Homeless Management Information System lead agency.

Both Irvine and Orange County currently have a number of existing programs to assist individuals experiencing homelessness, including shelters, provided by Orange County.

2.2 MAJOR COMMUNITY ELEMENTS

The City provides the educational, employment, recreational, and cultural opportunities of a large city and, since its incorporation in 1971, has grown to include strong, diverse residential and business communities. At 50 years old, Irvine is a relatively young city; however, it is continuing its history of master planning through redevelopment of the former El Toro Marine Corps Air Station into the Great Park Neighborhoods and through the redevelopment of underutilized commercial and industrial uses into much needed housing.[13]

The identification of assets potentially affected by climate change related events follows FEMA's LHMP Guidance categorizing community elements as follows:

Essential Services

Fire and Emergency Services

The City contracts with the Orange County Fire Authority (OCFA) to provide fire protection and emergency services in the community. OCFA is a regional fire service agency that serves 23 Orange County cities and all unincorporated areas and protects over 1.6 million residents from its 71 fire stations located throughout the county.[14]

There are eleven (11) strategically located fire stations in the City of Irvine, which allow firefighters and paramedics to provide timely responses to emergencies and to efficiently respond to volume demand.[15]

Police Services

The Irvine Police Department is comprised of six (6) distinct Divisions which operate under the direction and management of the Chief of Police. Each Division contains unique and specialized Bureaus, Units, and Sections responsible for overseeing and maintaining the programs of the Department. The Divisions are as follows:

- Administration, including the Office of the Chief of Police, public information officer and support services.
- Business Services, including budget/grant office, communications (9-1-1 dispatch), technology support, regulatory affairs, technical services, property, and custody.
- Operations, including patrol and criminal investigations.

[13] City of Irvine. 2022a. https://www.cityofirvine.org/. Accessed May 3, 2022.
[14] City of Irvine. 2022e. Public Safety. https://www.cityofirvine.org/irvine-gives/public-safety. Accessed May 2, 2022.
[15] Orange County Fire Authority (OCFA). 2022b. https://ocfa.org/AboutUs/FireStations.aspx. Accessed May 2, 2022.

- Support Services, including emergency management, traffic/special events, and community outreach.
- Office of Professional Development, including Academy and POST training section, firearms and range section and recruitment, personnel, and hiring section.
- Office of Professional Standards, including Internal Affairs, risk management. and worker's compensation.[16]

Transportation Systems

The City of Irvine is served by multiple modes of transportation including bus, light rail, train, biking, and walking. The Street & Right-of-Way Maintenance Division maintains 470 centerline miles of roadway, over 1,155 linear miles of curb and gutter, 900 miles of sidewalk, approximately 5,600 catch basins well as access ramps, traffic signs, pavement markings, and street striping (Irvine 2022f). Partners like the Orange County Transportation Authority (OCTA), Amtrak, iShuttle, Spectrumotion all work together to provide the transportation network in the City of Irvine.

Active Transportation Options

- Biking. The City of Irvine provides a system of 113.24 miles of off-street bikeway trails and 286.42 lane miles of on-street bikeways.[17]
- The iShuttle, operated and managed by the OCTA, serves residents, employees and employers in the Irvine Spectrum Area and the Irvine Business Complex by taking commuters and residents to and from work and home.
- ACCESS is OCTA's shared-ride service for people who are unable to use the regular, fixed-route bus service because of functional limitations caused by a disability. These passengers must be certified by OCTA to use the ACCESS system by meeting the Americans with Disabilities Act (ADA) eligibility criteria.
- The Irvine Station, located in the Spectrum area of the City, is a growing transportation hub in South Orange County.
- The Irvine Transportation Network is a "one-stop shop" for transportation information for anyone living in, working in, or traveling through the Irvine Business Complex (IBC).
- TRIPS is a transportation service available to Irvine residents (18 and older) who are unable to drive due to permanent physical and/ or cognitive disability.
- Amtrak is an intercity rail system throughout the nation with several stops throughout Orange County and Southern California.
- Metrolink is a commuter rail system throughout Southern California linking communities to employment and activity centers. It provides reliable transportation and mobility for the entire region while creating less congested roadways and more livable communities.
- Spectrumotion helps Irvine Spectrum employees find the best possible way to commute to work.
- Mobility Guide: The City of Irvine offers a variety of transportation options for seniors and special needs population.

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[16] City of Irvine. 2022b. Police. https://www.cityofirvine.org/ipd-divisions-bureaus-units. Accessed May 2, 2022.
[17] Transportation. https://www.cityofirvine.org/work/transportation. Accessed May 2, 2022.

Lifeline Utility systems

Infrastructure plays a vital role in mitigating the effects of hazard events. When infrastructure fails, it can exacerbate the extent of certain hazards or create complications for rescue workers trying to reach victims. For example, fallen utility poles, because of high winds or seismic activity, can obstruct roadways and prevent emergency vehicles from reaching affected areas. The following are brief descriptions of major infrastructure in the city that may be affected by climate-related hazards:

Electricity

Irvine receives its electrical supply from Southern California Edison. There are seven substations located within the City connecting 220kV and 66 kV powerlines that run both east to west and north to south. These lines bring power to Irvine and the surrounding cities and provide connection to other regional power sources as well.13 These connections help Irvine access auxiliary electricity sources, should any of its immediate infrastructure fail. However, a larger and more regional failure of the power grid would likely disrupt power transmission to Irvine for an extended time period until power can be restored.[18]

Water Supply

Approximately 35 percent of Irvine's drinking water is purchased from the Metropolitan Water District (MWD) of Southern California. This imported water comes from the Colorado River via the Colorado River Aqueduct and from Northern California via the State Water Project. The remaining 65 percent of Irvine's drinking water supply comes from Irvine Ranch Water District's (IRWD) local groundwater wells in the Orange County Groundwater Basin, managed by the Orange County Water District (OCWD). These wells range in depth from 400 to 2,000 feet and extract high quality water. The blend of imported and groundwater vary according to the time of year and the customer's geographical location within the District.[19]

Wastewater Capacity

The City of Irvine's wastewater conveyance and treatment is provided by IRWD. IRWD conveys all of sewage from the City of Irvine to their Michelson Water Recycle Plant (MWRP) and Los Alisos Water Recycle Plant except for the small area known as the Irvine Business Complex, which is conveyed to Orange County Sanitary District. The Irvine Business Complex is roughly bounded by San Diego Creek to the east, CA-78 to the south, Warner Ave. the north, and the City of Irvine's boundary to the west. IRWD is actively planning to address conveyance and treatment issues over the planning period and has laid out a progressive and comprehensive plan.[20]

Stormwater Management

The Public Drainage Program is responsible for the maintenance and upkeep of City public drainage facilities. The Program's responsibilities include the annual inspection and cleaning of all City storm drains and catch basins, erosion control of slopes along City open channels and other City drainage facilities, cleaning of debris and clearance of drainage systems after storm events and the prevention of standing water issues/concerns in City right-of-way areas. The Clean Water Program has two goals: maintain water quality and protect beaches, lagoons and creeks from illicit discharges, sewage spills and other pollutants.[21]

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[18] City of Irvine. 2020. Local Hazard Mitigation Plan. October.
[19] City of Irvine. 2022. https://www.cityofirvine.org/community-development/water-quality. Accessed May 2, 2022.
[20] City of Irvine. 2021a. 6th Cycle 2021-2029 Housing Element – Second Draft. November 19, 2021.
[21] City of Irvine. 2022. https://www.cityofirvine.org/public-works-department/public-drainage. Accessed May 2, 2022.

Waste Management

Waste Management of Orange County provides all residential/multi-family refuse, recycling, and green waste service as well as bulky item and Christmas tree collection.

Hazardous Materials

The threat that hazardous materials pose to human health depends on the type of material, frequency, and duration of exposure, and whether chemicals are inhaled, penetrate skin, or are ingested, among other factors. Exposure to hazardous materials can result in short- or long-term effects, including major damage to organs and systems in the body, or death. Hazardous waste is any material with properties that make it dangerous or potentially harmful to human health or the environment. Hazardous materials can also cause health risks if they contaminate soil, groundwater, and air, potentially posing a threat long after the initial release.[22]

Hazardous materials can cause damage to physical assets in Irvine if they are released into the environment. Corrosive hazardous materials can damage the exteriors of any buildings or structures designated as a critical facility or facility of concern by the city. Flammable hazardous materials can potentially start fires and may cause any nearby critical facilities to flashover. Sites that are closer to the origin for the release of the hazardous materials are more at threat than those that are further away. Figure 2-2: Critical Facilities and Hazardous Materials Sites shows hazardous materials sites identified in the city.

Economic Elements

Irvine Spectrum

The Irvine Spectrum is one of the City of Irvine's two major business centers. It is comprised of 5,000 acres, 38 million square feet of commercial space, and 3,500 companies that employ nearly 80,000 people. The City's major retail center, the Irvine Spectrum Center, is comprised of 1.2 million square feet and more than 130 stores, restaurants, and entertainment venues.11 This location is major attraction in the City due to its convenient location between I-5 and I-405 and draws a significant amount of visitors and employees from outside the City.

Irvine Business Complex

The Irvine Business Complex is a 2,800-acre area in the western part of the City containing industrial, commercial office, and residential uses. The zoning in this part of the City allows for over 15,000 base residential units, non-residential uses (commercial, office, industrial), and hospitality uses. This area of the City is a major economic hub as a significant of amount of people enter the City every day to work in the businesses within this complex.[23]

Natural Resource Areas

The City features 20 developed community park sites totaling over 387 acres and six special facilities totaling 55.1 acres. In total, 39 public neighborhood parks and vista points totaling 178.6 acres and many private neighborhood parks are in Irvine. Moreover, the City has off-street bicycle trails totaling over 63 miles. In addition to parks, the City is in a league of its own when it comes to trails and preserved open spaces.

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[22] City of Irvine. 2020. Local Hazard Mitigation Plan. October.
[23] City of Irvine. 2020. Local Hazard Mitigation Plan. October.

The Jeffrey Open Space Trail, Bommer Canyon, and Quail Hill are a few of the treasured areas that have been preserved in connection with Irvine's historic Open Space Initiative and are examples of the extraordinary recreational opportunities available to residents. Among these community park facilities, the Orange County Great Park, currently being developed, will consist of over 1,300 acres of parkland, and will serve the residents of Irvine and the region with significant amenities, open space, and passive and active recreational facilities and enhance the living environment surrounding residences in the area.[24]

Institutional Uses

Several higher education institutions are in the City, including the University of California, Irvine; Concordia University; Irvine Valley College; University of Southern California (Orange County Center); and campuses of University of La Verne and Pepperdine University.[25] Combined enrollment for these schools is over 41,000 students, which can greatly increase the City's daytime population, impact roadways, and community services.[26]

CRITICAL FACILITIES AND FACILITIES OF CONCERN

Essential Facilities are further categorized as Critical Facilities (CF) and Facilities of Concern (FOC) and consist of properties and structures that play important roles in government operations and the services they provide to the community. Examples of CFs and COFs include local government offices and yards, community centers, public safety buildings like police and fire stations, schools, and any other properties a city has deemed essential for its operations. CFs may also serve dual roles if a city designates them as points of public assembly during an emergency. CFs are often owned by the City, but many are also owned and operated privately, such as some utilities and telecommunication infrastructure.

The Hazard Mitigation Planning Committee for the 2020 LHMP Update identified 213 CFs or FOC in Irvine that fall into 6 different categories based on their function or characteristics. Table 2.5: Critical Facilities and Facilities of Concern shows the number of CFs and FOC in each category, the total estimated value of the facilities in each category, and examples of the facilities in each. Appendix D of the LHMP has a complete list of the CFs and FOC. Figure 2-2: Critical Facilities and Hazardous Materials Sites shows the locations of CFs and FOC (and hazardous materials sites) in Irvine that were mapped. Some facilities were not mapped due to security concerns.

The potential loss value is the total insured value of the CFs that fall within the hazard zone. It is intended to provide the ballpark estimate of the cost of replacement if the property is completely or severely damaged. Actual costs of repair could be smaller or larger than the provided estimate. The data was provided by the City's Property Schedule and therefore, information for facilities not owned by the City are not shown (e.g., bridges, private buildings). In some instances, replacement cost information was not made available. Where this occurs "N/A" has been used within the table.

[24] City of Irvine, 6th Cycle 2021-2029 Housing Element – Second Draft. November 19, 2021.
[25] City of Irvine. 2021a. 6th Cycle 2021-2029 Housing Element – Second Draft. November 19, 2021.
[26] City of Irvine. 2020. Local Hazard Mitigation Plan. October.

Table 2.5: Critical Facilities and Facilities of Concern

Category	Number of Facilities		Examples	Potential Loss*,[27]
	Critical	Concern		
City Vital Operations	4	1	City Hall, Police Station, Operations Support	$99,520,918
City Community Centers	12	0	Community Centers	$32,171,675
City Resident Services	4	5	Senior Centers, Animal Shelter, Daycare, Other Community Facilities	$13,173,434
City Recreation Support	0	21	Parks, Recreation Amenities, Sports Complexes, and support facilities	$56,969,379
Bridges	120	0	Overpasses and underpasses	$166,687,247
Schools	0	46	Irvine Unified School District and Tustin Unified School District Facilities	N/A
Total	**140**	**73**		**$368,522,653**

* Based on the City of Irvine insured replacement values

City of Irvine Adaptive Capacity to Climate-Related Hazards

The City of Irvine has implemented programs or partnered with external agencies to prepare, respond, and help the community recover from manmade and natural hazards, including those that are climate related. The following programs improve the overall adaptive capacity of the City:

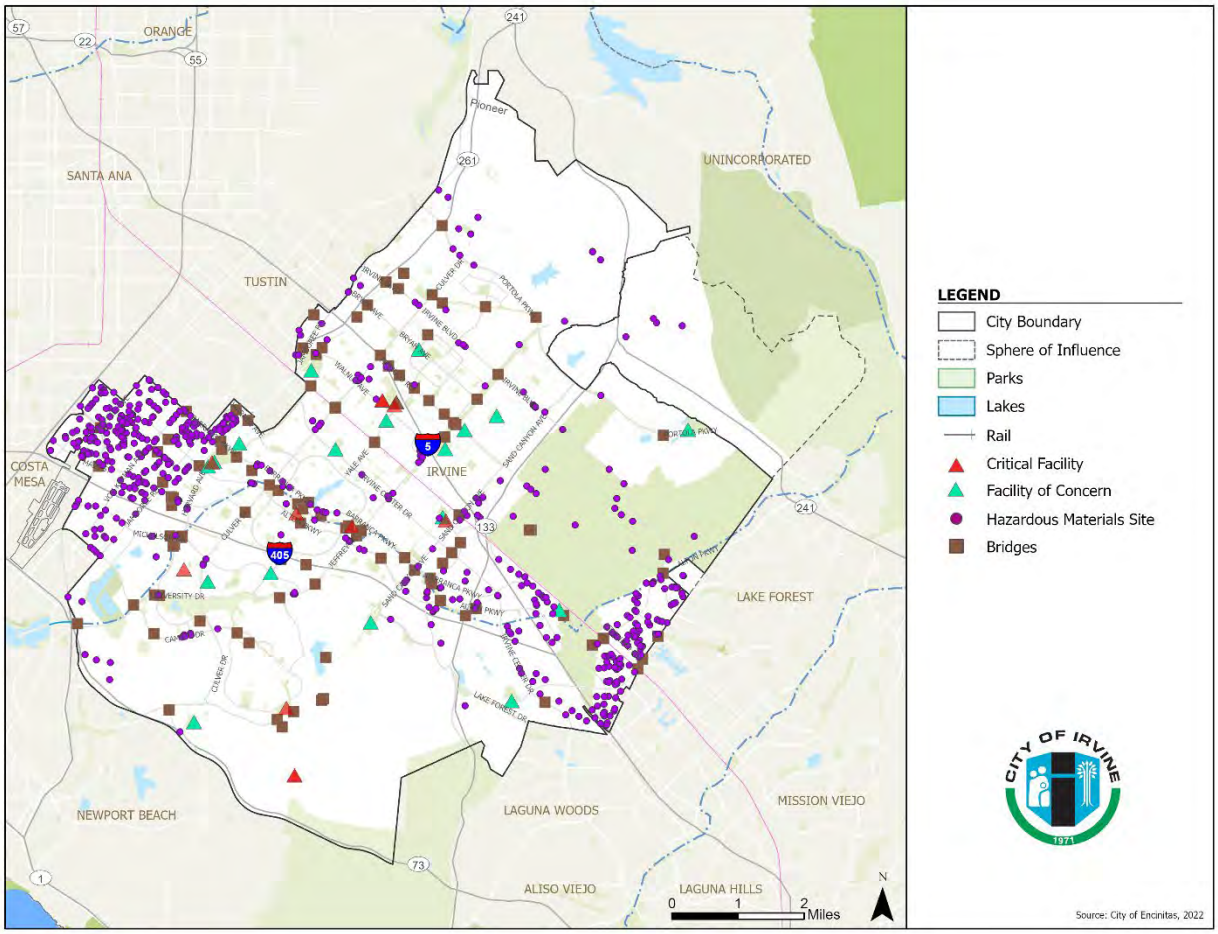
Prepare Irvine

The Irvine Police Department Office of Emergency Management mobilizes local first responders for hazardous events but recognizes that they cannot reach everyone in our City right away. In times of disaster, a trained and informed public is better prepared to protect themselves, their families, their workplace, and their neighbors.[28]

[27] City of Irvine. October 2019. 2018-2019 Statement of Values

[28] City of Irvine. 2022. Prepare Irvine. https://www.cityofirvine.org/prepare. Accessed May 3, 2022.

Figure 2-2: Critical Facilities and Hazardous Materials Sites



AlertOC

AlertOC is a mass notification system designed to keep Orange County informed of emergencies that may require immediate lifesaving actions. Time-sensitive voice and text messages from the City of Irvine will be sent to city residents and workers warning of hazardous events, including wildfire.[29]

AB 38

As of July 1, 2021, a seller of a property that is located in a high or very high fire hazard severity zone as identified by the Director of Forestry and Fire Protection must provide to the buyer documentation stating that the property is in compliance with local vegetation management ordinances.[30]

[29] AlertOC. 2022. https://member.everbridge.net/453003085613900/login. Accessed May 3, 2022.
[30] State of California. 2019. AB38, Wood. Fire safety: low-cost retrofits: regional capacity review: wildfire mitigation. https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201920200AB38. Accessed May 3, 2022.

CERT

Irvine's Community Emergency Response Team (CERT) is a program designed to prepare citizens to help themselves, their families, and their neighbors in the event of a catastrophic disaster. Because professional emergency service personnel will not be able to help everyone immediately, CERT training can make a difference in saving lives and protecting property in our community. The training includes the basic skills important in disaster response, such as disaster medical operations, fire suppression, and light search and rescue.[31]

IDEC

The Irvine Disaster Emergency Communications (IDEC) is an organized team of over 60 experienced, trained and dedicated amateur radio operators (Hams). Members routinely volunteer their time and extensive radio communication skills to augment normal methods of communications used by the Irvine Police Department in times of emergencies or major disasters.

Translation Services

The City of Irvine's website offers translation for 81 languages to provide information for the diverse community members.[32]

[31] City of Irvine. 2022. https://www.cityofirvine.org/irvine-gives/public-safety. Accessed May 2, 2022.
[32] City of Irvine. 2022. https://www.cityofirvine.org/. Accessed May 3, 2022.

CHAPTER 3. VULNERABILITY ASSESSMENT

Addressing the widespread impacts of climate change represents a significant challenge for the state. A changing climate presents California with five key climate hazards: (1) higher temperatures and extreme heat events, (2) more severe wildfires, (3) more frequent and intense droughts, (4) flooding due to extreme precipitation events, and (5) coastal flooding and erosion from sea-level rise. These hazards will threaten public health, safety, and well-being—including from life-threatening events, damage to public and private property and infrastructure, and impaired natural resources.[33]

Follow state guidance, this report provides an assessment of the city's vulnerabilities to climate change. It identifies and describes the climate hazards and other climate effects that may affect the city in the future. The vulnerability assessment follows the process outlined in Phase 2 of APG 2.0 and is composed of the following three steps:

- Exposure: The purpose of this step is to understand is to characterize the city's exposure to current and projected climate hazards. Existing hazards that can be worsened by the effects of climate change are identified and described, based on historical data, including the City's LHMP. Climate data are used to develop projections for how existing hazards are expected to change by mid- and late century from future climate change.

- Sensitivity: This step will characterize potential future climate impacts to community populations and assets. Using historical data, research from regional and state reports on climate impacts, this step explores how sensitive vulnerable populations and assets may be affected by the projected impacts of climate change hazards.

- Adaptive Capacity: The City and its supporting agencies, and countywide organizations have already taken steps to build resilience and protect sensitive populations and assets from hazards. Thus, the purpose of this step is to characterize to characterize Irvine's current capability to cope with the projected impacts from climate hazards to vulnerable populations and assets. The adaptive capacity of the City to adapt to each of the identified climate impacts is determined through a review of existing plans and programs.

3.1 EXISTING HAZARDS

The LHMP provides a comprehensive understanding of hazards, including those worsened by climate change. It evaluates emerging climate risks, sea-level rise, coastal storms, erosion, floods, landslides, wildfires, extreme heat, and drought/water supply hazards. Three major existing hazards that are anticipated to become more frequent or severe because of climate change are wildfires, landslides, and flooding.

[33] California Legislative Analyst's Office (LAO). 2022. Budget and Policy Post. Climate Change Impacts Across California Crosscutting Issues. April 5, 2022. https://lao.ca.gov/Publications/Report/4575. Accessed April 11, 2022.

3.1.1 FLOODING

Historical documents show that damaging floods occurred in the Los Angeles Basin in 1884, 1916, 1927, 1937, 1938, 1969, and 1997. The last one included the inundation of the lowlands in the Santiago Hills, EL Toro, San Joaquin Marsh, and Upper Newport Bay areas. It is expected that future developments will be protected from 100-year floods by the continuation of measures which alleviate flood hazards, such as channels, retention basins, and drains.[34]

3.1.2 WILDFIRES AND SMOKE

The topography of the foothills of the Santa Ana Mountains and San Joaquin Hills in Irvine is extremely conducive to wildfires. The community is bordered by natural, undeveloped hillsides/ mountains to the northeast and open space areas to the southwest. In between these two areas is most the City's developed areas. Over the past two decades, Irvine has been impacted by fires in or adjacent to the city such as the Santiago Fire in 2007, Freeway Complex Fire in 2008, the Canyon Fire in 2017, and the Silverado Fire in 2020.

3.1.3 GEOLOGIC AND SEISMIC HAZARDS

Liquefaction occurs when seismic energy shakes an area with low-density, fine grain soil, like sand or silt, is also saturated with water. When the shaking motion reaches these areas, it can cause these loosely packed soils to suddenly compact, making the waterlogged sediment behave more like a liquid than solid ground. During liquefaction events, the liquified soil can lose its stability which can cause damage to buildings and infrastructure built upon it. In severe cases, buildings may completely collapse. Pipelines or other utility lines running through a liquefaction zone can be breached during an event, potentially leading to flooding or release of hazardous materials.

Although earthquakes are not explicitly a climate hazard, climate change could potentially cause them to become more destructive because of an increased risk of liquefaction—the process by which semi-saturated or saturated sediment loses structural competency under intense shaking.[35] Rising groundwater associated with sea level rise can increase the amount of saturated sediment and the risk of liquefaction.

Landslides occur when earth on slopes become destabilized, typically after heavy rains, when the precipitation saturates the soil and makes it less stable, or when significant erosion from rainfall destabilizes the ground. Slopes that have recently burned face a greater risk from rain-induced landslides, as the fires burn up many of the trees, brush, and other vegetation that help stabilize the earth. Earthquakes may also be a source of landslides as the shaking can destabilize already loosened soils.

Major landslides have occurred throughout the Southern California region. For example, landslides were set off by the 1971 San Fernando and 1994 Northridge earthquakes. As a master planned community, the City of Irvine has taken numerous steps to mitigate landslide hazards as part of the development process. As a result, the City has not experienced significant landslide events.[36]

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[34] City of Irvine. 2015a. General Plan Safety Element.
[35] USGS. (n.d.-b). *Natural hazards: What is liquefaction?* https://www.usgs.gov/faqs/what-liquefaction. Accessed March 2022.
[36] City of Irvine. 2020. Local Hazard Mitigation Plan. October.

3.2 ANALYZING CLIMATE CHANGE

Climate change effects are categorized as direct or indirect. Direct effects are caused by the initial impacts of increased greenhouse gas (GHG) emissions, while indirect effects occur because of the direct effect(s). The direct climate change effects include changes in temperature and precipitation. The indirect effects, which can occur because of isolated changes or a combination of changes in the direct effects (e.g., temperature or temperature plus precipitation), include extreme heat events drought, wildfires, onshore flooding associated with large precipitation events, landslides, and coastal flooding and inundation resulting from sea level rise.

To assess the potential direct and indirect effects from climate change, APG 2.0 recommends using Cal-Adapt, a global climate simulation model data. Cal-Adapt addresses uncertainty surrounding potential GHG emissions with the use of Representative Concentration Pathways. The RCPs in this vulnerability assessment rely upon two future emissions scenarios: RCP 4.5 and RCP 8.5. RCP 4.5 represents a medium emissions scenario of GHG emissions and assumes emissions will rise, then even out near the middle of the century, and decrease to below 1990 levels by the end of the 21st century. RCP 8.5 is a high emissions scenario where GHG emissions continue to increase through the end of the 21st century.[37]

Cal-Adapt also includes ten global climate models, downscaled to local and regional resolution using the Localized Constructed Analogs statistical technique. Four of these models were selected by California's Climate Action Team Research Working Group as priority models for research contributing to California's Fourth Climate Change Assessment2. Projected future climate from these four models can be described as producing:

- A warm/dry simulation (HadGEM2-ES),
- A cooler/wetter simulation (CNRM-CM5),
- An average simulation (CanESM2), and
- The model simulation that is most unlike the first three for the best coverage of different possibilities (MIROC5).

3.2.1 DIRECT EFFECTS OF CLIMATE CHANGE

There are two primary direct effects of climate change: changes to temperature and changes to precipitation. These changes include increases or decreases in temperature and precipitation. They also include changes in the frequency, duration, and intensity of changes to these patterns.

CHANGES IN TEMPERATURE

Observations over the past century indicate that temperature has increased across southern California. Based on 1896-2015 temperature records for the California South Coast NOAA Climate Division, which encompasses the City of Irvine, California's Fourth Climate Change assessment for the Los Angeles region reports significant trends in annual average, maximum, and minimum temperature around 0.16°C per decade.

[37] Bedsworth et al. 2018. Statewide Summary Report. California's Fourth Climate Change Assessment. Publication number: SUMCCCA4-2018-013.

Every month has experienced significant positive trends in monthly average, maximum, and minimum temperature. Monthly average and minimum temperatures have increased the most in September and monthly maximum temperatures have increased the most in January, with each trend exceeding 0.2°C per decade.[38]

According to Cal-Adapt, the historic, observed (1961-1990) annual average maximum temperature for the Irvine was 72.0°F, and the historic, observed annual average minimum temperature was 50.5°F. As shown in **Table 3-1: Change in Annual Average Temperature**, both are projected to increase by mid-century and further increase by the end of the century. The annual average maximum temperature in the city is projected to be 75.7°F by mid-century and 76.4°F by the end of the century under the medium emissions scenario. Under the high emissions scenario, the annual average maximum temperature in the study area is projected to be 76.6°F by mid-century and 79.6°F by the end of the century. This equates to an increase in temperatures of 4.4°F to 7.6°F by the end of the 21st century, according to the medium or high emissions scenario.[39]

Table 3-1: Change in Annual Average Temperature

Annual Average Temperature	Historic Annual Average Temperature (1961 - 1990)	Medium Emissions (RCP 4.5)		High Emissions (RCP 8.5)	
		Mid-Century	End-Century	Mid-Century	End-Century
Maximum	72.0	75.7	76.4	76.6	79.6
Minimum	50.5	53.8	54.7	54.9	57.9
F = degrees Fahrenheit					

California Energy Commission. 2022. CalAdapt. Local Climate Change Snapshot for Irvine: Annual Average Maximum and Minimum Temperature. https://cal-adapt.org/tools/local-climate-change-snapshot. Accessed April 28, 2022.

Annual Average Minimum Temperature

According to Cal-Adapt, the annual average minimum temperature is projected to increase in Irvine (Table 3-1. Change in Annual Average Temperature), consistent with the projected trend of overall warming for the region. Under the RCP 4.5 scenario, average minimum temperatures are projected to increase by approximately 4.2°F by 2100. Under the RCP 8.5 scenario, an increase of approximately 7.4°F for average minimum temperatures by 2100 is projected. With increasing minimum temperatures, it is anticipated that the city will experience warmer conditions throughout the year; however, this does not preclude severe winter weather events from occurring.

Changes in Precipitation

Precipitation over the Los Angeles region, including the City of Irvine is highly variable from year to year and only about five storms each year make up 50 percent of the annual precipitation total according to California's Fourth Climate Change assessment for the Los Angeles region. Natural climate variability phenomena, such as the El Niño-Southern Oscillation, can influence the amount of precipitation that the region receives, but there are no clear trends in historical precipitation for this region.[40]

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[38] Hall, Alex, Neil Berg, Katharine Reich. (University of California, Los Angeles). 2018. Los Angeles Summary Report. California's Fourth Climate Change Assessment. Publication number: SUM-CCCA4-2018-007.
[39] California Energy Commission. 2022. Cal-Adapt Data Download Tool: LOCA Downscaled CMIP5 Climate Projections. https://cal-adapt.org/data/download/. Accessed April 28, 2022.
[40] Hall, Alex, Neil Berg, Katharine Reich. (University of California, Los Angeles). 2018. Los Angeles

Annual Average Precipitation Levels

According to Cal-Adapt, annual projected precipitation levels in the city are expected to experience modest change by the end of the century. **Table 3-2: Change in Annual Average Precipitation** identifies estimated annual average precipitation levels. The results of these projections suggest that during average years, precipitation levels will be similar to conditions currently experienced within the city, with a potential increase in average annual rain at the end of the century under the RCP 8.5 scenario.

Table 3-2: Change in Annual Average Precipitation

Historic Annual Average Precipitation (1961 - 1990)	Medium Emissions (RCP 4.5)		High Emissions (RCP 8.5)	
	Mid-Century	End-Century	Mid-Century	End-Century
13.3	13.2	13.2	13.0	14.5

CalAdapt. Local Climate Change Snapshot for Irvine: Annual Average Precipitation. https://cal-adapt.org/tools/local-climate-change-snapshot. Accessed May 2, 2022.

3.2.2 INDIRECT EFFECTS OF CLIMATE CHANGE

This analysis addresses five indirect effects of the projected changes to temperature and changes to precipitation: Extreme heat events, drought, wildfire and smoke, flooding, and liquefaction.

Mental Health

Before focusing on the indirect effects of changes in temperature and precipitation, it is important to note that the impacts from climate change such as fires and floods can have acute mental health impacts. As reported in the state's 4th Climate Change Assessment, there are potential links between extreme weather events and anxiety and depression, post-traumatic stress disorder, and suicide.[41]

3.2.2.1 EXTREME HEAT EVENTS

Extreme heat events are a period when temperatures are abnormally high relative to a designated location's normal temperature range. Extreme heat events are one of the leading weather-related causes of death in the United States—from 1999 through 2009, extreme heat exposure caused more than 7,800 deaths.[42] There are generally three types of extreme heat events:

- Extreme Heat Days: a day during which the maximum temperature surpasses 98 percent of all historic high temperatures for the area, using the time between April and October from 1961 to 1990 as the baseline.
- Warm Nights: a day between April to October when the minimum temperature exceeds 98 percent of all historic minimum daytime temperatures observed between 1961 to 1990.
- Extreme Heat Waves: a successive series of extreme heat days and warm nights where extreme temperatures do not abate. While no universally accepted minimum length of time for a heat wave event exists, Cal-Adapt considers four, successive extreme heat days and warm nights to be the minimum threshold for an extreme heat wave.

Summary Report. California's Fourth Climate Change Assessment. Publication number: SUM-CCCA4-2018-007.

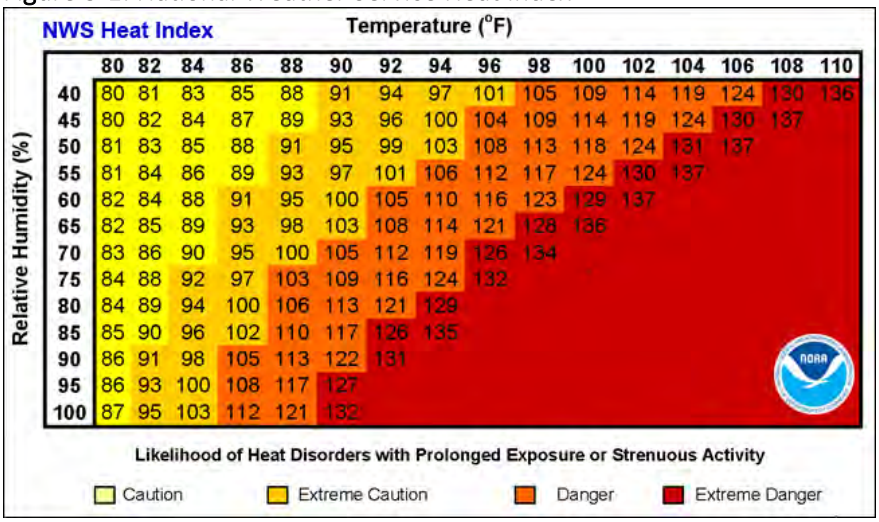
[41] Hall, Alex, Neil Berg, Katharine Reich. (University of California, Los Angeles). 2018. Los Angeles
Summary Report. California's Fourth Climate Change Assessment. Publication number: SUM-CCCA4-2018-007.

[42] United States Global Change Research Program, 2016: The Impacts of Climate Change on Human Health in the United States: A Scientific Assessment. A. Crimmins, J. Balbus, J. L. Gamble, C. B. Beard, J. E. Bell, D. Dodgen, R. J. Eisen, N. Fann, M. D. Hawkins, S. C. Herring, L. Jantarasami, D. M. Mills, S. Saha, M. C. Sarofim, J. Trtanj, and L. Ziska, Eds.

Extreme heat events will feel different from region to region since different areas have different historic high temperatures. For example, an extreme heat day on the coast will feel different than an extreme heat day in the High Desert. The reason for this is how humidity plays a factor in the perceived heat that people feel. Humid conditions will make a day feel hotter than non-humid conditions, even though the temperature may be the same. The difference between the perceived temperature and the actual temperature is known as the "heat index."

To illustrate the effect of the heat index, a 90-degree day with 50 percent humidity feels like 95°F whereas a 90°F day with 90 percent humidity feels like 122°F. **Figure 3-1: National Weather Service Heat Index** shows National Oceanic and Atmospheric Administration (NOAA)'s National Weather Service Heat Index.[43]

Figure 3-1: National Weather Service Heat Index



Source: National Oceanic and Atmospheric Administration National Weather Service Heat Index.

Historical Extreme Heat Events

Local data from within Irvine is generally available using the Tustin Irvine Ranch National Weather Service Cooperative Network station. The data indicates that the average maximum temperature for the area from all years between 1902 and 2003 is 85.2°F, occurring in the month of August.[44] Given that the minimum threshold for an extreme heat day in Irvine is 93.2°F, it is rare that the temperature exceeds this threshold on a regular basis. Still, extreme heat events have occurred in the region which occasionally impact the City as well. Some significant historic extreme heat events include:

- September 1963, the temperature reached 113°F at the now defunct El Toro Air Force Base and the surrounding region was hot as well, including coastal areas. Temperatures in Carlsbad and Oceanside reached 108°F. School children and employees were sent home due to the heat and some agricultural crops were destroyed.

[43] National Oceanic and Atmospheric Administration (NOAA)'s National Weather Service Heat Index. https://www.weather.gov/safety/heat-index. Accessed March 31, 2022.
[44] Western Regional Climate Center. 2020. Tustin Irvine Ranch, California (049087). https://wrcc.dri.edu/cgi-bin/cliMAIN.pl?ca9087. Accessed May 3, 2022.

- April 1989, daily high temperature records were set for all weather monitoring stations in Southern California. Los Angeles and Riverside set records at 106°F and 104°F respectively.[45]

More recent extreme heat events have also affected the greater region surrounding Irvine:

- On October 23, 2017, Southern California experienced two extreme heat days. The weather monitoring station at Long Beach Airport indicated that temperatures reached 105°F that day.[46]
- Throughout July 2018, extreme heat waves occurred throughout Southern California, including Irvine. The hottest day of the heat waves occurred on July 6 when temperatures reached 114°F in Santa Ana, CA. A second but less intense extreme heat wave occurred on July 25 where regional temperatures went above 100°F in places like Burbank. While local temperature data for Irvine is not available the weather monitoring station at nearby Long Beach Airport indicates that the temperature reached 95°F that day.[47]
- On Sunday, September 6, 2020, the temperature at John Wayne Airport Station measured 104°F.[48]
- For two consecutive days, on April 7-8, 2022, the temperature at John Wayne Airport Station measured 100°F.[49]

Unusually hot days and multi-day heat waves are a natural part of day-to-day variation in weather. As the Earth's climate warms, however, hotter-than-usual days and nights are becoming more common and heat waves are expected to become more frequent and intense. Increases in these extreme heat events can lead to more heat-related illnesses and deaths, especially if people and communities do not take steps to adapt.[50]

Vulnerability to Extreme Heat Events

Exposure

The Fourth Assessment indicates that Southern California can expect longer and hotter heat wave, with continued future warming over the region.[51] Annual mean maximum temperature could increase by 7.6°F by 2100 (see **Table 3-1: Change in Annual Average Temperature**).[52] As illustrated in **Table 3-3: Change in Number of Extreme Heat Days** the annual number of extreme heat days (over 92.1°F) in the City could increase up to 19 days by 2100.[53]

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[45] National Oceanic and Atmospheric Administration. May 2017. "A History of Significant Weather Events in Southern California." https://www.weather.gov/media/sgx/documents/weatherhistory.pdf

[46] Weather Underground. 2019. Long Beach Airport, California – October 2017. https://www.wunderground.com/history/monthly/us/ca/long-beach/KLGB/date/2017-10. Accessed May 3, 2022.

[47] Climate Signals. December 2018. Southern California Heat Wave July 2018. https://www.climatesignals.org/events/southern-california-heat-wave-july-2018. Accessed May 3, 2022.

[48] Weather Underground. 2020. John Wayne Airport, California – September 6, 2020. https://www.wunderground.com/history/monthly/us/ca/costa-mesa/KSNA/date/2020-9. Accessed May 3, 2022.

[49] Weather Underground. 2020. John Wayne Airport, California – April 7 - 8, 2022-4. Accessed May 3, 2022.

[50] Sarofim, M.C., S. Saha, M.D. Hawkins, D.M. Mills, J. Hess, R. Horton, P. Kinney, J. Schwartz, and A. St. Juliana. 2016. Chapter 2: Temperature-related death and illness. In: The impacts of climate change on human health in the United States: A scientific assessment. U.S. Global Change Research Program.

[51] Southern California Association of Governments. Southern California Climate Adaptation Planning Guide. October 2020.

[52] California Energy Commission. 2022. CalAdapt. Local Climate Change Snapshot for Irvine: Annual Average Maximum Temperature. https://cal-adapt.org/tools/local-climate-change-snapshot. Accessed April 28, 2022.

[53] California Energy Commission. 2022. CalAdapt. Local Climate Change Snapshot for Irvine: Extreme Heat Days. https://cal-adapt.org/tools/local-climate-change-snapshot. Accessed April 28, 2022.

Table 3-3: Change in Number of Extreme Heat Days

Number of Extreme Heat Days*	Historic Annual Average Extreme Heat Days (1961 - 1990)	Medium Emissions (RCP 4.5)		High Emissions (RCP 8.5)	
		Mid-Century	End-Century	Mid-Century	End-Century
	4	8	10	10	23

*Number of days in a year when daily maximum temperature is above a threshold temperature of 92.1 °F.
Note: Threshold temperature used in this tool is location specific. It is defined as the 98th percentile value of historical daily maximum/minimum temperatures (from 1961–1990, between April and October) observed at a location.

Source: California Energy Commission. CalAdapt. Local Climate Change Snapshot for Irvine: Extreme Heat Days. https://cal-adapt.org/tools/local-climate-change-snapshot. Accessed April 28, 2022.

Warm Nights

An atmospheric Urban Heat Island (UHI) is defined as warmer air in urban areas than in the surrounding areas and may be small and non-existent during the day and most intense at night and during the winter due to the slow release of heat from urban infrastructures. Atmospheric UHI causes human discomfort during the night and like surface UHI (See Extreme Heat Events, Sensitivity: Social), can have negative public health impacts.[54]

Warm night temperatures affect the ability of a community and its residents to effectively cool down from extreme heat days. If temperatures remain higher than normal during the night, the compounding impacts from high daytime temperatures can be highly detrimental to public health.

According to Cal-Adapt, a warm night event in Irvine is a night when the evening temperature exceeds 65.5°F. Table 3-4: Change in Number of Warm Nights identifies the projected average number of warm nights that would occur each year under the RCP 4.5 and RCP 8.5 scenarios. By 2100, an estimated 35 to 72 warm nights (RCP 4.5 and RCP 8.5, respectively) could be experienced (compared to only four days annually based on observed historical conditions). Based on these projections, the city can anticipate increased demand - towards the end of the century - for cooling centers and calls for service from vulnerable populations, which are expected to be disproportionately impacted by extreme heat conditions.

Table 3-4: Change in Number of Warm Nights

Number of Warm Nights*	Historic Annual Average Warm Nights (1961 - 1990)	Medium Emissions (RCP 4.5)		High Emissions (RCP 8.5)	
		Mid-Century	End-Century	Mid-Century	End-Century
	4	25	35	34	72

*Number of days in a year when daily minimum temperature is above a threshold temperature of 65.5 °F.
Note: Threshold temperature used in this tool is location specific. It is defined as the 98th percentile value of historical daily maximum/minimum temperatures (from 1961–1990, between April and October) observed at a location.

Source: California Energy Commission. CalAdapt. Local Climate Change Snapshot for Irvine: Warm Nights. https://cal-adapt.org/tools/local-climate-change-snapshot. Accessed April 28, 2022.

[54] Southern California Association of Governments. Southern California Climate Adaptation Planning Guide. October 2020.

Sensitivity: Major Community Elements

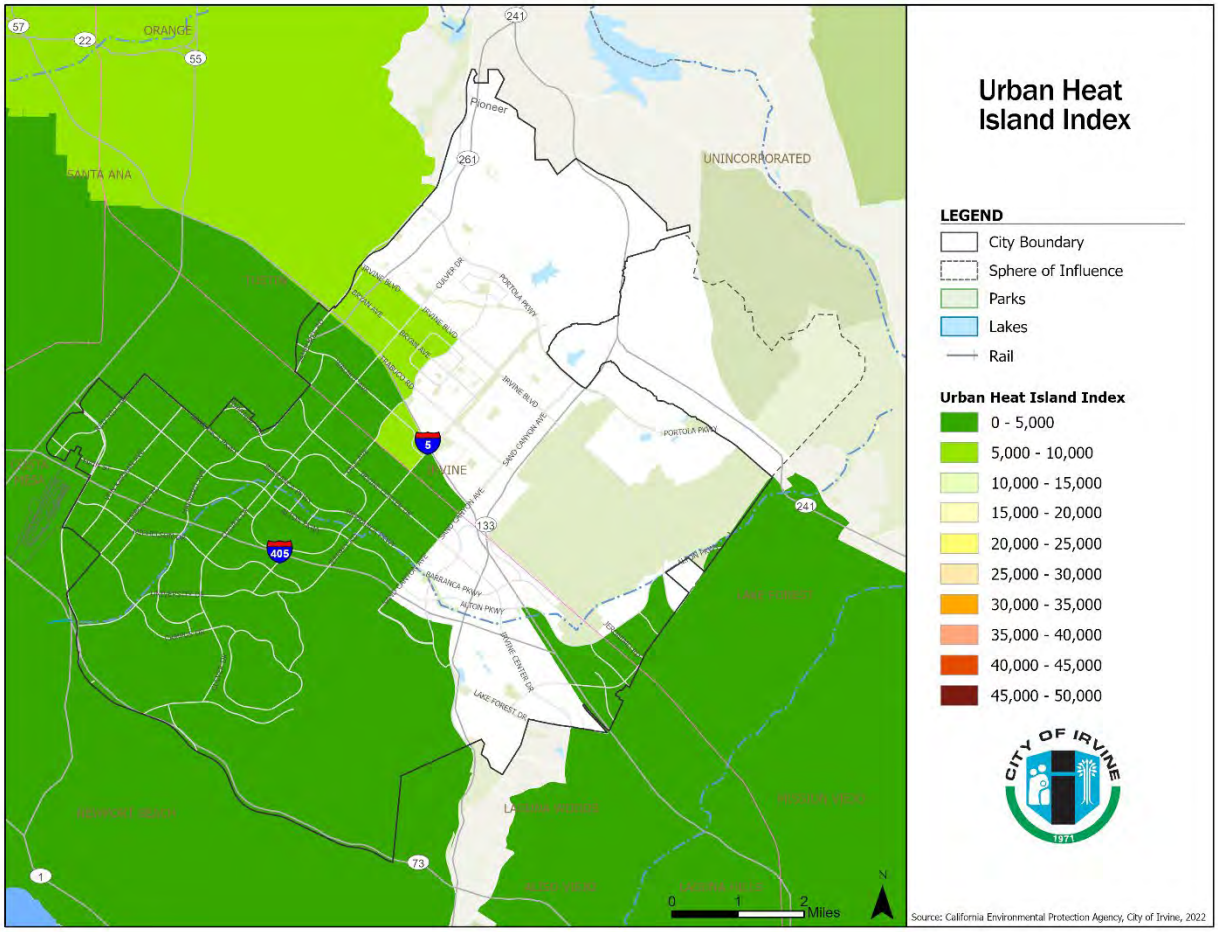
The impacts of extreme heat events will be most severely felt in highly developed areas of the city that are intensely paved and surrounded by buildings constructed of dark (heat absorbing) materials without the cooling benefits of tree shade. Urbanized areas can experience higher temperatures, greater pollution, and negative health effects, especially during summer months than rural communities. This phenomenon is known as the Urban Heat Island Effect (UHIE). Urban heat islands are created by a combination of heat-absorptive surfaces (e.g., dark pavement and roofing), heat-generating activities (e.g., automobile engines and industrial generators), and the absence of "green spaces" (vegetative surfaces that provide evaporative cooling). During extreme heat days and heatwaves, asphalt and darker surfaces reduce nighttime cooling (as retained heat is released from these surfaces). The UHIE is known to intensify extreme heat days and heatwaves.

An Urban Heat Island Index (UHII) can be calculated by atmospheric modeling, as a temperature differential over time between an urban census tract and nearby upwind rural reference points at a height of two meters above ground level, where people experience heat. The modeling covered 182 warm season days from 2006 and 2013, with one-hour timesteps, so the UHII is the sum of 24 * 182 = 4,368 hourly temperature differences. Since 2020, the index is also reported in degree-hours per day on a Celsius scale – a measure of heat intensity over time, calculated by dividing the UHII by 182 days. An increase of one degree over an eight-hour period would equal eight degree-hours, as would an increase of two degrees over a four-hour period.[55]

As illustrated in **Figure 3-2: Urban Heat Island Index**, the city is not severely impacted by the UHIE that may intensify extreme heat days and heatwaves. However, even without a large UHIE, the city is still projected to have extreme heat days and many types of infrastructure are affected by extreme heat, including roads and rails.

[55] California Environmental Protection Agency. 2022. Urban Heat Island Interactive Maps. https://calepa.ca.gov/urban-heat-island-interactive-maps-2. Accessed April 12, 2022.

Figure 3-2: Urban Heat Island Index



Source: California Environmental Protection Agency. 2022

Sensitivity: Major Community Elements

Transportation Systems

High temperatures increase the risk of pavement deterioration, depending on the paving materials and the traffic load of a given road.[56,57] The type of pavement used is typically based on historical climate conditions; the increasing occurrence of frequent and prolonged extreme heat outside of historical norms will present challenges to the roadway system.[58]

[56] Daniel, J.S., J.M. Jacobs, E. Douglas, R.B. Mallick, and K. Hayhoe. 2014. Impact of climate change on pavement performance: Preliminary lessons learned through the Infrastructure and Climate Network (IC Net). dot:10.1061/9780784413326.001.
[57] Rowan, E., C. Evans, M. Riley-Gilbert, R. Hyman, R. Kafalenos, B. Beucler, B. Rodehorst, A. Choate, and P. Schultz. 2013. Assessing the sensitivity of transportation assets to extreme weather events and climate change. Transportation Research Record: Journal of the Transportation Research Board 2326(1):16—23. doi:10.3141/2326-03.
[58] Holsinger, H. 2017. Preparing for change. FITWA-HRT-17-002. Public Roads 80(4). McLean, VA: Office of Research, Development, and Technology, Federal High Administration. https://highways.dot.gov/public-roads/januaryfebruary-2017/preparing-change. Accessed April 11, 2022.

Extreme heat may also cause pavement heave and damage to transportation infrastructure and functioning.[59] Extreme heat is also problematic for rail systems, as railroad tracks exposed to high temperatures are at risk of warping or buckling.[60]

Lifeline Utility Systems

As heat waves worsen, energy systema will need to adapt to help communities and businesses cope with rising temperatures. Access to air conditioning will be vital for vulnerable populations, even life saving for the elderly, young children, and those with pre-existing health conditions. However, increased cooling needs for both air conditioning and refrigeration will place significant stress on the power system during periods of extreme heat. And if that power comes from fossil-fired power plants, there may also be an increase in soot, smog, and other forms of air pollution with the associated public health consequences.[61] Impacts on electricity resources from climate hazards can include stress and physical damage to the electricity generation, transmission, and distribution system.

Transmission facilities face increasing climate change-related risks because of increased frequency of wildfires, severe wind, and the extreme heat. Extreme heat and drought can add stress to transmission systems, resulting in system failure. Electrical infrastructure may fail due to increased electrical loads and stress from longer periods of increased operation. A 2011 study found that just one extra day with temperatures above 90 F increases annual household energy use by 0.4 percent.[62]

Higher temperatures can reduce the water supply in California from reduced precipitation and snowpack and earlier snowmelt.[63]

Economic Elements

Laborers in weather-exposed industries such as construction and agriculture are the most prone to extreme heat impacts, even if they work fewer hours when it is hotter. Workers are less productive when it's hotter out.[64] Exposure to high temperatures may affect worker safety by increasing rates of workplace injuries[65] and it may also affect the performance and productivity of workers.[66] Higher temperatures tend to reduce growth in many industries that involve substantial indoor work, including retail, services, and finance.

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[59] Guo Y, Gasparrini A, Li S, Sera F, Vicedo-Cabrera AM, de Sousa Zanotti Stagliorio Coelho M, et al. (2018) Quantifying excess deaths related to heatwaves under climate change scenarios: A multicountry time series modelling study. PLoS Med 15(7): e1002629.

[60] Magill, B. 2014. "Sun kinks" in railways join the list of climate change's toll. Scientific American, June 2. www.scientificamerican.com/article/sun-links-in-railways-Join-the-list-of-climate-change-s-toll. Accessed April 11, 2022.

[61] Abel, D.W., T. Holloway, M. Harkey, P. Meter, D. Ahl, V.S. Limaye, and J.A. Patz. 2018. Air-quality-related health impacts from climate change and from adaptation of cooling demand for buildings in the eastern United States: An interdisciplinary modeling study. PLOS Medicine 15(7):1—27.dot:10.1371/journal.pmed.1002599.

[62] Deschênes, Olivier and Michael Greenstone. 2011. Climate Change, Mortality, and Adaptation: Evidence from Annual Fluctuations in Weather in the US. American Economic Journal: Applied Economics Vol. 3 No. 4 October 2011

[63] U.S. Environmental Protection Agency. 2016. What Climate Change Means for California. https://www.epa.gov/sites/production/files/2016-09/documents/climate-change-ca.pdf

[64] Lemione, Derek. 2021. 4 ways extreme heat hurts the economy. Cornell University Alliance for Science. August 3. https://allianceforscience.cornell.edu/blog/2021/08/4-ways-extreme-heat-hurts-the-economy. Accessed May 6, 2022.

[65] Park, J., Pankratz, N., & Behrer, A. (2021). Temperature, Workplace Safety, and Labor Market Inequality. IZA Discussion Paper No. 14560

[66] Cui, W., Cao, G., Park, J. H., Ouyang, Q., & Zhu, Y. 2013. Influence of indoor air temperature on human thermal comfort, motivation and performance. Building and environment, 68, 114-122.

An 1°F increase in the average summer temperature is associated with a reduction in the annual growth rate of state-level output of 0.15 to 0.25 percentage points and rising temperatures could reduce U.S. economic growth by up to one-third over the next century.[67]

This increase in electricity use on hot days stresses electric grids right when people depend on them most, as seen in California during recent heat waves. Blackouts can be quite costly for the economy, as inventories of food and other goods can spoil and many businesses either have to run generators or shut down. For instance, the 2019 California blackouts cost an estimated $10 billion.[68]

Natural Resource Areas

Extreme temperatures — as opposed to warmer average temperatures — are the catalyst for a growing number of extinctions. In 2002, researchers looked at 538 plant and animal species at 581 sites around the world that had been previously surveyed. The goal was to understand what aspect of climate change was the most serious threat to biodiversity. They found that 44 percent of the species at the sites had gone locally extinct, and that the culprit was an increase in the temperature of the hottest days of the year.[69]

Birds suffer more than other animals as they are diurnal and exposed to the hottest part of the day. Small mammals live underground and are generally nocturnal. Insects are small and can take advantage of smaller habitat niche although some insects have taken a heat hit as well. A recent study found that the number of areas that native bumblebees occupy has plummeted 46 percent in North America and 17 percent in Europe compared to surveys taken from 1901 to 1974. Those bee-less areas were also places with a high degree of climate variation, especially higher temperatures. "Climate change is related to the growing extinction risk that animals are facing around the world," lead author Peter Soroye said, because of "hotter and more frequent extremes in temperatures."[70]

Water stress induced mortality processes such as hydraulic failure or carbon starvation are caused by extreme heat (and drought). Many trees operate at or near their tolerance limit for water stress and may not be able to acclimate or acclimate fast enough to keep pace with the changing climate.[71] Even if such stresses do not directly kill trees themselves, they can increase vulnerability to mortality from pests as witnessed by the large-scale forest dieback from bark beetle outbreaks taking place across North America.[72]

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[67] Colacito, Riccardo; Bridget Hoffmann, Toan Phan. 2018. Temperature and Growth: A Panel Analysis of the United States. Journal of Money, Credit, and Banking. December 3. https://doi.org/10.1111/jmcb.12574. Accessed May 6, 2022.
[68] Wara, Michael. 2019. Impacts of Wildfire on Electric Grid Reliability. Senate Energy and Natural Resources Committee Testimony. December 19.
[69] Roman-Palacios, Cristian and John J Wiens. 2020. Recent responses to climate change reveal the drivers of species extinction and survival. Proceedings of the National Academy of Sciences. February 10. https://doi.org/10.1073/pnas.1913007117
[70] Soroye, Peter. Tim Newbold, Jeremy Kerr. 2020. Climate change contributes to widespread declines among bumble bees across continents. Science. February 7. Pp. 685-688. DOI: 10.1126/science.aax8591.
[71] Williams I N, Torn M S, Riley W J and Wehner M F 2014 Impacts of climate extremes on gross primary production under global warming Environ. Res. Lett
[72] Hicke J A, Meddens A J H, Allen C D and Kolden C A 2013 Carbon stocks of trees killed by bark beetles and wildfire in the western United States Environ. Res. Lett.

Sensitivity: Vulnerable Populations

Higher temperatures and extreme heat can lead to heat cramps, heat exhaustion, heat stroke, respiratory illness, and increase the risk of heat-related mortality in addition to expansion of vector-borne disease.[73] Whereas a heat event can be relatively harmless for those with a reliable means for staying hydrated and cool, it can be deadly for others. Young children, the elderly, or people suffering from serious medical conditions are physiologically more vulnerable to heatstroke. Some senior citizens also take medicines that can make it harder for their bodies to maintain a safe internal temperature, creating an additional threat from extreme heat events. Young children may not be aware of the signs of dehydration or ways of protecting themselves from heatstroke.

Surface UHI can cause urban surface areas to become 50 to 90 degrees Fahrenheit warmer than the air temperature and is present at all hours of the day and the night, but is most intense during the day and in the summer. Due to changes in the sun's intensity, its magnitude varies with seasons. Surface UHI contributes to human discomfort during the day and an increase in energy demand for air conditioning. If a person does not have access to air conditioning, the daytime heat can lead to heat-related illnesses.[74]

Sudden spikes in heat can catch people by surprise. Stores can rapidly sell out of fans, air-conditioning units, or drinking water during a heatwave. Lower-income households or those with limited mobility may be unable to acquire enough insulation or cooling devices without significant advance preparations. This can be further compounded by the threat of Public Safety Power Shutoff events. During these events, extreme heat impacts may affect larger portions of the City and populations that wouldn't be viewed as vulnerable under normal circumstances.[75]

Figure 3-3: Heat Health Action Index displays the Heat Health Action Index from the California Natural Resources Agency's California Heat Assessment Tool (CHAT). CHAT uses a dataset that was designed to investigate how the frequency of HHEs will change throughout the 21st century. The HHAI is a statistically weighted result of social (e.g., education, income, linguistic isolation), health (e.g., asthma, percent low birth weight), and environmental (e.g., pollution, tree canopy) indicators and is intended to represent overall heat vulnerability. Represented by US Census Tract, the range is from 0 to 100, with lower scores representing less heat vulnerability. All census tracts are projected to have low vulnerability to heat which corresponds to Cal-Adapts projections for the number of Extreme Heat Days through the end of the century (see Table 3-3: Change in Number of Extreme Heat Days).

While the general population may be less vulnerable to extreme heat events, people have unique and individual thresholds. Extreme heat events including heat waves can lead to illness and death, particularly among older adults, the very young, and other vulnerable populations. People living in homelessness are at a high risk of health complications during heat waves, especially if they are unsheltered. According to data counts by the OC Health Care Agency, in 2017, there were approximately 4,800 individuals experiencing homelessness in the county, with over 50 percent unsheltered, approximately 25 percent in emergency shelters, and 20 percent in transitional shelters.[76] During a heat wave, these people are very vulnerable to heatstroke, especially if they are unable to reach a cooling center.

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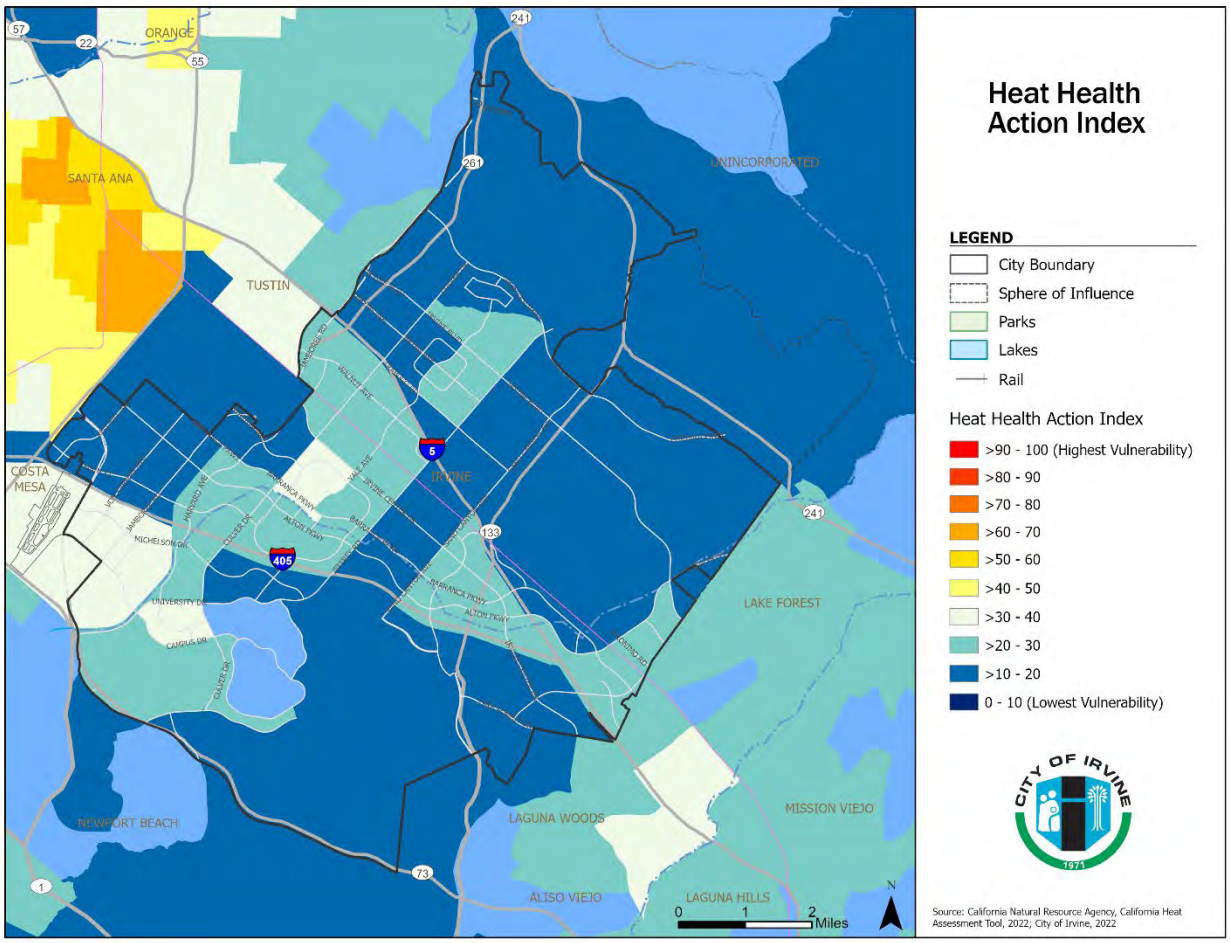
[73] Southern California Association of Governments. 2020. Extreme Heat & Public Health Report. September.
[74] Southern California Association of Governments. 2020. Extreme Heat & Public Health Report. September.
[75] City of Irvine. 2020. Local Hazard Mitigation Plan. October.
[76] OCGov. 2017. Orange County Point in Time Count 2017: Homelessness in Orange County. http://www.ocgov.com/civicax/filebank/blobdload.aspx?BlobID=64596

Adaptive Capacity

Current research indicates that most people can adapt biologically and physically to incremental increases in average normal temperatures. children, pregnant women, and older adults are more susceptible to adverse effects because they are less able to regulate their body temperatures. Other at-risk groups include individuals working outdoors, outdoor athletes, the socially isolated and those with incomes below the federal poverty level, as well as communities of color. Continuous exposure to increased heat over time will impact how individuals are able to work and play both now and in the future.[77]

Figure 3-3: Heat Health Action Index



Regulation and Planning

California is dedicated to addressing the climate change impacts on transportation infrastructure, including funding and research initiatives as well as department- and agency-led projects to assess climate-related vulnerabilities and plan for more climate-resilient transportation infrastructure.

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[77] National Institute of Heath, National Institute of Environmental Health Sciences. 2022. *Temperature-related Death and Illness*. https://www.niehs.nih.gov/research/programs/climatechange/health_impacts/heat/index.cfm#footnote1 Accessed April 7, 2022.

- Chapter 5 of 2017 (SB 1, Beall) Provided $20 Million for Climate Adaptation Planning Grants to prepare for and reduce damage from climate change impacts on transportation infrastructure.
- Chapter 118 of 2016 (AB 2800, Quirk) Established the Climate-Safe Infrastructure Working Group to convene a working group consisting of engineers, scientists, and architects to examine how to incorporate climate change impact data into state infrastructure planning, design, construction, operations, and maintenance.
- Agency (CalSTA) Developed Climate Action Plan for Transportation Infrastructure. Developed in response to Executive Order N-19-19, which called for CalSTA to leverage discretionary state transportation funds to reduce GHG emissions in the transportation sector and adapt to climate change.

Renewable energy and electricity storage technologies can add flexibility to the electricity grid. Together with microgrids, renewables can support increased grid resilience and reliability in the face of extreme weather. Electricity storage also has the potential to replace fossil-fired "peaking" power plants, which are called upon in times of high demand for electricity such as during extreme heat events.[78]

The City has addressed extreme heat in planning documents such as their Local Hazard Mitigation Plan, Urban Forestry Policy, and Cool Blocks Program. The City also has regulations and programs in place that are beneficial during extreme heat events by limiting further potential public health impacts. The plans and programs for the City and supporting agencies are described in Chapter 2: City of Irvine Adaptive Capacity to Climate-Related Hazards, in addition to those below:

City of Irvine Local Hazard Mitigation Plan (2020)

The 2020 LHMP included mitigation actions to decrease the risks associated with extreme heat, including:

- Notify residents through public service announcements a couple of days in advance of a severe weather event. Focus on media methods that target vulnerable populations, such as elderly, sick, lower-income, or persons with limited mobility to better ensure they have adequate time to prepare.
- Implement a tree-planting program to diversify tree age and increase shaded areas in the City to reduce the effects of the urban heat island effect.
- Expand use of public facilities (libraries, community centers, etc.) as warming/cooling centers for vulnerable populations during extreme weather events, and assess facility needs in order to automatically open these facilities as extreme weather centers when conditions require.
- Promote passive cooling design (brise soleil, long roof overhangs, locating windows away from southern facades, etc.) in new developments during the design review process.
- Upgrade HVAC within City facilities to more efficient systems that may include split systems or decentralized systems that allow for heating and cooling the spaces needed, not entire buildings.
- Evaluate the long-term capacity of designated cooling centers and shelters in the City to provide enough relief from extreme heat. Assess the need to expand services as the frequency, length, and severity of future heatwaves potentially change as a result of climate change.

[78] Abel, D.W., T. Holloway, M. Harkey, P. Meter, D. Ahl, V.S. Limaye, and J.A. Patz. 2018. Air-quality-related health impacts from climate change and from adaptation of cooling demand for buildings in the eastern United States: An interdisciplinary modeling study. PLOS Medicine 15(7):1—27. dot:10.1371/journal.pmed.1002599.

Urban Forestry Policy (2009)

Trees are a source of shade, air conditioning and other environmental benefits, and yield both a high quality of life and economic benefits to the community, including enhanced property values. An urban forest is an integral part of the city's infrastructure providing significant ecological, social, and economic benefits including improved air quality, reduced erosion and stormwater runoff, energy conservation, improved health, and enhanced livability. The Irvine Public Works Department's Landscape Maintenance Division is guided by an Urban Forestry Policy (2009) to provide for orderly inventorying, inspection, trimming, removal, and planting to promote the health and safety of the community.[79]

Cool Block Program (2021)

Developed and funded by the Empowerment Institute, the Cool City Challenge (CCC) initiative is a $1 million grant competition among California cities to develop the most innovative pathways to carbon neutrality, including the Cool Block program which requires recruitment of 200 Cool Block team leaders to lead their neighbors through a shared learning program to improve sustainability and quality of life in their own neighborhoods, with an eye toward rapid expansion across the city.

The Cool Block program also reduces climate emissions and utility bills while building resiliency and local emergency preparedness against climate disasters such as extreme heat, floods, wildfires, and extreme storm events that are already worsening considerably worldwide. The strategy developed through the CCC will identify and incentivize innovative climate solutions, create bottom-up change from the demand side (consumers) and connect it to top-down change from the supply-side (business, technology, and policy adoption). The resultant community synergy can empower social, environmental, and economic outcomes not previously imagined possible.[80]

3.2.2.2 DROUGHT + WATER SUPPLY

Warmer temperatures also contribute to more frequent and intense droughts by leading to a decline in and faster melting of winter snowpack, greater rates of evaporation, and drier soils. These conditions decrease the amount of spring and early summer snowmelt runoff upon which the state historically has depended for its annual water supply, while they increase the demand for irrigation water in both agricultural and urban settings. The period of 2012 through 2015 represents the state's four driest consecutive years on record in terms of statewide precipitation, and 2021 was the third driest single year. Moreover, 2022 already experienced the driest consecutive January and February in the Sierra Nevada, based on records dating back over one hundred years.

Drought may lead to water-related problems. When rainfall is less than normal for weeks, months, or years, the flow of streams and rivers declines, water levels in lakes and reservoirs fall, and the depth to water in wells increases. If dry weather persists and water-supply problems develop, the dry period can become a drought.[81]

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[79] City of Irvine. 2009. Public Works Department Urban Forestry Policy. March 17.
[80] City of Irvine. 2021. https://www.cityofirvine.org/cool-block-program. Accessed May 2, 2022.
[81] United States Geological Survey. 2022. California Water Sciences Center. California Drought. https://ca.water.usgs.gov/california-drought/what-is-drought.html. Accessed April 12, 2022.

As a result, droughts have widespread impacts across the state, including mandatory water use restrictions, reductions in agricultural crop production, over-pumping of groundwater which damages infrastructure from land sinking and dries up domestic well and degraded habitats for fish and wildlife.[82]

Historical Drought Events

The 2007–2011 California drought marked the beginning of increased restrictions on State Water Project (SWP) pumping from the Bay-Delta due to environmental considerations. In April 2007, MWD notified its member agencies that it expected challenges in meeting demands due to insufficient imported water supplies from the SWP and the Colorado River. To meet demands, MWD announced that it would implement shortage-related actions consistent with its Water Surplus and Drought Management Plan.

In January 2014, Governor Brown proclaimed a state of emergency throughout California, calling for increased conservation across the state.

On March 1, 2022, the California Department of Water Resources reported, "Statewide, the snowpack is 63 percent of average for this date. With only one month left in California's wet season and no major storms in the forecast, Californians should plan for a third year of drought conditions."[83]

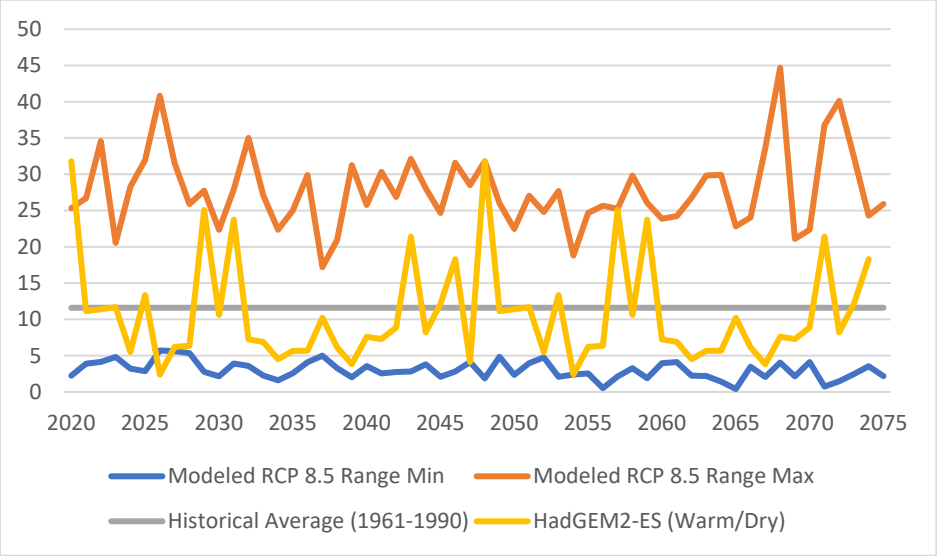
Vulnerability to Drought

Exposure

As shown in Table 3-2: Change in Annual Average Precipitation, under both the medium and high emissions scenarios, Irvine is not expected to experience significant changes in average precipitation. California, and by default the City, has been experiencing prolonged periods of drought. Recent research suggests that extended drought occurrence (a "mega-drought") could become more pervasive in future decades. An extended drought scenario is predicted for all of California from 2025 to 2075 under the HadGEM2-ES simulation and high emissions scenario. The extended drought scenario is based on the average annual precipitation between 1961 and 1990 of 10.9 inches. As shown in **Figure 3-4: Projected Drought Conditions**, under the projected drought scenario between 2025 and 2075, Irvine's precipitation would decrease by 2.7 inches; with the variability in annual precipitation would be between 2.4 and 25.1 inches for the HadGEM 2-ES model.[84]

[82] State of California, Legislative Analyst's Office. 2022. Budget and Policy Post. Climate Change Impacts Across California Crosscutting Issues. April 5, 2022. https://lao.ca.gov/Publications/Report/4575. Accessed April 11, 2022.
[83] California Department of Water Resources. 2022. Statewide Snowpack Falls Well Below Average Following Consecutive Dry Months. March 1, 2022. https://water.ca.gov/News/News-Releases/2022/March-22/March-2022-Snow-Survey. Accessed April 12, 2022.
[84] California Energy Commission. Cal-Adapt. 2022. Extended Drought Scenarios, Precipitation by Water Year for Irvine. https://cal-adapt.org/tools/extended-drought/#lat=33.0450&lng=-117.2539&boundary=place&climvar=Wildfire. Accessed April 28, 2022.

Figure 3-4: Projected Drought Conditions



Source: California Energy Commission. CalAdapt. Local Climate Change Snapshot for Irvine: Extended Drought Scenarios. https://cal-adapt.org/tools/local-climate-change-snapshot. Accessed April 28, 2022.

Sensitivity: Major Community Elements

Drought will continue to be a foreseeable event in the future of California, including Irvine. Since most droughts are almost entirely contingent on global weather phenomena, which vary from year to year, it is impossible to predict either the frequency or severity of future drought events in Irvine. Droughts that result from infrastructure failure are equally impossible to predict since the circumstances that lead to infrastructure failure are unique to each situation.[85]

As vegetation changes because of drought conditions, the animal species that depend on certain plant communities for food supply and habitat may be affected. The projected increase in the duration of droughts through the end of the century may threaten ecosystems as species become weak due to limited access to water and become susceptible to disease, pest, and decay.[86]

Climate change is anticipated to abate drought in certain situations but, on the other hand, could also intensify and exacerbate it in other cases. In some cases, climate change-intensified weather patterns, like El Niño-Southern Oscillation (ENSO), may bring more rain to California and Irvine which would abate drought conditions. In other years, climate change may also prolong the *La Niña* phase of ENSO which could lead to longer periods with no precipitation in California.

Lifeline Utility Systems

Climate change is also expected to increase the average temperature and cause more frequent and prolonged heat waves in California and Irvine. During these events, water supplies may be diverted for cooling functions in the City.

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[85] City of Irvine. 2020. Local Hazard Mitigation Plan. October.

[86] California Natural Resources agency, Governor's Office of Planning and Research, and California Energy Commission. 2019. California's Fourth Climate Change Assessment; San Diego Region Report. Available: https://www.energy.ca.gov/sites/default/files/2019-11/Reg_Report-SUM-CCCA4-2018-009_SanDiego_ADA.pdf. Accessed April 12, 2022.

Hotter temperatures may also lead to increased surface water evaporation which could lead to greater water consumption. If a drought were to occur during a future heat wave, it could place the water supply under strain.

From a regional perspective, warmer overall temperatures in California are anticipated to lead to a reduction in statewide water supplies. Much of California's water comes from melted snow in the High Sierra. As the average temperature grows warmer with climate change, the amount of precipitation that falls as snow is expected to shift towards rain. As less snow falls, the amount of melted water from the snowpack in the Sierra Nevada will decrease, reducing the water that will flow into the reservoirs and aqueducts that supply Southern California. This could place strain on the City's imported water supply, leading to greater reliance on Orange County's local groundwater. If regional water agencies, like OCWD, do not account for increased groundwater withdrawal, Irvine and the greater Orange County region could experience subsidence as a result.

Economic Elements

The water sector is central to public health and the economy. Water utilities ensure a reliable supply of clean water to communities and ecosystems and contribute significantly to the resilience of many other sectors, including agriculture, energy, and manufacturing. Drought can result in impacts to water utility operations, including:

- Loss of water pressure and water supply
- Poor water quality from the source that may require additional treatment to meet drinking water standards
- Inability to access alternative and supplementary water sources because of high demand by and competition from other users
- Increased customer demand
- Increased costs and reduced revenues related to responding to drought impacts.

Within Irvine, approximately 1,323 acres of land are designated for agricultural use, which is scattered throughout the City (Irvine 2020). These farmers may be impacted in future drought conditions by increased cost for water, lower water quality, and the introduction of potential pests that may expand during a drought.

Drought, as well as recreationists' negative perceptions of drought, fire bans, or wildfires, may result in decreased visitations, cancellations in hotel stays, a reduction in booked holidays, or reduced merchandise sales. Reduced revenues in the sector can negatively impact the livelihood of small outdoor recreation businesses that have limited resources to manage the financial burden of drought. This, in turn, impacts the mental health of small business owners, staff, and communities. [87] A continued drought combined with elevated temperatures could impact the operations of the Great Park's Farm + Food Lab and Farmer's Market.

Natural Resource Areas

When a drought occurs, the existing pressures on the ecosystem's natural water supplies are amplified. If the ecosystem's water needs aren't considered in water allocation decisions, then this already vulnerable ecosystem may be pushed beyond the threshold at which it can recover.

[87] National Integrated Drought Information Systems. Water Utilities. https://www.drought.gov/sectors/water-utilities. Accessed May 5, 2022.

The ecosystem will begin to function differently, leading to a loss in the critical services it once provided humans—such as purifying water and air, preventing erosion, and providing recreation opportunities.[88] An exceptionally severe drought could dramatically reduce the amount of water available for landscaping in Irvine and deprive trees of the irrigation they require for their survival (Irvine 2020).

Droughts can also lead to the expansion of territory for existing pests and introduction of new pests. Pests that are currently afflicting trees in Orange County include the following:

- Asian Citrus Psyllid: Carries a plant disease known as Huanglongbing, or citrus-greening disease, which kills citrus trees. Parts of the City of Irvine are in the quarantine area for this pest.
- Gold Spotted Oak Borer: Burrow into oak trees which kills the tree over time.
- Invasive Shot Hole Borer: Burrow into all kinds of native trees in all kinds of settings, including urban areas. These insects carry the Fusarium Dieback fungus which kills the tree.[89]

Any tree has the potential to be infested by pests that could result in the tree's death. This means all areas of Irvine that are landscaped with trees could experience tree mortality. These areas include parks, landscaped parkways and street medians, schools, as well as private homes or businesses.[90]

Sensitivity: Vulnerable Populations

Droughts are unlikely to cause serious social threats to households in Irvine, though residents and business owners in the City may experience financial costs associated with water conservation efforts. Those who have less access to financial resources, such as low-income households or seniors, may be harder hit if higher water fees are imposed during a severe drought event.[91]

Adaptive Capacity

The city's reliance on various in internal and regional water resources, including the IRWD and the OCWD, will remain a critical issue for the city's resilience to drought periods.

City of Irvine

The City has addressed drought in planning documents such as their LHMP, Water Management Program, and Urban Water Master Plan. The City also has regulations and programs in place that are beneficial during drought events by limiting further potential public health impacts. The plans and programs for the City and supporting agencies are described in Chapter 2: City of Irvine Adaptive Capacity to Climate-Related Hazards, in addition to those below:

City of Irvine Local Hazard Mitigation Plan (2020)

The 2020 LHMP included mitigation actions to decrease the risks associated with drought, including:

- Coordinate closely with IRWD on water use and water conservation efforts throughout the City.

[88] National Integrated Drought Information Systems. Ecosystems. https://www.drought.gov/sectors/ecosystems. Accessed May 5, 2022.
[89] Orange County Fire Authority. 2018. Ready, Set, Go, Newsflash! https://www.ocfa.org/Uploads/SafetyPrograms/OCFA%20Newsflash_Tree%20Pests_3-Page%20Version.pdf
[90] City of Irvine. 2020. Local Hazard Mitigation Plan. October.
[91] City of Irvine. 2020. Local Hazard Mitigation Plan. October.

- Update "Division 7 - Sustainability in Landscaping "of the Irvine Municipal Code of Ordinances and the Master Streetscape & Landscape Design Manual to reflect the latest advances in best practices in landscape design that reduce water use within the City.
- Encourage drought tolerant native landscaping, low-flow water fixtures beyond the state minimum code, and daytime watering restrictions on properties throughout the city to reduce water consumption.
- Use drought-tolerant plants when installing new or retrofitting City-owned landscapes. Limit turf that is not drought tolerant to recreational fields and lawns, and only in instances where no feasible drought-tolerant alternatives exist.

City of Irvine Water Management Program (2009)

The Irvine Public Works Department's Landscape Maintenance Division is guided by a Water Management Program (2009). The policy directs City staff to use smart controller technology, crop coefficients, weather data, and field observations to accurately water the landscape. with the purpose of "apply[ing] the least amount of water necessary to maintain healthy plant material."[92]

City of Irvine Water Quality Ordinance

The Water Quality Ordinance (No. 10-06) gives the City of Irvine adequate legal authority as may be necessary to carry out the requirements of the NPDES Permit and accomplish the requirements of the Clean Water Act.[93]

Irvine Ranch Water District

To manage the water supply for Irvine, the IRWD is guided by the following plans and programs:

Urban Water Management Plan (Draft 2020)

IRWD's Urban Water Management Plan (UWMP) identifies imported and local water supplies needed to meet future demands, including groundwater recovery and water recycling, as well as IRWD's current and planned conservation measures. This helps to ensure that IRWD can provide the service area with a reliable supply of high-quality water to meet current and future demands. The UWMP is updated every five years and submitted to the California Department of Water Resources. The prior 2015 UWMP was adopted by IRWD's Board in 2016.

Water Shortage Contingency Plan (2021)

IRWD's Water Shortage Contingency Plan provides a series of response actions that IRWD may implement in the event of a water shortage due to drought or emergency. It assumes that under a Climate Change scenario, that the anticipated Water Bank Usage would be 7,300 to 11,500 acre feet per year.

The District obtains a majority of its water through groundwater (52 percent) and imported water (14 percent). To ensure a reliable water supply during times of drought, regulatory constraints and other emergencies, the District maintains a diverse water supply portfolio that also includes the following:

[92] City of Irvine. 2009. Public Works Department Water Management Program. March 17.
[93] City or Irvine. 2010. City Council Ordinance No. 10-06. Water Quality. July 13.

Recycled Water

IRWD produces about a quarter of our supply by capturing water that normally would run out to sea, treating it, and reusing it for irrigation and other non-potable, or non-drinking, uses. We also supplement our supplies by cleaning non-potable groundwater to make it suitable for irrigation. Every gallon of recycled water and cleaned groundwater we use saves a gallon of drinking water.

Water Banking

Strand Ranch Water Banking Project

Located in Kern County, the Strand Ranch Water Banking Project improves IRWD's water supply reliability by capturing low-cost water available during wet years for use during periods of drought or critical need. Using a system of 502 acres of constructed groundwater recharge ponds on Strand Ranch, IRWD can store up to 50,000 acre-feet in the Water Bank and may recharge or recover up to 17,500 acre-feet in any single year.

Kern Fan Groundwater Storage Project

IRWD is partnering with Rosedale-Rio Bravo Water Storage District in the development of the Kern Fan Groundwater Storage Project, which will provide substantial water supply reliability benefits to the agencies. IRWD and Rosedale are actively pursuing both State and Federal funding for the project. Following are links to important documents related to securing State of California Water Storage Investment Program funding and Federal Water Infrastructure Improvements for the Nation (WIIN) Act Funding.

Water Storage Investment Program

On July 24, 2018, the California Water Commission voted to conditionally award the Kern Fan Project $67.5 million. IRWD and Rosedale are now working to complete additional requirements outlined in the program regulations in order to execute a final funding agreement and receive funds.

Water Supply Reliability Program

IRWD has purchased property in Riverside County that is located within the Palo Verde Irrigation District. Ownership of this land will eventually become another element of IRWD's long-term program to increase water supply reliability for its customers during droughts and other potential water supply interruptions. This land is currently farmed by a tenant farmer; IRWD expects to continue with the practice.

Orange County Water District

OCWD believes the best way to mitigate drought is to increase water supply. Examples of how OCWD is increasing local water supplies and securing long-term water reliability, include expansion of the groundwater replenishment system, a forecast-informed reservoir operation, sustainable management of the groundwater basin, implementation of a Santa Ana River conservation and conjunctive use program, and exploration of ocean desalination.[94]

[94] Orange County Water District. 2022. Drought in California. https://www.ocwd.com/learning-center/drought/. Accessed May 4, 2022.

Metropolitan Water District

Water Surplus and Drought Management (WSDM) Plan

Diversifying the region's water supplies and developing adequate and healthy water storage reserves have proven to be the backstop for water supply reliability. These actions have also contributed to improved seismic resilience for the region. Stored water reserves provide certainty for meeting the needs of the region's vast service area when traditional sources of supply are challenged by drought, climate change, seismic events, and other risks. It is critical that these storage resources be developed, managed, and enhanced.

MWD's WSDM Plan, which defines a regional water management strategy for MWD and its member agencies, has focused on using storage to manage water supplies and enhance reliability since 1999. The WSDM Plan includes the following guiding principle: MWD will encourage storage of water during periods of surplus and work jointly with its member agencies to minimize the impacts of water shortages on the region's retail consumers and economy during periods of shortage.

Water Supply Allocation Plan

When continued drought, earthquakes, or other natural disasters lead to shortages of supplies, MWD distributes a limited amount of water through its Water Supply Allocation Plan (WSAP). First developed in 2008, Metropolitan's WSAP takes a basic premise --to fairly distribute a limited amount of water supply-- and applies it through a detailed methodology to reflect a range of local conditions and needs of the region's retail water consumers. In particular, under severe drought conditions or a potential seismic event that impacts imported conveyance systems, it may be necessary and prudent to call for greater reductions in the use of limited water supplies and to reduce reliance on storage reserves. The WSAP has 10 levels of water supply allocations, each corresponding to a five percent reduction of supply. A Level 2 allocation, for example, represents a reduction of approximately 10 percent in overall water supply available to each member agency. The level of WSAP reduction implemented would correlate to the severity of the seismic event.

3.2.2.3 WILDFIRE + SMOKE

Wildfire in southern California is influenced by a multitude of factors: a dry and warm Mediterranean climate with periodic episodes of Santa Ana winds and droughts, the type and spatial distribution of vegetation (along with dead/ dry vegetation caused by pests), varying topography, large urban-wildland interfaces, past fire suppression attempts, and human activities.[95]

According to the state's Fourth Climate Change Assessment, by 2100, the frequency of extreme wildfires burning over 25,000 acres could increase by nearly 50 percent. As with other climate hazards, the state already is beginning to experience an increase in severe wildfires. Most of California's largest and most destructive wildfires have occurred in recent decades. This pattern has been particularly notable in the last few years, which have seen some of the worst wildfires in the state's recorded history. Five of the twenty most destructive wildfires in the state's history occurred in 2020 alone, with an additional two in 2021. [96]

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[95] Hall, Alex, Neil Berg, Katharine Reich. (University of California, Los Angeles). 2018. Los Angeles Summary Report. California's Fourth Climate Change Assessment. Publication number: SUM-CCCA4-2018-007.

[96] State of California, Legislative Analyst's Office. 2022. Budget and Policy Post. Climate Change Impacts Across California Crosscutting Issues. April 5, 2022. https://lao.ca.gov/Publications/Report/4575. Accessed April 11, 2022.

Not only do high-severity wildfires take lives and level homes, businesses, and community infrastructure, they also destroy fish and wildlife habitats. Moreover, intense wildfires can also impair air quality throughout the state. The Los Angeles Region Report as part of the to the state's Fourth Climate Change Assessment describes how the LA-Long Beach region already has some of the worst air quality in the country, ranking as the most polluted region in the United States for ozone and among the top 10 most polluted cities for year-round and short-term particle pollution. And, while air quality in the region has improved in recent decades, climate change threatens to reverse this trend. Higher future temperatures are likely to increase the production of ground-level ozone, a respiratory irritant that is a component of smog. Ground-level ozone is associated with various negative health outcomes, including reduced lung function, pneumonia, asthma, cardiovascular-related morbidity, and premature death.[97]

The City is composed of relatively flat land and hillsides along its northern and southern borders. The hillsides are an integral part of the community's image and identity, providing a visual backdrop, an environmental preserve, and a recreational resource. There are several open space areas within the city, characterized by shrubs and native trees. During the dry months, the wildfire risk in these open, vegetated areas can increase when exacerbated by occasional Santa Ana winds and elevated temperatures. Additionally, extreme weather conditions, such as high temperature, low humidity, and/or winds of extraordinary force, may cause an ordinary, localized fire to expand into a more intense and difficult to control wildfire. Currently, many homes within the city are in the urban-wildland interface, which is characterized by zones of transition between wildland and developed areas and often include heavy fuel loads that increase wildfire risk.

Historical Wildfire Events

- Freeway Complex Fire – a 2008 wildfire that burned parts of Yorba Linda, Anaheim, Brea, Chino Hills, and Diamond Bar. Over 30,000 acres were burned destroying 314 homes, 43 outbuildings, and 4 commercial structures. No fatalities were reported during this event (CAL FIRE 2018)
- Santiago Fire – Began on October 21, 2007, in the foothills north of Irvine and east of the City of Orange. Over 28,000 acres were burned, resulting in the destruction of 14 homes and 24 outbuildings. No fatalities were reported during this event.
- Canyon Fire – a 2017 wildfire that burned in the Anaheim Hills area of Orange County. In total the fire burned 9,217 acres, destroyed 25 structures, and damaged another 55. In total, 16,570 people were evacuated from their homes in Anaheim, Orange, and Tustin.[98]
- Silverado Fire starting on October 26, 2020, resulted in the evacuation of over one-third of the City's population.[99]

Vulnerability to Wildfire

Climate change will result in changes in precipitation patterns, increased temperature, and drought conditions. Wetter months may lead to increased vegetative growth while following periods of drought will allow for the vegetative growth to dry up creating greater amounts of fuel for fires. Climate change will also worsen existing severe wind events, which fuel the spread and intensity of

[97] Hall, Alex, Neil Berg, Katharine Reich. (University of California, Los Angeles). 2018. Los Angeles Summary Report. California's Fourth Climate Change Assessment. Publication number: SUM-CCCA4-2018-007.
[98] Graham, Jordan. 2017. "Canyon Fire 2 now 90 percent contained, full containment expected Tuesday". OC Register. Retrieved February 5, 2020.
[99] City of Irvine. 2021a. 6th Cycle 2021-2029 Housing Element – Second Draft. November 19, 2021.

wildfires. Santa Ana wind events blow in an offshore direction in parts of Southern California and are caused by the formation of large high-pressure systems over eastern California, Nevada, and Utah, producing winds that are strong and extremely dry. Santa Ana winds have caused some of the region's most damaging wildfires and account for some of the worst extreme heat events. While future wind events are predicted to decrease, the intensity of a severe wind event over a shorter amount of time is predicted to increase.[100]

Future projections indicate that southern California may experience a larger number of wildfires and burned area by the mid-21st century under RCP8.5. Overall burned area is projected to increase over 60 percent for Santa Ana-based fires and over 75 percent for non-Santa Ana fires.[101]

Exposure

The potential for wildland fires represents a hazard where development is adjacent to open space or within proximity to wildland fuels. Steep hillsides and varied topography within portions of the city also contribute to the risk of wildland fires.

Wildfires are not measured on a specific scale and are usually classified by size (e.g., acres burned) or impact (buildings destroyed or damaged, injuries or deaths, cost of damage, etc.). The risk of wildfire is classified on a three-tier scale of fire hazard severity zones (FHSZs): very high, high, and moderate. These classes do not correspond to a specific risk or intensity of fire but are qualitative terms that consider many factors. Fire-prone areas are also classified by the agency responsible for fire protection. Federal Responsibility Areas (FRAs) fall to federal agencies such as the US Forest Service, the Bureau of Land Management, and the National Park Service. State Responsibilities Areas (SRAs) fall to the California Department of Forestry and Fire Protection (CAL FIRE), and Local Responsibility Areas (LRAs) fall to local governments.

CAL FIRE data was used to identify Very High Fire Hazard Severity Zones (VHFHSZ) in the city that are included in the LRA (See Figure 3-5: Fire Hazard Severity Zones) identifies the City's Critical Facilities and Facilities of Concern. All structures located within this fire zone are at an elevated risk to wildfire impacts.

Fire hazards are probable in the City due to large quantities of combustible vegetation, poor access to fire hazard areas, and lack of water supply for fire protection in fire hazard areas. Development within these zones is regulated through the Uniform Building Code and Uniform Fire Code. Requirements imposed as part of the development review process include fire lanes, fuel modification zones, fire retardant building materials, smoke detectors and automatic sprinkler systems, depending on the size and type of development. Special fire protection consideration is given to industries handling hazardous materials, multi-story buildings with high occupant levels, and large built-up areas with combustible roof coverings. High hazard areas are predominantly in the hilly portions of the City with volatile chaparral as the fuel source.[102]

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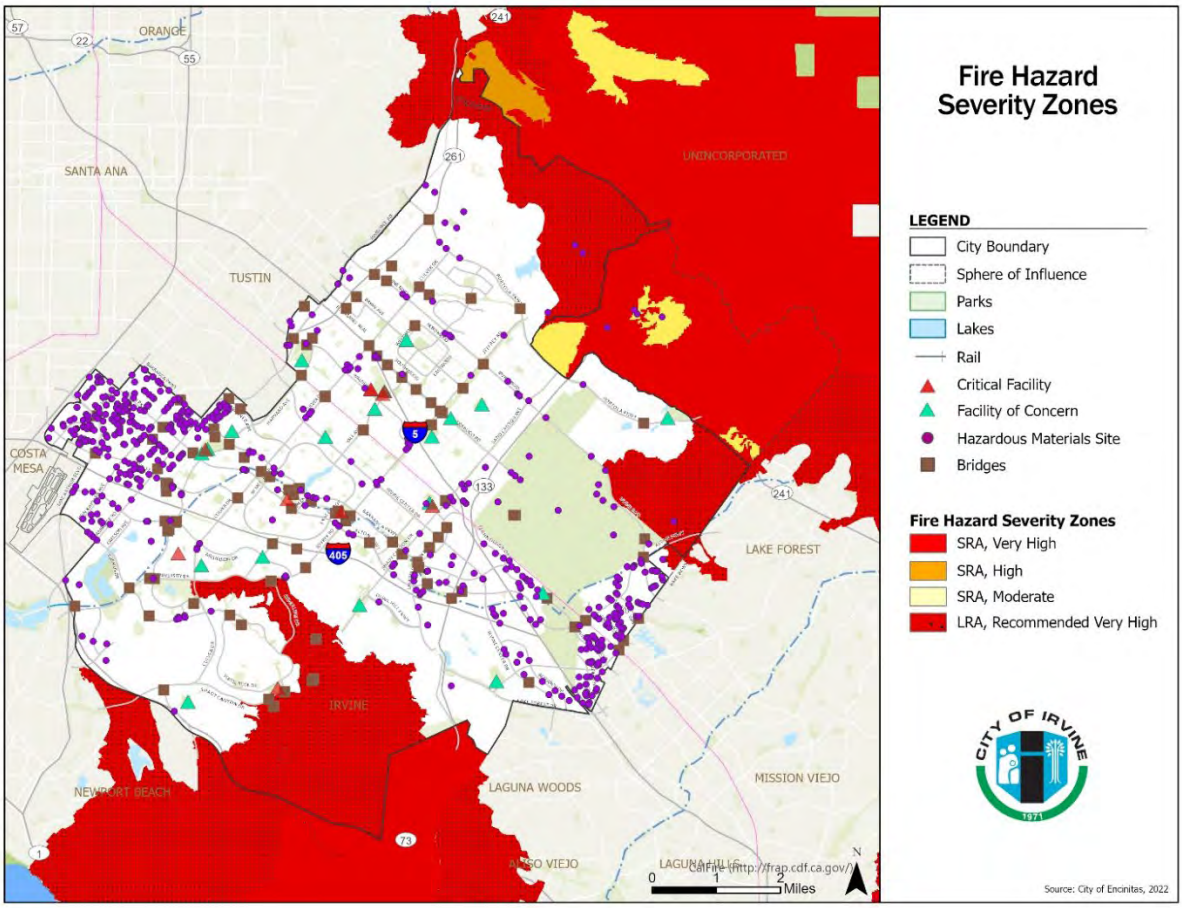
[100] California Natural Resources agency, Governor's Office of Planning and Research, and California Energy Commission. 2019. California's Fourth Climate Change Assessment; San Diego Region Report. Available: https://www.energy.ca.gov/sites/default/files/2019-11/Reg_Report-SUM-CCCA4-2018-009_SanDiego_ADA.pdf. Accessed April 12, 2022.

[101] Hall, Alex, Neil Berg, Katharine Reich. (University of California, Los Angeles). 2018. Los Angeles Summary Report. California's Fourth Climate Change Assessment. Publication number: SUM-CCCA4-2018-007.

[102] City of Irvine. 2015a. General Plan Safety Element.

Figure 3-5: Fire Hazard Severity Zones



Essential Facilities

Table 3-5: Critical Facilities and Facilities of Concern (Fire Hazard Severity Zone) identifies six Critical Facilities and one Facility of Concern within this zone, which could result in a potential loss of approximately $1.4 million. While these areas have a high degree of vulnerability to wildfire, other areas of the City may also be susceptible due to ember cast. These areas typically referred to as the Wildland Urban Interface (WUI) are vulnerable if the right conditions exist. Typically, the WUI is impacted if adequate fuels are combined with dry conditions and strong winds. Sometime the ignition of a wildfire may occur as a result if power lines located around overgrown trees cause a spark and catch the tree on fire. These types of incidents are the main impetus for the newly established Public Safety Power Shutoff (PSPS) program that is occurring throughout the State. The City of Irvine currently has 11 circuits that could be affected by future PSPS events.

Table 3-5: Critical Facilities and Facilities of Concern (Fire Hazard Severity Zone)

Category	Number of Facilities		Examples	Potential Loss*
	Critical	Concern		
City Vital Operations	-	-	City Hall, Police Station, Operations Support	$0
City Community Centers	-	-	Community Centers	$0
City Resident Services	-	-	Senior Centers, Animal Shelter, Daycare, Other Community Facilities	$0
City Recreation Support	-	1	Parks, Recreation Amenities, Sports Complexes, and support facilities	$168,300
Bridges	6	-	Overpasses and underpasses within the City	$1,256,640
Schools**	-	-	Irvine Unified School District and Tustin Unified School District Facilities	N/A
Total	**6**	**1**		**$1,424,940**

* Based on the City of Irvine insured replacement values

**Replacement Values unavailable

As the frequency, severity and impacts of wildfire are sensitive to climate change as well as other factors, including development patterns, temperature increases, wind patterns, precipitation change and pest infestations, it is difficult to project exactly where and how fires will burn. Instead, climate models estimate increased risk to wildfires. The Keetch-Byram Drought Index (KBDI) represents a simplified proxy for favorability of occurrence and spread of wildfire but is not itself a predictor of fire. As shown in Table 3-6: City of Irvine KBDI > 600 (days), The city's risk to wildfire is projected to substantially increase by end of the century compared with the historic baseline. This will lead to an increased risk for areas in Irvine susceptible to wildfire and corresponding smoke.

Table 3-6: City of Irvine KBDI > 600 (days)

KBDI > 600 (days)	Historic KBDI > 600 (days) (1961 - 1990)	Medium Emissions (RCP 4.5)		High Emissions (RCP 8.5)	
		Mid-Century	End-Century	Mid-Century	End-Century
	15	51	61	61	108

Source: California Energy Commission. CalAdapt. Local Climate Change Snapshot for Irvine: Wildfire KBDI. https://cal-adapt.org/tools/local-climate-change-snapshot. Accessed April 28, 2022.

KBDI is cumulative. The KBDI values increase on dry and warm days and decrease during rainy periods. In California we would expect KBDI to increase from the end of the wet season (spring) into the dry season (summer & fall). The list below explains what values of KBDI represent:

0–200	Soil moisture and fuel moistures are high, low wildfire risk.
200–	Soil and fuels start to dry, average wildfire risk.
400–	Onset of drought with moderate to serious wildfire risk.
600–	Severe drought, extreme wildfire risk and increased wildfire occurrence.

Climate change is expected to cause an increase in temperatures as well as more frequent and intense drought conditions. This will likely increase the amount of dry plant matter available for fuel, increasing the risk of wildfire statewide. In the foothills of the Santa Ana Mountains and San Joaquin Hills, which are already highly prone to wildfires, climate change is expected to increase the number of acres burned annually. Based on the RCP 8.5 scenario, with the CanESM2 model, the annual average of area burned could increase to an average of 212.5 hectares by the end of the century, which is an increase of 35 hectares from the annual mean for 1961-1990.[103] However, increases in fuel supplies could cause wildfires to move faster or spread into more-developed areas, which could increase the threat to Irvine.

These are unique challenges for the City as 29 percent of households in the Fire Hazard Severity Zone have at least one individual age 65 years and older. Additionally, almost 15 percent of households have at least one person living with a disability. Challenges that these populations face include potential inability to access emergency supplies, evacuate, or receive and understand emergency information. The effects of climate change hazards can result in infrastructure disruptions including power outages. Such events could result in additional health hazards for the elderly or persons with disabilities who rely on power to sustain medical equipment/assistive technology use.

According to **Table 3-7: Fire Hazard Severity Zone Vulnerable Populations,** residents living in the VHFHSZ have a median income that is approximately $23,000 higher than the city-wide figure, more households with at least one person living with a disability, and fewer residents living under the poverty limit. Compared to citywide households, there is a substantially larger number of households in the fire hazard zone with a resident aged 65 years and older.

Table 3-7: Fire Hazard Severity Zone Vulnerable Populations

	FHSZ	Irvine
Total Population[1]	7,641	262,665
Percent of residents that are children (less than 10 years)[2]	11.5%	10.4%
Percent of households that have people 65+ years[1]	29.0%	20.6%
Percentage of households with at least one person living with a disability[1]	14.9%	12.3%
Median age[2]	36.9	34.0
Total households[1]	3,491	94,490
Median household income[2]	$136,305	$113,097
Percent of rental households[2]	46.1%	48.7%
Percent of household income below poverty level[1]	9.4%	13.1%

Source: US Census Bureau, American Community Survey (ACS) 2015 - 2019[1], US Census Bureau 2010 Summary File 1, ESRI Forecasts 2021[2]

As shown in **Table 3-8: English Proficiency and Languages Spoken at Home Among Residents 5 Years and Older - FHSZ**, the majority of the estimated 7.231 residents in the Very High Fire Hazard Severity Zone aged 5 years and older are fluent in English. 4.2 percent of the population residing in the VHFHSZ are not fluent in English.

[103] Cal-Adapt. 2022. Modeled Annual Area Burned under a High Emissions (RCP 8.5) Scenario and Central Population Growth scenario: Irvine, California. https://cal-adapt.org/tools/wildfire. Accessed May 5, 2022.

Table 3-8: English Proficiency and Languages Spoken at Home Among Residents 5 Years and Older - FHSZ

	Number of Speakers	Percent Not Fluent in English
English Only	4,263	-
Spanish	339	5.6%
Indo-European Languages	464	4.1%
Asian and Pacific Island Languages	2,023	13.1%
Other Languages	142	0%

Note: Percentage values rounded to nearest tenth decimal.

Source: US Census Bureau, American Community Survey 2015 - 2019, ESRI 2022

Sensitivity: Major Community Elements

Transportation Systems

Wildfire could damage roads in several ways. Unsafe conditions and damage could lead to road closures. Typical asphalt mixtures could ignite or melt/excessively soften. Debris from fires and subsequent landslides could block roads.[104,105] Most major roads have sidewalks that create a small defensible space as well as development of the surrounding areas. Roads can be damaged by increased traffic of heavy vehicles, and vehicles that exceed weight limits, used during emergency response or recovery efforts. Costs associated with transportation infrastructure losses include repair costs, clean-up costs, and costs related to service disruptions.[106]

Lifeline Utility Systems

Additionally, wildfire can cause direct and indirect damage to electrical infrastructure. Direct exposure to fire can sever transmission lines, and heat and smoke can affect transmission capacity. Other impacts of climate change also threaten electricity infrastructure, including wildfires that can destroy poles and towers carrying transmission lines.[107]

Wildfire events can physically damage water infrastructure including pipes, water meters, dams, spillways, and other structures and equipment. Costs associated with water infrastructure losses include repair costs, clean-up costs, and costs related to service disruptions.

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[104] Carvel, R., & Torero, J. (2006). The Contribution of Asphalt Road Surfaces to Fire Risk in Tunnel Fires: Preliminary Findings. Proceedings of the International Conference on Risk and Fire Engineering for Tunnels, Stations, and Linked Underground Spaces (pp. 83-87). Hong Kong: Tunnel Management International.

[105] Cannon, S., & DeGraff, J. (2009). The Increasing Wildfire and Post-Fire Debris-Flow Threat in Western USA, and Implications for Consequences of Climate Change. In K. Sassa, & P. Canuti, Landslides - Disaster Risk Reduction (pp. 177-190). Verlag Berlin Heidelberg: Springer.

[106] Feo, Teresa J., Amber J. Mace, Sarah E. Brady, and Brie Lindsey. 2020. The Costs of Wildfire in California An Independent Review of Scientific and Technical Information. California Council on Science and Technology. ISBN Number: 978-1-930117-66-2.

[107] Davis, M., and S. Clemmer. 2014. Power failure: How climate change puts our electricity at risk—and what we can do. Cambridge, MA: Union of Concerned Scientists. https://www.ucsusa.org/sites/default/files/2019-10/Power-Failure-How-Climate-Change-Puts-Our-Electricity-at-Risk-and-What-We-Can-Do.pdf. Accessed April 11, 2022.

Mitigation actions specifically to reduce water infrastructure losses primarily include infrastructure hardening and defensible space. Water infrastructure damage can also cause contamination of drinking water supplies that can pose a risk to public health.[108]

Wildfires can damage or destroy gas, electric, and telecommunications infrastructure including poles, towers, lines, pipes, and other physical assets.[109] Damage is primarily caused by direct exposure to the flames and heat from the fire, but carbon build-up and particulate matter from wildfire smoke can also damage components used to deliver electricity.[110] Furthermore, flame retardants and firefighting techniques used to suppress fires can also damage utility infrastructure.[111]

Economic Elements

Wildfire can lead to the loss of buildings and infrastructure that may need to be repaired from damage or replaced if destroyed. Additional economic losses include the value of personal property or inventory that was damaged along with the home or commercial building, costs associated with temporary accommodations or service disruptions, and costs related to toxic material and debris cleanup. When infrastructure losses cause service disruptions, the costs can be borne by customers and communities far from the perimeter of the wildfire.[112]

Natural Resource Areas

Furthermore, because of historical forest management trends over the past century, increased temperatures, and more frequent drought, California wildfires are characteristically hotter and more intense as compared to naturally occurring fire regimes. As such, soil structure and moisture retention are damaged leading to increased susceptibility to erosion or landscapes. If Irvine's foothills become covered with dry, overgrown vegetation because of drought condition, extreme heat events and high winds increase the threat of wildfires.

Beyond direct damage to physical property and harmful effects on public safety, wildfires also result in secondary impacts: a major consequence of wildfires is post-fire flooding and debris flow. The risk of floods and debris flows after fires increases due to vegetation loss and soil exposure. These flows are a risk to life because they can occur with little warning and can exert great force on objects in their path.

Wildfires could alter hydrology by changing vegetation, increasing runoff, and resulting in more sediment that could block drainage and damage structures.[113] This impact would be caused by upstream factors; wildfires are unlikely to directly burn and/or damage outfalls themselves due to construction materials and placement near bodies of water.

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[108] Feo, Teresa J., Amber J. Mace, Sarah E. Brady, and Brie Lindsey. 2020. The Costs of Wildfire in California An Independent Review of Scientific and Technical Information. California Council on Science and Technology. ISBN Number: 978-1-930117-66-2.

[109] California Governor's Office of Emergency Services (Cal OES) 2018. California State Hazard Mitigation Plan.https://www.caloes.ca.gov/HazardMitigationSite/Documents/002-2018%20SHMP_FINAL_ ENTIRE%20PLAN.pdf

[110] Aspen Environmental Group. (2008). Sunrise Powerlink Project Attachment 1A: Effect of Wildfires on Transmission Line Reliability. Retrieved from https://www.cpuc.ca.gov/Environment/info/aspen/sunrise/deir/apps/a01/App%201%20ASR%20z_Attm%201A-Fire%20Report.pdf

[111] Sathaye, J., Dale, L., Larsen, P., Fitts, G., Koy, K., Lewis, S., & Lucena, A. (2011). Estimating Risk To California Energy Infrastructure From Projected Climate Change. LBNL-4967E, 1026811. https://doi.org/10.2172/1026811

[112] Feo, Teresa J., Amber J. Mace, Sarah E. Brady, and Brie Lindsey. 2020. The Costs of Wildfire in California An Independent Review of Scientific and Technical Information. California Council on Science and Technology. ISBN Number: 978-1-930117-66-2.

[113] U.S. DOT. 2018. Transportation Climate Change Sensitivity Matrix. U.S. Department of Transportation. Retrieved from https://toolkit.climate.gov/tool/transportation-climate-change-sensitivity-matrix

Conservation areas and open space in the city provide crucial ecosystem services such as the provisioning of clean air and water and climate regulation. If conservation areas are damaged, endangered species could be at increased risk species survival. If habitats of sensitive species are subject to frequent disturbance or destruction, resources may be needed to conserve these species. In addition, in the event of damage, more insects, pests, or invasive species.

Community parks are used for recreation, exercise, as gathering spaces, and sites of natural, historical, tribal cultural, and archaeological resources. Loss of or damage to community parks would interfere with their ability to serve these various functions.

Sensitivity: Vulnerable Populations

Wildfires are major public health concern as they can cause immediate health impacts through burns, injuries, and heat stress. However, a wildfire can influence the health outcomes of an area larger than the burn area because the associated smoke can travel long distances and worsen the air quality for extended periods. Wildfires can be a significant contributor to air pollution in both urban and rural areas and have the potential to significantly impact public health through particulates and volatile organic compounds in smoke plumes. Wildfires are a major source of particulate matter, which is an air pollutant that increases one's risk for respiratory illnesses, cardiovascular disease, negative birth outcomes, and premature death.[114] Wildfire smoke contains numerous primary and secondary pollutants, including particulates, polycyclic aromatic hydrocarbons, carbon monoxide, aldehydes, organic compounds, gases, and inorganic materials with toxicological hazard potentials.[115] Wildfire smoke also increases exposure to ground level ozone and toxic chemicals (e.g., pesticides, plastics, and paints) released from burned building and other man-made materials. Individuals sheltering in place are also at risk of exposure to hazardous air quality because wildfire smoke penetrates homes, particularly older homes.[116] Beyond these immediate health impacts, the stress, displacement, and loss of home and community from wildfires can cause significant mental health impacts, such as anxiety, depression, and post-traumatic stress disorder.[117]

Outside of the property owners directly impacted by a wildfire event, wildfires can also impact seniors and persons with disabilities. During hazard events such as wildfires, flooding, or extreme storms, the elderly, and other vulnerable populations such as persons with disabilities may require additional assistance to adequately respond. These groups may have limited mobility, be immuno-compromised, and/or not receive notifications regarding current conditions and evacuation requirements. For example, a senior who lives alone may not be aware that a wildfire is burning close to their residence and they have been ordered to evacuate if those notifications were sent in manner that doesn't reach them.

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[114] Bell, J.E., S.C. Herring, L. Jantarasami, C. Adrianopoli, K. Benedict, K. Conlon, V. Escobar, J. Hess, J. Luvall, C.P. Garcia-Pando, D. Quattrochi, J. Runkle, and C.J. Schreck, III, 2016: Ch. 4: Impacts of Extreme Events on Human Health. The Impacts of Climate Change on Human Health in the United States: A Scientific Assessment. U.S. Global Change Research Program, Washington, DC, 99–128.

[115] Künzli, N. et al. 2006. Health effects of the 2003 Southern California wildfires on children. Am J Respir Crit Care Med. 174:1221-8.

[116] Rudolph, L., Harrison, C., Buckley, L. & North, S. (2018). Climate Change, Health, and Equity: A Guide for Local Health Departments. Oakland, CA and Washington D.C., Public Health Institute and American Public Health Association.

[117] Hanigan, Ivan C., Colin D. Butler, Philip N. Kokic, and Michael F. Hutchinson. 2012. "Suicide and Drought in New South Wales, Australia, 1970–2007." Proceedings of the National Academy of Sciences of the United States of America 109 (35): 13950–55.

Persons with disabilities may require special mobility devices or caregiver assistance to go outside which may not arrive as quickly as needed. Other groups with increased threat levels include people with lower-incomes, renters, and the homeless. These groups may not possess enough financial resources to rebuild their homes or search for new homes in the aftermath of a fire.[118]

As shown in Table 3-8: English Proficiency and Languages Spoken at Home Among Residents 5 Years and Older - FHSZ, the majority of the estimated 7.231 residents in the Very High Fire Hazard Severity Zone aged 5 years and older are fluent in English. While 4.2 percent of the population residing in the VHFHSZ are not fluent in English, the City implements programs intended to communicate information to the diverse community of residents and workers with different backgrounds including the City of Irvine's website offers translation for 81 languages[119] and the Irvine Police Department is prepared to communicate with individuals with limited English proficiency[120]

Adaptive Capacity

The City has addressed wildfire in planning documents such as their Local Hazard Mitigation Plan, Emergency Management Plan, and Evacuation Plan (Annex XIII). The City also has regulations and programs in place that are beneficial during wildfires by limiting further potential public health impacts. The plans and programs for the City and supporting agencies are described in Chapter 2: City of Irvine Adaptive Capacity to Climate-Related Hazards, in addition to those below:

City of Irvine Local Hazard Mitigation Plan (2020)

The 2020 LHMP included mitigation actions to decrease the risks associated with wildfires, including:

- Promote the proper maintenance and separation of power lines and efficient response to fallen power lines.
- Remove highly flammable vegetation in Very High, High, and Moderate Fire Hazard Severity Zones and replant with fire-adapted specimens.
- Create a hillside weed abatement pilot program using goats or other livestock to reduce fuel loads in fire-prone areas.
- Routinely participate in the update of the Orange County Community Wildfire Preparedness Plan for areas within the Very High, High, and Moderate Fire Hazard Severity Zones.
- Create a rapid response plan from among Irvine's and Orange County's first responders to secure hospital, nursing, and assisted living facilities, especially those located within fire hazard severity zones.
- Reinforce and regularly inspect fire retardant infrastructure such as sprinklers, fire hose terminals, and fire suppression systems in City facilities.
- Coordinate with partners to clear dead vegetation in flood control facility footprints, railroad rights-of-way, parks, and open spaces, especially during and after a drought episode.
- Expand the fire hazard prevention awareness campaign to residents in the High and Very High Fire Hazard Severity Zones.
- Work with OCFA on home preparedness assessments to assist more residents in understanding and addressing their wildfire risk.

[118] City of Irvine. 2020. Local Hazard Mitigation Plan. October.
[119] City of Irvine. 2022. https://www.cityofirvine.org/. Accessed May 3, 2022.
[120] City of Irvine. n.d. Policy 345. Limited English Proficiency Services.

- Require all new development in Very High, High, and Moderate Fire Hazard Severity Zones to use noncombustible building materials such as masonry, brick, stucco, concrete, steel, or others as appropriate. Establish zones of defensible space around homes in Very High, High, and Moderate Fire Hazard Severity Zones.[121]

Orange County Fire Authority

For urban areas within the City, the OCFA is able to satisfy fire and basic life safety goals by having a first due unit on scene within a five-minute response time 80 percent of the time. Advanced life support response goals are within eight minutes 80 percent of the time. The service demand for areas considered suburban, rural, or undeveloped typically can expect increased response time goals of up to 15-20 minutes. In order to mitigate the impact of longer response times in these areas, certain building and fire codes are applied at time of development. Some of these may include automatic fire sprinklers, fire retardant building materials, and other special response enhancements unique to the development.[122]

Orange County Fire Authority – Ready, Set, Go Program

The City of Irvine participates in the CAL FIRE/OCFA "Ready, Set, Go!" program to help property owners property prepare well in advance of a wildfire to increase safety and protect property. This program provides comprehensive information on how to improve structure resistance to wildfires and prepare people to be ready to leave early in a safe manner.[123]

3.3.2.4 FLOODING

A flood occurs when land that does not normally have bodies of water becomes suddenly inundated with water. Flooding can occur after periods of heavy rainfall, whether it occurs as a single extreme episode or as a series of storms. Drainages and stream courses may flood their banks and shores if their capacity is exceeded by rainwater. When heavy rainfall hits an area where the ground is already saturated, the risk of flooding is high. In developed areas, the presence of pavement and other impervious surfaces means that the ground is less able to absorb water. As a result, rainwater must be carried away in storm channels or waterways.[124]

Floods pose several threats to communities and public safety. Flooding can cause property damage, destroy homes, and carry away vehicles or other large debris. Topsoil and vegetation can be swept away by floodwaters, leading to erosion. Floodwaters may impede the movement of victims fleeing a flood or of first responders attempting to reach people in need of help.[125]

Climate models predict that California will experience less frequent but more intense storm patterns in the coming decades, including the state's precipitation more frequently falling as rain rather than snow compared to historical trends. Additionally, the state's streams and rivers will swell more in some years from earlier and faster spring snowmelt caused by higher temperatures.

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[121] City of Irvine. 2020. Local Hazard Mitigation Plan. October.
[122] City of Irvine. 2015a. General Plan Safety Element.
[123] Orange County Fire Authority. 2022. Ready, Set, Go. https://www.ocfa.org/RSG/Ready. Accessed May 3, 2022.
[124] City of Irvine. 2020. Local Hazard Mitigation Plan. October.
[125] City of Irvine. 2020. Local Hazard Mitigation Plan. October.

Scientists suggest the combination of these factors could lead to a 50 percent increase in runoff in future years, challenging the capacity of the state's existing reservoirs, canals, levees, and other flood control systems, and increasing the risk of inland flooding. Floods cause significant risk to human life, and damage roads, buildings, and other infrastructure.[126]

FLOODING

Increases in temperature and precipitation can lead to extreme precipitation events and sea level rise that could lead to flooding in the City. In the context of climate change for Irvine, this analysis categorizes flood types according to climate effect: Onshore flooding caused by precipitation-driven events and coastal flooding. The following describes the types of floods within each category.

Onshore Flooding from Precipitation-Driven Events

- Inland flooding occurs when moderate precipitation accumulates over several days, intense precipitation falls over a brief period, or a river overflow because of an ice or debris jam or dam or levee failure.
- A flash flood is caused by heavy or excessive rainfall in a brief period, generally less than six hours. Flash floods are usually characterized by raging torrents after heavy rains that rip through riverbeds, urban streets, or mountain canyons. They can occur within minutes or a few hours of excessive rainfall.

Coastal Flooding

- A coastal flood, or chronic inundation of land areas along the coast, is caused by higher-than-average high tide and worsened by heavy rainfall and onshore winds (i.e., wind blowing landward from the ocean).
- Storm surge is an abnormal rise in water level in coastal areas, over and above the regular astronomical tide, caused by forces generated from a severe storm's wind, waves, and low atmospheric pressure.[127]

The following analyses describe onshore flooding and coastal flooding vulnerabilities resulting from projected climate change for the city of Irvine.

Onshore Flooding from Precipitation Events

Variability in the climate is likely to result in changes to the frequency, intensity, and duration of precipitation events causing heavy rainfall, thunderstorms, and hail. Like other California regions, the high year-to-year variability of precipitation in Irvine is severely affected by extreme precipitation events (days having precipitation at or exceeding the 95th percentile), which accounts for 80 percent of the year-to-year variability.[128]

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[126] State of California, Legislative Analyst's Office. 2022. Budget and Policy Post. Climate Change Impacts Across California Crosscutting Issues. April 5, 2022. https://lao.ca.gov/Publications/Report/4575. Accessed April 11, 2022.
[127] NOAA National Severe Storms Laboratory. *Severe Weather 101.* https://www.nssl.noaa.gov/education/svrwx101/floods/types. Accessed April 6, 2022.
[128] Jennings, M.K., D. Cayan, J. Kalansky, A.D. Pairis, D.M. Lawson, A.D. Syphard, U. Abeysekera, R.E.S. Clemesha, A. Gershunov, K. Guirguis, J.M. Randall, E.D. Stein, S. Vanderplank. (San Diego State University). 2018. San Diego County Ecosystems: Ecological Impacts of Climate Change on A Biodiversity Hotspot. California's Fourth Climate Change Assessment, California Energy Commission. Publication number: CCCA4- EXT-2018-010.

Most of the heaviest events occur during winter. While days with measurable precipitation become less frequent in Southern California, extreme precipitation events are anticipated to intensify. It is predicted that the state will experience prolonged periods of drought followed by extreme precipitation (See Section 3.2.2.2: Drought).

For Irvine, projections show only a slight change in average annual rainfall through the end of the century (Table 3-2: Change in Annual Average Precipitation). Globally, climate change is anticipated to lead to more variability in the intensity of rainfall events from year to year and longer transitions between droughts and deluges.[129] Historically, the City has experienced an average of about 1.5 extreme precipitation events per year. Under the medium emissions scenario, the city is still expected to experience 1.5 extreme precipitation events per year through the end of the century. Under the high emissions scenario, the City is expected to experience a little over 1.5 extreme precipitation events per year by mid-century and the late century.[130]

The primary concern for precipitation-driven hazards is flooding. Areas of Irvine already experiencing flooding when there are heavy rainfall events could find that flooding increases in the future. However, the forecasted changes in Maximum 1-Day Precipitation, the greatest amount of daily rain or snow (over a 24-hour period) for each year, are not anticipated to be substantially differ from historic records (see **Table 3-9. Change in Maximum 1-Day Precipitation**). Therefore, impacts from flooding caused by the largest precipitation-driven events should not be dramatically different than what the community currently experiences.

Table 3-9. Change in Maximum 1-Day Precipitation

Maximum 1-Day Precipitation	Historic Maximum 1-Day Precipitation (1961 - 1990)	Medium Emissions (RCP 4.5)		High Emissions (RCP 8.5)	
		Mid-Century	End-Century	Mid-Century	End-Century
	1.387	1.505	1.542	1.584	1.605

Source: California Energy Commission. CalAdapt. Local Climate Change Snapshot for Irvine: Maximum 1-Day Precipitation. https://cal-adapt.org/tools/local-climate-change-snapshot. Accessed April 28, 2022.

Historical Onshore Flooding Events

- February 6 – 8, 1998. Heavy rain. Up to 3" rainfall over all of Southern California. Catastrophic and widespread flooding, especially in Newport Beach and Irvine. Lots of property damage in southern Orange County. Evacuations and swift water rescues. Landslides, mud slides, and sink holes. Roads, bridges, and railroads damaged.[131]
- April 21, 2001. Mud, rockslides, and minor flooding occurred over highways and Interstates along and through the mountains and foothills. At elevations above 4000 feet, 2-4 inches of snow fell. [132]
- In January 2011, California received a Presidential Declaration for the Severe Winter Storms, Flooding, and Debris and Mud Flows that occurred over a nearly three-week period. During this incident, the State of California incurred well over $75 million in damages, of which over $36 million occurred within Orange County. Much of the damage impacted private and public property, as well as critical infrastructure.

[129] Swain, D. L. (2018). Increasing precipitation volatility in twenty-first-century California. Nature Climate Change.
[130] California Energy Commission. Cal-Adapt Extreme Precipitation Events Tool. Available: https://cal-adapt.org/tools/extremeprecipitation/. Accessed April 28, 2022.
[131] National Weather Service. 2017. A History of Significant Weather Events in Southern California.
[132] NCEI. Storm Events Database. https://www.ncdc.noaa.gov/stormevents/. Accessed May 2, 2022.

- In 2014 heavy rains affecting most of Southern California caused flooding on a section of Bastanchury Road that was nearly a foot deep. Nearby weather stations reported that more than an inch of rain had fallen in a span of three hours.
- In September 2015, flooding of roadways caused severe traffic congestion across Southern California, including Orange County. In the City of Los Angeles, 7,300 people lost power for most of the day, and there more than 500 traffic collisions across the entire region as a result of the road conditions.
- 2017 Winter Storms[66] included three storms over six days inundating southern California. Heavy rains, combined with already saturated soil, produced flash flooding across much of Orange County. Streets flooded with 1 to 3 feet of water in Huntington Beach, Santa Ana, and Newport Beach (Irvine 2020).

Exposure

Flood zones are geographic areas that the Federal Emergency Management Act (FEMA) has defined according to varying levels of flood risk. These zones are depicted on a community's Flood Insurance Rate Map (FIRM) or Flood Hazard Boundary Map. Each zone reflects the severity or type of flooding in the area. In Irvine the 100-year and 500-year floodplains are not contiguous areas but consist instead of various pockets across the city. Most of these areas fall within the major drainages within the City, which include:

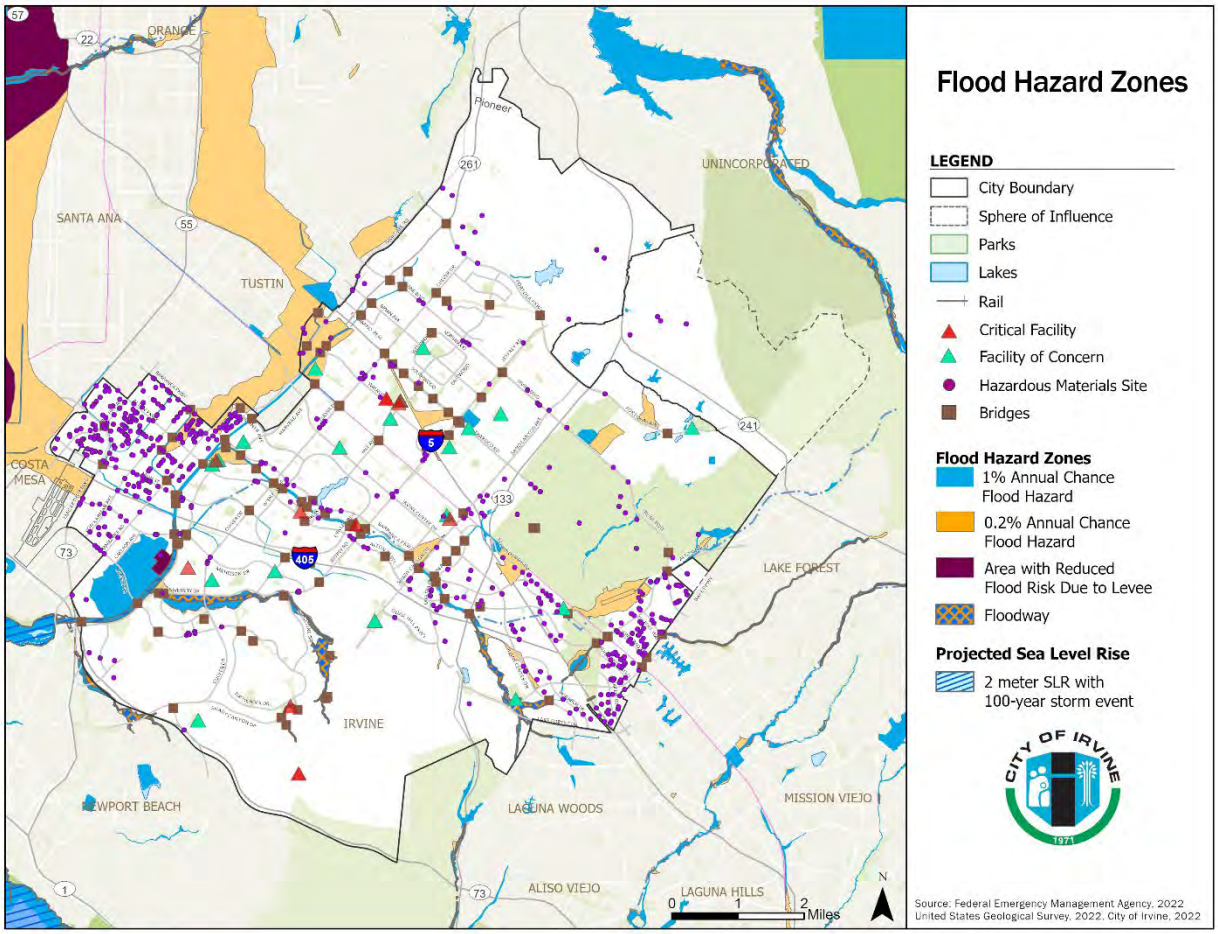
- San Diego Creek
- Serrano Creek
- Borrego Canyon Wash
- Agua Chinon Wash
- Bee Canyon Wash
- Peters Canyon Wash
- Sand Canyon Wash

Figure 3-6: Flood Hazard Zones shows the mapped flood hazard zones for 100-year and 500-year flood events in Irvine. This map also depicts the 1-meter sea level rise data, which suggests that sea level rise may affect drainage along San Diego creek. To prevent potential flooding, Irvine has more than a dozen detention or retarding basins, generally located on, or adjacent to drainages within the City. Use of these facilities is intended to reduce downstream erosion by storing water for a limited period. These strategies can also assist with dam inundation impacts.

Floodplain mapping studies are provided by the National Flood Insurance Program. Irvine participates in the program by adopting FEMA-approved floodplain studies, maps, and regulations. These studies may be funded through federal grants; state, city, and regional agencies; and private parties. The program is designed for flood insurance and floodplain management applications.[133]

[133] City of Irvine. 2020. Local Hazard Mitigation Plan. October.

Figure 3-6: Flood Hazard Zones



Portions of the City are located within the 100-year flood zone (1.0 percent Annual Chance of Flooding) and the 500-year flood zone (0.2 percent Annual Chance of Flooding). Any physical assets located within these mapped boundaries can expect to be inundated if enough precipitation were to fall exceeding the storm drain infrastructure design capacity in these areas. Electronic or mechanical equipment on the ground could become waterlogged and nonfunctional. The City has several key underpasses beneath major freeways and rail lines, that if flooded could impact circulation throughout the City.

In addition, the City has key locations along Sand Canyon Avenue, Jamboree Road, Culver Drive, and Jeffrey Road that require pump stations to ensure these underpasses do not fill with water. **Figure 3-6: Flood Hazard Zones** identifies the 100-year and 500-year FEMA flood zone designations. **Table 3-10: Critical Facilities and Facilities of Concern (100-Year Flood)** identifies the physical assets in Irvine located within the 100-year flood zone. Assets include 55 bridges and three City Recreation Support facilities. Potential losses associated with this flood zone could amount to over $130 million. This estimate also includes three assets that have the potential to be impacted by 1 meter of sea level rise. These three bridges are located along San Diego Creek and have a replacement value of over $40 million. In addition, **Table 3-11: Critical Facilities and Facilities of Concern (500-Year Flood)** identifies the additional assets located within the 500-year flood zone, which account for six CFs and two FOC that account for over $12.5 million in additional assets exposed to flooding within the City.

Table 3-10: Critical Facilities and Facilities of Concern (100-Year Flood)

Category	Number of Facilities		Examples	Potential Loss*
	Critical	Concern		
City Vital Operations	-	-	City Hall, Police Station, Operations Support	$0
City Community Centers	-	-	Community Centers	$0
City Resident Services	-	-	Senior Centers, Animal Shelter, Daycare, Other Community Facilities	$0
City Recreation Support	-	3	Parks, Recreation Amenities, Sports Complexes, and support facilities	$17,390,145
Bridges	55	-	Overpasses and underpasses within the City	$113,203,067
Schools	-	-	Irvine Unified School District and Tustin Unified School District Facilities	N/A
Total	**55**	**3**		**$130,593,212**

* Based on the City of Irvine insured replacement values

** Includes three bridges that may be affected by Sea Level Rise ($40,571,700)

*** Replacement Values unavailable

Table 3-11: Critical Facilities and Facilities of Concern (500-Year Flood)

Category	Number of Facilities		Examples	Potential Loss*
	Critical	Concern		
City Vital Operations	-	-	City Hall, Police Station, Operations Support	$0
City Community Centers	1	-	Community Centers	$462,067
City Resident Services	1	-	Senior Centers, Animal Shelter, Daycare, Other Community Facilities	$2,148,923
City Recreation Support	-	2	Parks, Recreation Amenities, Sports Complexes, and support facilities	$1,499,624
Bridges	4	-	Overpasses and underpasses within the City	$8,450,960
Schools**	-	-	Irvine Unified School District and Tustin Unified School District Facilities	N/A
Total	**6**	**2**	**-**	**$12,561,574**

* Based on the City of Irvine insured replacement values

**Replacement Values unavailable

Table 3-12: Flooding - Vulnerable Populations shows the proportions of Irvine's vulnerable populations who are likely to face a greater threat from a flood event in the City. Median household income in the 100-year flood zone is significantly higher than the citywide average. In addition, households with one member aged 65 years and older is significantly lower (4.8 percent) than the citywide average (19.5 percent). The demographics for the 500-year flood zone are like the 100-year flood zone statistics, with exception to a lower median household income and a higher percentage of households with one member aged 65 years and older.

Table 3-12: Flooding - Vulnerable Populations

	100-Year Flood	500-Year Flood	City of Irvine
Total Population[1]	370	7,635	262,665
Percent of residents that are children (less than 10 years)[2]	19.1%	10.3%	10.4%
Percent of households that have people 65+ years[1]	16.5%	12.6%	20.6%
Percentage of households with at least one person living with a disability[1]	12.1%	7.9%	12.3%
Median age[2]	36.4	35.5	34.0
Total households[1]	141	2,685	94,490
Median household income[2]	$156,785	$98,260	$113,097
Percent of rental households[2]	33.3%	-[3]	48.7%
Percent of household income below poverty level[1]	12.1%	12.0%	13.1%

Source: US Census Bureau, American Community Survey (ACS) 2015 - 2019[1], US Census Bureau 2010 Summary File 1, ESRI Forecasts 2021[2], Data discrepancy – no value provided for rental occupied housing units.

As shown in Table 3-13: English Proficiency and Languages Spoken at Home Among Residents 5 Years and Older – 100-Year Flood and Table 3-14: English Proficiency and Languages Spoken at Home Among Residents 5 Years and Older – 500-Year Flood, the majority of the estimated the residents in the 100-year or 500-year flood zones aged 5 years and older are fluent in English. 7.7 percent of residents in the 100-year flood zone and 6 percent of residents in the 500-year flood zone are not fluent in English.

Table 3-13: English Proficiency and Languages Spoken at Home Among Residents 5 Years and Older – 100-Year Flood

	Number of Speakers	Percent Not Fluent in English
English Only	138	-
Spanish	2	0%
Indo-European Languages	32	6.3%
Asian and Pacific Island Languages	177	15.3%
Other Languages	2	0%

Note: Percentage values rounded to nearest tenth decimal.

Source: US Census Bureau, American Community Survey 2015 - 2019, ESRI 2022

Table 3-14: English Proficiency and Languages Spoken at Home Among Residents 5 Years and Older – 500-Year Flood

	Number of Speakers	Percent Not Fluent in English
English Only	3,145	-
Spanish	282	4.6%
Indo-European Languages	999	2.4%
Asian and Pacific Island Languages	2,427	14.5%
Other Languages	255	13.3%

Note: Percentage values rounded to nearest tenth decimal.

Source: US Census Bureau, American Community Survey 2015 - 2019, ESRI 2022

COASTAL FLOODING AND INUNDATION

Coastal Flooding

While Irvine is not considered a coastal community, their drainage infrastructure connects to the ocean and may be tidally influenced. In the event future sea level rise affects drainage infrastructure, it could impact future flooding within the City. As an inland community that has coastally influenced drainage infrastructure another concern that should be addressed is the potential influence of sea level rise on flood control infrastructure. In the case of Irvine, a small portion of the flood control infrastructure in the northwestern corner of the City may be influenced by sea level rise in the future.

According to OPC's *State of California Sea-Level Rise Guidance: 2018 Update*, based on projected sea-level rise for Los Angeles, there is a 0.5 percent probability that Irvine could experience between 0.7 feet of sea level rise by 2030, 1.8 feet by 2050, 6.7 feet by 2100 under the high emissions, RCP 8.5 scenario.[134]

These projections were used to select corresponding localized sea level rise modeling thresholds produced by the United States Geological Service (USGS) through their Coastal Storm Modeling System version 3.0 (CoSMoS). CoSMoS produces projections of coastal flooding and inundation that could result from sea level rise and storms while factoring in changes in beaches and the retreat of cliffs and bluffs along the California coast.[135]

The OPC projections were translated to the closest data available from CoSMoS. Based on this data selection process, the following sea level rise projections were used to estimate the exposure from daily average flooding and storm surge (100-year) flooding: 0.25 meters of sea level rise (2030 timeframe), 0.5 meters (2050 timeframe), and 2.0 meters of sea level rise (2100 timeframe).[136]

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[134] Ocean Protection Council. 2018. State of California Sea-Level Rise Guidance: 2018 Update.

[135] USGS. (n.d.). Coastal Storm Modeling System (CoSMoS). https://www.usgs.gov/centers/pcmsc/science/coastal-storm-modeling-system-cosmos?qtscience_center_objects=0#qt-science_center_objects. Accessed April 6, 2022.

[136] Sea level rise (SLR) projections from the Ocean Protection Council (OPC) were provided in feet. The United States Geological Survey's CoSMoS 3.0 model used to map the extent of flooding operates using the metric system. The OPC SLR projections (with associated timeframes) were matched to the closest value in CoSMoS for use in the analyses. As a result, the scenario elevations from CoSMoS may differ from the OPC projections.

Storm surge (100-year storm) flooding was used to estimate exposure to more severe but periodic flooding and represents the extent of flooding that would occur during a 100-year (one percent annual chance) storm assuming each sea level rise scenario. The storm surge flooding scenario is not additive to the daily flooding scenario.

Exposure

Table 3-15: Critical Facilities and Facilities of Concern (0.25-meter, 1 meter, and 2-meter SLR, both with and without 100-Year Storm Event) illustrates only the extent of flooding that would occur during a 100-year (one percent annual chance) storm at 2 meters because it represents the most severe case for the City and yet still had no impact on Critical Facilities, Facilities of Concern, or hazardous materials sites, or homes. Three bridges would be affected by projected sea level rise, but as they are concrete or pre-stressed concrete intended for water use, the effect of increased water levels should be minimal.

Table 3-15: Critical Facilities and Facilities of Concern (0.25-meter, 1 meter, and 2-meter SLR, both with and without 100-Year Storm Event)

Category	Number of Facilities		Examples	Potential Loss*
	Critical	Concern		
City Vital Operations	-	-	City Hall, Police Station, Operations Support	$0
City Community Centers	-	-	Community Centers	$0
City Resident Services	-	-	Senior Centers, Animal Shelter, Daycare, Other Community Facilities	$0
City Recreation Support	-	-	Parks, Recreation Amenities, Sports Complexes, and support facilities	$0
Bridges	3	-	Overpasses and underpasses within the City	$ 40,571,700
Schools	-	-	Irvine Unified School District and Tustin Unified School District Facilities	N/A
Total	**3**	**-**		$ 40,571,700

* Based on the City of Irvine insured replacement values

Sensitivity: Major Community Elements

Transportation Systems

Flooding may temporarily stop any type of transportation in the City. Debris carried by floodwaters can block roadways, hinder access for vehicles, and potentially affect emergency response services. Rushing water only one foot deep is enough to carry small vehicles. The city has key underpasses beneath major freeways and rail lines, that if flooded could impact circulation throughout the city.[137]

[137] City of Irvine. 2020. Local Hazard Mitigation Plan. October.

Lifeline Utility Systems

Water pipes, wastewater pipes, and wastewater pump stations show low to medium vulnerability to coastal flooding and high vulnerability to coastal erosion. Flooding would not have a severe impact on underground pipes or pump stations, but erosion could compromise the functionality of the system.

In addition, flooding in watersheds could impact water quality by bringing more nutrients and total dissolved solids into the water supply.

Electronic or mechanical equipment on the ground could become waterlogged and nonfunctional.

Hazardous Materials

Flood water may have high levels of raw sewage or other hazardous substances. During a flood, underground storage tank (UST) systems may become displaced or damaged and release their contents into the environment, causing soil, surface water, and groundwater contamination. Flooding events can generate tons of debris, including building rubble, soil and sediments, green waste (e.g.., trees and shrubs), personal property, ash, and charred wood.[138]

Economic Elements

A severe flood situation where the maximum anticipated flood depth of one foot is realized, may prevent people who own smaller vehicles from driving to work, leading to reduced economic activity. Severe flooding that causes serious damage to homes and businesses may also result in reduced economic activity until repair work is completed.

Natural Resources Areas

Storm events could cause erosion on trails. Periodic flooding may temporarily limit access to parks, but once flood waters recede the park should be usable again with limited clean up.

Precipitation-driven flooding has the potential to impact habitats. Increased precipitation patterns could encourage the growth of invasive species.

Sensitivity: Vulnerable Populations

The threat of a flood will primarily affect those residents living within the 100-year and 500-year flood zones. Many of these zones are located along drainages within the City. Floodwaters in these areas are anticipated to rise to more than a maximum of one foot. Flooding of this type would likely inundate curb cuts as well as sidewalks to some extent. Any people in Irvine who walk or bike as their main form of transportation may encounter greater difficulties with their mobility if they do not have access to an alternative means of transportation. Seniors, persons with disabilities, and low-income persons are those most likely to be threatened.

In a flood event, any people in Irvine who walk or bike as their main form of transportation may encounter greater difficulties with their mobility if they do not have access to an alternative means of transportation. Seniors, persons with disabilities, and low-income persons are those most likely to be threatened.

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[138] United States Environmental Protection Agency. 2022. https://www.epa.gov/natural-disasters/flooding. Accessed May 6, 2022.

Flooding is the second most deadly weather-related hazard in the United States, which can be attributed mostly to drowning. Other effects can include building damage, mold, and respiratory damage.[139]

Additionally, persons who are experiencing homelessness may be caught outside during flood conditions without any shelter. Though floodwaters in Irvine are not expected to exceed a depth of one foot, even a floodwater depth of six inches may render any makeshift structures uninhabitable during the flood event. Possessions such as sleeping bags or electronic devices may be damaged or swept away by the floodwaters. Factors that make people sensitive to flooding are related to their ability to evacuate or escape the flood.[140]

As shown in **Table 3-13: English Proficiency and Languages Spoken at Home Among Residents 5 Years and Older – 100-Year Flood** and **Table 3-14: English Proficiency and Languages Spoken at Home Among Residents 5 Years and Older – 500-Year Flood**, the majority of the estimated the residents in the 100-year or 500-year flood zones aged 5 years and older are fluent in English. While 27 of the 351 residents in the 100-year flood zone and 423 of the 7,108 residents in the 500-year flood zone are not fluent in English, the City implements programs intended to communicate information to the diverse community of residents and workers with different backgrounds including the City of Irvine's website offers translation for 81 languages[141] and the Irvine Police Department is prepared to communicate with individuals with limited English proficiency[142]

Adaptive Capacity

The City has addressed flooding in planning documents such as their Local Hazard Mitigation Plan, Emergency Management Plan, and Evacuation Plan (Annex XIII). The City also has regulations and programs in place that are beneficial during flooding by limiting further potential public health impacts. The plans and programs for the City and supporting agencies are described in Chapter 2: City of Irvine Adaptive Capacity to Climate-Related Hazards, in addition to those below:

City of Irvine Local Hazard Mitigation Plan (2020)

The 2020 LHMP included mitigation actions to decrease the risks associated with flooding, including:

- Investigate permeable paving and use landscaped swales for new and replacement of City-owned hardscaped areas.
- Encourage the use of porous surfaces on new and significantly retrofitted residential and commercial developments to reduce runoff.
- Conduct frequent cleanings of storm drain intakes, especially before and during the rainy season.
- Update the City's Master Plan of Drainage on a regular basis to incorporate new data and/or address emerging issues.
- Analyze if new critical facilities can be built a minimum of 1 foot higher than the anticipated 500-year flood elevation height, to determine where it is feasible.
- Retrofit roadway medians to capture storm water during rain events.
- Prioritize retrofit improvements along major arterials/ roadways throughout the City.

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[139] Hall, A., N. Berg, and K. Reich. 2018. Los Angeles Summary Report. California's Fourth Climate Change Assessment. University of California, Los Angeles. Publication number: SUM-CCCA4-2018-007.
[140] City of Irvine. 2020. Local Hazard Mitigation Plan. October.
[141] City of Irvine. 2022. https://www.cityofirvine.org/. Accessed May 3, 2022.
[142] City of Irvine. n.d. Policy 345. Limited English Proficiency Services.

- Evaluate City assets and resources to ensure effective response (accepting evacuees) during a tsunami evacuation incident.

Floodplain Districts

While there is limited physical or social vulnerability to onshore precipitation-driven flooding, the City is well prepared to adapt to future effects of climate change related to flooding. The City recognizes that the flood hazard areas of the City of Irvine are subject to periodic inundation which results in loss of life and property, health and safety hazards, disruption of commerce and governmental services, extraordinary public expenditures for flood protection and relief, and impairment of the tax base, all of which adversely affect the public health, safety, and general welfare. In addition, these flood losses are caused by uses that are inadequately elevated, floodproofed, or protected from flood damage. The cumulative effect of obstructions in areas of special flood hazards which increase flood heights and velocities also contributes to the flood loss.

In response, the City of Irvine has adopted floodplain management regulations with the purpose of "promot[ing] the public health, safety, and general welfare, and to minimize public and private losses due to flood conditions in specific areas." The City applies a Floodplain District designation to all areas identified as flood channels and floodplains on maps published by the Federal Emergency Management Agency, Federal Insurance Administration, and flood insurance rate maps designating the floodway/ floodplain areas. Any development within this zone is required to incorporate a series of improvements or modifications to ensure the ability of structures to withstand periodic flooding.[143]

Municipal Code

The City of Irvine's construction codes are based upon the California Code of Regulations, Title 24 that includes the California Administrative Code, Building Code, Residential Code, Electrical Code, Mechanical Code, Plumbing Code, Energy Code, Historical Building Code, Fire Code, Existing Building Code, Green Building Standards Code, and California Referenced Standards Code. They are the minimum necessary to protect the public health, safety, and welfare of the City's residents.

3.3.2.5 GEOLOGIC AND SEISMIC HAZARDS

In the context of climate change vulnerability, increased liquefaction and heightened possibility of landslide events are a concern. Both hazards an indirect effect of increased precipitation and flooding because soils must be saturated with water for liquefaction or landslides to occur.

- Liquefaction occurs when seismic energy shakes an area with low-density, fine grain soil, like sand or silt, which is also saturated with water. When the shaking motion reaches these areas, it can cause these loosely packed soils to suddenly compact, making the waterlogged sediment behave more like a liquid than solid ground.
- Landslides occur when earth on slopes become destabilized, typically after heavy rains, when the precipitation saturates the soil and makes it less stable, or when significant erosion from rainfall destabilizes the ground. Slopes that have recently burned face a greater risk from rain-induced landslides, as the fires burn the trees, brush, and other vegetation that help stabilize the earth.

[143] City of Irvine. 1995. Municipal Code, Division 5- Overlay Districts, Chapter 5-2- Floodplain District. https://library.municode.com/ca/irvine/codes/zoning?nodeId=ZOOR_DIV5OVDI_CH5-2FLDI_S5-2-1STAU. Accessed May 3, 2022.

Earthquakes may also be a source of liquefaction and landslides as the shaking can destabilize already loosened soils. Southern California is considered as one of the most seismically active regions in the United States because the faulting is dominated by the compression regime associated with the "big bend" of the San Andreas Fault Zone.

While no active faults (Alquist-Priolo Special Study Zones) are located within Irvine, there are several regional faults within Alquist-Priolo Special Study Zones near the City that could result in seismic hazards should an earthquake occur along one of them. While earthquake faults have been located in the City, they are not considered active (shown movement at the surface in the past 13,000 years) and therefore do not require delineation within a special study zone.[144]

Historical Earthquake Events

- The largest recent fault rupture near Irvine was the 1994 Northridge earthquake, a 6.7 Mw event approximately 56 miles from Irvine, and the most destructive earthquake in the United States in nearly 100 years. This event killed sixty people, injured more than 7,000, left 20,000 people homeless and damaged more than 40,000 buildings in Los Angeles, Ventura, Orange, and San Bernardino Counties. Damage to Angel Stadium occurred as a result of this event.[145]
- More recently and closer to the City, a 5.1 Mw earthquake occurred in La Habra in 2014. This event caused fault rupturing adjacent to but not directly on the Puente Hills and Whittier faults (Graves n.d.).
- Most recently a significant swarm of earthquakes in the Ridgecrest area occurred on July 4th and 5th 2019. Three tremors ranging from 5.4 to 7.1 Mw occurred within the Eastern California shear zone, a region of distributed faulting associated with motion across the Pacific-North America plate boundary, and an area of high seismic hazard.[146]

VULNERABILITY

Exposure

Liquefaction potential is predominantly located within the northern portion of the City, as well as along stream courses in the Santa Ana foothills and San Joaquin Hills. **Table 3-16: Critical Facilities and Facilities of Concern (Liquefaction)** identifies the areas susceptible to liquefaction and location of CFs and FOC. Give the extent of the liquefaction zone and density of City facilities, this hazard poses the greatest potential loss. Over $233 million in City assets composed of 78 CFs and 30 FOC are located within these areas. Potential losses include 70 bridges and 20 schools in the City of Irvine.

[144] City of Irvine. 2020. Local Hazard Mitigation Plan. October.
[145] 2022. M 6.7 - 1km NNW of Reseda, CA (Northridge Earthquake) Overview. Accessed May 6, 2022. https://earthquake.usgs.gov/earthquakes/eventpage/ci3144585/executive
[146] 2022. M 7.1 - 2019 Ridgecrest Earthquake Sequence Overview https://earthquake.usgs.gov/earthquakes/eventpage/ci3144585/executive. Accessed May 6, 2022.

Table 3-16: Critical Facilities and Facilities of Concern (Liquefaction)

Category	Number of Facilities		Examples	Potential Loss*
	Critical	Concern		
City Vital Operations	2	-	City Hall, Police Station, Operations Support	$56,786,352
City Community Centers	4	-	Community Centers	$3,331,110
City Resident Services	2	3	Senior Centers, Animal Shelter, Daycare, Other Community Facilities	$9,029,015
City Recreation Support	-	7	Parks, Recreation Amenities, Sports Complexes, and support facilities	$31,486,344
Bridges	70	-	Overpasses and underpasses within the City	$132,520,697
Schools**	-	20	Irvine Unified School District and Tustin Unified School District Facilities	N/A
Total	**78**	**30**		**$233,153,518**

* Based on the City of Irvine insured replacement values

A large proportion of the City's population (over 37 percent) face the threat of impact due to liquefaction. Thankfully, much of the construction that has occurred over the years throughout the City has taken liquefaction into consideration. Newer buildings constructed in these areas are anticipated to contain moderate- and high-income tenants that would have greater amounts of disposable income to use during recovery after an incident. However, lower income residents and residents located in areas of older construction may be impacted greater due to the lack of financial resources need to make repairs and/or the cost associated with retrofitting older buildings.

Figure 3-7: Liquefaction Zones highlights areas with potential for liquefaction, specifically along the City boundary and in the northern center of the City, primarily in low-lying zones.[147] In Irvine, there may be a potential for liquefaction in areas with loose sandy soils combined with a shallow groundwater table, which typically are in alluvial river valleys/basins and floodplains. The underlying dataset combine existing liquefaction areas from local maps, National Earthquake Hazards Reduction Program which rates soils from hard to soft and known hydric soils from the United States Department of Agriculture Soil Survey to identify the potential areas where liquefaction may occur.[148]

[147] City of Irvine. 2021a. 6th Cycle 2021-2029 Housing Element – Second Draft. November 19, 2021.
[148] City of Irvine. 2020. Local Hazard Mitigation Plan. October.

Figure 3-7: Liquefaction Zones

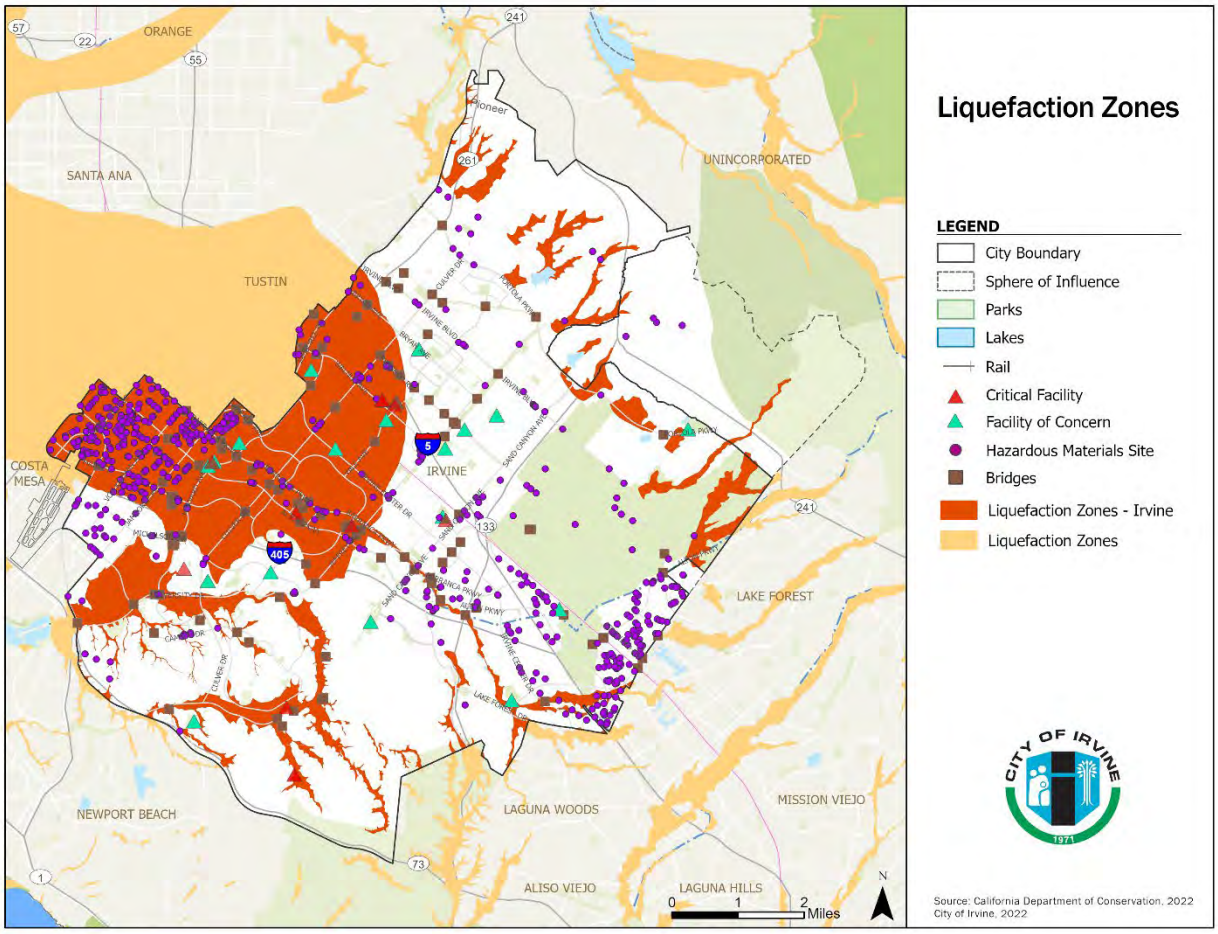


Table 3-17: Liquefaction Zones – Vulnerable Populations compares the populations within the liquefaction hazard zones with city wide populations. This hazard zone covers the largest population and number of households by far, which have a median household income that is approximately $3,000 higher than the Citywide figure. Persons living with a disability is approximately 25 percent higher than the City average, while households with a member aged 65 years and older is approximately 20 percent higher than the City average.

Table 3-17: Liquefaction Zones – Vulnerable Populations

	Liquefaction	Irvine
Total Population[1]	96,491	262,665
Percent of residents that are children (less than 10 years)[2]	9.9%	10.4%
Percent of households that have people 65+ years[1]	24.0%	20.6%
Percentage of households with at least one person living with a disability[1]	15.0%	12.3%
Median age[2]	36.0	34.0
Total households[1]	34,164	94,490
Median household income[2]	$108,995	$113,097
Percent of rental households[2]	53.2%	48.7%
Percent of household income below poverty level[1]	11.4%	13.1%

Source: US Census Bureau, ACS 2015 - 2019[1], US Census Bureau 2010 Summary File 1, ESRI Forecasts 2021[2]

As shown in **Table 3-18: English Proficiency and Languages Spoken at Home Among Residents 5 Years and Older – Liquefaction Zones**, the majority of the estimated the residents in the liquefaction zone aged 5 years and older are fluent in English. 6.6 percent of residents in the liquefaction zone are not fluent in English.

Table 3-18: English Proficiency and Languages Spoken at Home Among Residents 5 Years and Older – Liquefaction Zones

	Number of Speakers	Percent Not Fluent in English
English Only	46,225	-
Spanish	5,294	5.8%
Indo-European Languages	10,497	10.9%
Asian and Pacific Island Languages	25,627	15.5%
Other Languages	536	17.2%

Note: Percentage values rounded to nearest tenth decimal.

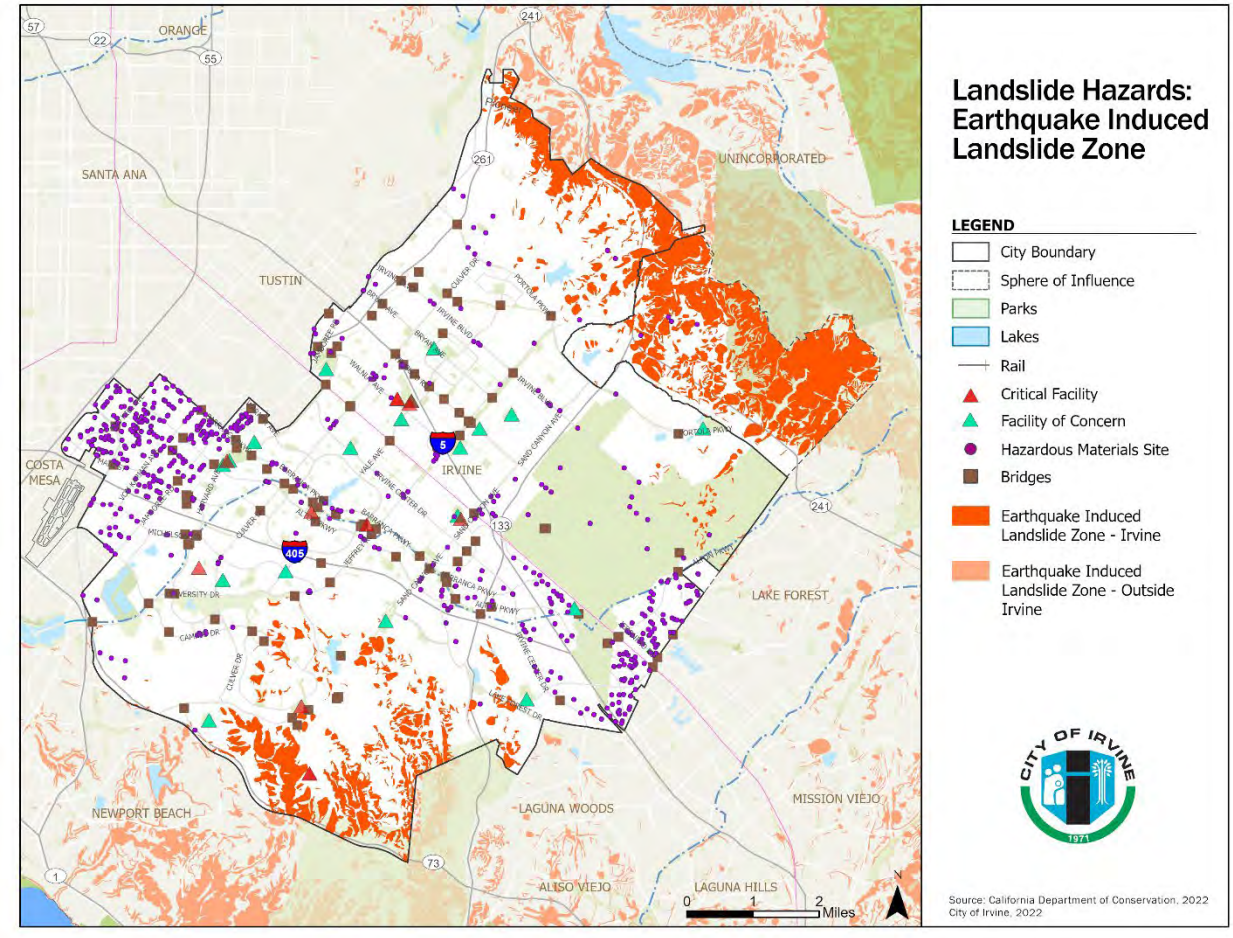
Source: US Census Bureau, American Community Survey 2015 - 2019, ESRI 2022

Landslides

Landslides occur when earth on slopes become destabilized, typically after heavy rains, when the precipitation saturates the soil and makes it less stable, or when significant erosion from rainfall destabilizes the ground. Slopes that have recently burned face a greater risk from rain-induced landslides as the fires burn up many of the trees, brush, and other vegetation that help stabilize the earth. Earthquakes may also be a source of landslides as the shaking can destabilize already loosened soils. There is the potential for landslides in the steeper portions of the foothills of the Santa Ana Mountains to the northeast of the City and the San Joaquin Hills to the southwest of the City. These areas are characterized with steep topography and geologic units that can become unstable. Figure 3-8: Earthquake Induced Landslide Zone identifies the areas of the City that are considered vulnerable to seismic induced landslides. Even these areas, however, are designated as having a moderately low risk of landslides due to seismic conditions, and a low likelihood of a landslide under other conditions (Dept. of Conservation 1976). While no definitive scale for measuring landslides exists, landslide events are usually measured using the amount of material that is displaced (i.e., the cubic feet of earth that moved).

Given the topography and geologic units within the foothills of the Santa Ana Mountains and San Joaquin Hills, it is anticipated that landslide risk will remain high in those areas. However, the City requires mitigation of these types of conditions, which reduces landslide potential in the developed areas of the City. Regarding seismic activity, as **Figure 3-8: Earthquake Induced Landslide Zone** illustrates areas of the foothills of the Santa Ana Mountains and San Joaquin Hills that have the potential to fail during an earthquake. Destabilization of slopes and hills due to intense rainstorms also has the potential to cause future landslides. These can be further exacerbated after a wildfire, where vegetation becomes loosened and therefore more susceptible to becoming part of a future landslide. Overall, the probability of future occurrence within Irvine is considered occasional.[149]

Figure 3-8: Earthquake Induced Landslide Zone



As shown in **Table 3-19: Earthquake-Induced Landslide Zone - Vulnerable Populations** less than one percent of the city' households are potentially exposed to this landslide hazards. The demographics of vulnerable populations differ from those of the entire city, with a 40 percent increase in people aged 65 years and older, consistent with a higher median age.

[149] City of Irvine. 2020. Local Hazard Mitigation Plan. October.

However, with only one-third of the number of total City households living below the poverty level, a greater percentage of homeowners, and an equivalent household income, the vulnerable populations may better resources to adequately adapt to a hazardous situation or reside in a structure with adequate safety measures in place.

Table 3-19: Earthquake-Induced Landslide Zone - Vulnerable Populations

	Landslide	Irvine
Total Population[1]	1,999	262,665
Percent of residents that are children (less than 10 years)[2]	12.7%	10.4%
Percent of households that have people 65+ years[1]	28.3%	20.6%
Percentage of households with at least one person living with a disability[1]	12.6%	12.3%
Median age[2]	38.8	34
Total households[1]	612	94,490
Median household income[2]	$116,840	$113,097
Percent of rental households[2]	31.1%	48.7%
Percent of household income below poverty level[1]	4.2%	13.1%

Source: US Census Bureau, American Community Survey (ACS) 2015 - 2019[1], US Census Bureau 2010 Summary File 1, ESRI Forecasts 2021[2]

As shown in **Table 3-20: English Proficiency and Languages Spoken at Home Among Residents 5 Years and Older – Landslide Zone**, the majority of the estimated the residents in the earthquake induced landslide zone aged 5 years and older are fluent in English. 10.2 percent of residents in the earthquake induced landslide zone are not fluent in English.

Table 3-20: English Proficiency and Languages Spoken at Home Among Residents 5 Years and Older – Landslide Zone

	Number of Speakers	Percent Not Fluent in English
English Only	1,065	-
Spanish	84	3.6%
Indo-European Languages	104	2.9%
Asian and Pacific Island Languages	553	32.4%
Other Languages	5	0%

Note: Percentage values rounded to nearest tenth decimal.

Source: US Census Bureau, American Community Survey 2015 - 2019, ESRI 2022

Sensitivity: Major Community Elements

Liquefaction and Landslides

As climate change is anticipated to change the usual precipitation patterns in Southern California, including Irvine, periods of both rain and drought are anticipated to become more intense and frequent. Therefore, climate change could, depending on the circumstances, increase the future risk of liquefaction in Irvine.

Essential Facilities

During liquefaction events, the liquified soil can lose its stability which can cause damage to buildings and infrastructure built upon it. In severe cases, buildings may completely collapse. (See Figure 3-7: Liquefaction Zones and Figure 3-8: Earthquake Induced Landslide Zone).

Transportation Systems

Services and mobility may be disrupted during and following a liquefaction event. Sidewalks, roadways, and pipelines may become fractured and disjointed as a result of the liquefying soils. Roads and sidewalks may be usable in some form, but a severe liquefaction event may render them impassible until they are repaired. Landslides may block roadways causing long-term disruptions to the roadway network, infrastructure systems and city capabilities.

Lifeline Utility Systems

Broken gas and water pipelines would result in utilities outages in Irvine homes and businesses. Since these are underground, the duration of the outage could likely be extended until the pipelines are excavated and replaced by utility operators. Damage to power lines is unlikely since the power lines themselves are not rigid structures and can move if any of the transmission towers experience slight leaning.[150]

Underground utility lines in slide-prone areas or above-ground lines built on or above them, can be damaged in a landslide, causing service outages.

Hazardous Materials

Pipelines or other utility lines running through a liquefaction zone can be breached during an event, potentially leading to flooding or release of hazardous materials. The shaking of the ground can also damage or destroy underground utilities or pipelines, potentially leading to releases of hazardous materials as well as flooding if water lines are breached. Sinking of the ground could also reduce the distance to the groundwater table, which could raise the risk of contamination from hazardous materials.[151]

Economic Elements

Homes may be damaged and mid-rise office buildings in the Centerpointe Complex would likely be rendered unsafe for occupancy if they experience any leaning or structural damage resulting from the liquefaction. Homes and businesses are typically damaged or destroyed by landslides. In addition to potentially causing significant injuries or fatalities, this can cause economic harm and create a need for long-term emergency sheltering and temporary housing until these buildings can be reconstructed.

In consideration of future degradation of structures, the City will want to monitor the quality of older housing stock to ensure it is still safe in a liquefaction event. The U. S. Department of Housing and Urban Development may consider units substandard if they were built before 1940. Fortunately for the City, less than one percent of housing units were built before 1940.[152]

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[150] City of Irvine. 2020. Local Hazard Mitigation Plan. October.
[151] City of Irvine. 2020. Local Hazard Mitigation Plan. October.
[152] US Census. 2020 ACS 5-Year Estimates Data Profiles/Housing Characteristics. https://data.census.gov/cedsci/table?tid=ACSDP5Y2020.DP04&g=0400000US06_1600000US0636770&hidePreview=true. Accessed May 3, 2022.

Irvine is a relatively new master-planned community with multiple homeowners' associations that monitor the external physical and property conditions of housing units throughout the City. The median year structures were built was 1998.[153]

Natural Resource Areas

Landslides could affect sensitive ecological areas around the community, causing localized harm to the region's ecosystem, although widespread disruptions are unlikely.[154]

Sensitivity: Vulnerable Populations

As shown in Table 3-18: English Proficiency and Languages Spoken at Home Among Residents 5 Years and Older – Liquefaction and Table 3-20: English Proficiency and Languages Spoken at Home Among Residents 5 Years and Older – Landslide, the majority of the estimated the residents in the liquefaction or earthquake induced landslide zones aged 5 years and older are fluent in English. While 5,815 of the 88,179 residents in the liquefaction zone and 185 of the 1,811 residents in the earthquake induced landslide zone are not fluent in English, the City implements programs intended to communicate information to the diverse community of residents and workers with different backgrounds including the City of Irvine's website offers translation for 81 languages[155] and the Irvine Police Department is prepared to communicate with individuals with limited English proficiency[156]

Adaptive Capacity

The City has addressed geologic and seismic events in planning documents such as their Local Hazard Mitigation Plan, Emergency Management Plan, and Evacuation Plan (Annex XIII). The City also has regulations and programs in place that are beneficial during geologic and seismic events by limiting further potential public health impacts. The plans and programs for the City and supporting agencies are described in Chapter 2: City of Irvine Adaptive Capacity to Climate-Related Hazards, in addition to those below:

City of Irvine Local Hazard Mitigation Plan (2020)

The 2020 LHMP included mitigation actions to decrease the risks associated with liquefaction and landslides, including:

- Coordinate with Irvine Ranch Water District and the Navy on subsidence monitoring in areas of active groundwater extraction and work with water utilities to develop strategies based on the amount and severity of subsidence occurring.
- Consider reducing land use densities in areas of significant landslide threat and identify strategies for existing development downstream of these hazard areas.
- Encourage the installation of resilient (seismically appropriate) piping for new or replacement pipelines, in close coordination with local water, natural gas, and other providers.
- Assess soft story conditions for apartment buildings constructed prior to 1980.
- Conduct an educational campaign and incentives to encourage the use of reinforced chimneys, anchored rooftop-mounted equipment, window film, and other preventative measures to reduce damage at private buildings.

[153] Irvine Ranch Water District. 2021. 2020 Water Shortage Contingency Plan. June 28.
[154] City of Irvine. 2020. Local Hazard Mitigation Plan. October.
[155] City of Irvine. 2022. https://www.cityofirvine.org/. Accessed May 3, 2022.
[156] City of Irvine. n.d. Policy 345. Limited English Proficiency Services.

- Educate community groups and industry representatives assist in outreach to residents and businesses to obtain earthquake insurance through the California Earthquake Authority.
- To the extent feasible, construct all new and significantly retrofitted City-owned facilities to remain operational in the event of a major earthquake.
- Improve local understanding of the threat of a major earthquake by conducting a city-wide scenario modeling potential loss of life and injuries, destroyed and damaged structures, and interruptions to key services.
- Retrofit key critical City facilities with seismically rated window film treatments that ensure glass windows do not shatter during a strong seismic event. Promote retrofit of key community facilities not owned by the City.
- In coordination with Caltrans, update facilities condition assessments for bridges along evacuation routes to identify bridges that need seismic retrofitting. Consider pursuing highest standard improvement options (e.g., replacement instead of retrofitting) for bridges with seismic deficiencies.
- Pursue ground improvement projects, such as constructing a high strength capping layer, soil mixing, stone columns, soil wicks, chemical and pressure grouting, and other soil improvement techniques that reduce liquefaction susceptibility for key critical facilities in the event of an earthquake.
- Incentivize utilities to install flexible jointing and pipelines across fault segments located within the City. Ensure these pipelines have the necessary countermeasures to ensure breakage of lines is kept to a minimum and adequate shut off mechanisms to reduce exposure of pipeline contents to residents and businesses.

Hillside Overlay District

The purpose of the Hillside Overlay District is to provide regulations for the development of those areas in the City of Irvine and the sphere of influence which, due to their topography, require special consideration to assure that they are developed in a way that will substantially maintain their natural character and environmental and aesthetic values.[157]

Irvine Ranch Water District: Water Shortage Contingency Plan (2021)

IRWD's Water Shortage Contingency Plan provides a series of response actions that IRWD may implement in the event of a water shortage due to drought or emergency. It assumes that under a climate change scenario, that the anticipated Water Bank Usage would be 7,300 to 11,500 acre feet per year.[158] (See Drought: Adaptive Capacity

[157] City of Irvine. 1994. Municipal Code, Division 5- Overlay Districts, Chapter 5-2- Floodplain District. https://library.municode.com/ca/irvine/codes/zoning?nodeId=ZOOR_DIV5OVDI_CH5-4HIOVDI. Accessed May 3, 2022.
[158] Irvine Ranch Water District. 2021. 2020 Water Shortage Contingency Plan. June 28.

3.3 VULNERABILITY SCORING

The goal of this step is to identify priority climate vulnerabilities based on systematic scoring. Vulnerability scores are based on the combination of potential impact and adaptive capacity and help identify the major climate vulnerabilities. The scoring process utilizes numerical values, yet is primarily qualitative in nature.

Potential impacts are ranked through a method known as "vulnerability scoring," which is the recommended method identified in the 2020 update of the California Adaptation Planning Guide (APG 2.0). Major community elements and vulnerable populations at risk for each climate change–related effects were previously discussed per hazard according to exposure, sensitivity, and adaptive capacity. These scores are then used to determine an overall vulnerability score.

Methodology

This analysis uses the 2020 Irvine LHMP Hazard Scoring FEMA-based methodology as a baseline to score exposure and sensitivity. For the LHMP, each hazard is assigned a score of 1 to 4. The four criteria are:

- Probability: The likelihood that the hazard will occur in Irvine in the future.
- Location: The size of the area that the hazard would affect.
- Maximum probable extent: The severity of the direct damage of the hazard to Irvine.
- Secondary impacts: The severity of indirect damage of the hazard to Irvine.

The 2020 LHMP Committee assigned a weighting value to each criterion, giving a higher weight to the criteria deemed more important, and multiplied the score for each criterion by the weighing factor to determine the overall score for each criterion. The weighting values were recommended by FEMA:

- Probability: 2.0
- Location: 0.8
- Maximum probable extent: 0.7
- Secondary impacts: 0.5

After calculating the total impact score for each hazard (sum of the location, maximum probable extent, and the secondary impact). FEMA guidance recommends multiplying the total impact score by the overall probability to determine the final score for each hazard. A final score between 0 and 12 is considered a low-threat hazard, 12.1 to 42 is a medium-threat hazard, and a score above 42 is considered a high-threat hazard as illustrated in Table 3-21: Criterion Scoring (LHMP).

Table 3-21: Criterion Scoring (LHMP)

Probability		**Maximum Probable Extent**	
The estimated likelihood of occurrence based on historical data.		**The anticipated damage to a typical structure in the community. (Primary Impact)**	
Probability	**Score**	**Impact**	**Score**
Unlikely—less than a 1 percent chance each year.	1	Weak—little to no damage	1
Occasional—a 1 to 10 percent chance each year.	2	Moderate—some damage, loss of service for days	2
Likely—a 10 to 90 percent chance each year.	3	Severe—devastating damage, loss of service for months	3
Highly likely—more than a 90 percent chance each year.	4	Extreme—catastrophic damage, uninhabitable conditions	4
Location		**Secondary Impact**	
The projected area of the community affected by the hazard.		**The estimated secondary impacts to the community at large.**	
Affected Area	**Score**	**Impact**	**Score**
Negligible—affects less than 10 percent of the planning area.	1	Negligible—no loss of function, downtime, and/or evacuations	1
Limited—affects 10 to 25 percent of the planning area.	2	Limited—minimal loss of functions, downtime, and/or evacuations	2
Significant—affects 25 to 75 percent of the planning area.	3	Moderate—some loss of functions, downtime, and/or evacuations	3
Extensive—affects more than 75 percent of the planning area.	4	High—major loss of functions, downtime, and/or evacuations	4

Source. City of Irvine. 2020. Local Hazard Mitigation Plan. October.

To perform the climate vulnerability ranking, the APG scoring rubric (See Table 3-22: Potential Impact and Adaptive Capacity Scoring Rubric) was applied to the LHMP final Hazard Scores (See Table 3-23: Hazard Scores) so the potential impact and adaptive capacity of each Major Community Element could be compared. Scores of 0 – 20 were considered Limited Impact, scores of over 20 to 40 were considered Moderate Impact, and scores above 40 were considered High Impact.

Table 3-22: Potential Impact And Adaptive Capacity Scoring Rubric (APG)

Score*	Potential Impact	Adaptive Capacity
Limited	Impact is unlikely based on projected exposure; would result in minor consequences to public health, safety, and/or other metrics of concern.	The population or asset lacks capacity to manage climate impact; major changes would be required.
Moderate	Impact is somewhat likely based on projected exposure; would result in some consequences to public health, safety, and/or other metrics of concern.	The population or asset has some capacity to manage climate impact; some changes would be required.
High	Impact is highly likely based on projected exposure; would result in substantial consequences to public health, safety, and/or other metrics of concern.	The population or asset has high capacity to manage climate impact; minimal to no changes are required.

Source: CalOES APG 2.0, Modified.

Table 3-23: Hazard Scores (LHMP)

Hazard Type*	Probability	Impact			Total Score	Potential Impact Score
		Location	Primary Impact	Secondary Impacts		
Seismic Hazards[1]	4	4	4	4	64.0	High
Wildfire	4	3	3	3	48.0	High
Drought	3	4	4	4	48.0	High
Extreme Heat[2]	3	4	2	2	33.6	Moderate
Geologic Hazards[3]	2	2	3	3	20.8	Moderate
Flooding[4]	2	3	2	2	19.2	Limited

*Climate Change considerations discussed as appropriate within this hazard.

[1] Seismic Hazards includes: Fault Rupture, Seismic Shaking, Liquefaction

[2] The original category was Severe Weather includes: Extreme Heat, Severe Wind, Rain

[3] Geologic Hazards includes: Expansive Soils, Landslides, Methane Containing Soils, and Subsidence

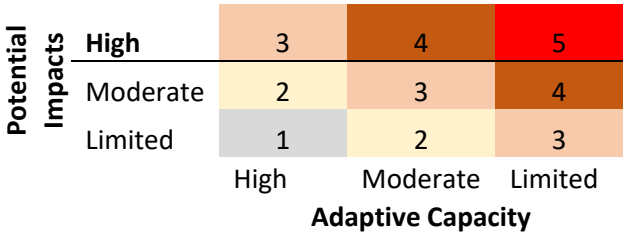
[4] Flooding includes a discussion regarding sea level rise

Source: Irvine LHMP 2020, modified.

Applying these generalized "Potential Impact Scores" from Table 3-23: Hazard Scores (LHMP) to the APG Vulnerability Score matrix (See Table 3-24: Vulnerability Score Matrix) produces an Irvine-focused vulnerability score for each Major Community Element and Vulnerable Population in Irvine by climate hazard (See Table 3-25: Climate Hazard Vulnerability Scores).

Note: The LHMP generalized the hazard impacts to the full community and this assessment considers subcomponents (i.e., Major Community Elements). Therefore, the "Potential Impact Scores" from the Table 3-23: Hazard Scores (LHMP) were considered only as a baseline. Additional information from this report's evaluation of Major Community Elements and Vulnerable Populations exposure and sensitivity to climate hazards may have altered the final climate vulnerability scores as shown in Table 3-25: Irvine Climate Hazard Vulnerability Scores.

Table 3-24: Vulnerability Score Matrix



Source: CalOES APG 2.0

Table 3-25: Irvine Climate Hazard Vulnerability Scores

Liquefaction	**Impact**	**Adaptive Capacity**	**Score**
Essential Facilities	High	Moderate	4
Transportation Systems	High	Limited	5
Lifeline Utility Systems	High	Moderate	4
Hazardous Materials	High	Moderate	4
Economy	Moderate	High	2
Natural Resource Areas	Limited	High	3
Vulnerable Populations	Moderate	Moderate	3

Wildfire + Smoke	**Impact**	**Adaptive Capacity**	**Score**
Essential Facilities	High	Moderate	4
Transportation Systems	Moderate	High	2
Lifeline Utility Systems	High	Moderate	4
Hazardous Materials	High	Moderate	4
Economy	Moderate	Moderate	3
Natural Resource Areas	High	Limited	5
Vulnerable Populations	High	Moderate	4

Drought	**Impact**	**Adaptive Capacity**	**Score**
Essential Facilities	Limited	High	4
Transportation Systems	Limited	High	1
Lifeline Utility Systems	High	Moderate	4
Hazardous Materials	Limited	High	4
Economy	Moderate	Moderate	3
Natural Resource Areas	High	Limited	5
Vulnerable Populations	Limited	Moderate	2

Table 3-25: Irvine Climate Hazard Vulnerability Scores (continued)

Extreme Heat	Impact	Adaptive Capacity	Score
Essential Facilities	Moderate	High	2
Transportation Systems	Moderate	Moderate	3
Lifeline Utility Systems	High	Moderate	4
Hazardous Materials	Moderate	Moderate	3
Economy	Moderate	Moderate	3
Natural Resource Areas	High	Limited	5
Vulnerable Populations	High	Limited	5

Landslide	Impact	Adaptive Capacity	Score
Essential Facilities	Limited	High	1
Transportation Systems	Moderate	High	2
Lifeline Utility Systems	Moderate	Moderate	3
Hazardous Materials	Limited	Moderate	2
Economy	Limited	High	1
Natural Resource Areas	Limited	High	1
Vulnerable Populations	Limited	High	1

Flooding	Impact	Adaptive Capacity	Score
Essential Facilities	Limited	High	1
Transportation Systems	Moderate	Moderate	3
Lifeline Utility Systems	Moderate	Moderate	3
Hazardous Materials	Limited	High	1
Economy	Limited	High	1
Natural Resource Areas	Limited	High	1
Vulnerable Populations	Limited	High	1

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APPENDIX C

Greenhouse Gas Emissions Inventory.

IRVINE CLIMATE ACTION AND ADAPTATION PLAN

Greenhouse Gas Emissions Inventory Report for the City of Irvine Climate Action and Adaptation Plan

Prepared For:

City of Irvine
Public Works and Transportation Department
1 Civic Center Plaza
City of Irvine, CA 92606
Contact: 949-724-7562

Prepared By:

1230 Columbia Street, Suite 440
San Diego, CA 92101
Contact: 619-795-0113

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ACRONYMS AND ABBREVIATIONS

ADC	Alternative daily cover
CalRecycle	California Department of Resources Recycling and Recovery
CAP	Climate action plan
Cap-and-Trade	California Greenhouse Gas Cap-and-Trade Program
CARB	California Air Resources Board
CAAP	Climate Action and Adaptation Plan
CEC	California Energy Commission
City	City of Irvine
CH_4	Methane
CO_2	Carbon dioxide
CO_2e	Carbon dioxide equivalent
Community Protocol	*U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions*
CPUC	California Public Utilities Commissions
eGRID	Emissions & Generation Resource Integrated Database
EMFAC2021	EMissions FACtor model
EPA	U.S. Environmental Protection Agency
GHG	Greenhouse gas
GWP	Global warming potential
HPMS	Highway Performance Monitoring System
HVAC	Heating, ventilation, and air conditioning
ICLEI	ICLEI - Local Governments for Sustainability
IRWD	Irvine Ranch Water District
IPCC	Intergovernmental Panel on Climate Change
ITAM	Irvine Transportation Analysis Model
JPA	Joint Power Authority
kWh/AF	Kilowatt-hours per acre-foot
lb/MWh	Pounds per megawatt-hour
lb/therm	Pounds per therm
LFG	Landfill gas
LPG	Liquid propane gas
Methane Regulation	Greenhouse Gas Emission Standards for Crude Oil and Natural Gas Facilities
MPO	Metropolitan Planning Organization
MSW	Municipal solid waste
$MTCO_2e$	Metric tons of carbon dioxide equivalent

MWh	Megawatt-hour
N_2O	Nitrous oxide
OCSan	Orange County Sanitation District
OPR	Governor's Office of Planning and Research
RTAC	Regional Targets Advisory Committee
RTDM	Regional Transportation Demand Model
RTP	Regional Transportation Plan
SB	Senate Bill
SCAQMD	Southern California Air Quality Management District
SCE	Southern California Edison
SoCalGas	Southern California Gas Company
TCR	The Climate Registry
VMT	Vehicle miles traveled
WWTP	Wastewater treatment plant

1 INTRODUCTION

This report describes the major GHG emission sources and activities for communitywide and municipal operations in the year 2019, which will inform the City's Climate Action and Adaptation Plan (CAAP).

1.1 INVENTORY PURPOSE AND DESCRIPTION

The first step in a city's climate action planning process is to develop a GHG emissions inventory, which is a snapshot of the GHG emissions associated with sources and activities within its jurisdiction in a given year. The purpose of an inventory is to:

- establish a baseline against which future emissions levels and future reduction targets can be measured,
- understand the sectors and sources generating GHG emissions and their relative contribution to total emissions, and
- monitor progress towards achievement of GHG reduction targets.

Preparing a GHG emissions inventory is a critical step in climate action planning. To develop and implement a plan that will effectively reduce GHG emissions, local governments must first have a comprehensive understanding of the emissions that are generated by activities within their jurisdictions. GHG emissions inventories not only serve to provide this knowledge, but they also act as the basis for measuring progress and provide agencies with a framework to track emissions over time and assess the effectiveness of actions taken to reduce emissions. Additionally, local governments often prepare inventories to exhibit accountability and leadership, motivate community action, and demonstrate compliance with regulations.

A GHG emissions inventory estimates emissions generated within a defined geographic boundary during a single year. It identifies the sectors, sources, and activities that are producing these emissions and the relative contribution of each, while also providing a baseline used to forecast emissions trends into the future. This information is used to set reduction targets that are consistent with State and/or local objectives and then identify local measures for reducing GHG emissions as part of the City's CAAP.

1.2 SUMMARY OF RESULTS

1.2.1 GHG Emissions from Communitywide Activities and Sources

Communitywide activities generated approximately 2,247,593 $MTCO_2e$ in 2019. The largest emissions-generating sectors include on-road transportation (51 percent), nonresidential building energy (24 percent), and residential building energy (13 percent). Collectively, on-road transportation and building energy (nonresidential and residential) account for approximately 88 percent of all emissions in 2019. The remaining 12 percent of emissions are attributable to solid waste (7 percent), off-road vehicles and equipment (3 percent), water supply (1 percent), and wastewater treatment (less than 1 percent).

The 2019 inventory will be the City's GHG emissions baseline for the CAAP and will be used to forecast emissions and set emissions reductions targets. Table 1 and Figure 1 present the results of the City's 2019 community GHG emissions inventory by sector. Descriptions of each emissions sector, including key sources of emissions, are provided in further detail in Section 3, "Data, Methods, and Assumptions."

Table 1 City of Irvine Community GHG Emissions Inventory, 2019

Sector	GHG Emissions ($MTCO_2e$)	Percent of Total
On-Road Transportation	1,140,206	51
Nonresidential Building Energy	550,138	24
Residential Building Energy	291,405	13
Solid Waste	160,626	7
Off-Road Vehicles and Equipment	68,756	3
Water Supply	30,798	1
Wastewater Treatment	5,665	<1
Total	**2,247,593**	**100**

Notes: Totals may not sum exactly due to independent rounding. GHG = greenhouse gases; $MTCO_2e$ = metric tons of carbon dioxide equivalent; NA = not applicable.

Source: Ascent Environmental 2024.

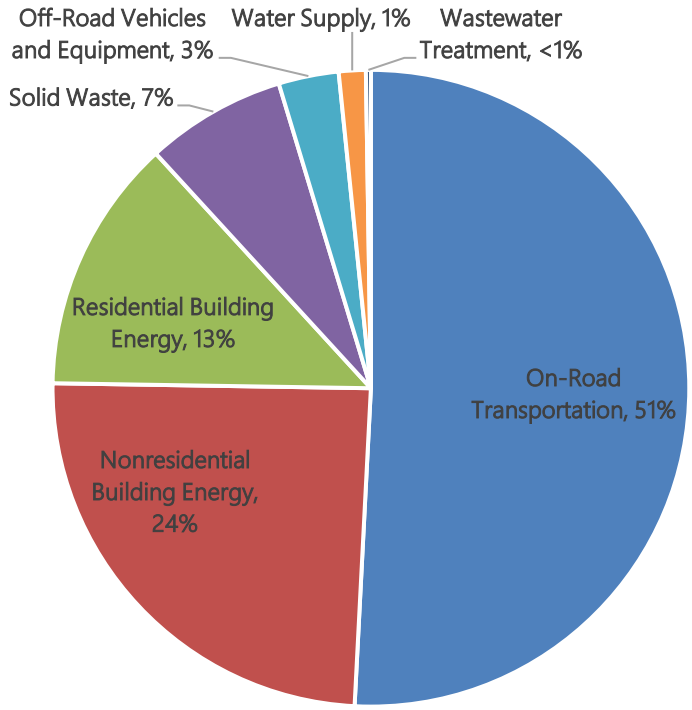

Figure 1 City of Irvine Community GHG Emissions Inventory, 2019

1.2.2 GHG Emissions from Municipal Operations

The City's municipal operations generated approximately 18,566 $MTCO_2e$ in 2019, which makes up less than one percent of the city's communitywide total emissions. Buildings and facilities (65 percent) and employee commutes (16 percent) account for approximately 81 percent of emissions of municipal operations emissions in 2019. The remaining 19 percent of emissions are attributable to wastewater treatment (6 percent), vehicle fleet (6 percent), streetlights and traffic signals (6 percent), solid waste (1 percent), and water supply (<1 percent). Table 2 presents the City's 2019 municipal operations GHG emissions inventories by sector, and Figure 2 illustrates the municipal operations inventory.

Table 2 City of Irvine Municipal Operations Greenhouse Gas Emissions Inventory, 2019

Sector	$MTCO_2e$	Percent of Total
Buildings and Facilities	12,003	65
Employee Commute	3,032	16
Wastewater Treatment	1,144	6
Vehicle Fleet	1,127	6
Streetlights and Traffic Signals	1,097	6
Solid Waste	159	1
Water Supply	4	<1
Total	**18,566**	**100**

Notes: Totals may not sum exactly due to independent rounding. $MTCO_2e$ = metric tons of carbon dioxide equivalent.

Source: Ascent Environmental 2022.

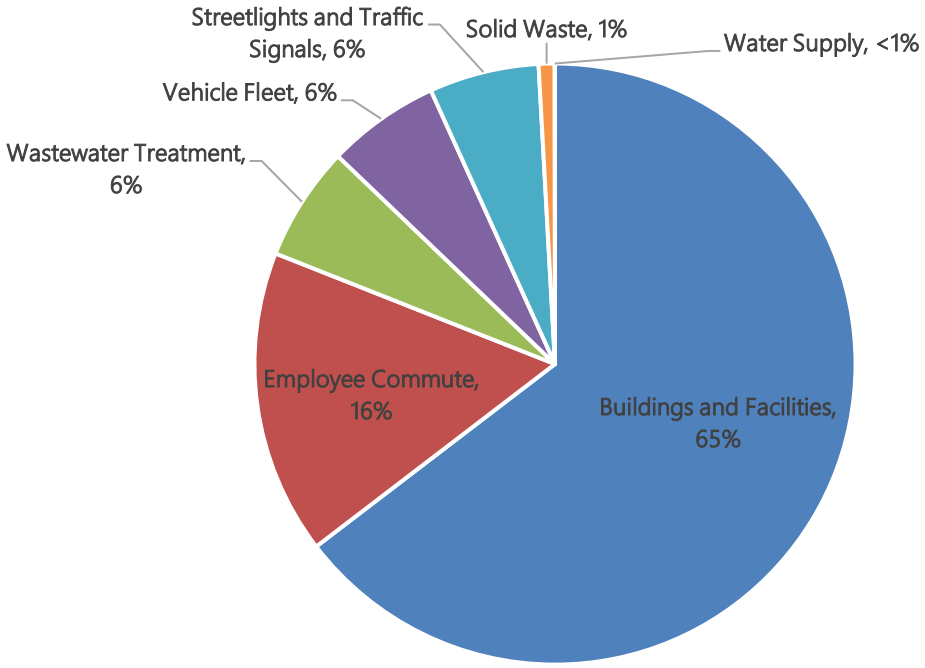

Figure 2 City of Irvine Municipal Operations GHG Emissions Inventory, 2019

1.3 ORGANIZATION OF THIS REPORT

The remainder of this report consists of the following sections:

- **Section 2: Inventory Overview** outlines considerations for preparing community and municipal GHG emissions inventories, summarizes industry-leading protocols and methods for inventories, discusses inventory boundaries, and describes the emissions sectors and sources that are included and excluded in the community GHG emissions inventory.
- **Section 3: Data, Methods, and Assumptions** describes the data, methods, and assumptions used in the community and municipal inventories and presents GHG emissions estimates by sector.

2 INVENTORY OVERVIEW

2.1 CONSIDERATIONS FOR DEVELOPING AN INVENTORY

Nations, states, local jurisdictions, public agencies, and corporations estimate GHG emissions for different purposes. Several general approaches exist to quantify GHG emissions, and the method chosen by governments or private entities is driven by the purpose for developing an inventory. State, federal, and international agencies have developed industry protocols and recommendations for local governments preparing GHG emissions inventories at the community level.

2.1.1 Production-based Inventories

The GHG emissions inventory approach generally used by local governments in the climate action planning process, known as a "production-based" inventory, estimates GHG emissions generated by activities occurring within a defined boundary during a single year. This has become the standard approach recommended by industry protocols and includes emissions that are generated from community activities that occur within the jurisdictional boundary of the inventory, such as those emitted from natural gas furnaces used for heating buildings throughout a community. It also includes certain "trans-boundary" emissions that are associated with activities occurring within the inventory's boundary but are released into the atmosphere outside of the boundary. For example, electricity emissions in a production-based inventory are attributed to a community based on electricity consumption within the inventory boundary, even if the electricity was generated and produced GHG emissions outside of the inventory boundary. More information regarding considerations for preparing production-based inventories is included in Sections 2.3.2 through 2.4.1.

2.1.2 Consumption-based Inventories

In addition to production-based emissions inventories, corporations, local governments, and other entities have prepared "consumption-based" emissions inventories. A consumption-based emissions inventory includes the total lifecycle GHG emissions generated by the production, shipping, use, and disposal of goods and services consumed in a community within a given year. For example, for transportation sector GHG emissions, this approach includes the emissions resulting from motor vehicle production processes, shipping the vehicle to the consumer, producing and refining fuel used in the vehicle, the combustion of the fuel used in the vehicle, and disposal of the vehicle at the end of its useful life.

This report addresses how inventories of the City's emissions from communitywide sources and activities and municipal operations were developed using a production-based approach. This is consistent with recommendations and guidance from industry protocols (described further in Section 2.2), and State agencies, including the California Air Resources Board (CARB) and the Governor's Office of Planning and Research (OPR). Production-based inventories provide local governments with the information needed to develop effective climate action policy within their communities; because of this, the production-based inventory method is the most common approach taken by local governments across California and nation.

2.2 PROTOCOLS AND METHODOLOGIES

2.2.1 Protocols for Accounting and Reporting of Greenhouse Gas Emissions

Several inventory protocols have been developed to provide guidance for communities and local governments to account for emissions accurately and consistently. ICLEI – Local Governments for Sustainability (ICLEI) develops protocols for local-scale accounting of emissions that have become the industry standard for local governments developing GHG emissions inventories.

The most recent guidance for community-scale emissions inventories is ICLEI's July 2019 publication *U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions* (Community Protocol), Version 1.2 (ICLEI 2019). State agencies, including CARB and OPR, recommend that jurisdictions prepare community GHG emissions inventories using the guidelines included in the Community Protocol (CARB 2017: 100; OPR 2017: 226).

The Community Protocol identifies six principles for GHG accounting and reporting. These principles were adapted from internationally recognized sources and were used to guide the development of the Community Protocol. ICLEI recommends that local governments consider the principles when preparing an inventory. The GHG accounting and reporting principles are summarized below.

- Relevance, Including Policy Relevance, and Utility for Users: The ultimate objective and intent of an inventory should be considered during the inventory development process. Inventories should be organized in a way that is understandable and useful for policy makers and the public while appropriately reflecting community GHG emissions and enabling the evaluation of emissions trends over time.
- Accuracy: The use of GHG emissions accounting methods that are expected to systematically under- or over-estimate emissions should be avoided. Decisionmakers should be able to act with reasonable assurance as to the integrity of emissions estimates.
- Completeness: Community GHG emissions inventories should be as comprehensive as possible and include all emissions associated with the community, as well as community GHG emissions "sinks" (i.e., the opposite of an emissions source; any reservoir, natural or otherwise, that accumulates and stores GHG emissions).
- Measurability: Methods used to quantify GHG emissions should be readily available, adequately substantiated and of known quality, and updated regularly as established methods evolve.
- Consistency and Comparability: Community inventories should consistently use preferred, established methods to enable tracking of emissions over time, evaluation of reduction measures effectiveness, and comparison between communities. Alternative methods should be documented and disclosed.
- Transparency: All relevant data sources, methods, and assumptions should be disclosed and described to allow for future review and replication. Similarly, all relevant issues should be documented and addressed coherently.

Consistent with the above principles as well as industry standards and best practices, the City's inventory of GHG emissions from communitywide sources and activities primarily follows methodologies provided by the Community Protocol (it also follows methodologies from CARB for certain sectors and sources not included in the Community Protocol).

ICLEI has also developed guidance to assist local governments in conducting inventories of emissions from their governmental operations. The City's municipal operations inventory follows methodologies from ICLEI's latest technical guidance in its May 2010 publication *Local Government Operations Protocol (LGOP) for the Quantification and Reporting of Greenhouse Gas Emissions Inventories* (ICLEI 2010).

2.2.2 California Air Resources Board Methods

Each year, CARB develops and publishes the California GHG Emission Inventory for emissions statewide in California. CARB follows Intergovernmental Panel on Climate Change (IPCC) guidelines for national reporting, and its overarching approach and many of its methods align with the Community Protocol. As climate change science and GHG emissions accounting practices have evolved, CARB has implemented additional methodologies for certain emissions sectors and sources that are not included in the Community Protocol.

The inventory is aligned with the CARB inventory as much as possible. Consistency with the State's methodologies and approaches will be beneficial for upcoming phases of the CAAP development process, including estimating projected GHG emissions in the future (i.e., forecasting emissions), setting GHG emissions reduction targets, and measuring progress towards established targets.

The City's inventories use methods provided by CARB and the California GHG Emission Inventory for several emissions sectors and sources. For example, although the Community Protocol recommends using the U.S. Environmental Protection Agency's (EPA's) NONROAD model, emissions from off-road vehicles and equipment in the city were obtained from CARB's OFFROAD models, which provide more geographic-specific emissions estimates for California using the best available data.

2.3 EMISSIONS SECTORS AND SOURCES

There are several approaches for categorizing and grouping GHG emissions in inventories. Generally, community GHG emissions are organized into emissions sectors, which typically include:

- Building energy
- Transportation
- Solid waste
- Off-road equipment
- Water
- Wastewater

Sometimes community sectors are broken down further, such as residential building energy and nonresidential building energy, and sectors may also be combined, such as water and wastewater. Local governments may also include additional relevant sectors, such as agriculture. Municipal GHG emissions are also organized into emissions sectors, which typically include:

- Building and facilities
- Streetlights and traffic signals
- Employee commutes
- Vehicle fleets
- Solid waste
- Water supply
- Wastewater treatment

The purpose of categorizing GHG emissions into broad sectors is to provide local governments and the public with a useful organization of community emissions. Importantly, GHG emissions sectors may not align directly with economic sectors (e.g., hospitality), but there may be overlap for some communities.

Within GHG emissions sectors, emissions are generated in a variety of ways. For example, motor vehicles burn fossil fuels and emit GHGs directly into the atmosphere; the electricity used in homes and businesses produces indirect emissions from power plants; and solid waste that ends up in landfills breaks down and releases GHG emissions over time. The Community Protocol organizes different types of community GHG emissions into two general categories:

- GHG emissions **sources** are those that release emissions directly into the atmosphere as a result of any physical process that occurs within the jurisdictional boundary of the inventory. Natural gas combustion for heating in homes and diesel fuel combustion in motor vehicles within the community are examples of GHG emissions sources.
- GHG emissions **activities** are those that release emissions into the atmosphere either directly or indirectly as a result of the use of energy, materials, and/or services within the community. For example, GHG emissions from a community's electricity use are accounted for and considered GHG emissions activities, even if the burning of fossil fuels to generate the electricity occurred and produced emissions outside of the inventory boundary.

For the sake of clarity, this report uses "GHG emissions sources" to represent both direct in-boundary emissions *sources* as well as indirect emissions that are produced out-of-boundary as a result of *activities* that occur within the community. The GHG emissions sources in the City's community inventory are organized under six sectors: building

energy (residential and nonresidential), on-road transportation, off-road vehicles and equipment (e.g., lawn and landscape equipment), solid waste, water supply, and wastewater treatment.

2.3.1 Community Protocol-Compliant Sources

When developing a community inventory, it is important for local governments to determine what will be included in the inventory scope. This may be influenced by factors such as the purpose and intended narrative of the inventory, the reporting framework that will be used, and the GHG emissions sources present in the community. While local governments have some flexibility in determining an inventory's scope, the Community Protocol requires the inclusion of a minimum of five emissions sources in community inventories:

1. Use of electricity by the community.
2. Use of fuel in residential and commercial stationary combustion equipment.
3. On-road passenger and freight motor vehicle travel.
4. Use of energy in potable water and wastewater treatment and distribution.
5. Generation of solid waste by the community.

The Community Protocol strongly encourages local governments to include other emissions-generating sources in accounting and reporting as well. Considerations for including additional sources are outlined in the following section.

2.3.2 Additional Sources

Many local governments go beyond the minimum requirements of the Community Protocol. Beyond the five emissions sources required by the Community Protocol, the additional GHG emissions sources included in a community inventory are determined by the jurisdiction conducting the inventory. The Community Protocol recommends the Local Government Significant Influence reporting framework, where local governments account for all emissions sources over which they have authority or significant influence. The additional source included in the community inventory is off-road vehicles and equipment.

This approach benefits the overall climate action planning process because it emphasizes the emissions sources that the local government has the greatest ability to address (ICLEI 2019: 29). For example, because the City has limited control over the waste that is generated by other communities but is disposed at landfills within the city, imported waste-related emissions are excluded from the City's inventory.

2.4 BOUNDARIES

The scope and boundary chosen for estimating GHG emissions may vary depending on the focus and/or intent of the inventory. For example, while corporate inventories use the concept of ownership to guide GHG emissions accounting—where emissions generated by all sources and activities owned by the entity are accounted for, regardless of where emissions are produced—community-scale inventories serve to convey information about emissions associated with politically defined communities (ICLEI 2019: 12).

As described in the previous sections, production-based community inventories include emissions that are produced within a community's geographic boundary as well as those that are produced outside the boundary but result from activities within the community. Regardless of location within or outside of a community's boundary, upstream emissions generated by the consumption of goods and services are excluded from production-based inventories. Inventories following the Community Protocol are required to include several emissions sources; however, certain emissions sources that are located within the inventory boundary may be excluded from a community inventory. The following section outlines considerations and the decision-making framework for determining what GHG emissions sources are included or excluded from an inventory.

2.4.1 Inventory Boundaries

The CAAP aims to reduce GHG emissions from sources within the city for which the City has operational control, regulatory authority, or significant influence. As a result, the City's inventories include emissions generated from sources and activities that occur within the boundaries of the city and over which the City has operational control, regulatory authority, or significant influence.

The inventories do not include emissions generated from activities located within the city's boundary but outside of its jurisdiction, as the City does not have operational control, regulatory authority, or significant influence over these emissions sources.

GHG emissions generated from the University of California, Irvine (UCI) campus, located within the City's boundaries are excluded from the community inventory because UCI is a division of the state government over which the City has no operational control, regulatory authority, or significant influence. Furthermore, one stationary source is located on the UCI campus is regulated by CARB under the California Greenhouse Gas Cap-and-Trade Program (Cap-and-Trade).

The GHG emissions sectors and sources included and excluded in the 2019 community inventories are presented in Table 3. Additionally, Table 3 identifies the protocol that provided the methodology for estimating GHG emissions from each emissions source. Emissions sources that identify multiple protocols used a combination of data and methods from multiple protocols. For example, off-road vehicles and equipment calculations used methods consistent with IPCC and the Community Protocol but substituted California-specific data obtained from CARB for less geographic-specific data provided by the protocols. More information on the protocols used for each emissions source can be found in Attachment A.

Table 3 Summary of Sectors and Sources in Community and Municipal Operations Inventories

Sector/Source	Included	Excluded	Protocol(s)
Community Inventory			
On-Road Transportation			
On-Road Transportation	Emissions from 100 percent of vehicle trips within the city (internal-internal) and 50 percent of vehicle trips starting or ending outside the city (internal-external and external-internal)	Emissions from 100 percent of pass-through vehicle trips starting and ending outside the city (external-external)	Community Protocol
Building Energy			
Electricity	Emissions associated with all electricity consumed within the city	NA	Community Protocol
Natural Gas	Emissions from natural gas consumed within the city	NA	Community Protocol
Backup Generators	Emissions from diesel, natural gas, and gasoline consumed in backup generators within the city	NA	Community Protocol
Solid Waste			
Community-Generated Solid Waste	Emissions from all waste generated within the city	Emissions from waste generated outside of the city but disposed of within the city	Community Protocol
Off-Road Vehicles and Equipment			
Off-Road Vehicles and Equipment	Emissions from off-road vehicles and equipment within the city	NA	Community Protocol/CARB
Wastewater Treatment			

Sector/Source	Included	Excluded	Protocol(s)
Wastewater Treatment	Emissions associated with wastewater generated within the city	Emissions from wastewater generated outside of the city but treated within the city	Community Protocol
Water Supply			
Water Supply	Emissions associated with water use within the city	NA	Community Protocol
Municipal Inventory			
Buildings and Facilities			
Electricity	Emissions associated with electricity consumed from municipal operations	NA	LGOP
Natural Gas	Emissions from natural gas consumed from municipal operations	NA	LGOP
Backup Generators	Emissions from diesel, natural gas, and gasoline consumed in backup generators from municipal facilities	NA	LGOP
Streetlights and Traffic Signals			
Electricity	Electricity used for streetlights and traffic signals within the city	NA	LGOP
Employee Commute			
VMT	VMT from municipal employee commute trips	NA	LGOP
Vehicle Fleet			
Fuel Use	Fuel consumption from municipal owned and operated vehicles (on-road and off-road)	NA	LGOP
Solid Waste			
Solid Waste Disposed	Emissions from all waste generated by municipal employees	NA	LGOP
Wastewater Treatment			
Wastewater Treatment	Emissions associated with wastewater generated by municipal employees	NA	LGOP
Water Supply			
Water Supply	Emissions associated with water use from municipal facilities	NA	LGOP

Notes: CARB = California Air Resources Board; Community Protocol = U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions; LGOP = Local Government Operations Protocol; NA = not applicable; VMT = vehicle miles traveled.

Source: Ascent Environmental 2022.

3 DATA, METHODS, AND ASSUMPTIONS

3.1 OVERVIEW OF ACTIVITY DATA AND EMISSIONS FACTORS

The basic calculation for estimating GHG emissions involves two primary inputs: activity data and emissions factors. Activity data refers to the relevant measurement of an activity resulting in emissions, and emissions factors represent the amount of GHGs emitted on a per unit of activity basis. Emissions factors are applied to activity data (i.e., the two values are multiplied together) to estimate GHG emissions. For example, in the community residential energy sector, activity data of annual community electricity consumption in megawatt-hours (MWh) is multiplied by an emissions factor in pounds of GHG per MWh, which results in a pounds of GHG emissions value. This calculation-based methodology is used for estimating emissions from most sources in the City's production-based inventories. An overview of activity data and emissions factors for each emissions source, along with data sources, is shown in Table 4. Detailed methods are described in the following sections.

Table 4 2019 City of Irvine Summary of Activity Data and Emissions Factors

Sector/Source	Input Type	Description and Data Sources
Community		
On-Road Transportation		
On-Road Transportation	Activity data	VMT data from ITAM Traffic Model 2021 and SCAG RTP Model 2016.
	Emissions factor	Orange County-specific emissions factors from CARB
Building Energy		
Electricity	Activity data	Electricity consumption data from SCE
	Emissions factor	SCE Power Content Label and CARB Mandatory Reporting of Greenhouse Gases (MRR)
Natural Gas	Activity data	Natural gas consumption data from SoCalGas
	Emissions factor	Average emissions factors from TCR
Backup Generators	Activity data	Fuel consumption data estimated from SCAQMD permit data
	Emissions factor	Average emissions factors from TCR
Solid Waste		
Community-Generated Solid Waste	Activity data	Waste disposal data from CalRecycle
	Emissions factor	Mixed municipal solid waste emissions factor from EPA
Off-Road Vehicles and Equipment		
Off-Road Vehicles and Equipment	Activity data	Off-road vehicles and equipment activity and emissions factors data from CARB
	Emissions factor	
Wastewater Treatment		
Wastewater Treatment	Activity data	Wastewater generation and process-related data from IRWD and OCSan
	Emissions factor	Emissions factors based on treatment processes from IRWD, OCSan, and ICLEI
Water Supply		
Water Supply	Activity data	Water consumption data from IRWD
	Emissions factor	Energy intensity factors from CPUC
Municipal		
Buildings and Facilities		
Electricity	Activity data	Electricity consumption data from SCE

Sector/Source	Input Type	Description and Data Sources
	Emissions factor	SCE Power Content Label and CARB Mandatory Reporting of Greenhouse Gases (MRR)
Natural Gas	Activity data	Natural gas consumption data from SoCalGas
	Emissions factor	Average emissions factors from TCR
Backup Generators	Activity data	Fuel consumption from the City
	Emissions factor	Average emissions factors from TCR
Streetlights and Traffic Signals		
Electricity	Activity data	Electricity use from streetlights and traffic signals from SCE
	Emissions factor	SCE Power Content Label and CARB Mandatory Reporting of Greenhouse Gases (MRR)
Employee Commute		
VMT	Activity data	Employee commute mileage from the City
	Emissions factor	Orange County-specific emissions factors from CARB
Vehicle Fleet		
Fuel consumption	Activity data	Fuel consumption from the City
	Emissions factor	Fuel consumption emissions factors from TCR
Solid Waste		
Solid Waste Disposed	Activity data	Waste disposal data from CalRecycle
	Emissions factor	Municipal solid waste emissions factor from EPA
Wastewater Treatment		
Wastewater Treatment	Activity data	Wastewater generation and process-related data from IRWD and OCSan
	Emissions factor	Emissions factors based on treatment processes from IRWD, OCSan, and ICLEI
Water Supply		
Water Supply	Activity data	Water consumption data from IRWD
	Emissions factor	Energy intensity factors from CPUC

Notes: CalRecycle = California Department of Resources Recycling and Recovery; CARB = California Air Resources Board; CPUC = California Public Utilities Commission; EPA = U.S. Environmental Protection Agency; ICLEI = ICLEI – Local Governments for Sustainability; IRWD = Irvine Ranch Water District; ITAM = Irvine Transportation Analysis Model; OCSan = Orange County Sanitation District; RTP = Regional Transportation Plan; SCAG = Southern California Association of Governments; SCAQMD = Southern California Air Quality Management District; SCE = Southern California Edison; SoCalGas = Southern California Gas Company; TCR = The Climate Registry; VMT = vehicle miles traveled.

Source: Ascent Environmental 2022.

3.2 GLOBAL WARMING POTENTIALS AND EMISSIONS UNITS

GHG emissions other than carbon dioxide (CO_2) generally have a stronger insulating effect and thus, a greater ability to warm the Earth's atmosphere through the greenhouse effect. This effect is measured in terms of a pollutant's GWP. CO_2 has a GWP factor of one while all other GHGs have GWP factors measured in multiples of one relative to the GWP of CO_2. This conversion of non-CO_2 gases to one unit enables the reporting of all emissions in terms of carbon dioxide equivalent (CO_2e), which allows consideration of all gases in comparable terms and makes it easier to communicate how various sources and types of GHG emissions contribute to climate change. The standard unit for reporting emissions is metric tons of carbon dioxide equivalent ($MTCO_2e$).

Consistent with the best available science, these inventories use GWP factors published in the Sixth Assessment Report from IPCC, where methane (CH_4) and nitrous oxide (N_2O) have GWP factors of 27.9 and 273, respectively (IPCC 2021). These values represent the GWP of GHG on a 100-year time horizon. This means that CH_4 is approximately 28 times stronger than CO_2 and N_2O is 273 times stronger than CO_2 in their potential to warm Earth's atmosphere over the

course of 100 years. The use of 100-year GWP values is consistent with CARB methods and reflects the long-term planning horizon of the CAAP.

3.3 DATA QUALITY AND ACCURACY

When preparing a GHG emissions inventory, the goal is to use the best available data and methodologies to develop the most accurate picture of a community's emissions. However, some degree of inaccuracy is inherent to all inventories. As described by the Community Protocol, "While no community inventory is fully comprehensive (some emissions cannot be estimated due to a lack of valid methods, a lack of emissions data, or for other reasons), community inventories often aim to provide as complete a picture of GHG emissions associated with a community as is feasible" (ICLEI 2019: 12). The accuracy of a GHG emissions inventory is primarily dependent on activity data (e.g., tons of solid waste generated by a community), emissions factors (e.g., grams of CO_2 per vehicle mile traveled [VMT] in a county), and scaling factors (e.g., percentage of county-level off-road vehicles and equipment emissions attributed to a local jurisdiction). The year 2019 was chosen for the inventories because it is the most recent calendar year for which representative data are available due to the changes in activity that have occurred in 2020 and 2021 due from the COVID-19 pandemic. Thus, the year 2019 is most representative year of typical conditions.

Development of the City's GHG emissions inventories was a robust and comprehensive process rooted in industry standards and best practices, and it included extensive research and consultation with City staff and departments and regional and State agencies and organizations to obtain data that are as accurate as feasible. The City recognizes that even though its inventory is consistent with all protocols previously discussed and the data used are as accurate as feasible, perfect precision in emissions estimates is not possible at this time. The following are assumptions that were made due to the unavailability of data:

- Community and municipal wastewater activity data. Wastewater-related data within the city was limited. The inventories assume that the Irvine Ranch Water District (IRWD) and Orange County Sanitation District (OCSan) were the two centralized wastewater treatment plants (WWTPs) serving the city. Because wastewater treated according to each entity was unable to be provided, their service boundaries within the city limits were mapped. This mapping exercise was able to determine what proportion of the city's population is serviced by each entity and was then applied to each entity's treatment types. Attachment B of this report provides the service boundary map of IRWD and OCSan within the city limits.
- Community back-up generator activity data: Because generator hours of operations were not able to be provided for each generator operating in 2019 from Southern California Air Quality Management District (SCAQMD), a conservative estimated number of operating hours was applied for both maintenance and emergency scenarios. Fuel consumption was also not available and was replaced using average rates using CARB's OFFROAD model.
- Scaling factors used to attribute emissions to the city level. Certain emissions sectors use data that are not specific to the city but Orange County as a whole, and scaling factors were used to apportion data to the city. For example, emissions data for off-road vehicles and equipment, obtained from CARB's OFFROAD models, are provided for the entire county. Population, employment, and service population factors (i.e., the proportion of the city compared to the entire county) were used to scale county-level data to the city.

3.4 COMMUNITY INVENTORY DATA AND ASSUMPTIONS

3.4.1 Sector-Specific Assumptions and Methods

The following sections describe in detail the methods, data, and assumptions that were used in estimating the City's community GHG emissions in 2019. Population and employment data were used to scale activity levels for certain emissions sources and sectors. Population and employment data for 2019 were obtained from the City's land use database and the Center for Orange County Projections. The list below summarizes this information at a high level for each sector.

- **Building Energy:** Annual electricity and natural gas usage data for the City were provided by Southern California Edison (SCE) and Southern California Gas Company (SoCalGas). Annual nonresidential backup generator usage was provided by SCAQMD. Emissions factors for nonresidential backup generator fuels were obtained from TCR.
- **On-Road Transportation:** For the on-road transportation sector, annual VMT were obtained from Iteris using the Irvine Transportation Analysis Model (ITAM) Traffic Model 2021 and Southern California Association of Governments (SCAG) Regional Transportation Plan (RTP) Model 2016. Vehicle emissions factors were derived from the 2021 EMissions FACtor (EMFAC2021) model, CARB's statewide mobile source emissions inventory model.
- **Off-Road Vehicles and Equipment**: Off-road vehicles and equipment emissions were estimated from CARB's OFFROAD2007 and OFFROAD2021 models and scaled by population, employment, or service population (i.e., the sum of population and employment) depending on the equipment type.
- **Solid Waste:** Emissions associated with waste generated by residents and businesses in the city were estimated using disposal data available from the California Department of Resources Recycling and Recovery (CalRecycle) for landfills receiving waste from the city. Landfill gas (LFG) collection information was available from EPA.
- **Water Supply:** Using guidance provided by ICLEI, water supply emissions were estimated using water consumption data from IRWD in combination with region-specific energy intensity factors obtained from the California Public Utilities Commissions (CPUC).
- **Wastewater Treatment:** Emissions from wastewater treatment depend on the types of treatment processes and equipment that centralized WWTPs use. Data regarding treatment processes, population served, digester gas combustion, and daily nitrogen load were obtained from IRWD and OCSan.

3.4.2 Utility Emissions Factors

Emissions of CO_2, CH_4, and N_2O per MWh of electricity or therm of natural gas can vary by location and from year to year depending on several factors. Utility-specific emissions factors were obtained and used throughout the 2019 inventories to estimate GHG emissions from electricity and natural gas consumption. Sources for electricity and natural gas emissions factors are shown below.

- **Electricity:** SCE's emissions factor for 2019 was derived from its Power Content Label, which shows 16.1 percent natural gas and 32.6 percent from unspecified sources of power (unspecified power is electricity that has been purchased through open market transactions and is not traceable to a specific generation source: SCE 2019). In total, this implies that SCE's portfolio is 48.7 percent carbon-emitting power.[1] This 48.7 percent was then multiplied by the CARB emissions factor for Mandatory Reporting of Greenhouse Gases (MRR) of 0.428 MT CO2e/MWh, which reflects the emissions from unspecified power, and additionally is similar to the emission factor from an average single-cycle natural gas power plant (CARB 2018: 16).
- **Natural Gas:** Utility natural gas emissions factors for CO_2, CH_4, and N_2O were obtained from TCR's 2020 Default Emission Factors (TCR 2020).

Specific utility emissions factors used in the inventory calculations are shown in Tables 5 and 6. Emissions factors are shown in standards units for electricity (pounds of GHG per MWh) and natural gas (pounds per therm).

Table 5 2019 City of Irvine Electricity Emissions Factors

Provider	Pollutant	Emissions Factor (lb/MWh)
SCE	CO_2e	459.52

Notes: CH_4 = methane; CO_2 = carbon dioxide; lb = pounds; MWh = megawatt-hours; N_2O = nitrous oxide; SCE = Southern California Edison.
Source: Utility emissions factors provided by SCE. Table compiled by Ascent Environmental in 2022.

[1] This memorandum uses "carbon-emitting power" as a shorthand to refer to the sum of power generated by natural gas-fired generators and unspecified power.

Table 6 2019 City of Irvine Natural Gas Emissions Factors

Provider	Pollutant	Emissions Factor (lb/therm)
SoCalGas	CO_2	11.7
	CH_4	0.00104
	N_2O	0.0000220

Notes: CH_4 = methane; CO_2 = carbon dioxide; lb = pounds; MWh = megawatt-hours; N_2O = nitrous oxide; SoCalGas = Southern California Gas Company.
Source: Utility emissions factors provided by TCR. Table compiled by Ascent Environmental in 2022.

RESIDENTIAL ENERGY

Residential energy emissions in the city result indirectly from electricity consumption and directly from onsite combustion of natural gas. SCE is the provider of residential energy in the city. To calculate the $MTCO_2e$ of residential electricity consumption, the emissions factor shown in Table 5 was applied to electricity consumption data. Annual residential natural gas consumption in therms was obtained from SoCalGas. CO_2, CH_4, and N_2O emissions factors for natural gas were applied to consumption data to estimate $MTCO_2e$ from residential natural gas usage.

NONRESIDENTIAL ENERGY

Nonresidential energy emissions, which are generated by commercial and industrial uses, result indirectly from electricity consumption and directly from onsite combustion of natural gas. SCE provides nonresidential electricity in the city. Emissions associated with nonresidential energy consumption were quantified using the same methods as described above for residential energy calculations.

Data for annual nonresidential backup generators were obtained from SCAQMD, expressed as gallons for diesel fuel and standard cubic feet for propane and natural gas. Emissions factors obtained from TCR were applied to fuel consumption data to estimate GHG emissions associated with nonresidential backup generator usage.

3.4.3 Building Energy

Residential and nonresidential building energy use in the city resulted in approximately 841,543 $MTCO_2e$ in 2019. This sector generated approximately 37 percent of the city's emissions in 2019 and represents the second-largest emissions sector in the inventory. Emissions were a result of natural gas combustion for heating and cooking in homes and businesses and electricity use, primarily for lighting and heating, ventilation, and air conditioning (HVAC) and to power appliances. A marginal amount of nonresidential building energy emissions was associated with the consumption of diesel, natural gas, and gasoline in backup generators.

Nonresidential natural gas use accounted for approximately 19 percent of the city's 2019 building energy emissions, and residential natural gas use accounted for approximately 21 percent. Nonresidential electricity accounted for approximately 46 percent of the city's 2019 building energy emissions, and residential electricity use accounted for approximately 14 percent. Nonresidential backup generators accounted for 1 percent of emissions from the building sector in 2019. The GHG emissions associated with energy consumed by the All-American Asphalt facility have been included in this inventory under the nonresidential energy use category. Annual electricity, natural gas, and backup generator usage and GHG emissions are shown in Table 7, and additional information regarding each emissions source and calculations are discussed below.

Table 7 2019 City of Irvine Community Building Energy Use and GHG Emissions

Energy Type	Quantity	GHG Emissions
Electricity	MWh	$MTCO_{2e}$
Residential	559,329	116,584
Nonresidential	1,847,715	385,130

Energy Type	Quantity	GHG Emissions
Electricity Total	*2,407,044*	*501,715*
Natural Gas	**therms**	**$MTCO_2e$**
Residential	32,849,598	174,820
Nonresidential	30,158,957	160,501
Natural Gas Total	*63,008,555*	*335,322*
Backup Generators	**NA**	**$MTCO_2e$**
Nonresidential	NA	4,507
Energy Combined	**NA**	**$MTCO_2e$**
Residential	NA	291,405
Nonresidential	NA	550,138
Total	**NA**	841,543

Notes: Totals in columns may not sum exactly due to independent rounding. GHG = greenhouse gas; $MTCO_2e$ = metric tons of carbon dioxide equivalent; MWh = megawatt-hours; NA = not applicable.

Source: Ascent Environmental 2022.

3.4.4 On-Road Transportation

Based on modeling conducted, on-road transportation in the city resulted in approximately 1,140,206 $MTCO_2e$ in 2019, or 51 percent of the city's emissions in 2019. The on-road transportation sector represents the largest emissions sector in the city. Annual VMT and GHG emissions from on-road transportation are shown in Table 8. Additional details and calculation methodologies and assumptions are described below.

Table 8 2019 City of Irvine Community On-Road Transportation VMT and GHG Emissions

Source	Annual VMT	GHG Emissions ($MTCO_2e$)
On-Road Transportation	2,910,428,375	1,144,206

Notes: GHG = greenhouse gas; $MTCO_2e$ = metric tons of carbon dioxide equivalent; VMT = vehicle miles traveled.

Source: Ascent Environmental 2022.

On-road transportation emissions are primarily the result of the combustion of gasoline and diesel fuels in passenger vehicles (i.e., cars, light-duty trucks, and motorcycles), medium- and heavy-duty trucks, and other types of vehicles permitted to operate "on road." To a smaller degree, emissions from on-road electric vehicles also result from upstream electricity generation; these emissions are represented in annual electricity emissions in the city. Due to lack of available data, emissions from the combustion of natural gas and other non-electric alternative fuels in on-road vehicles were not included in the community inventory and are assumed to have minimal contribution to total emissions.

Iteris conducted a VMT analysis that considered daily and annual VMT in the city for 2019. These VMT estimates are associated with trips that begin or end in the city. VMT estimates included 100 percent of vehicle trips that both originate from and end in the city (i.e., fully internal trips), 50 percent of trips that either end in or depart from the city (i.e., internal-external, or external-internal trips), and zero percent of vehicle trips that are simply passing through the city boundaries (i.e., external-external, or "pass-through," trips). This vehicle trip accounting method is consistent with the Regional Targets Advisory Committee (RTAC) origin-destination method established through SB 375 and CARB recommendations.

Emissions factors for on-road VMT were derived separately for light-duty vehicles and medium/heavy-duty vehicles, using Orange County-wide data from EMFAC2021. These emissions factors were combined with city-specific VMT data for these same vehicle categories provided by Iteris, and used to calculate a weighted average emissions factor for all city VMT.

3.4.5 Off-Road Vehicles and Equipment

Based on modeling conducted, off-road vehicles and equipment operating in the county emitted approximately 68,756 $MTCO_2e$ in 2019, or 3 percent of the 2019 inventory. The largest emissions-generating off-road categories include construction and mining equipment and industrial equipment. The estimated annual emissions and scaling factors used are presented in Table 9 by vehicles and equipment type. Additional details regarding calculation methods and assumptions are discussed below.

Table 9 2019 City of Irvine Community Off-Road Vehicles and Equipment GHG Emissions and Scaling Method

Off-Road Vehicles and Equipment Type	GHG Emissions ($MTCO_2e$)	Scaling Method
Construction and Mining Equipment	19,536	Service Population
Entertainment Equipment	267	Employment
Industrial Equipment	25,201	Employment
Lawn and Garden Equipment	708	Population
Light Commercial Equipment	5,330	Employment
Portable Equipment	14,647	Employment
Recreational Equipment	267	Population
Transportation Refrigeration Units	2,799	Service Population
Total	**68,756**	NA

Notes: Totals may not sum exactly due to independent rounding. GHG = greenhouse gas; $MTCO_2e$ = metric tons of carbon dioxide equivalent; NA = not applicable.

Source: Data provided by Ascent Environmental in 2022, based on modeling from CARB's OFFROAD2007 and OFFROAD2021.

Emissions from the off-road vehicles and equipment sector result from fuel combustion in off-road vehicles and equipment. Data associated with this sector were available from CARB's OFFROAD2007 and OFFROAD2021 models. These models provide emissions details at the state, air basin, or county level. Orange County emissions data from OFFROAD2007 and OFFROAD2021, which include emissions from incorporated areas of the county, were apportioned to the City of Irvine using custom scaling factors depending on the off-road vehicle and equipment type. For example, due to the likely correlation between commercial activity and employment, the city's portion of emissions from light commercial equipment in the entire county is assumed to be proportional to the number of jobs in the city as compared to the entire county.

OFFROAD2007 provides emissions details for all off-road vehicle and equipment types, but OFFROAD2021 only provides details for certain types of off-road vehicles and equipment that are relevant to the county (i.e., it does not include emissions estimates for all off-road vehicle and equipment types). CARB recommends using OFFROAD2007 where desired information is unavailable from the OFFROAD2021 model, so data from both models were used (CARB 2020). Additionally, while OFFROAD2021 provides estimates of CO_2 emissions, it does not provide estimates for CH_4 and N_2O emissions. To estimate CH_4 and N_2O emissions from the vehicle and equipment types included in OFFROAD2021, ratios of CH_4 to CO_2 and N_2O to CO_2 were obtained from OFFROAD2007 and applied to CO_2 data from OFFROAD2021 to calculate CH_4 and N_2O emissions.

3.4.6 Solid Waste

Based on modeling conducted, the solid waste sector was responsible for approximately 160,626 $MTCO_2e$ in 2019, or 7 percent of community GHG emissions. Community-generated solid waste emissions are associated primarily with the decomposition of solid waste generated by the city in landfills, while a smaller proportion of emissions are produced by the decomposition of alternative daily cover (ADC) generated by the city. Table 10 summarizes emissions from the solid waste sector. Additional details regarding calculation methods and assumptions are discussed below.

Table 10 2019 City of Irvine Community Solid Waste Quantity and GHG Emissions

Source	Quantity (tons)	GHG Emissions ($MTCO_2e$)
Community-Generated Solid Waste	389,271	160,626

Notes: Totals may not sum exactly due to independent rounding. GHG = greenhouse gas; $MTCO_2e$ = metric tons of carbon dioxide equivalent.

Source: Ascent Environmental 2022.

COMMUNITY-GENERATED SOLID WASTE

CH_4 emissions generated by community-generated solid waste occur from the decay of landfill disposed waste generated annually by residences and businesses in the city. A total of 389,271 tons of landfilled waste was reported for the city in 2019. In addition to landfilled waste, communities send ADC to landfills. ADC is non-earthen material used to cover an active surface of a landfill at the end of each operating day to control for vectors, fires, odors, blowing litter, and scavenging. This material can include compost, construction and demolition waste, sludge, green material, shredded tires, spray-on cement, and fabric. Given that ADC can also include organic material, CH_4 emissions from landfills result from organic decomposition in both waste disposal and ADC. ADC from the city was reported to be 37,188 tons in 2019. Data for landfilled waste and ADC was obtained from CalRecycle (CalRecycle 2021).

The amount of CH_4 released from community-generated waste depends on the LFG management systems of the landfills at which the waste is disposed. Information regarding the use of an LFG capture system was available from EPA's Landfill Methane Outreach Program. All facilities included an LFG capture system; therefore, the default LFG collection efficiency of 0.75 was applied to adjust emissions estimates, as recommended by the Community Protocol. Default waste characterization emissions factors obtained from EPA were used in calculations.

3.4.7 Water Supply

Based on modeling conducted, water supply emissions accounted for 30,798 $MTCO_2e$ in 2019. GHG emissions associated with water supply occur from the indirect use of energy associated with water extraction, conveyance, treatment, and distribution to the point of use (e.g., residences, businesses). Energy consumption for supplying water was estimated by applying energy intensity factors (i.e., the total amount of energy required to produce a unit of water for a particular use) to water supply consumption values. Water supply emissions are estimated by applying electricity emissions factors to water consumption values. A portion of the water supply is from local sources within the city, so the inventory assumes that a majority of electricity usage associated with extracting, conveying, treating, and distributing water is captured in the buildings energy sector because these activities take place within the city. The water supply that is sourced from sources outside of the jurisdiction generated 30,798 $MTCO_2e$. Table 11 presents water supply volume, as well as associated GHG emissions for the city in 2019. The methods used are explained in more detail below.

Table 11 2019 City of Irvine Community Water Supply Quantity and GHG Emissions

Source	Quantity	GHG Emissions ($MTCO_2e$)
Water Supply (AF)	125,010	30,798

Notes: AF = acre-feet; GHG = greenhouse gas; $MTCO_2e$ = metric tons of carbon dioxide equivalent.

Source: Ascent Environmental 2022.

ENERGY INTENSITY FACTOR

An energy intensity factor, regarding water supply emissions, is defined by the amount of energy (e.g., electricity, natural gas) required to produce a unit of water for a particular use. Electricity is the primary source of energy used for water extraction, conveyance, treatment, and distribution in the Central Coast hydrologic region. Other energy sources may include fossil fuel-powered pumps and backup generators at treatment plants, but these sources that may be used were considered negligible. Thus, for purposes of this analysis, energy intensity is based on electricity use only and is expressed as kilowatt-hours per acre-foot (kWh/AF).

In 2015, the CPUC commissioned a study of hydrologic zones in California and their relative energy intensities for water extraction, conveyance, treatment, and distribution. The city is within the South Coast hydrologic zone, which has specific energy intensities by supply type (e.g., local surface water, imported deliveries). Using the energy intensities for the South Coast hydrologic zone, a weighted factor for water extraction, conveyance, treatment, and distribution of 1,182 kWh/AF was derived for water supply in the city.

ENERGY CONSUMPTION

To estimate water supply-related energy consumption, the energy intensity factor described above was applied to a water consumption estimate of 125,010 acre-feet per year, resulting in GHG emissions of 30,798 $MTCO_2e$.

3.4.8 Wastewater Treatment

Based on modeling conducted, wastewater treatment resulted in GHG emissions of approximately 5,665 $MTCO_2e$, which represents less than 1 percent of total emissions. Wastewater treatment emissions are summarized in Table 12, and additional details for this sector are included below.

Table 12 2019 City of Irvine Wastewater Treatment GHG Emissions

Wastewater Treatment Type	GHG Emissions ($MTCO_2e$)
Centralized WWTPs	5,665

Notes: GHG = greenhouse gas; $MTCO_2e$ = metric tons of carbon dioxide equivalent; WWTP = wastewater treatment plant.

Source: Ascent Environmental 2022.

CENTRALIZED WASTEWATER TREATMENT PLANTS

Emissions associated with the treatment of sewage are highly dependent on the processes and components used by specific WWTPs such as lagoons, nitrification or denitrification, and digester gas or combustion devices. There are two centralized wastewater treatment providers for the city. IRWD and OCSan are the centralized WWTPs that collect wastewater from customers' homes and businesses. Collected wastewater enters the regional sewer system, which is operated by IRWD, and is then conveyed and pumped to either facility where it is treated before being safely reintroduced to the environment. Specific data regarding the type of WWTP and associated processes, population served, digester gas production, and daily nitrogen load were available from IRWD and OCSan. Due to lack of available data of water treatment amounts from the two providers, the proportion of the populations served by each provider was applied to the total wastewater treated in the city.

Stationary CH_4 and N_2O emissions from the combustion of digester gas were calculated based on the volume of digester gas provided by OCSan, using Community Protocol equation WW.1b. This equation accounts for the known digester gas content.

OCSan process CH_4 emissions from lagoons were calculated based on population data, using Community Protocol equation WW.6(alt) for anaerobic or facultative lagoons. Equation WW.6(alt) contains factors for the maximum CH_4 production capacity of domestic wastewater and a CH_4 correction factor for anaerobic systems. Fugitive N_2O emissions for both OCSan and IRWD were estimated based on nitrogen discharge using Community Protocol WW. 12. Process N_2O emissions were also calculated based on population data, using Community Protocol WW.7 for WWTPs with nitrification or denitrification. These equations contain nitrogen loading factors and WWTP emission factors. Fugitive N_2O emissions from effluent discharge were calculated based on average daily nitrogen load data provided by OCSan and IRWD, using Community Protocol equation WW.12.

Energy-related emissions result from the energy required for wastewater treatment operations, including the energy used in wastewater conveyance as well as energy used throughout wastewater treatment processes and to provide power to the treatment facilities. OCSan energy emissions were based on energy usage using Community Protocol equation WW.15. Because IRWD is located within the city, the inventory assumes that energy-related emissions from wastewater treatment are captured in the buildings energy sector emissions estimates.

3.4.9 Emissions Sources Excluded from the Community Inventory

Additional GHG emissions sources were evaluated for the City's community inventory. Although these sources are not included in the total community GHG emissions for the inventory, they provide additional context for understanding emissions in the city. Details regarding GHG emissions from regulated stationary sources are discussed below.

REGULATED STATIONARY SOURCES

GHG emissions are generated from a variety of regulated stationary sources operating within the city. As shown in Table 13, many facilities include two types of GHG emissions estimates: those considered "Covered" and those considered "Non-Covered." "Covered" emissions are those that are regulated by CARB under Cap-and-Trade. "Non-Covered" emissions are associated with the facilities regulated under Cap-and-Trade but are separate from the allowance budget. Cap-and-Trade establishes an aggregate GHG allowance budget on covered entities and provides a trading mechanism for compliance instruments (allowance or offset credit). Facilities regulated under Cap-and-Trade may purchase allowances to emit GHG emissions from facilities that reduce GHG emissions (e.g., solar farms) or sell emission offset credits to regulated facilities that need to reduce their emissions to meet CARB's industry-wide emissions cap. Currently, CARB gives such allowances to facilities that emit more than 25,000 $MTCO_2e$ per year. These entities primarily involve heavy industrial activities that consume large amounts of natural gas and are eligible purchasers of Cap-and-Trade emissions allowances because the facility emits more than 25,000 $MTCO_2e$ per year. Due to the involvement of facilities located in the city in Cap-and-Trade, the State, and not the City, has the regulatory authority for reducing emissions from this sector. For the purposes of developing the community inventory, emissions associated with Cap-and-Trade covered facilities, including the non-covered emissions, are excluded.

Table 13 2019 City of Irvine GHG Emissions from Regulated Stationary Sources

Facility Name	Industry Description	Covered GHG Emissions ($MTCO_2e$)	Non-Covered GHG Emissions ($MTCO_2e$)	Total GHG Emissions ($MTCO_2e$)
All American Asphalt - Irvine	Other Combustion Source	0	10,301	10,301
Allergan	Other Combustion Source	0	7,911	7,911
Bowerman Power LFG, LLC	In-State Electricity Generation	0	90,879	90,879
Braun Medical Inc	Other Combustion Source	50,645	0	50,645
Maruchan, Inc. - Laguna Canyon	Other Combustion Source	0	20,076	20,076
Petro-Diamond	Transportation Fuel Supplier	1,938,755	125,029	2,063,784
University of California, Irvine	Other Combustion Source	69,138	4	69,142
Total	**NA**	**2,007,893**	**145,109**	**2,153,002**

Notes: Totals may not sum exactly due to independent rounding. GHG = greenhouse gases; $MTCO_2e$ = metric tons of carbon dioxide equivalent; NA = not applicable.

Source: Data obtained from CARB; table compiled by Ascent Environmental in 2022.

UC IRVINE

UC Irvine generates GHG emissions from building and facility operations, student dormitories, student and employee commute, vehicle fleet, solid waste, water, and wastewater. UC Irvine is part of the University of California, a division of the state government and is not under the jurisdiction of the City and its emissions are not included in the City's community inventory. However, to provide context for the GHG emissions generated by UC Irvine, Table 14 shows the 2019 GHG emissions quantified by UC Irvine as part of its sustainability initiatives.

Table 14 2019 University of California Irvine Greenhouse Gas Emissions Inventory

Sector	$MTCO_2e$	Percent of Total
Stationary Combustion	77,368	82
Mobile Combustion	1,106	1
Process	90	0
Fugitive	4,812	5
Purchased Electricity – Location Based	11,413	12
Total	**94,789**	**100**

Notes: Totals may not sum exactly due to independent rounding. $MTCO_2e$ = metric tons of carbon dioxide equivalent.

Source: The Climate Registry 2019

RAILWAYS

There are several train operators with routes that travel through Irvine's city limits that provide passenger and freight services. Passenger train operators with stations in the city include Amtrak and Metrolink and freight train operators traveling through the city include BNSF. BNSF does not have stations located in Irvine and simply passes through as part of its route. Because both passenger and freight rail operators are managed and owned by agencies and companies outside the city, the City does not have regulatory authority or significant influence over railway operations. Railway emissions in the city were estimated to be 2,396 $MTCO_2e$ in 2019. However, because the City does not have regulatory authority over railway emissions occurring within the City's boundaries, these emissions are excluded from the City's community inventory.

SOLID WASTE

The Frank R. Bowerman Landfill is a commercial landfill operating the city. Only municipal waste from commercial haulers and vehicles with commercial status are accepted at the landfill. Because the landfill is regulated under the County of Orange Waste and Recycling Department, the City has limited control over its operations. Thus, the waste that is generated by other communities or entities at the landfill are excluded from the City's community inventory, consistent with the Community Protocol.

3.5 MUNICIPAL OPERATIONS INVENTORIES DATA AND ASSUMPTIONS

3.5.1 Sector-Specific Assumptions and Methods

The following sections describe in detail the methods, data, and assumptions that were used in estimating the City's municipal operations GHG emissions in 2019. Employment data obtained from the City were used to scale activity levels for certain emissions sources and sectors.

The following summarizes data sources and methods used in estimating the City's municipal operations GHG emissions in 2019:

- **Buildings and Facilities:** Annual municipal electricity and natural gas usage data for the City and utility emissions factors were provided by SCE and SoCal Gas. Additional emissions factors were obtained from EPA and TCR. Annual municipal backup generator usage was provided by the City, and emissions factors for backup generators were available from TCR.
- **Streetlights and Traffic Signals:** Annual municipal electricity use for all streetlights and traffic signals was provided by the City. The SCE electricity emissions factors used in the buildings and facilities sector were used for streetlights and traffic signals.

- **Employee Commute:** Emissions associated with municipal employee commutes were calculated using employment data provided by the City, including the number of temporary and permanent employees, and average trip distances. Vehicle emissions factors were derived using EMFAC2021.
- **Vehicle Fleet:** Municipal vehicle fleet fuel consumption data was provided by the City. This fleet includes both on-road vehicles as well as off-road vehicles and equipment. Emissions factors were obtained from TCR.
- **Solid Waste:** Because annual municipal-generated solid waste data were unavailable, solid waste generation estimates were conducted using the number of municipal employees provided by the City, and average solid waste disposal per public administration employee data from CalRecycle. Emissions factors were obtained from EPA.
- **Water Supply:** Water supply data was provided by the City's water purveyors, IRWD and OCSan. Emissions were estimated by applying the region-specific energy intensity factors to the municipal water consumption volumes provided by each water purveyor. SCE utility emissions factors were used to estimate GHG emissions.
- **Wastewater Treatment:** Data regarding treatment processes, population served, digester gas production and combustion, BOD load, and nitrogen load were obtained from IRWD and OCSan.

It should be noted that the GHG emissions associated with the County's employee commute, solid waste generation, water consumption, and wastewater treatment are not additive emissions to the community inventory GHG emissions. The VMT data estimated for employee commute are already reflected in the community VMT travel model used. Municipal solid waste generation is included in community solid waste disposal tonnage data. Water and wastewater activity and emissions data do not exclude activities from municipal operations and therefore may result in overlapping emission results.

3.5.2 Buildings and Facilities

Municipal buildings and facilities accounted for approximately 12,003 $MTCO_2e$ in 2019, or 65 percent of total municipal operations emissions in 2019. This sector includes emissions from energy (i.e., electricity, natural gas, diesel) used for all City buildings and facilities, primarily for lighting, HVAC, pumps, generators, and other equipment. Electricity accounted for approximately 84 percent of emissions from this sector in 2019, while natural gas and diesel backup generators accounted for 16 percent and less than 1 percent, respectively. Buildings and facilities include City-owned and leased buildings, as well as other infrastructure such as park buildings, park lighting and irrigation controllers, and other facilities. Building energy use and emissions by source are presented in Table 15 below.

Table 15 2019 City of Irvine Municipal Operations Buildings and Facilities GHG Emissions

Source	Quantity	GHG Emissions ($MTCO_2e$)
Electricity (MWh)	48,640	10,138
Natural Gas (therms)	350,650	1,862
Backup Generators (gallons)	289	3
Total	**NA**	**12,003**

Notes: Totals may not sum exactly due to independent rounding. GHG = greenhouse gas; $MTCO_2e$ = metric tons of carbon dioxide equivalent; MWh = megawatt-hours; NA = not applicable.

Source: Ascent Environmental 2022

Buildings and facilities energy use data for 2019 was provided by SCE and SoCal Gas, and generator fuel usage was provided by the City. Municipal electricity GHG emissions were estimated using the same method described in Section 3.4.2. Municipal natural gas and backup generator GHG emissions were estimated using emissions factors from TCR.

3.5.3 Streetlights and Traffic Signals

City streetlights and traffic signals accounted for approximately 1,097 $MTCO_2e$ in 2019, or 6 percent of total municipal operations emissions in 2019. This sector includes emissions associated with electricity consumption to power City-owned streetlights and traffic signals, including road and highway lights. Electricity consumption and GHG emissions associated with streetlights and traffic signals are shown in Table 16.

Table 16 2019 City of Irvine Municipal Operations Streetlights and Traffic Signals GHG Emissions

Source	Quantity	GHG Emissions ($MTCO_2e$)
Electricity (MWh)	5,262	1,097

Notes: Totals may not sum exactly due to independent rounding. GHG = greenhouse gas; $MTCO_2e$ = metric tons of carbon dioxide equivalent; MWh = megawatt-hours.

Source: Ascent Environmental 2022

Electricity consumption from streetlights and traffic signals was provided by the City. GHG emissions were estimated using the methods and emissions factors as described in the buildings energy sector.

3.5.4 Employee Commute

Employee commute accounted for approximately 3,032 $MTCO_2e$ in 2019, approximately 16 percent of total municipal operations emissions in 2019. This sector estimates GHG emissions associated with fuel use and VMT for City of Irvine employees commuting to and from work. Table 17 shows employee commute VMT and GHG emissions.

Table 17 2019 City of Irvine Municipal Operations Employee Commute GHG Emissions

Source	VMT	GHG Emissions ($MTCO_2e$)
Employee Commute	8,541,341	3,032

Notes: Totals may not sum exactly due to independent rounding. GHG = greenhouse gas; $MTCO_2e$ = metric tons of carbon dioxide equivalent; VMT = vehicle miles traveled.

Source: Ascent Environmental 2022

Average daily VMT were estimated based on employee survey data. This figure was applied to the number of temporary and permanent employees in 2019. The inventory assumes that temporary employees commute to work 2.5 days per week on average, while permanent employees commute 5 days per week on average. To account for holidays and vacations, an annualization factor of 48 weeks was applied to weekly employee commute VMT estimates. Emissions were estimated using emissions factors derived from EMFAC2021, as discussed in the on-road transportation sector.

3.5.5 Vehicle Fleet

City-owned vehicle fleet emissions accounted for 1,127 $MTCO_2e$ in 2019, approximately 6 percent of total municipal operations emissions in 2019. This sector includes emissions estimated from on-road and off-road vehicles and equipment owned and operated by the City. Table 18 displays vehicle fleet usage and GHG emissions.

Table 18 2019 City of Irvine Municipal Operations Vehicle Fleet GHG Emissions

Fuel Type	Fuel Use (gallons)	GHG Emissions ($MTCO_2e$)
Gasoline	107,728	954
Compressed Natural Gas	23,155	173
Total	**130,883**	**1,127**

Notes: Totals may not sum exactly due to independent rounding. GHG = greenhouse gas; $MTCO_2e$ = metric tons of carbon dioxide equivalent.

Source: Ascent Environmental 2022

Vehicle fleet fuel consumption data (i.e., gallons of gasoline and diesel fuel) for 2019 were provided by the City for all City-owned vehicles and equipment. Because additional vehicle fleet data were unavailable, total emissions for gasoline and diesel fuel were estimated using emissions factors obtained from TCR. Fuel-specific CO_2 emissions factors were available for both gasoline and CNG, while the CH_4 and N_2O emissions factors were aggregated factors for both gasoline and diesel fuel in passenger cars and light-duty trucks.

3.5.6 Solid Waste

Municipal solid waste disposal accounted for approximately 159 $MTCO_2e$ in 2019, or 1 percent of total municipal operations emissions in 2019. Solid waste emissions are generated from the decomposition of organic material in landfills. Table 19 presents estimated tons of solid waste disposal and associated GHG emissions from municipal operations.

Table 19 2019 City of Irvine Municipal Operations Solid Waste GHG Emissions

Source	Quantity (tons)	GHG Emissions ($MTCO_2e$)
Landfill Disposed Waste	476	159

Notes: Totals may not sum exactly due to independent rounding. GHG = greenhouse gas; $MTCO_2e$ = metric tons of carbon dioxide equivalent.

Source: Ascent Environmental 2022

Annual municipal disposed solid waste data was unavailable, so municipal-generated solid waste tonnages were estimated using an average solid waste disposal per public administration employee (tons/employee/year) figure obtained from CalRecycle (CalRecycle 2020). This figure was applied to the number of the City's municipal employees to calculate municipal tons of disposed solid waste. Methods use to estimate GHG emissions associated with solid waste disposal from municipal operations are consistent with those described in the community solid waste sector.

3.5.7 Water Supply

Water supplied for the City's municipal operations resulted in approximately 4 $MTCO_2e$ in 2019, or less than 1 percent of total municipal operations GHG emissions in 2019. For the water supply from local sources within the city, the electricity usage associated with extracting, conveying, treating, and distributing water is captured in the buildings and facilities energy sector because these activities take place within the city. Therefore, the electricity usage and emissions associated with extracting, conveying, treating, and distributing water from outside the city boundary was applied to the municipal water sector. Water usage and associated electricity consumption is provided in Table 20.

Table 20 2019 City of Irvine Municipal Operations Water Supply GHG Emissions

Source	Quantity	GHG Emissions ($MTCO_2e$)
Water consumption (MG)	44	4

Notes: GHG = greenhouse gas; MG = million gallons; MWh = megawatt-hours.

Source: Ascent Environmental 2022

Municipal water consumption volumes were provided by IRWD. To obtain municipal water supply energy use and calculate associated GHG emissions, the region-specific energy intensity factors, methods, and emissions factors described in the community water supply sector were applied.

3.5.8 Wastewater Treatment

Wastewater emissions associated with municipal operations accounted for approximately 1,144 $MTCO_2e$ in 2019, or 6 percent of total municipal operations emissions in 2019. Municipal wastewater GHG emissions associated with this sector included emissions generated by the energy used to treat municipal wastewater as well as emissions that are produced as a result as wastewater treatment processes. GHG emissions from municipal wastewater are shown in Table 21.

Table 21 2019 City of Irvine Municipal Operations Wastewater GHG Emissions

Source	GHG Emissions ($MTCO_2e$)
Wastewater Treatment	1,144

Notes: Totals may not sum exactly due to independent rounding. GHG = greenhouse gas; $MTCO_2e$ = metric tons of carbon dioxide equivalent.

Source: Ascent Environmental 2022

IRWD and OCSan provided wastewater-related data for the City's municipal operations. Methods for estimating emissions from these sources are based on the methodology described in the community wastewater sector and were scaled based on municipal employee population. GHG emissions were estimated using utility emissions factors provided by TCR.

4 REFERENCES

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Attachment A

Greenhouse Gas Inventories Data
and Calculations

Community Inventory and Forecast $MTCO_2e$

	Inventory	BAU	BAU	Leg-Adjusted	Leg-Adjusted
GHG Emissions Source	**2019**	**2030**	**2040**	**2030**	**2040**
Residential Electricity	116,584	127,045	136,555	22,304	5,424
Residential Natural Gas	174,820	190,507	204,767	181,255	187,877
Non-Residential Electricity	385,130	430,536	471,815	74,797	18,398
Non-Residential Natural Gas (buildings)	160,501	179,424	196,626	169,735	178,853
Non-Residential Natural Gas (backup generators)	1,025	1,145	1,255	582	638
Non-Residential Diesel (backup generators)	3,472	3,881	4,253	2,811	3,081
Non-Residential Gasoline (backup generators)	10	11	13	8	9
On-Road Transportation	1,140,206	1,155,749	1,169,879	793,628	334,698
Construction and Mining	19,536	21,614	24,668	21,614	24,668
Entertainment Equipment	267	295	341	295	341
Industrial	25,201	27,892	32,233	27,892	32,233
Lawn and Garden Equipment	708	776	874	776	874
Light Commercial Equipment	5,330	5,899	6,817	5,899	6,817
Portable Equipment	14,647	16,212	18,734	16,212	18,734
Recreational Equipment	267	293	329	293	329
Transport Refrigeration Units	2,799	3,097	3,534	3,097	3,534
Solid Waste	160,626	175,038	188,141	175,038	188,141
Wastewater	5,665	6,159	6,620	6,173	6,620
Water	30,798	43,202	46,436	9,973	1,831
Total	**2,247,593**	**2,388,776**	**2,513,892**	**1,512,383**	**1,013,100**

On-Road Transportation

Year	Emissions Sector	Calculation Sector	Sub-Sector	EMFAC Categories	Annual VMT	Notes	g CO2 per mi	g CH4 per mi	g N2O per mi	MT CO2	MT CH4	MT N2O	MT CO2e
2019	On-Road	On-Road	Countywide	All Other Buses, LDA, LDT1, LDT2, LHD1, LHD2, MCY, MDV, MH, Motor Coach, OBUS, PTO, SBUS, T6 CAIRP heavy, T6 CAIRP small, T6 instate construction heavy, T6 instate construction small, T6 instate heavy, T6 instate small, T6 OOS heavy, T6 OOS small, T6 Public, T6 utility, T6TS, T7 Ag, T7 CAIRP, T7 CAIRP construction, T7 NNOOS, T7 NOOS, T7 POAK, T7 Public, T7 Single, T7 single construction, T7 SWCV, T7 tractor, T7 tractor construction, T7 utility, T7IS, UBUS	2,910,428,375	ITAM Model - Iteris							1,140,206

Building Energy

Year	Emissions Sector	Calculation Sector	Fuel Type	Utility (if applicable)	Sub-Sector	Fuel Use	Unit	Notes	Energy Use (kBTU)	MT CO2	MT CH4	MT N2O	MT CO2e	Activity Data Sourc
2019	Building Energy	Building Energy	Electricity	SCE	Residential	559,328,663	kWh	Source: SCE	1,908,508,532	98,442	8	1	116,584	*SCE*
2019	Building Energy	Building Energy	Electricity	SCE	Non-Residential	1,847,715,105	kWh	Source: SCE; Commercial and industrial sources; UCI MTCO2e electricity subtracted	6,304,665,353	325,198	28	3	385,130	*SCE*
2019	Building Energy	Building Energy	Natural Gas	SoCal Gas	Residential	32,849,598	therm	Source: SoCal Gas	3,284,175,499	174,300	15	0	174,820	*SoCal Gas*
2019	Building Energy	Building Energy	Natural Gas	SoCal Gas	Non-Residential	30,158,957	therm	Source: SoCal Gas	3,015,175,639	160,023	14	0	160,501	*SoCal Gas*
2019	Building Energy	Building Energy	Diesel	NA	Non-Residential	339,437	gal	Source: SCAQMD	46,874,577	3,466	0	0	3,472	*SCAQMD*
2019	Building Energy	Building Energy	Natural Gas	NA	Non-Residential	18,726,107	scf	Source: SCAQMD	19,212,986	1,019	0	0	1,025	*SCAQMD*
2019	Building Energy	Building Energy	Gasoline	NA	Non-Residential	1,162	gal	Source: SCAQMD	145,266	10	0	0	10	*SCAQMD*

Waste Generation

Year	Emissions Sector	Sub-Sector	Landfill Name	Annual Waste Tonnage Delivered from Jurisdiction	Annual ADC Tonnage Delivered from Jurisdiction	Percent of year under LFG collection	LFG Collection Efficiency	Oxidation Rate	Notes	MT CO2	MT CH4	MT N2O	MT CO2e
2019	Solid Waste	Waste Generation	Community-Generated Solid Waste Disposed of Outside Jurisdiction	389,271	37,188	100%	75%	10%	Total of all tonnage sent to landfills outside of the city. https://www2.calrecycle.ca.gov/LGCentral/DisposalReporting/Destination/DisposalByFacility		5,757.20		160,626

Off-Road Vehicles and Equipment

Year	Emissions Sector	Calculation Sector	Sub-Sector	Jurisdiction Scaling Method	Jurisdiction Scaling Factor	Notes	CO2 (tons/day)	CH4 (tons/day)	N2O (tons/day)	MT CO2	MT CH4	MT N2O	MT CO2e
2019	Off-Road	OffRoad Equipment	Construction and Mining	Service Population	0.111858677		58.93678243	4.91E-04	3.47E-05	53.46656497	4.46E-04	3.15E-05	19,536
2019	Off-Road	OffRoad Equipment	Entertainment Equipment	Employment	0.150235703		0.805466754	4.53E-06	0.00E+00	0.730707357	4.11E-06	0.00E+00	267
2019	Off-Road	OffRoad Equipment	Industrial	Employment	0.150235703		75.79148241	3.34E-03	6.24E-04	68.75689597	3.03E-03	5.66E-04	25,201
2019	Off-Road	OffRoad Equipment	Lawn and Garden Equipment	Population	0.09167253		2.095999968	2.83E-04	1.23E-04	1.901459731	2.56E-04	1.12E-04	708
2019	Off-Road	OffRoad Equipment	Light Commercial Equipment	Employment	0.150235703		15.96617265	5.79E-04	3.76E-04	14.48427234	5.25E-04	3.41E-04	5,330
2019	Off-Road	OffRoad Equipment	Portable Equipment	Employment	0.150235703		44.20096462	3.87E-05	1.23E-05	40.09845209	3.51E-05	1.12E-05	14,647
2019	Off-Road	OffRoad Equipment	Recreational Equipment	Population	0.09167253		0.757356841	5.26E-04	1.24E-04	0.687062766	4.78E-04	1.12E-04	267
2019	Off-Road	OffRoad Equipment	Transport Refrigeration Units	Service Population	0.111858677		8.444054263	6.97E-05	5.84E-06	7.660319367	6.32E-05	5.30E-06	2,799

Water

Year	Emissions Sector	Sub-Sector	Water District/Provider	Location	Extraction and Conveyance	Treatment	Water Use (AF/year)	Percent of Source Inside Jurisdiction	Utility (if applicable)	Notes	Fuel Use	Unit	Energy Use (kBTU)	MT CO2	MT CH4	MT N2O	MT CO2e	MT CO2e / MWh
2019	Water	Water	IRWD	South Coast	Local Deliveries	Recycled Water - Tertiary Treatment + Disinfection	24,006	100%	SCE	*Recycled water treated within the City of Irvine boundary.*	-	kWh	-				-	0.208436
2019	Water	Water	IRWD	South Coast	Groundwater	Conventional Potable Treatment	86,917	0%	SCE	*Groundwater basin excludes sources outside city boundary. Fuel use based on IRWD provided energy intensity for potable water. (Energy intensity should be updated ebrgy 5-years according to IRWD Embedded Energy Plan)*	89,669,282	kWh	305,964,277				18,690	0.208436
2019	Water	Water	IRWD	South Coast	State Water Project	Conventional Potable Treatment	12,988	0%	eGrid CAMX	*Approximately 13% of IRWD's potable water needs are met by imported water purchased and supplied by Metropolitan through MWDOC/SWP. (2020 Urban Water Management Plan)*	54,002,203	kWh	184,263,156				11,256	0.208436
2019	Water	Water	IRWD	South Coast	State Water Project	Untreated	1,099.78	0%	eGrid CAMX	*Untreated water is assumed to all be imported from the SWP*	4,085,668	kWh	13,940,876				852	0.208436

Wastewater Process Emissions

Year	Emissions Sector	Sub-Sector	WWTP Name	WWTP Process	WW Equation	Digester Gas (ft3/day)	Fraction of CH4 in Biogas	Population Served	RTU Content of biogas	Mass of incinerated biosolids	FP	BOD5 Load (kg BOD5/day)	N Load (kg N/day)	Methanol Load (MT CH3OH/day)	Sludge Treatment Type	F_ind-com	EF_effluent	N uptake	Natural Gas (therms)	Electricity (MWh)	Utility (if applic	Notes	MT CO2	MT CH4	MT N2O	MT CO2e
2019	Wastewater	WWTP	OCSD	Stationary Methane Emissions from Combustion of Digester Gas (Heat Content known)	WW.1.b	22,701			630											-			-	0.017	-	0.466
2019	Wastewater	WWTP	OCSD	Process Methane Emissions from Wastewater Treatment Lagoons (population method)	WW.6 (alt)			13,414								1.25				#VALUE!			-	178.587	-	4,983
2019	Wastewater	WWTP	OCSD	Fugitive Nitrous Oxide Emissions from Effluent Discharge	WW.12								57.46				0.0025			-			-	-	0.06237	22.5
2019	Wastewater	WWTP	OCSD	Energy-related Emissions Associated with Wastewater Collection and Treatment	WW.15															757	SCE		133.173	0.011	0.001	133.9
2019	Wastewater	WWTP	RWD	Fugitive Nitrous Oxide Emissions from Effluent Discharge	WW.12								567.58				0.005			-			-	-	1.63	444.27
2019	Wastewater	WWTP	RWD	Process Nitrous Oxide Emissions from Wastewater Treatment Plants with Nitrification or Denitrification	WW.7			37,407								1.25				-			-	-	0.05	13
2019	Wastewater	WWTP	RWD	Process Nitrous Oxide Emissions from Wastewater Treatment Plants with Nitrification or Denitrification	WW.7			200,782								1.25				-			-	-	0	69
2019	Wastewater	WWTP	RWD	Energy-related Emissions Associated with Wastewater Collection and Treatment	WW.15															-	SCE	Energy data not provided	-	-	-	-

Demographics

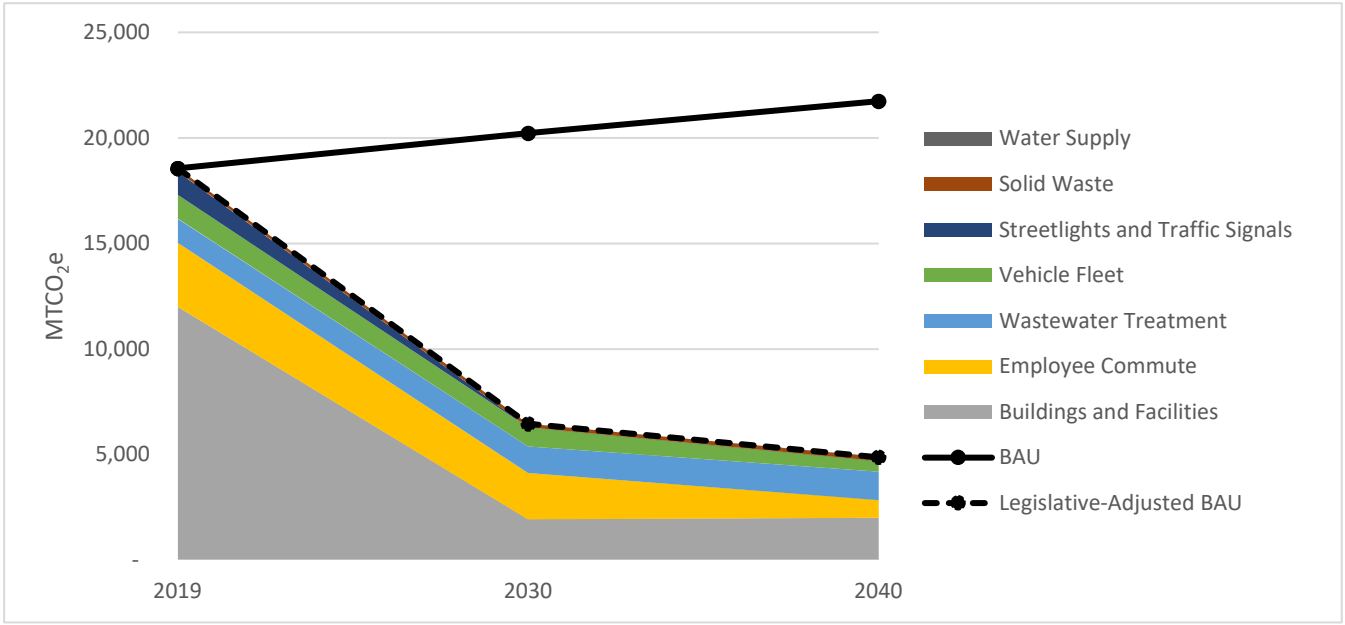
City of Irvine Greenhouse Gas Inventory and Forecasts

	Population								Employment								Service Population							
Subarea	**2018**	**2019**	**2025**	**2030**	**2035**	**2040**	**2045**	**2050**	**2018**	**2019**	**2025**	**2030**	**2035**	**2040**	**2045**	**2050**	**2018**	**2019**	**2025**	**2030**	**2035**	**2040**	**2045**	**2050**
City	288,749	291,124	305,372	317,246	329,119	340,993	352,866	364,740	248,264	250,954	267,092	280,541	293,989	307,438	320,886	334,335	537,013	542,077	572,464	597,786	623,108	648,431	673,753	699,075
Total County	3,144,784	3,175,692	3,361,142	3,440,882	3,499,318	3,531,540	3,534,620	3,537,700	1,642,949	1,670,400	1,835,106	1,886,065	1,927,505	1,960,051	1,980,433	2,000,815	4,787,733	4,846,092	5,196,248	5,326,947	5,426,823	5,491,591	5,515,053	5,538,515

	Population								Employment								Service Population							
Growth Rates	**2018**	**2019**	**2025**	**2030**	**2035**	**2040**	**2045**	**2050**	**2018**	**2019**	**2025**	**2030**	**2035**	**2040**	**2045**	**2050**	**2018**	**2019**	**2025**	**2030**	**2035**	**2040**	**2045**	**2050**
Percent Growth from 2019	NA	NA	4.89%	8.97%	13.05%	17.13%	21.21%	25.29%	NA	NA	6.43%	11.79%	17.15%	22.51%	27.87%	33.23%	NA	NA	5.61%	10.28%	14.95%	19.62%	24.29%	28.96%
Percent of Total County	9.18%	9.17%	9.09%	9.22%	9.41%	9.66%	9.98%	10.31%	15.11%	15.02%	14.55%	14.87%	15.25%	15.69%	16.20%	16.71%	11.22%	11.19%	11.02%	11.22%	11.48%	11.81%	12.22%	12.62%
Percent Growth from 2040																								

Emissions Summary, $MTCO_2e$

		Inv	BAU	BAU	Leg-adjusted	Leg-adjusted
Sector	Sub-sector	2019	2030	2040	2030	2040
Buildings and Facilities	Electricity	10,138	11,048	11,875	0	0
Buildings and Facilities	Natural Gas	1,862	2,029	2,181	1,947	2,019
Buildings and Facilities	Backup Generators (Diesel)	3	3	3	3	3
Employee Commute	Employee Commute	3,032	3,304	3,551	2,192	842
Wastewater Treatment	Wastewater Treatment	1,144	1,246	1,340	1,246	1,340
Vehicle Fleet	Gasoline	954	1,040	1,117	772	424
Vehicle Fleet	Compressed Natural Gas	173	189	203	140	77
Streetlights and Traffic Signals	Streetlights and Traffic Signals	1,097	1,195	1,285	0	0
Solid Waste	Solid Waste	159	174	187	174	187
Water Supply	Water Supply	4	5	5	2	1
	Total	**18,566**	**20,232**	**21,746**	**6,477**	**4,892**



Vehicle Fleet

Irvine Municipal Operations Greenhouse Gas Inventories and Forecasts

Vehicle Fleet	2019				2030				2040			
Source	**gallons/year**	**Emissions Factor (kg CO2/gal)**	**MT CO2/year**	**Total MT CO2e/year**	**Scaling Factor**	**gallons/year**	**BAU Total MT CO2e/year**	**Leg-Adjust BAU Total MT CO2e/year**	**gallons/year**	**BAU Total MT CO2e/year**	**Leg-Adjust BAU Total MT CO2e/year**
Gasoline	107,728	8.78	946	954	Employment	117,395	1,040	771.92	126,182	1117	423.75
CNG	23,155	6.8463744	159	173	Employment	25,232	189	140.17	27,121	203	76.95
Total				**1,127**			**1,228**	**912**		**1,320**	**501**

Energy Consumption

Irvine Municipal Operations Greenhouse Gas Inventories and Forecasts

Electricity

	2019						2030				2040			
Source	MWh/year	Emission Factor MT CO2e/MWh)	Emission Factor (MT CH4/MWh)	Emission Factor (MT N2O/MWh)	Total MT CO2e/year	Scale Factor	BAU MWh/year	Leg-Adjust BAU MWh/year	BAU Total CO2e (MT/year)	Leg-Adjust BAU Total CO2e (MT/year)	BAU MWh/year	Leg-Adjust BAU MWh/year	BAU Total CO2e (MT/year)	Leg-Adjust BAU Total CO2e (MT/year)
Buildings & Facilities Electricity (SCE)	48,640	0.208436			10,138	Employment	53,004	52,745	11,048	-	56,972	49,134	11,875	-
Streetlights & Traffic Signals (SCE)	5,262	0.208436			1,097	Employment	5,734	5,734	1,195	-	6,164	6,164	1,285	-
Total					**11,235**				**12,243**	**-**			**13,160**	**-**

Source: 2019 electricity data provided by SoCal Edison

Source: 2020 streetlight & traffic signal data provided by City

Assumed Streetlights and Traffic Signals are included in Buildings and Facilities

Natural Gas

	2019						2,030				2040			
Source	therms/year	Emission Factors (lb/therm)			Total MT CO2e/year	Scale Factor	BAU therms/year	Leg-Adjus BAU therms/year	BAU Total CO2e (MT/year)	Leg-Adjust BAU Total CO2e	BAU therms/year	Leg-Adjus BAU therms/year	BAU Total CO2e (MT/year)	Leg-Adjust BAU Total CO2e (MT/year)
		CO_2	CH_4	N_2O										
Buildings & Facilities Natural Gas (SoCalGas)	350,650	11.7	0.000226742	0.000005	1,862	Employment	382,113	366,633	2,029	1,947	410,716	380,203	2,181	2,019
Total					1,862				2,029	1,947			2,181	2,019

Source: Municipal Natural Gas Useage, SoCal Gas

Backup Generators

	2019						2030				2040			
Source	gallons/year	Emissions Factor (kg CO2/gal)	Emissions Factor (g CH4/MMBTU)	Emissions Factor (g N2O/MMBTU)	Total MT CO2e/year	Scale Factor	BAU gallons/year	Leg-Adjust BAU gallons/year	BAU Total MT CO2e/year	Leg-Adjust BAU Total MT CO2e/year	BAU gallons/year	Leg-Adjust BAU gallons/year	BAU Total MT CO2e/year	Leg-Adjust BAU Total MT CO2e/year
Diesel	289	10.21	0.9	0.4	3	Employment	314	313	3.22	3.20	285	285	2.91	2.92
Total					3				3.22	3.20			2.91	2.92

Source: Municipal Backup Generator Usage, provided by the City

Building Energy Efficiency Assumptions

Commercial Reduction (kWh)	5.94%
Commercial Reduction (therms)	49.20%

Wastewater Treatment
Irvine Municipal Operations Greenhouse Gas Inventories and Forecasts

Wastewater Emissions Totals	2019	2030		2,040	
		BAU	Leg-Adjust BAU	BAU	Leg-Adjust BAU
Total (MT CO2e/year)	1,144	1,246.387	1,246	1,340	1,340

OCSD

WW.1a Stationary Methane Emissions from Combustion of Digester Gas

	2019	2030	2,040
Volume of Digester Gas Produced per Day (scf/day)		-	0
Fraction of CH4 in Digester Gas			-
BTU of CH4	1028	1028	1,028
BTU to MMBTU conversion	0.000001	0.000001	0
CH4 emissions factor (kg CH4/MMBTU)	0.0032	0.0032	0
MT CH4/year	-	-	-
Total MT CO2e/year	0.0000	0.0000	0.0000

WW.1b Stationary Methane Emissions from Combustion of Digester Gas (Heat Content known) - OCSD

	2019	2030	2040
Volume of Digester Gas Produced per Day (scf/day)	2,684	2,925	3,144
BTU Content of Digester Gas	630.00	630.00	630.00
BTU to MMBTU conversion	0.000001	0.000001	0.000001
CH4 emissions factor (kg CH4/MMBTU)	0.0032	0.0032	0.0032
MT CH4/year	0.00198	0.00215	0.00231
Total MT CO2e/year	0.0551	0.0601	0.0646

Source: OC Sanitation District

WW.2a Stationary Nitrous Oxide Emissions from Combustion of Digester Gas

	2019	2030	2040
Volume of Digester Gas Produced per Day (scf/day)			
Fraction of CH4 in Digester Gas			
BTU of N2O	1028	1028	1028
BTU to MMBTU conversion	0.000001	0.000001	0.000001
N2O emissions factor (kg CH4/MMBTU)	0.00063	0.00063	0.00063
MT N2O/year	-	-	-
Total MT CO2e/year	0.0000	0.0000	0.0000

WW.6 Process Methane Emissions from Wastewater Treatment Lagoons

	2019	2030	2040
BOD load (kg/day)			
Fraction of BOD removed in primary treatment			
Maximum CH4 producing capacity for domestic wastewater (kg CH4/kg BOD removed)	0.6	0.6	0.6
CH4 correction factor for anaerobic systems	0.8	0.8	0.8
MT CH4/year	0.000000	0.000000	0.000000
Total MT CO2e/year	0.0000	0.0000	0.0000

WW.7 Process Nitrous Oxide Emissions from Wastewater Treatment Plants with Nitrification or Denitrification - IRWD

	2019	2030	2040
Population of Municipal Employees	1,586	1,728	1,858
Emission factor for a WWTP with nitrification or denitrification (g N2O/ person / year) - LAWRP	7.00	7.00	7.00
Emission factor for a WWTP with nitrification or denitrification (g N2O/ person / year) - MWRP	3.20	3.20	3.20
MT N2O/year	0.0162	0.0176	0.0189
Total MT CO2e/year	4.42	4.81	5.17

Source: Irvine Ranch Water District

WW.11 Fugitive Methane Emissions from Septic Systems (BOD5 Load Known) - OCSD

	2019	2030	2040
Amount of BOD5 produced per day (kgBOD5/day)	92.3957	100.68613	108.22291
Maximum CH4 producing capacity for domestic wastewater (kg CH4/kg BOD5 removed)	0.6	0.6	0.6
CH4 correction factor for septic systems	0.22	0.22	0.22
MT N2O/year	4.4516230	4.8510576	5.2141800
Total MT CO2e/year	124.2003	135.3448	145.4758

Source: OC Sanitation District

WW.12 Fugitive Nitrous Oxide Emissions from Effluent Discharge - OCSD

	2019	2030	2040
Average total nitrogen per day (kg N/day)	6.7936	7.40314	7.95730
Emission factor (kg N2O-N/kg sewage-N discharged)	0.025	0.025	0.025
Molecular weight ratio of N2O to N2	1.57	1.57	1.57
MT N2O/year	0.0973264	0.1060593	0.1139981
Total MT CO2e/year	26.5701	28.9542	31.1215

Source: OC Sanitation District

WW.12 Fugitive Nitrous Oxide Emissions from Effluent Discharge - IRWD

	2019	2030	2040
Average total nitrogen per day (kg N/day)	1263.7367	1,377.12903	1,480.21301
Emission factor (kg N2O-N/kg sewage-N discharged)	0.005	0.005	0.005
Molecular weight ratio of N2O to N2	1.57	1.57	1.57
MT N2O/year	3.6209214	3.9458189	4.2411803
Total MT CO2e/year	988.5116	1077.2086	1157.8422

Source: Irvine Ranch Water District

WW.15 Energy-related Emissions Associated with Wastewater Collection and Treatment

	2019	2030 BAU	2030 Leg-Adjust BAU	2040 BAU	2040 Leg-Adjust BAU
MWh/year	89.46	97.49	97.49	101.14	101.14
Emission Factor (MT CO2/MWh)	0.2	0.2	0.010	0.2	0.00
Emission Factor (MT CH4/MWh)	0.0000	0.0000	0.00000	0.0000	0.00000
Emission Factor (MT N2O/MWh)	0.0000	0.0000	0.00000	0.0000	0.00000
Total Electricity (MTCO2e/year)	0.007	0.007	0.000	0.008	0.000
Natural Gas (therms/year)		-	-	-	-
Emission Factor (lb CO2/therm)	11.7	11.7	11.7	11.7	11.7
Emission Factor (lb CH4/therm)	0.000226742	0.000226742	0.000226742	0.000226742	0.000226742
Emission Factor (lb N2O/therm)	0.000005	0.000005	0.000005	0.000005	0.000005
Total Natural Gas (MTCO2e/year)		-	-	-	-
Total MT CO2e/year	0.007	0.007	0.000	0.008	0.000

Source: OC Sanitation District

IRWD

Table 14. Summary of Annual Emission Estimates for N2O from Wastewater Treatment Process, Calendar Year: 2019

Population Served (persons)	Comment	City	Facility	Emission Factor (g N2O/person/year)	Emissions N2O (metric tons)	GWP
58,771	Population to LAWRP \	Lake Forest	LAWRP	3.2	0.18806745	310
315,420	Population to MWRP \	Irvine	MWRP	7.0	2.207941088	310

374,191	Population Subtotal WW	Totals	2.396008537	

Source: Irvine Ranch Water District

Table 21. Summary of Annual Emission Estimates for N2O from Wastewater Treatment Effluent at MWRP, Calendar Year: 2019

Year	Nitrogen Load (kg/yr)	Emission Factor (kg N2O-N/kg sewage-N produced)	Emissions N20 (tonne)	GWP	Emissions CO2e (tonne)
2019	325,482.15	0.005	1.63	310	504.4973

Source: Irvine Ranch Water District

Row Labels	Sum of 2019 Electricity Usage (kWh)	Sum of 2019 Cost ($)
Buildings	115,381.39	16,624.19
Baker WTP	17,893,593.92	2,124,698.23
El Toro SGU	260.00	191.79
LAWRP	7,243,189.00	866,986.31
MWRP	30,619,574.06	3,517,836.46
Non-Potable Supply IDP	7,581,642.52	774,301.56
Non-Potable Supply Other	19,916,468.65	2,010,598.47
Other Wastewater	792,752.71	122,957.07
Potable Supply DATS	9,429,871.61	1,115,991.23
Potable Supply IDP	3,917.98	1,234.09
Potable Supply Other	25,478,061.34	2,729,955.34
#N/A/NATURAL TREAT	8,177.97	35,776.78
Potable Supply Wells 21 & 22	42,694.43	5,354.92
Grand Total	109,412,845.82	$12,848,479.57

Source: Irvine Ranch Water District

OCSD

Answer	Unit	Comments	Original Inquiry Items
280k			Population of the City served by the wastewater facility
2.6M			Total population (City + other jurisdictions) served by the wastewater facility
Yes			Does the wastewater treatment facility have a digester?
4,400,000	scf/day	Combusted*	If yes, please include whether digester gas is combusted for energy or flared, and the volume of gas combusted and/or flared (scf/day)
630	BTU/CuFt		If combusted, please include either the energy content of digester gas (btu/scf) or percent CH4 in digester gas, and whether energy is recovered from combustion.
N/A			If flared, please include the percent CH4 in digester gas and the destruction efficiency.
N/A			Provide data on other wastewater treatment plant process (e.g. lagoons, nitrification or denitrification, cluster package systems).
151,468	kg/Day	BOD(C)	Average Biological Oxygen Demand (BOD) per day. (kilograms per day [kg/day])
11,137	kg/Day	as Ammonia	Average daily nitrogen discharge. (kilograms per day [kg/day]) Municipal Operations
70,141	MG/Year		Volume of wastewater treated for municipal operations only. (MG/year or acre feet/year)
146,661,641	kWh/Year		Electricity usage associated with treating wastewater for municipal facilities only. (kWh/year and/or therms/year)

*excess is flared but it is a very small amount (~1%) compared to what is combusted in the co-generation facilities and boilers

Source: OC Sanitation District

	Service Population	Irvine Municipal Proportion of Total OCSD Service Population
OCSD	2,600,000	-
Muncipal Employees	1,586	0.06%

Source: OC Sanitation District

2019 Percent of IRWD Population	Service Population	Irvine Municipal Proportion of Total OCSD Service Population
City of Irvine	281,405	0.39%
IRWD	408,483	-

Source: Irvine Ranch Water District

Employee Commute	2019			2030			2040		
Source	**VMT/year**	**MTCO2e/year**	**Scaling Factor**	**VMT/year**	**BAU MTCO2e/year**	**Leg-Adjust BAU MTCO2e/year**	**VMT/year**	**BAU MTCO2e/year**	**Leg-Adjust BAU MTCO2e/year**
Employee Commute	8,541,341	3,032	Employment	9,307,737	3,304	2,192	10,004,461	3,551	842
Total	**8,541,341**	**3,032**		**9,307,737**	**3,304**	**2,192**	**10,004,461**	**3,551**	**842**

Source: Municipal Employee data, provided by the City

EMFAC data for light-duty (LD) vehicles)

LD emissions ($MTCO_2e$)	9,901,375			7,112,243		2,520,335
LD VMT	27,897,139,975			30,198,215,373		29,939,056,700
LD g CO2e/VMT	354.9		355	236	354.9	84.2

Solid Waste

Irvine Municipal Operations Greenhouse Gas Inventories and Forecasts

Solid Waste Emissions Totals	2019	2030	2040
Total (MTCO2e/year)	159	174	187

Municipal-Generated Solid Waste	2019	2030	2,040
Municipal Employees	1586	1728	1,858
Average Solid Waste Disposal Per Employee (tons/employee/year)	0.3	0.3	0
Solid Waste Disposal (tons)	475.8	518.5	557
LFG Capture Rate	75%	75%	1
Percent of Landfills Accepting Waste from Milpitas with LFG Capture	89%	89%	1
Oxidation Rate	0.1	0.1	0
EPA Emissions Factor (MTCH4/wet short ton)	0.06	0.06	0
Total Emissions (MTCO2e/year)	159.30	173.59	187

Water Supply

Irvine Municipal Operations Greenhouse Gas Inventories and Forecasts

Water			2019				2030				2040			
Water Provider	MGY	Total MWh	Emission Factor MT CO2/MWh)	Emission Factor (MT CH4/MWh)	Emission Factor (MT N2O/MWh)	Total CO2e (MT/year)	MGY	Total MWh	BAU Total CO2e (MT/year)	Leg-Adjust BAU Total CO2e (MT/year)	MGY	Total MWh	BAU Total CO2e (MT/year)	Leg-Adjust BAU Total CO2e (MT/year)
IRWD - Recycled (Inside City Limits - Excluded)		-	0	0	0	0	0	-	-	-	-	-	-	-
IRWD - Potable (Groundwater)	38.6	13	0	0	0	3	42	14	3	1	45	15	3	1
IRWD - Potable (SWP)	5.8	8	0	0	0	2	6	9	2	1	7	9	2	0.364
Total	44.40	21				4	48	23	5	2	52.01	24	5	1

YEAR	WATER SOURCE	CUSTOMER NAME	IRVINE CITY LIMITS	USAGE (MG)
2019	POTABLE	CITY OF IRVINE	INSIDE	44.40
2019	RECYCLED	CITY OF IRVINE	INSIDE	830

Energy Intensity

	EF (kWh/AF)	EF (MWh/MG)	AF_MG
Potable Supply	429.95	0.140099613	3.06888785
Potable Treatment	311.48	0.101496052	
Potable Distribution	290.24	0.094574978	140.099613
TOTAL	1,032	0.336170642	
Non-Potable Supply	150.75	0.04912203	
Non-Potable Treatment	82.15	0.026768655	
Non-Potable Distribution	834.85	0.27203666	
TOTAL	1,068	0.347927344	

SWP Emissions Factor	EF (kWh/AF)	EF (MWh/MG)
Extraction and Conveyance - South Coast	3214	1.047284931
Treatment - South Coast	443	0.144351968
Distribution - South Coast	501	0.163251322
Total	4158	1.354888221

						Default EMFAC Emissions Factor, pounds CO2e/VMT	Leg-adjusted Emissions Factor, pounds CO2e/VMT	
EMFAC category	Description	Subject to ACC2?	Gallons / year	EMFAC VMT / gallon of fuel in 2019	Annual VMT estimate	2019	2030	2040
LDA	Passenger Vehicles	Yes	2,203	29	63,078	0.67	0.40	0.11
LDT1	Light-Duty Trucks	Yes	11,125	23	260,759	0.82	0.61	0.26
MDV	Medium-Duty Trucks	Yes	75,010	18	1,360,796	1.06	0.75	0.34
LHD1	Light-Heavy-Duty Trucks	No	13,205	14	185,579	1.43	1.07	0.69
LHD2	Light-Heavy-Duty Trucks	No	9,687	13	130,114	1.56	1.22	0.81
T6 Public Class 4	Public Fleet Truck	No	4,522	8	37,329	2.79	2.39	1.60
T6 Public Class 5	Public Fleet Truck	No	3,160	8	26,722	2.68	2.36	1.60
T6 Public Class 6	Public Fleet Truck	No	384	8	3,144	2.81	2.37	1.60
T6 Utility Class 7	Utility Fleet Truck	No	8,361	9	76,132	2.56	2.02	1.08
T7 Utility Class 8	Utility Fleet Truck	No	1,978	6	12,033	3.84	3.39	2.29
UBUS	Urban Buses	No	1,487	4	5,253	5.29	4.97	0.47
All Light-duty						1.08	0.78	0.39
All vehicles						1.21	0.90	0.46
Weighted average emissions factors as a percent of 2019							74.3%	37.9%

Calculate scalar from CO2 to CO2e for vehicle fleet		1	27	273		
		CO2	CH4 (in CO2e units)	N2O (in CO2e units)	CO2e	CO2e / CO2 ratio
	Gasoline	47,557,617	41,132	367,963	47,966,713	100.86%
	Natural Gas	553,778	20,546	30,819	605,143	109.28%

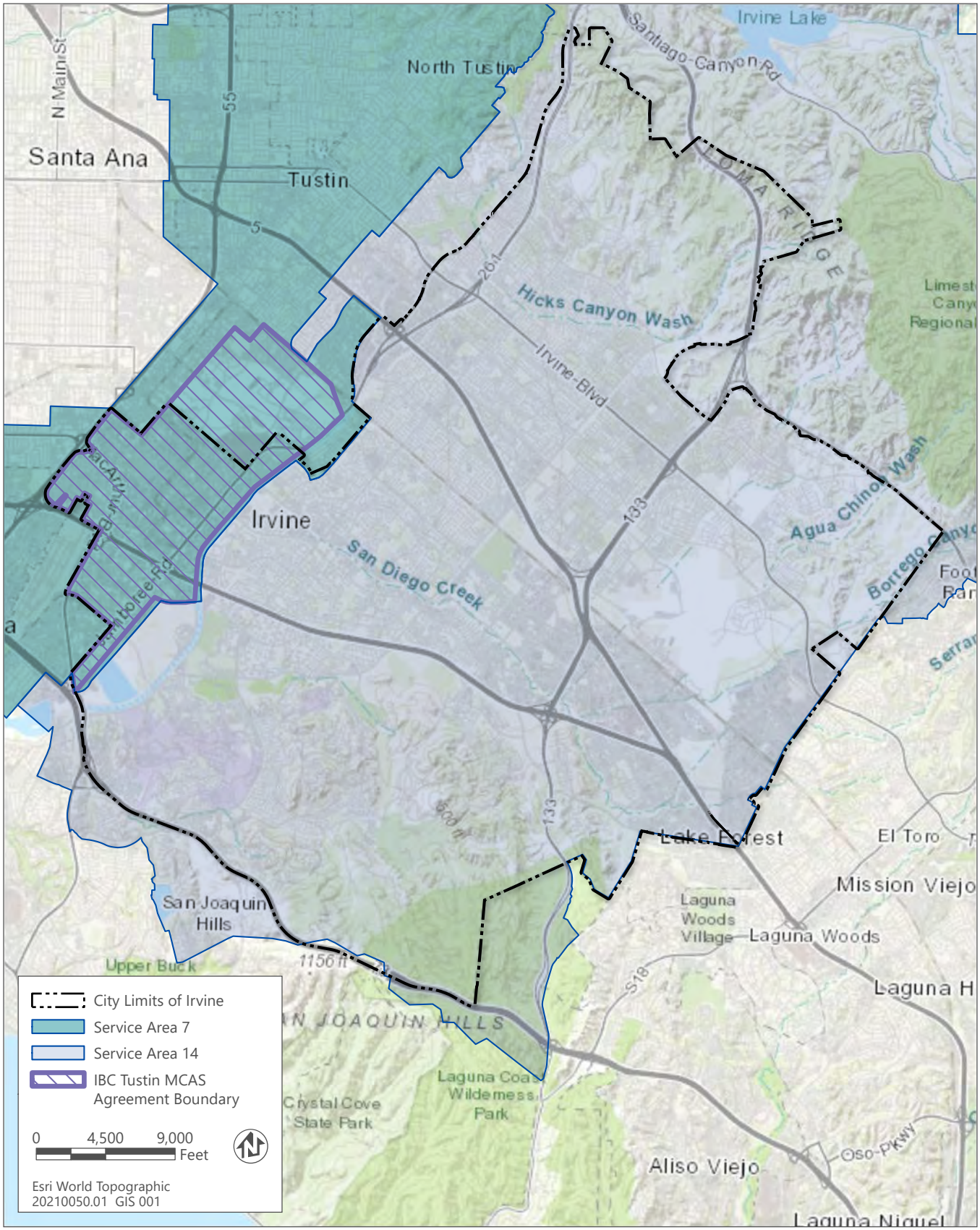
Demographics

Irvine Municipal Operations Greenhouse Gas Inventories and Forecasts

Irvine Employees	2017	2018	2019	2020	2021	2030	2035	2040	2045
All	1,487	1,566	1,586	1,566	1,489	1,728	1,793	1,858	1,922
Percent Growth from 2019	--	--	0	0	0	0	0	17%	21%

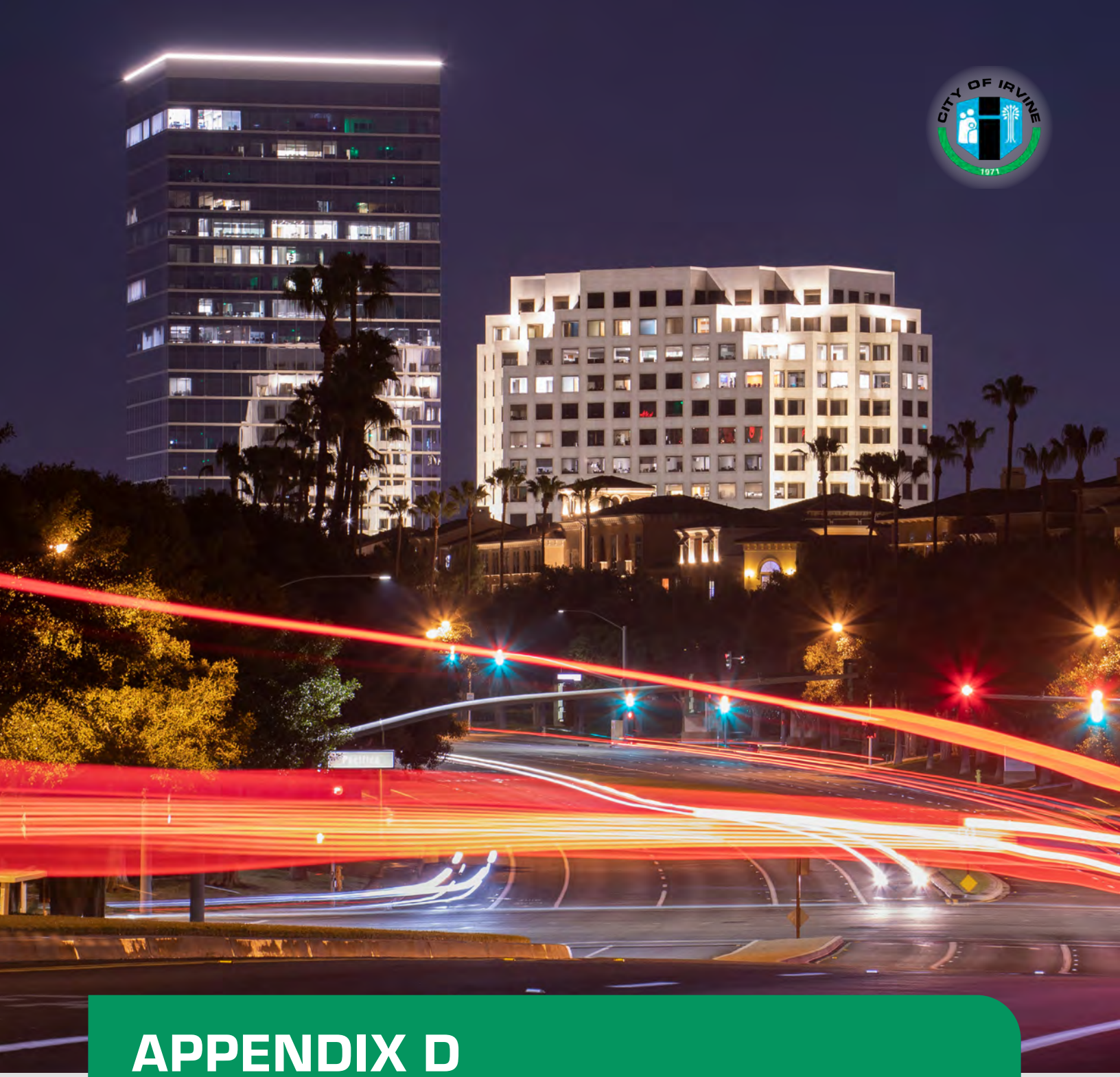
Attachment B

Wastewater Service Boundaries Map



Source: adapted by Ascent in 2021. 12/21/2021

City of Irvine Wastewater Service Boundaries



APPENDIX D

Greenhouse Gas Emissions Forecast.

IRVINE CLIMATE ACTION AND ADAPTATION PLAN

Memo

1230 Columbia St, Suite 440
San Diego, CA 92101
619.219.8000

Date: October 11, 2024

To: City of Irvine – CAAP Project Team

From: Poonam Boparai, Fred Hochberg, Hannah Kornfeld, and Andrew Martin

Subject: Greenhouse Gas Emissions Forecasts Report for the City of Irvine Climate Action and Adaptation Plan

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INTRODUCTION

The City of Irvine (City) is developing a Climate Action and Adaptation Plan (CAAP) to reduce greenhouse gas (GHG) emissions and prepare the city for the impacts of climate change. This technical memorandum provides the results of these forecasts, and describes the methods, assumptions, emissions factors, and data sources used to prepare them. The GHG emissions forecasts provide a foundation for the City's climate action planning process, including establishing City-specific targets for reducing emissions levels, calculating additional reductions in emissions levels needed to meet the City's targets (also referred to as the emissions "gap"), and formulating and quantifying measures the City can take to meet its targets and close the gap.

ORGANIZATION OF THIS MEMORANDUM

This memorandum consists of two parts:

- Section 1: Summary of Inventory Results presents an overview of the City's 2019 GHG emissions inventories for community-wide activities and municipal operations.
- Section 2: Greenhouse Gas Emissions Forecasts summarizes the forecasted GHG emissions under "business-as-usual" (BAU) and legislative-adjusted BAU scenarios for the years 2030 and 2040. The first scenario, called the BAU scenario, does not account for GHG emissions reductions resulting from laws and regulations adopted by local, regional, State, or federal agencies; it illustrates how much emissions would increase due to population and economic growth if no actions to reduce emissions were taken. The second scenario, a legislative-adjusted BAU scenario, shows emissions reductions from laws and regulations enacted by regional, State, and federal agencies; it does not reflect City actions to reduce GHG emissions. Further reductions in GHG emissions from City actions will be evaluated as a next step in the process of preparing the CAAP.

1 SUMMARY OF INVENTORY RESULTS

1.1 2019 COMMUNITY-WIDE INVENTORY

According to the *Greenhouse Gas Emissions Inventory Report for the City of Irvine Climate Action and Adaptation Plan* (2019 Inventory Report), the community generated approximately 2,247,593 metric tons of carbon dioxide equivalent ($MTCO_2e$) in 2019. Figure 1 and Table 1 present 2019 community-wide emissions by sector.

The largest emissions-generating sectors include on-road transportation and nonresidential and residential building energy. The 2019 emissions level serves as the baseline to forecast emissions and set reduction targets in the CAAP. GHG emissions from stationary sources regulated by State and federal agencies (e.g., sources covered by the Cap-and-Trade program) and outside the City's jurisdiction and influence (e.g., University of California, Irvine [UC Irvine], County-operated landfill) are discussed in the 2019 Inventory Report but not reflected in the community-wide emissions total for 2019.

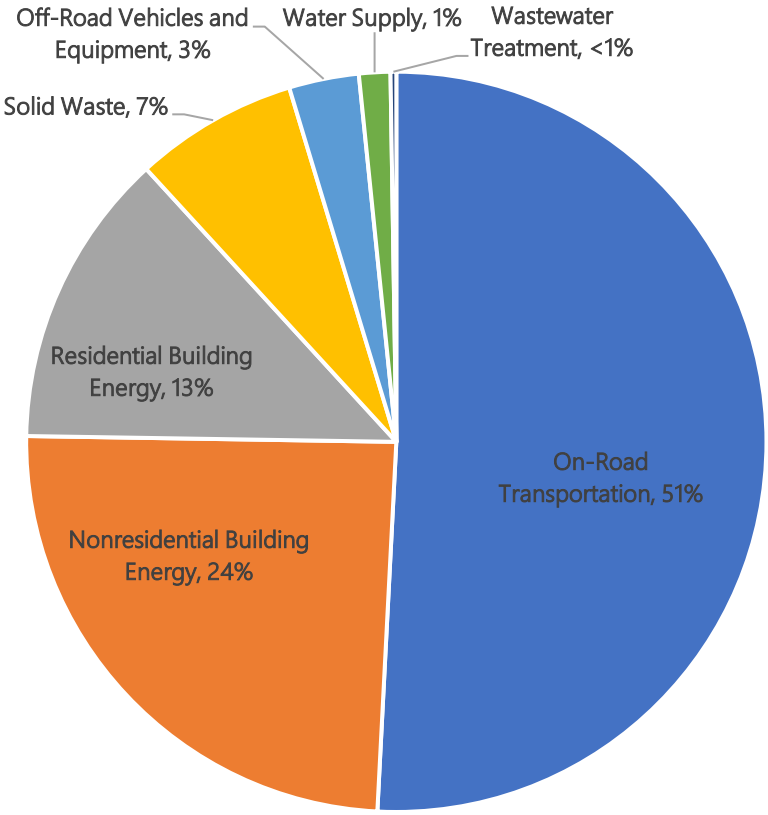

Figure 1 2019 Community-wide GHG Emissions Inventory in the City of Irvine

Note: Totals are rounded to the nearest percent.

Table 1 2019 Community-wide GHG Emissions Inventory in the City of Irvine

Sector	GHG Emissions ($MTCO_2e$)	Percent of Total
On-Road Transportation	1,140,206	51
Nonresidential Building Energy	550,138	24
Residential Building Energy	291,405	13
Solid Waste	160,626	7
Off-Road Vehicles and Equipment	68,756	3
Water Supply	30,798	1
Wastewater Treatment	5,665	<1
Total	**2,247,593**	**100**

Notes: Totals may not sum exactly due to independent rounding to the nearest percent. GHG = greenhouse gases; $MTCO_2e$ = metric tons of carbon dioxide equivalent.

Source: Data modeled by Ascent in 2024.

1.2 2019 MUNICIPAL OPERATIONS INVENTORY RESULTS

Based on the modeling conducted, the City's municipal operations generated approximately 18,566 $MTCO_2e$ in 2019. The employee commute and buildings and facilities sectors generated approximately 81 percent of total emissions. The 2019 inventory serves as the municipal operations GHG emissions baseline for the CAAP to forecast emissions and set emissions reductions targets. Table 2 and Figure 2 present the results of the City's 2019 municipal operations GHG emissions inventory by sector, and a description of each emissions sector, including key sources of emissions, is provided in further detail in *Greenhouse Gas Emissions Inventory Report for the City of Irvine Climate Action and Adaptation Plan*.

Table 2 2019 City of Irvine Municipal Operations GHG Emissions Inventory

Sector	GHG Emissions ($MTCO_2e$)	Percent of Total
Buildings and Facilities	12,003	65
Employee Commute	3,032	16
Wastewater Treatment	1,144	6
Vehicle Fleet	1,127	6
Streetlights and Traffic Signals	1,097	6
Solid Waste	159	1
Water Supply	4	<1
Total	**18,566**	**100**

Notes: Totals may not sum exactly due to independent rounding. GHG = greenhouse gases; $MTCO_2e$ = metric tons of carbon dioxide equivalent.

Source: Data modeled by Ascent in 2024.

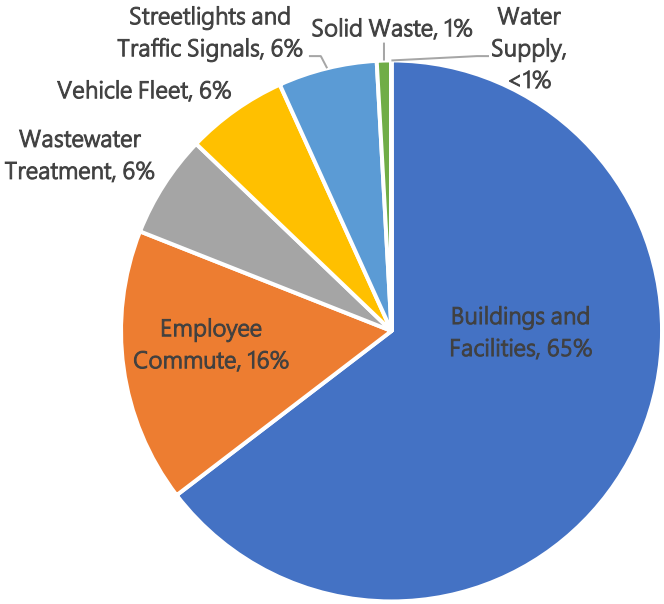

Figure 2 2019 City of Irvine Municipal Operations GHG Emissions Inventory

2 GREENHOUSE GAS EMISSIONS FORECASTS

2.1 COMMUNITY FORECAST RESULTS

The BAU GHG emissions forecasts provide an assessment of how emissions generated by community activities will change over time without further local, State, or federal action. In addition to accounting for the city's growth under a BAU scenario, an adjusted BAU forecast was prepared, which includes adopted legislative and regulatory actions at the State and federal levels that would affect emissions without any local action (referred to hereafter as 'legislative-adjusted BAU'). These include regulatory requirements to increase vehicle fuel efficiency and increase renewable energy sources in grid electricity portfolios. It is important to note that the legislative-adjusted BAU emissions forecasts only include emissions reductions associated with implementation of adopted federal and State legislation and regulations and do not include goals established by executive orders or targets established by federal or State agencies. These forecasts provide the City with the information needed to focus efforts on emissions sectors and sources that have the greatest opportunities for GHG emissions reductions.

The legislative-adjusted BAU GHG emissions forecasts for 2030 and 2040 are aligned with the reduction targets for statewide emissions levels established in State law, including the 2030 target set forth in Senate Bill (SB) 32 and the 2045 target set forth in Assembly Bill (AB) 1279:

- SB 32 (2016):
  - reduce statewide GHG emissions to 40% below 1990 levels by 2030.
- AB 1279 (2022):
  - achieve net zero GHG emissions statewide as soon as possible, but no later than 2045, and maintain net negative emissions thereafter; and
  - ensure that by 2045, statewide anthropogenic greenhouse gas emissions are reduced to at least 85% below the 1990 levels.

Both the BAU and legislative-adjusted BAU emissions forecasts were based on population and employment from the City's land use database and the California State University, Fullerton, Center for Demographic Research Orange County Projections. Population and employment are expected to increase by 17 and 23 percent, respectively, from 2019 to 2040. These growth factors were used to forecast emissions for most sectors. Additional information regarding the growth factors used for each sector is included in the following sections. Annual vehicle miles traveled (VMT) projections were developed using the origin-destination method using data from the Irvine Transportation Analysis Model (ITAM) Traffic Model 2021. Annual VMT by 2040 is projected to increase by 2.6 percent from 2019. VMT projections were used to scale emissions from the on-road transportation sector. Table 3 shows growth in population, employment, and annual VMT from 2019 to 2040.

Table 3 City of Irvine Community Demographic and Vehicle Miles Traveled Forecasts

Forecast Factor	2019	2030	2040
Population	291,124	317,246	340,993
Employment	250,954	280,541	307,438
Annual VMT	2,910,428,375	2,950,103,309	2,986,171,431

Notes: VMT = vehicle miles traveled.

Source: City of Irvine 2021; California State University, Fullerton 2018.

Table 4 shows baseline emissions in 2019 and BAU emissions forecasts for 2030 and 2040.

Table 4 Table 4. City of Irvine Community GHG Emissions Inventory and BAU Forecasts ($MTCO_2e$)

Sector	2019	2030	2040
On-Road Transportation	1,140,206	1,155,749	1,169,879
Nonresidential Building Energy	550,138	614,999	673,962
Residential Building Energy	291,405	317,552	341,322
Solid Waste	160,626	175,038	188,141
Off-Road Vehicles and Equipment	68,756	76,077	87,531
Water Supply	30,798	43,202	46,436
Wastewater Treatment	5,665	6,159	6,620
Total	**2,247,593**	**2,388,776**	**2,513,892**
Percent Change from 2019 Levels	—	6%	12%

Notes: Total may not sum exactly due to independent rounding. BAU = business-as-usual; GHG = greenhouse gas; $MTCO_2e$ = metric tons of carbon dioxide equivalent.

Source: Data modeled by Ascent in 2024.

Legislative-adjusted BAU emissions forecasts were prepared using the same demographic and VMT data that were used for the BAU forecasts, while accounting for regional, State, and federal laws and regulations that would affect local emissions. These forecasts provide the City with an understanding of future community emissions to inform the identification of emissions reduction measures developed to meet GHG targets. A summary of the legislative reductions applied is provided in Table 5.

Table 5 Table 5. Legislative Reductions Summary

Source	Legislative Reduction	Description	Sectors Applied
Regional	Orange County Power Authority (OCPA)	OCPA offers multiple electricity portfolios to its customers, each with its own percentage of renewable power. Customers that "opt out" of OCPA return to electric service with Southern California Edison. In the forecast years (i.e. all future years after 2019), it was assumed that approximately 62 percent of City of Irvine customers will take service on OCPA's 100% Renewable Choice Plan (100 percent renewable), 15 percent on the Smart Choice Plan (69 percent renewable), and 1 percent on the Basic Choice Plan (38 percent renewable). In total, this represents 77 percent of City of Irvine customers being served by OCPA (totals do not sum exactly due to independent rounding). The remaining 23 percent of customers are served by Southern California Edison (based on data provided by Lawrence, pers.comm., 2023 and City of Irvine 2023: 2).	Building Energy
State	California's Building Energy Efficiency Standards (2022 Title 24, Part 6)	Effective January 1, 2023, new residential and nonresidential buildings in California are required to comply with energy efficiency standards established by the California Energy Commission (CEC). The standards establish building performance requirements that encourage energy efficient approaches to building decarbonization, including energy efficiency improvements in the building envelope, electric heat pumps, photovoltaic arrays, and battery storage systems.	Building Energy
State	IRP (Integrated Resource Planning)	California Public Utilities Commission proceeding requiring California energy utilities to submit electric procurement plans to meet the State's GHG emissions reduction goals. Each utility's plan must reduce their GHG emissions below their share of total statewide electric sector emissions (38 million metric tons [MMT] of CO_2e by 2030 and 30 MMT by 2035 [CPUC 2022: 8]).[1]	Building Energy
State	SB 100	Updates the Renewable Portfolio Standard (RPS) to require procurement of 60 percent renewable energy by 2030. Additionally, all retail electricity sold in California must come from renewable or zero-carbon resources by 2045.	Building Energy
State	SB 1020 (Clean Energy, Jobs, and Affordability Act of 2022)	For retail electricity sales to California end-use customers, this bill requires that eligible renewable energy resources and zero-carbon resources comprise 90 percent by December 31, 2035, 95 percent by December 31, 2040, and 100 percent by December 31, 2045.	Building Energy
State	Pavley Clean Car Standards and Advanced Clean Car Standards I and II	Requires all new passenger cars, trucks and sport utility vehicles sold in California to meet increasingly stringent requirements regarding zero emissions technologies and emissions standards.	On-Road Vehicles
State	Truck and Bus Regulation	Requires diesel trucks and buses that operate in California to be upgraded to reduce GHG emissions.	On-Road Vehicles
Federal	Fuel Efficiency Standards for Medium- and Heavy-Duty Vehicles	Establishes fuel efficiency standards for medium- and heavy-duty engines and vehicles.	On-Road Vehicles

[1] IRP also requires that utilities submit a second, lower-carbon resource plan to meet statewide carbon goals. This second plan uses targets of 30 and 25 MMT in 2030 and 2035, respectively. However, this memorandum assumes the statewide emissions targets of 38 MMT in 2030 and 30 MMT in 2035 plan, as stated in Table 5, as a more conservative estimate of future electric sector emissions reductions.

Source	Legislative Reduction	Description	Sectors Applied
Federal	EPA Off-Road Compression-Ignition Engine Standards	Establishes standards for phasing of EPA diesel engine tiers for off-road compression-ignition equipment.	Off-Road Vehicles and Equipment

Notes: CEC = California Energy Commission; CO_2e = carbon dioxide equivalent; EPA = U.S. Environmental Protection Agency; GHG = greenhouse gas; OCPA = Orange County Power Authority; SB = Senate Bill.

Source: Prepared by Ascent in 2024.

The city's legislative-adjusted BAU emissions would decrease by approximately 55 percent between 2019 and 2040, as shown below in Table 6 and Figure 3. Figure 3 also shows the emissions trend that would occur without anticipated legislative reductions, accounting only for population, employment, and VMT changes (i.e., BAU emissions). Without the legislative reductions, emissions would be approximately 148 percent higher in 2040 compared to 2040 emissions levels in the legislative-adjusted BAU forecast. Emissions forecasts for each sector are discussed in detail in the following sections.

Table 6 Table 6. City of Irvine Community GHG Emissions Inventory and Legislative-Adjusted BAU Forecasts ($MTCO_2e$)

Sector	2019	2030	2040
On-Road Transportation	1,140,206	793,628	334,698
Nonresidential Building Energy	550,138	247,934	200,979
Residential Building Energy	291,405	203,559	193,301
Solid Waste	160,626	175,038	188,141
Off-Road Vehicles and Equipment	68,756	76,077	87,531
Water Supply	30,798	9,973	1,831
Wastewater Treatment	5,665	6,173	6,620
Total	**2,247,593**	**1,512,383**	**1,013,100**
Percent Change from 2019 Levels	—	-33%	-55%

Notes: Total may not sum exactly due to independent rounding. BAU = business-as-usual; GHG = greenhouse gas; $MTCO_2e$ = metric tons of carbon dioxide equivalent.

Source: Data modeled by Ascent in 2024.

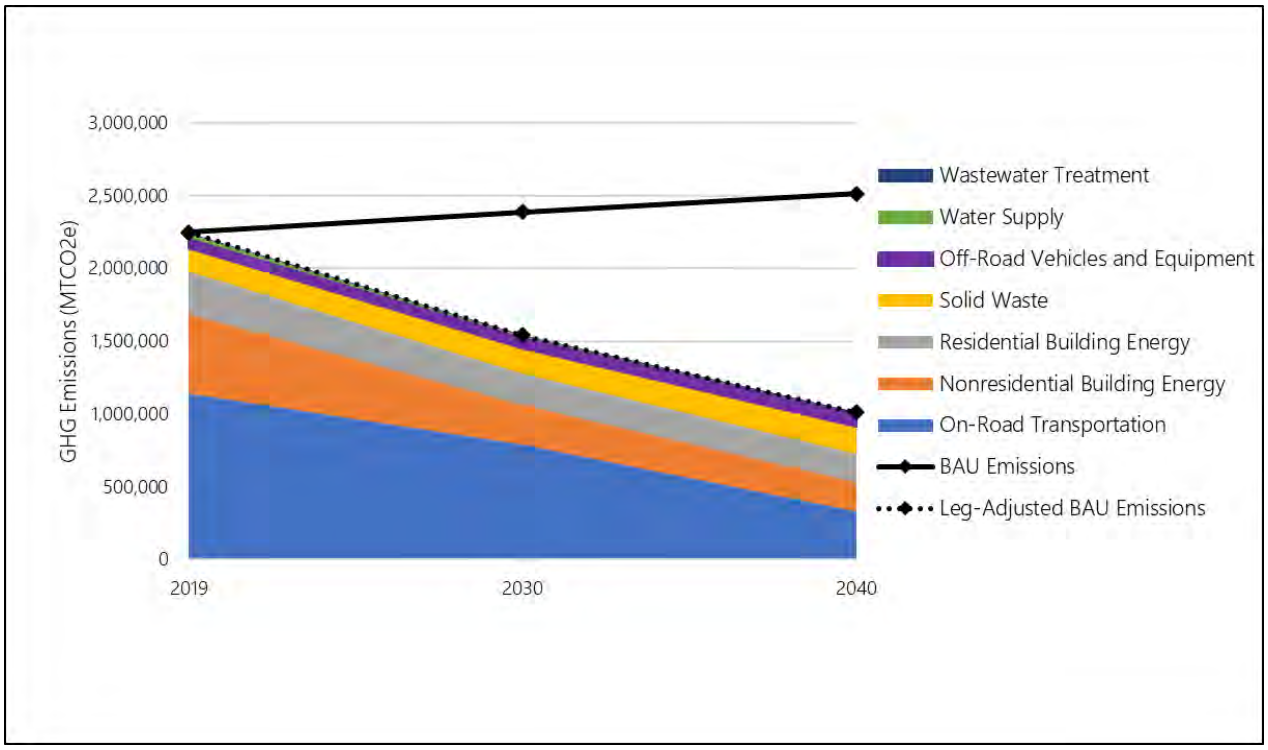

Figure 3 City of Irvine Community GHG Emissions Inventory and Forecasts

Notes: BAU = Business As Usual; $MTCO_2e$ = metric tons of carbon dioxide equivalent.

Source: Data modeled by Ascent in 2024.

2.2 COMMUNITY FORECAST METHODS BY SECTOR

2.2.1 Building Energy

BUILDING ENERGY ASSUMPTIONS

Building energy emissions in the city result directly from onsite combustion of natural gas and indirectly from electricity consumption. The combustion of fossil fuels (i.e., diesel, liquid propane gas [LPG], and natural gas) in backup generators also contributes to the city's building energy emissions. Southern California Edison (SCE) is an electricity provider and Southern California Gas Company (SoCalGas) is the natural gas provider in the city. Orange County Power Authority (OCPA) is a community choice aggregation agency established to source clean and renewable electricity in Orange County including the City of Irvine.

Electricity Emissions Factors

Emissions factors for electricity vary depending on the utility (SCE or OCPA), the carbon content of the different portfolios that each utility offers its customers, and year. To calculate City's overall electric emissions factor for a given year, a weighted average of OCPA emissions and SCE emissions was taken, accounting for participation rates and portfolio offerings across those two utilities (see Table 5 of this memorandum). This weighted average emissions factor was then applied to all electric usage. Table 7 below shows how this calculation was performed.

Table 7 Calculation of Weighted Emissions Electric Emissions Factor

Year	Participation rates by utility and power portfolio					$MTCO_2e$ / MWh by utility and power portfolio				
	SCE	OCPA Basic Choice Plan	OCPA Smart Choice Plan	OCPA 100% Renewable Choice Plan	Total	SCE	OCPA Basic Choice Plan	OCPA Smart Choice Plan	OCPA 100% Renewable Choice Plan	Weighted Average
2019	100%	0%	0%	0%	100%	0.208	NA	NA	NA	0.208
2030	23%	1%	15%	62%	100%	0.141	0.244	0.094	0	0.048
2040	23%	1%	15%	62%	100%	0.021	0.021	0.021	0.000	0.008

Notes: Total may not sum exactly due to independent rounding. NA = Not Applicable; OCPA = Orange County Power Authority; $MTCO_2e$ = metric tons of carbon dioxide equivalent; MWh = megawatt-hour; SCE = Southern California Edison.

Source: Data modeled by Ascent in 2024.

SCE's emissions factor for 2019 was derived from its Power Content Label, which shows 16.1 percent natural gas and 32.6 percent from unspecified sources of power (unspecified power is electricity that has been purchased through open market transactions and is not traceable to a specific generation source: SCE 2019). In total, this implies that SCE's portfolio is 48.7 percent carbon-emitting power (note: "carbon-emitting power" is used hereafter as a shorthand to refer to the sum of power generated by natural gas-fired generators and unspecified power). This 48.7 percent was then multiplied by California Air Resources Board (CARB) emissions factor for Mandatory Reporting of Greenhouse Gases (MRR) of 0.428 $MTCO_2e$/MWh, which reflects the emissions from unspecified power, and additionally is similar to the emission factor from an average single-cycle natural gas power plant (CARB 2018: 16).

Emissions factors for 2030 were derived from SCE and OCPA's IRP electricity resource plans as described in Table 5. In the case of SCE, its Integrated Resource Plan shows 67 percent GHG-free power in 2030 (SCE 2022). This corresponds to 33 percent emitting power from natural gas or unspecified power and thus 0.141 $MTCO_2e$/MWh based on the CARB emissions factor of 0.428 $MTCO_2e$/MWh shown above. In the case of OCPA, separate emissions factors for each portfolio (Basic Choice Plan, Smart Choice Plan, and 100% Renewable Choice Plan) were calculated. A percentage of carbon-free power for each OCPA portfolio was estimated by taking OCPA's overall ratio of carbon-free energy to renewable energy and multiplying that ratio by each portfolio's percentages of renewable content. This percentage of carbon-free power was then subtracted from 100 percent to yield a percentage of carbon-emitting power. Finally, this percent of carbon-emitting power was multiplied by 0.428 MTCO2e/MWh to yield an emissions factor. Table 8 below shows the results of this calculation.

Table 8 Derivation of 2030 OCPA Emissions Factors, by Portfolio

Calculation Factor	OCPA Basic Choice Plan	OCPA Smart Choice Plan	OCPA 100% Renewable Choice Plan
Percent Renewable	38%	69%	100%
Percent Carbon-Free	43%	78%	100%
Percent Carbon-Emitting Power	57%	22%	0%
Emissions Factor ($MTCO_2e$ / MWh)	0.244	0.094	0

Notes: OCPA = Orange County Power Authority; $MTCO_2e$ = metric tons of carbon dioxide equivalent. MWh = megawatt-hour.

Source: Data modeled by Ascent in 2024, based on data from Orange County Power Authority (2022).

Emissions factors for 2040 were calculated assuming implementation of SB 1020 (see Table 5, Legislative Reductions Summary). This bill requires 95 percent of all retail sales of electricity to California end-use customers to be from renewable or zero-carbon resources by December 31, 2040. This implies 5 percent emitting power, and thus 0.021

$MTCO_2e$/MWh based on the CARB emissions factor of 0.428 $MTCO_2e$/MWh shown in Table 7 above. It was assumed that the OCPA 100 percent renewable portfolio would remain at 100 percent renewable, as it is already above the 95 percent renewable or zero-carbon requirement of SB 1020.

Natural Gas Emissions Factors

Natural gas emissions are based on emissions factors obtained from The Climate Registry's (TCR's) 2020 Default Emission Factors, which are estimated to be 11.7 pounds of carbon dioxide equivalent per therm (lb CO_2e/therm). Emissions factors associated with natural gas combustion are not anticipated to change over time, as there are no legislative actions that would reduce the carbon intensity of natural gas.

Diesel Emissions Factors

Emissions from diesel fuel used to power backup generators are based on emissions factors from TCR, which are estimated to be 22.6 pounds of carbon dioxide equivalent per gallon (lb CO_2e/gal). Emissions factors associated with diesel combustion are not anticipated to change over time, as there are no legislative actions that would reduce the carbon intensity of diesel.

Gasoline Emissions Factors

Emissions from gasoline fuel used to power backup generators are based on emissions factors also from TCR, which are estimated to be 19.4 lb CO_2e/gal. Emissions factors associated with gasoline combustion are not anticipated to change over time, as there are no legislative actions that would reduce the carbon intensity of gasoline.

Energy Efficiency and Fuel Source

Future energy use was adjusted to reflect increased emissions-intensity stringency under California's Building Energy Efficiency Standards (California Code of Regulations Title 24 Part 6, hereafter referred to as "Title 24"). Title 24 standards apply to new residential and nonresidential construction. The 2019 Title 24 standards apply to projects constructed after January 1, 2020, and the 2022 Title 24 standards apply after January 1, 2023. To estimate adjusted future energy consumption resulting from Title 24 requirements in new construction, electricity- and natural gas-specific adjustment factors were calculated using the difference in the average energy use in residential and nonresidential buildings between those built to 2019 Title 24 standards and those built to 2022 Title 24 standards. Adjustment factors were calculated using data available from the California Energy Commission (CEC) that were developed for the 2022 Title 24 standards. In addition to accounting for Title 24 requirements by land use type (i.e., residential and nonresidential), CEC also developed estimates for energy usage rates by climate zone, and the city's climate zone (Zone 8) was used for the residential buildings analysis. Climate zone-specific data for nonresidential buildings were unavailable; therefore, nonresidential adjustment factors relied on statewide averages.

The adjustment factors (specific to both building type and energy type) were applied to the BAU growth in building energy use to estimate the energy consumption and associated GHG emissions of future development with legislative adjustments. It is important to note that although average electricity use in new residential buildings is anticipated to rise (due to an increase in electrical demand associated with electric appliances installed instead of natural gas appliances), emissions from new residential buildings are expected to be lower than they would be under 2019 Title 24 as a result of overall lower building emissions intensities (due to lower emissions factors associated with electricity compared to natural gas).

BUILDING ENERGY RESULTS

Emissions from future electricity, natural gas, and backup generator (i.e., diesel, natural gas, and gasoline) use were estimated by multiplying anticipated energy use by forecasted emissions factors. Future energy use was forecasted in two parts. First, energy use was scaled by population and employment growth factors detailed above. Second, energy emissions factors were adjusted as described in the previous section. Natural gas, diesel, and gasoline emissions

factors were not adjusted, as the emissions intensity of these energy sources is anticipated to stay constant. Table 9 summarizes the scaling factors and legislative reductions used to forecast building use by energy type.

Table 9 Building Energy Emissions Forecast Methods by Energy Type

Energy Type	Forecast Methods	
	Scale Factor	Applied Legislative Reductions
Electricity	Scaled by population growth for residential building energy; scaled by employment growth for nonresidential building energy.	Emissions factors derived from SCE and OCPA IRP plans. Accounts for Title 24 energy efficiency gains in new construction based on the best available data for average building energy efficiency.
Natural Gas		Accounts for Title 24 energy efficiency gains in new construction based on the best available data for average building energy efficiency.

Notes: IRP = Integrated Resource Plan; OCPA = Orange County Power Authority; RPS = Renewables Portfolio Standard; SCE = Southern California Edison.

Source: Prepared by Ascent in 2024.

RESIDENTIAL BUILDING ENERGY

Between 2019 and 2040, emissions from residential building energy would decrease by approximately 34 percent from 291,405 to 193,301 $MTCO_2e$ with legislative adjustments, despite overall population growth of approximately 17 percent over the same time. Table 10 shows the 2019 inventory and legislative-adjusted BAU forecasted emissions from the residential building energy sector by energy type for 2030 and 2040.

Table 10 Residential Building Energy GHG Emissions Inventory and Legislative-Adjusted BAU Emissions Forecasts (Annual $MTCO_2e$)

Energy Type	2019	2030	2040
Electricity	116,584	22,304	5,424
Natural Gas	174,820	181,255	187,459
Total	**291,405**	**203,559**	**193,301**

Notes: Totals may not sum exactly due to independent rounding. BAU = business-as-usual; GHG = greenhouse gas; $MTCO_2e$ = metric tons of carbon dioxide equivalent.

Source: Data modeled by Ascent in 2024.

NONRESIDENTIAL BUILDING ENERGY

Between 2019 and 2040, emissions from nonresidential building energy would decrease by approximately 63 percent from 550,138 to 200,979 $MTCO_2e$ with legislative adjustments, despite overall employment growth of approximately 23 percent over the same time. Table 11 shows the 2019 inventory and legislative-adjusted BAU forecasted emissions for the nonresidential building energy sector by energy type for 2030 and 2040.

Table 11 Nonresidential Building Energy GHG Emissions Inventory and Legislative-Adjusted BAU Forecasts (Annual $MTCO_2e$)

Energy Type	2019	2030	2040
Electricity	385,130	74,797	18,398
Natural Gas	160,501	169,735	178,853
Backup Generators	4,507	3,401	3,728
Total	**550,138**	**247,934**	**200,979**

Notes: Totals may not sum exactly due to independent rounding. BAU = business-as-usual; GHG = greenhouse gas; $MTCO_2e$ = metric tons of carbon dioxide equivalent.

Source: Prepared by Ascent in 2024.

2.2.2 Transportation

ON-ROAD TRANSPORTATION

Between 2019 and 2040, GHG emissions from on-road vehicles would decrease by approximately 71 percent from 1,140,206 to 334,698 $MTCO_2e$, accounting for an increase in VMT of approximately 2.6 percent, and future vehicle emissions factors modeled in California Air Resources Board's (CARB's) Emissions FACtor (EMFAC2021) model. VMT projections were developed using the origin-destination method and data from the ITAM model. With respect to the legislative adjustments included in this forecast, State and federal laws and regulations incorporated in the on-road transportation sector include the Pavley Clean Car Standards Advanced Clean Car I and II (ACC I and II) Standards, and fuel efficiency standards for medium- and heavy-duty vehicles. Pavley Clean Car Standards and fuel efficiency standards are included in EMFAC2021's emissions factor estimates and forecasts. Vehicle fleet assumptions were adjusted to account for the effect of Advanced Clean Car II (ACC II) Standards, including assumed new sales of battery electric vehicles and plug-in hybrids (CARB 2022: 5). The Low Carbon Fuel Standard was excluded in EMFAC2021 forecasts because the emissions benefits originate from upstream fuel production and do not directly reduce vehicle tailpipe emissions that affect the city's GHG emissions forecasts. Table 12 summarizes the scaling factors and legislative reductions used to forecast on-road transportation emissions.

Table 12 On-Road Transportation Emissions Forecast Methods

Source	Forecast Methods	
	Scale Factor	Applied Legislative Reductions
On-Road Transportation	Scaled by VMT estimates provided by Iteris.	EMFAC2021 forecasts vehicle fleet distributions by vehicle type and the emissions factors anticipated for each vehicle category based on both vehicle emissions testing and approved legislative reductions. EMFAC2021's forecasts incorporate the effects of federal standards and fuel efficiency standards for medium- and heavy-duty vehicles, as well as truck and bus regulations. Vehicle fleet assumptions were adjusted to account for the effect of Advanced Clean Car II (ACC II) Standards, including assumed new sales of battery electric vehicles and plug-in hybrids.

Notes: ACC II= Advanced Clean Cars II; CAFE = Corporate Average Fuel Economy; EMFAC2021 = California Air Resources Board's EMisson FACtor 2021 model.

Source: Prepared by Ascent in 2024.

Table 13 shows the 2019 inventory and legislative-adjusted BAU forecasted emissions from on-road transportation for 2030 and 2040.

Table 13 On-Road Transportation GHG Emissions Inventory and Legislative-Adjusted BAU Forecasts (Annual $MTCO_2e$)

Source	2019	2030	2040
On-Road Transportation	1,140,206	793,628	334,698

Notes: BAU = business-as-usual; GHG = greenhouse gas; $MTCO_2e$ = metric tons of carbon dioxide equivalent.

Source: Source: Data modeled by Ascent in 2024.

OFF-ROAD VEHICLES AND EQUIPMENT

Between 2019 and 2040, emissions associated with off-road vehicles and equipment used in the city would increase by 27 percent from 68,756 to 87,531 $MTCO_2e$, with legislative adjustments applied and overall growth in various demographics. Emissions were obtained primarily from CARB's latest off-road emissions model, OFFROAD2021, as well as from CARB's OFFROAD2007 model. With respect to the legislative adjustments in the off-road vehicle sector, OFFROAD2021 was used, which incorporates regulatory actions such as reformulated fuels and more stringent emissions standards. However, some off-road vehicle and equipment sources that are included in the OFFROAD2007 model are excluded from OFFROAD2021. For these sectors, emissions were obtained from OFFROAD2007. In addition, OFFROAD2021 provides CO_2 emissions but does not provide emissions from CH_4 and N_2O. Ratios of CH_4 and N_2O to CO_2 reported in OFFROAD2007 were calculated and applied to CO_2 data from OFFROAD2021 to calculate CH_4 and N_2O emissions, as recommended by CARB.

Orange County-level emissions from off-road vehicles and equipment were downscaled to the city, using changes in city-specific demographic factors. Table 14 summarizes the scaling factors and legislative reductions used to forecast off-road vehicle and equipment emissions.

Table 14 Off-Road Vehicles and Equipment Forecast Methods by Source

Source	Forecast Methods	
	Scale Factor	Applied Legislative Reductions
Construction and Mining	Service Population	OFFROAD2021 emissions factor considerations include EPA off-road compression-ignition engine standards implementation schedule.
Entertainment Equipment	Employment	
Industrial Equipment	Employment	
Lawn and Garden Equipment	Population	
Light Commercial Equipment	Employment	
Portable Equipment	Employment	
Recreational Equipment	Population	
Transport Refrigeration Units	Service Population	

Notes: EPA = U.S. Environmental Protection Agency; OFFROAD2021 = California Air Resources Board's OFFROAD2021 model.

Source: Data modeled by Ascent in 2024..

Table 15 shows the 2019 inventory and legislative-adjusted BAU forecasted emissions from the off-road vehicles and equipment sector for 2030 and 2040.

Table 15 Off-Road Vehicles and Equipment GHG Emissions Inventory and Legislative-Adjusted BAU Forecasts (Annual $MTCO_2e$)

Source	2019	2030	2040
Construction and Mining	19,536	21,614	24,668
Entertainment Equipment	267	295	341
Industrial Equipment	25,201	27,892	32,233
Lawn and Garden Equipment	708	776	874
Light Commercial Equipment	5,330	5,899	6,817
Portable Equipment	14,647	16,212	18,734
Recreational Equipment	267	293	329
Transport Refrigeration Units	2,799	3,097	3,534
Total	**68,756**	**76,077**	**87,531**

Notes: Totals may not sum exactly due to independent rounding. BAU = business-as-usual; GHG = greenhouse gas; $MTCO_2e$ = metric tons of carbon dioxide equivalent.

Source: Data modeled by Ascent in 2024.

2.2.3 Solid Waste

Between 2019 and 2040, solid waste emissions generated from community activities in the city would increase by approximately 17 percent from 160,626 to 188,141 $MTCO_2e$, accounting for overall population growth of approximately 17 percent over the same time. Solid waste sector emissions include CH_4 emissions from the decay of waste generated annually, which were scaled by population growth within the city between 2019 and 2040. No additional legislative reductions could be applied to this sector, so legislative-adjusted BAU emissions are equivalent to BAU emissions. Table 16 shows the 2019 inventory and legislative-adjusted BAU forecasted emissions from the solid waste sector for 2030 and 2040.

Table 16 Solid Waste GHG Emissions Inventory and Legislative-Adjusted BAU Forecasts (Annual $MTCO_2e$)

Source	2019	2030	2040
Community-Generated Solid Waste	160,626	175,038	188,141

Notes: BAU = business-as-usual; GHG = greenhouse gas; $MTCO_2e$ = metric tons of carbon dioxide equivalent.

Source: Data modeled by Ascent in 2024.

2.2.4 Water Supply

Between 2019 and 2040, water supply emissions generated from community activities in the city would decrease by 94 percent due to a decline in electricity emissions factors. It was assumed that certain proportions of water used within the city was extracted, conveyed, treated, and distributed within and outside the city boundary. For the water supply from local sources within the city, the electricity usage associated with extracting, conveying, treating, and distributing water is captured in the building energy sector because these activities take place within the city. Therefore, the electricity usage and emissions associated with extracting, conveying, treating, and distributing water from outside the city boundary was applied to the water sector. Electricity usage associated with water consumption is subject to RPS targets, pursuant to SB 100 requirements. Table 17 summarizes the scaling factor and legislative reduction used to forecast water supply emissions.

Table 17 Water Supply Forecast Methods and Legislative Reductions by Source

Source	Forecast Methods	
	Scale Factor	Applied Legislative Reductions
Water Consumption	Scaled by population growth.	See Section 2.1.1 (Building Energy), Electric Emissions Factors subsection, for legislative reductions applied to the electric sector.

Source: Data modeled by Ascent in 2024.

Table 16 shows the 2019 inventory and legislative-adjusted BAU forecasted emissions from the water supply sector for 2030 and 2040. Weighted average electric emissions factors shown in Table 7 were used to derive these figures.

Table 18 Water Supply GHG Emissions Inventory and Legislative-Adjusted BAU Forecasts (Annual $MTCO_2e$)

Source	2019	2030	2040
Water Supply	30,798	9,973	1,831

Notes: BAU = business-as-usual; $MTCO_2e$/year = metric tons of carbon dioxide equivalent per year.

Source: Data modeled by Ascent in 2024.

2.2.5 Wastewater Treatment

Between 2019 and 2040, community wastewater treatment emissions would increase by approximately 17 percent from 5,665 to 6,620 $MTCO_2e$. This change reflects an increase in wastewater generation resulting from population growth within the city of approximately 17 percent over the same time. Wastewater treatment-related emissions are generated from centralized wastewater treatment plants (WWTPs) providers for the city. Table 19 shows the 2019 inventory and legislative-adjusted BAU forecasted emissions from wastewater treatment sources for 2030 and 2040.

Table 19 Wastewater Treatment GHG Emissions Inventory and Legislative-Adjusted BAU Forecasts (Annual $MTCO_2e$)

Source	2019	2030	2040
Centralized WWTPs	5,665	6,173	6,620

Notes: BAU = business-as-usual; GHG = greenhouse gas; $MTCO_2e$ = metric tons of carbon dioxide equivalent; WWTP = wastewater treatment plant.

Source: Data modeled by Ascent in 2024.

2.3 MUNICIPAL OPERATIONS FORECAST RESULTS

Estimated municipal operations BAU emissions forecasts were based on predicted growth in City employment between 2019 and 2040. Municipal employment is expected to increase by 17 percent between 2019 and 2040. Change in municipal employment was the sole factor used to forecast BAU emissions for 2030 and 2040 for all sectors in the municipal operations inventory. Table 20 shows 2019 municipal employment and anticipated change in municipal employment for the forecast years.

Table 20 City of Irvine Municipal Operations Demographic Forecasts

Forecast Factor	2019	2030	2040
City Employment	1,586	1,728	1,858

Source: Ascent Environmental 2023.

Table 21 shows 2019 baseline emissions and BAU emissions forecasts for 2030 and 2040.

Table 21 City of Irvine Municipal Operations GHG Emissions Inventory and BAU Forecasts (Annual $MTCO_2e$)

Sector	2019	2030	2040
Buildings and Facilities	12,003	13,080	14,059
Employee Commute	3,032	3,304	3,551
Wastewater Treatment	1,144	1,246	1,340
Vehicle Fleet	1,127	1,228	1,320
Streetlights and Traffic Signals	1,097	1,195	1,285
Solid Waste	159	174	187
Water Supply	4	5	5
Total	**18,566**	**20,232**	**21,746**
Percent Change from 2019 Levels	—	*9%*	*17%*

Notes: Total may not sum exactly due to independent rounding. BAU = business-as-usual; GHG = greenhouse gas; $MTCO_2e$ = metric tons of carbon dioxide equivalent.

Source: Data modeled by Ascent in 2024.

Legislative-adjusted BAU emissions forecasts provide an assessment of how the City's municipal operations emissions would change over time without further action from the City. The legislative-adjusted BAU forecast accounts for laws and regulations at the regional, State, and federal levels that would affect emissions, such as regulatory requirements to increase vehicle fuel efficiency and building energy efficiency. These forecasts provide the City with the information needed to focus efforts on certain municipal operations emissions sectors and sources that have the most GHG reduction opportunities. A summary of legislative reductions applied is provided in Table 5. Municipal operations legislative-adjusted BAU emissions would decrease by approximately 74 percent between 2019 and 2040, as shown in Table 22 and Figure 4.

Table 22 City of Irvine Municipal Operations GHG Emissions Inventory and Legislative-Adjusted BAU Forecasts (Annual $MTCO_2e$)

Sector	2019	2030	2040
Buildings and Facilities	12,003	1,950	2,022
Employee Commute	3,032	2,192	842
Wastewater Treatment	1,144	1,246	1,340
Vehicle Fleet	1,127	912	501
Streetlights and Traffic Signals	1,097	0	-
Solid Waste	159	174	187
Water Supply	4	2	1
Total	**18,566**	**6,477**	**4,892**
Percent Change from 2019 Levels		**-65%**	**-74%**

Notes: Total may not sum exactly due to independent rounding. BAU = business-as-usual; GHG = greenhouse gas; $MTCO_2e$ = metric tons of carbon dioxide equivalent.

Source: Data modeled by Ascent in 2024.

Figure 4 also shows the emissions trend that would occur without anticipated legislative reductions, accounting only for changes in municipal employment (i.e., BAU emissions). 2040 legislative-adjusted emissions are approximately 22 percent of 2040 BAU emissions. Emissions forecasts for each sector are discussed in detail in the following sections.

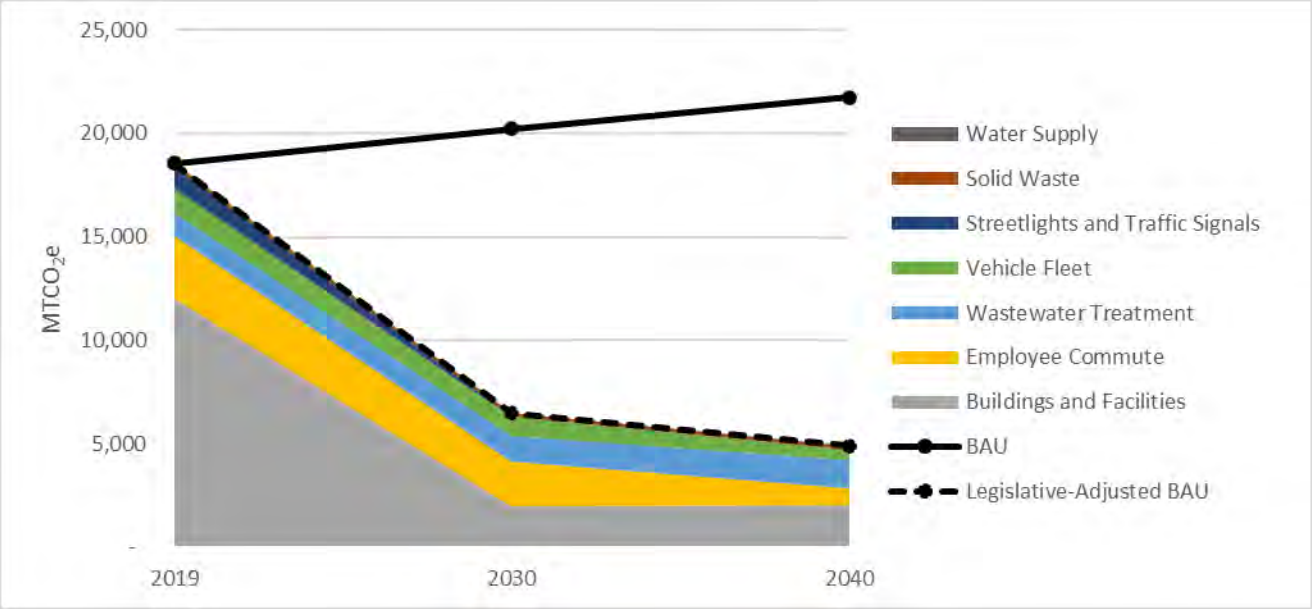

Figure 4 City of Irvine Municipal Operations GHG Emissions Inventory and Forecasts

Note: BAU = Business-as-usual; $MTCO_2e$ = metric tons of carbon dioxide equivalent.

Source: Data modeled by Ascent in 2024.

2.4 MUNICIPAL OPERATIONS FORECAST METHODS BY SECTOR

2.4.1 Buildings and Facilities Energy

Emissions from future electricity, natural gas, and backup generator use in City buildings and facilities were estimated by multiplying anticipated energy use by forecasted emissions factors. Future energy use was forecasted in two parts, as described in Section 2.1.1. Table 23 summarizes the legislative reductions used to forecast buildings and facilities emissions by energy type.

Table 23 Buildings and Facilities Energy Emissions Forecast Legislative Reductions by Energy Type

Energy Type	Applied Legislative Reductions
Electricity	Municipal buildings are subscribed to OCPA's 100% Renewable portfolio; therefore, electricity consumption in City buildings is modeled as zero-carbon (i.e., zero GHG emissions) by 2030. Increased energy efficiency due to 2022 Building Energy Efficiency Standards Title 24 was applied to new construction, based on the best available data for average building energy efficiency.
Natural Gas	Increased energy efficiency due to 2022 Building Energy Efficiency Standards Title 24 were applied to new construction, based on the best available data for average building energy efficiency.

Notes: OCPA = Orange County Power Authority.

Source: Ascent Environmental 2022.

Between 2019 and 2040, emissions from electricity, natural gas, and backup generators from municipal buildings and facilities would decrease by approximately 83 percent from 12,003 to 2,022 $MTCO_2e$, accounting for legislative adjustments and municipal employment changes. This change reflects increases in emissions from natural gas and backup generators combined with the City's automatic enrollment in OCPA's carbon-free option. Table 24 shows the 2019 inventory and legislative-adjusted BAU forecasted emissions for the municipal operations buildings and facilities energy sector by energy type for 2030 and 2040.

Table 24 Buildings and Facilities Energy GHG Emissions Inventory and Legislative-Adjusted BAU Forecasts (Annual $MTCO_2e$)

Energy Type	2019	2030	2040
Electricity	10,138	0	0
Natural Gas	1,862	1,947	2,019
Backup Generators	3	3	3
Total	**12,003**	**1,950**	**2,022**

Notes: Totals may not sum exactly due to independent rounding. BAU = business-as-usual; GHG = greenhouse gas; $MTCO_2e$ = metric tons of carbon dioxide equivalent.

Source: Data modeled by Ascent in 2024.

ELECTRICITY EMISSIONS FACTORS

Electricity emissions factors would reduce to zero by 2030, per enrollment of municipal buildings in OCPA's carbon free option (as shown in Table 21).

NATURAL GAS EMISSIONS FACTORS

Natural gas emissions are based on data from TCR, as described in Section 2.1.1. Emissions factors associated with natural gas combustion are not anticipated to change over time, as there are no legislative actions that would reduce the energy intensity of natural gas.

DIESEL EMISSIONS FACTORS

Emissions from diesel fuel used to power backup generators are based on emissions factors from TCR, as described in Section 2.1.1. Emissions factors associated with diesel combustion are not anticipated to change over time, as there are no legislative actions that would reduce the energy intensity of diesel fuel.

2.4.2 Streetlights and Traffic Signals

Between 2019 and 2040, emissions from streetlights and traffic signals would be reduced to zero. This reflects the City's automatic enrollment of municipal accounts in OCPA's carbon-free option. Table 25 summarizes the legislative reductions used to forecast streetlight and traffic signal emissions.

Table 25 Streetlights and Facilities Emissions Forecast Legislative Reductions

Source	Applied Legislative Reductions
Electricity	OCPA's carbon-free option was applied to OCPA's electricity emissions factors.

Notes: OCPA = Orange County Power Authority.

Source: Prepared by Ascent in 2024.

Table 26 shows the 2019 inventory and legislative-adjusted BAU forecasted emissions for the streetlights and traffic signals sector for 2030 and 2040.

Table 26 Streetlights and Traffic Signals GHG Emissions Inventory and Legislative-Adjusted BAU Forecasts (Annual $MTCO_2e$)

Source	2019	2030	2040
Streetlights and Traffic Signals	1,097	0	0

Notes: BAU = business-as-usual; GHG = greenhouse gas; $MTCO_2e$ = metric tons of carbon dioxide equivalent.

Source: Data modeled by Ascent in 2024.

2.4.3 Employee Commute

Between 2019 and 2040, GHG emissions from employee commutes would decrease by approximately 72 percent from 3,032 to 842 $MTCO_2e$, accounting for future vehicle emissions factors modeled in CARB's EMFAC2021 model and municipal employment change. It was assumed that employees that commute to work all use light-duty vehicles. With respect to the legislative adjustments included in this forecast, State and federal laws and regulations incorporated in the employee commute sector include the Pavley Clean Car Standards and ACC II Standards. Pavley Clean Car Standards are already included in EMFAC2021's emissions factor estimates and forecasts. Additional calculations were performed to incorporate the effects of ACCII.

It should be noted that the Low Carbon Fuel Standard was excluded in EMFAC2021 forecasts because most of the emissions benefits originate from upstream fuel production and do not directly reduce emissions in the City's municipal operations GHG emissions forecasts. Table 27 summarizes the legislative reductions used to forecast employee commute emissions.

Table 27 Employee Commute Forecast Legislative Reductions

Source	Applied Legislative Reductions
Employee Commute	EMFAC2021 forecasts vehicle fleet distributions and emissions factors based on vehicle emissions testing and approved legislative reductions. EMFAC2021's forecasts incorporate the effects of the CAFE standards. Separate calculations were performed to incorporate the effects of ACC II.

Notes: ACC II= Advanced Clean Cars II; CAFE = Corporate Average Fuel Economy; EMFAC2021 = California Air Resources Board's EMisson FACtor 2021 model.

Source: Prepared by Ascent in 2024.

Table 28 shows the 2019 inventory and legislative-adjusted BAU forecasted emissions from municipal employee commutes for 2030 and 2040.

Table 28 Employee Commute GHG Emissions Inventory and Legislative-Adjusted BAU Forecasts (Annual $MTCO_2e$)

Source	2019	2030	2040
Employee Commute	3,032	2,192	842

Notes: BAU = business-as-usual; GHG = greenhouse gas; $MTCO_2e$ = metric tons of carbon dioxide equivalent.

Source: Data modeled by Ascent in 2024.

2.4.4 Vehicle Fleet

Between 2019 and 2040, emissions associated with the City's municipal vehicle fleet would decrease by approximately 56 percent from 1,127 to 501 $MTCO_2e$, accounting for legislative adjustments and municipal employment change. Vehicle fleet fuel consumption data (i.e., gallons of gasoline and diesel fuel) for 2019 were provided by the City for all City-owned vehicles and equipment. Because additional vehicle fleet data were unavailable, total emissions for gasoline and diesel fuel were estimated using emissions factors obtained from TCR. With respect to the legislative adjustments in the vehicle fleet sector, improvements in fuel efficiency reported by CARB's EMFAC2021 model, as

described in Section 2.1.2, were applied to BAU emissions forecasts. Effects of ACCII standards were incorporated using calculations performed separately. Table 29 summarizes the legislative reductions used to forecast vehicle fleet emissions.

Table 29 Vehicle Fleet Forecast Legislative Reductions

Source	Applied Legislative Reductions
Vehicle Fleet	EMFAC2021 forecasts vehicle fleet distributions by vehicle type and the emissions factors anticipated for each vehicle category based on both vehicle emissions testing and approved legislative reductions. EMFAC2021's forecasts incorporate the effects of the CAFE standards. Additional calculations were performed to incorporate the effects of ACCII.

Notes: ACC II= Advanced Clean Cars II; CAFE = Corporate Average Fuel Economy; EMFAC2021 = California Air Resources Board's EMisson FACtor 2021 model.

Source: Prepared by Ascent in 2024.

Table 30 shows the 2019 inventory and legislative-adjusted BAU forecasted emissions from the vehicle fleet sector by fuel source for 2030 and 2040.

Table 30 Vehicle Fleet GHG Emissions Inventory and Legislative-Adjusted BAU Forecasts (Annual $MTCO_2e$)

Source	2019	2030	2040
Gasoline	954	772	424
CNG	173	140	77
Total	**1,127**	**912**	**501**

Notes: Totals may not sum exactly due to independent rounding. BAU = business-as-usual; CNG = compressed natural gas; GHG = greenhouse gas; $MTCO_2e$ = metric tons of carbon dioxide equivalent.

Source: Data modeled by Ascent in 2024.

2.4.5 Solid Waste

Between 2019 and 2040, municipal operations solid waste emissions would increase by approximately 17 percent from 159 to 187 $MTCO_2e$, accounting for municipal employment change. No additional legislative reductions could be applied to this sector, so legislative-adjusted BAU emissions are equivalent to BAU emissions. Table 31 shows the 2019 inventory and legislative-adjusted BAU forecasted emissions from the municipal operations solid waste sector for 2030 and 2040.

Table 31 Solid Waste GHG Emissions Inventory and Legislative-Adjusted BAU Forecasts (Annual $MTCO_2e$)

Source	2019	2030	2040
Solid Waste	159	174	187

Notes: BAU = business-as-usual; GHG = greenhouse gas; $MTCO_2e$ = metric tons of carbon dioxide equivalent.

Source: Data modeled by Ascent in 2024.

2.4.6 Water Supply

Between 2019 and 2040, emissions from water supplied for municipal operations would be reduced by 80 percent due to an increase in low-carbon electricity used for water pumping. For the water supply from local sources within the city, the electricity usage associated with extracting, conveying, treating, and distributing water is captured in the buildings and facilities energy sector because these activities take place within the city. Therefore, the electricity usage and emissions associated with extracting, conveying, treating, and distributing water from outside the city boundary was applied to the municipal water sector. Table 32 summarizes the legislative reductions used to forecast water supply emissions.

Table 32 Water Supply Forecast Legislative Reductions

Source	Applied Legislative Reductions
Water Consumption	SB 100 applied to SCE electric emissions factors: 60 percent renewable by 2030, 100 percent renewable by 2045.

Notes: RPS = Renewables Portfolio Standard; SB 100 = Senate Bill 100; SCE = Southern California Edison.

Source: Prepared by Ascent in 2024.

Table 33 shows the 2019 inventory and legislative-adjusted BAU forecasted emissions from municipal operations water supply for 2030 and 2040.

Table 33 Water Supply GHG Emissions Inventory and Legislative-Adjusted BAU Forecasts (Annual $MTCO_2e$)

Activity	2019	2030	2040
Water Supply Emissions	4	2	1

Notes: BAU = business-as-usual; GHG = greenhouse gas; $MTCO_2e$ = metric tons of carbon dioxide equivalent.

Source: Data modeled by Ascent in 2024.

2.4.7 Wastewater Treatment

Between 2019 and 2040, wastewater treatment emissions from municipal operations would increase by approximately 17 percent from 1,144 to 1,340 $MTCO_2e$, accounting for legislative reductions and municipal employment change. This reflects both an increase in wastewater generation and lower electricity emissions factors related to the 2030 and 2045 RPS targets for SCE, pursuant to SB 100, due to treatment processes located outside of the OCPA service area. Although electricity intensity factors are reduced through 2045, increases in process and fugitive emissions resulting from wastewater collection and treatment offset decreased electricity emissions. Table 34 summarizes the legislative reductions used to forecast emissions from municipal operations wastewater treatment.

Table 34 Wastewater Treatment Forecast Legislative Reductions

Source	Applied Legislative Reductions
Wastewater Treatment	SB 100 applied to SCE electric emissions factors: 60 percent renewable by 2030, 100 percent renewable by 2045.

Notes: RPS = Renewables Portfolio Standard; SCE = Southern California Edison.

Source: Data modeled by Ascent in 2024.

Table 35 shows the 2019 inventory and legislative-adjusted BAU forecasted emissions from wastewater treatment for 2030 and 2040.

Table 35 Wastewater Treatment GHG Emissions Inventory and Legislative-Adjusted BAU Forecasts (Annual $MTCO_2e$)

Activity	2019	2030	2040
Wastewater Treatment	1,144	1,246	1,340

Notes: BAU = business-as-usual; GHG = greenhouse gas; $MTCO_2e$ = metric tons of carbon dioxide equivalent.

Source: Data modeled by Ascent in 2024.

2.5 DISCUSSION

The community and municipal legislative-adjusted BAU emissions would decrease by approximately 55 percent and 74 percent between 2019 and 2040, respectively. This is a result of reductions that would be achieved from several legislative actions, including:

- a greater proportion of renewable and carbon-free electricity sources in SCE and OCPA;
- improved building energy efficiency through compliance with Title 24 standards; and
- reductions in on-road vehicle emissions factors due to State vehicle standards and ACC II.

Going forward, new legislative actions that would affect emissions may be adopted by State and federal agencies; however, because information regarding these regulatory changes is currently unavailable or not final, emissions reductions from future potential legislative actions are not quantified in this memorandum. Where new State regulations or programs are imminent and reasonably foreseeable, they can be incorporated as complementary actions to locally based GHG reduction measures.

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APPENDIX E

Greenhouse Gas Reduction Targets.

IRVINE

CLIMATE ACTION AND ADAPTATION PLAN

Memo

1230 Columbia Street, Suite 440
San Diego, CA 92124
619.219.8000

Date: April 4, 2025

To: City of Irvine – CAAP Project Team

From: Andrew Beecher and Poonam Boparai

Subject: Irvine Climate Action and Adaptation Plan: Greenhouse Gas Reduction Targets

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This memorandum summarizes the establishment of greenhouse gas (GHG) emissions reduction targets (GHG reduction targets) for 2030 and 2040 for the City of Irvine's (City's) Climate Action and Adaptation Plan (CAAP) that are in alignment with State plans and laws. The City's GHG reduction targets are informed by the State's GHG reduction targets, but the City intends to accelerate the timeline for achieving the long-term target.

ESTABLISHING GHG EMISSIONS REDUCTION TARGETS FOR 2030 AND 2040

The GHG reduction targets for 2030 and 2040 were developed in alignment with the California Climate Crisis Act (Assembly Bill 1279, 2022) and the California Air Resources Board's (CARB's) *2022 Scoping Plan for Achieving Carbon Neutrality* (2022 Scoping Plan). The Irvine City Council also adopted a resolution in 2021 referencing a zero-carbon local economy that is consistent with 2030 targets based on the most recent climate science. In June 2024, the Irvine City Council directed staff to incorporate a 2040 goal of zero emissions into the CAAP.

THE CALIFORNIA CLIMATE CRISIS ACT, AB 1279

Assembly Bill (AB) 1279 (Muratsuchi, 2022) makes it the policy of the State to do both of the following:

- Achieve net zero GHG emissions as soon as possible, but no later than 2045, and to achieve and maintain net negative emissions thereafter; and
- Ensure that by 2045, statewide anthropogenic GHG emissions are reduced to at least 85 percent below 1990 levels.

This statute defines net zero GHG emissions as a state in which GHG emissions released into the atmosphere are balanced by removals of GHG emissions over a period of time.

2022 SCOPING PLAN FOR ACHIEVING CARBON NEUTRALITY

The 2022 Scoping Plan addresses the emissions limits of AB 1279 by identifying a technologically feasible, cost-effective scenario to achieve statewide carbon neutrality by 2045 and a reduction in anthropogenic emissions by 85 percent below 1990 levels. It also Identifies a path to keep California on track to meet its SB 32 GHG reduction target of at least 40 percent below 1990 emissions by 2030, but concludes that additional reductions are needed by 2030 – to 48 percent below 1990 levels - for the state to stay on track to achieve net zero GHG emissions no later than 2045 pursuant to AB 1279.

A draft version of the 2022 Scoping Plan (May 2022) considered two alternative scenarios that would achieve statewide carbon neutrality by 2035 (referred to as Alternatives 1 and 2); ultimately CARB adopted the final 2022 Scoping Plan using the Proposed Scenario, which identifies a statewide pathway to carbon neutrality by 2045. CARB ultimately concluded that the Proposed Scenario for 2045 carbon neutrality is more cost effective and technologically feasible than the 2035 carbon neutrality alternatives, and identified "several feasibility concerns" with 2035 carbon neutrality. CARB performed analysis demonstrating that 2035 carbon neutrality alternatives 1 and 2 would have the following outcomes relative to the proposed 2045 carbon neutrality scenario:

- 5 times and 3 times slower job growth in 2035,
- 7 times and 6 times higher direct costs in 2035, and
- 6 times and 5 times slower economic growth in 2035 (CARB 2022a).

IRVINE ACHIEVES RESOLUTION (CITY COUNCIL RESOLUTION NO. 21-50)

In August 2021, the Irvine City Council adopted a resolution addressing climate change in Irvine's environment, values, and energy sources (ACHIEVES). The ACHIEVES resolution, among other things, states that, "The City of Irvine will endeavor to achieve a zero-carbon local economy consistent with 2030 targets based on the most recent climate science."

2022 SCOPING PLAN ALIGNED TARGETS

The City's GHG reduction targets are intended to exceed the State's targets, by establishing a more ambitious target to achieve carbon neutrality by 2040. To align the CAAP with the State's framework, the City's GHG reduction targets are also informed by the following State targets:

- Reducing emissions to 48 percent below 1990 levels by 2030 (per the 2022 Scoping Plan), and
- Reducing emissions to 85 percent below 1990 levels by 2045 (per AB 1279).

To develop community-specific targets for Irvine that align with these statewide targets, the 2022 Scoping Plan was reviewed to identify the emissions sectors in this statewide plan that are relevant and applicable to the City of Irvine. The review, summarized in Table 1, determined that the City has direct or indirect jurisdiction over activities that generate emissions and contribute to reductions in five of the eight emissions sectors included in the statewide inventory: residential and commercial, electric power, industrial, recycling and waste, and transportation.

Table 11 2022 Scoping Plan Emissions Sectors Applicable to the City of Irvine

Emissions Sectors – 2022 Scoping Plan	Applicable to City of Irvine?
Agriculture	No
Residential and Commercial	Yes

Emissions Sectors – 2022 Scoping Plan	Applicable to City of Irvine?
Electric Power	Yes
High Global Warming Potential (GWP) Gases	No
Industrial	Yes
Recycling and Waste	Yes
Transportation	Yes
Carbon Dioxide Removal (CDR)	No

Source: Ascent 2023.

The agriculture, high global warming potential (GWP) gases, and carbon dioxide removal (CDR) sectors are excluded for the following reasons. Minimal agricultural activity takes place in the City (relative to other emissions sources) and the City has limited to no ability to control or influence emissions of high GWP gases. The state's CDR sector identifies significant reductions from engineered strategies to remove significant levels of emissions from the atmosphere using technologies like direct air capture and carbon capture and storage, which are beyond the scope of municipal government. By excluding these sectors under this approach, community GHG reduction targets for the City can be established in proportion with statewide reductions for all sectors relevant to City jurisdiction to the extent feasible using available data. This target setting approach is consistent with the California Supreme Court decision in *Center for Biological Diversity v. California Department of Fish and Wildlife and Newhall Land and Farming (2015) 62 Cal.4th 204*, which determined that the approach of assessing a project's consistency with statewide emissions reduction goals must include a "reasoned explanation based on substantial evidence" that links the project's emissions (in this case, the project is the CAAP, which covers communitywide emission) to statewide GHG reduction goals.

The analysis uses 2019 data from the State's emission inventory and sector-level forecasted emissions in 2030 and 2040 from the 2022 Scoping Plan (CARB 2022b). These forecasted emissions are aligned with the Scoping Plan goal to reach 48 percent below statewide 1990 levels in 2030 and 85 percent below 1990 levels in 2045. In order to translate these targets to be relative to 2019, statewide emissions in future years from the applicable sectors are compared to 2019 statewide emissions from applicable sectors to determine the percentage reduction for the city. Data for 2019 are used because 1990 emissions data are not available for the city and because 2019 is the baseline year of the GHG emissions inventory used for the City's CAAP. This analysis is summarized in Table 2.

Table 2 Application of Statewide Emissions Reductions by Sector to Applicable City Sectors

Year	All Statewide Sectors		Statewide Sectors Applicable to City of Irvine	
	Statewide Emissions (2019 Inventory and 2022 Scoping Plan Scenario) ($MMTCO_2e$)	Percent Below 2019 levels	Statewide Emissions (2019 Inventory and 2022 Scoping Plan Scenario) ($MMTCO_2e$)	Percent Below 2019 levels
2019	404	-	352	-
2030	220	46%	196	44%
2045	-10	103%	41	88%

Notes: $MMTCO_2e$ = million metric tons of carbon dioxide equivalent.

Source: CARB 2022b, Ascent 2023.

Additional details on how the City of Irvine's 2030 and 2040 targets align with the 2022 Scoping Plan Scenario are provided in the following section.

CITY OF IRVINE CLIMATE ACTION AND ADAPTATION PLAN TARGETS

With adoption of the Irvine ACHIEVES resolution, the City committed to accelerating the reduction of locally generated GHG emission by exceeding the State's timeline under AB 1279 for reducing GHG emissions. However, considering CARB's analysis of achieving net zero GHG emissions by 2035, demonstrating that a pathway may not be economically feasible, the City has established a more ambitious target for the year 2040. Table 3 demonstrates the calculation of communitywide GHG emissions levels that align with the following targets:

- Reducing emissions to 44 percent below 2019 levels by 2030 (per the 2022 Scoping Plan), and
- Reducing emissions to 90 percent below 2019 levels by 2040 (exceeding the 2022 Scoping Plan).

The GHG reduction target for the year 2030 aligns with the State's identified target trajectory for 2030, as outlined in the 2022 Scoping Plan. This target also exceeds the legislative goal for 2030 established under SB 32 (i.e., 40% below 1990 levels by 2030).

Table 3 City of Irvine Target Emissions and Target Percent Reduction Relative to 2019 Levels

Year	CAAP GHG Reduction Target (relative to 2019 levels)	Target Emissions Levels ($MTCO_2e$/year)
2022	--	2,247,593
2030	44%	1,252,503
2040	90%	224,759

Notes: $MTCO_2e$ = metric tons of carbon dioxide equivalent.

Source: CARB 2022b, Ascent 2023.

REFERENCES

California Air Resources Board. 2022a. Draft 2022 Scoping Plan Update. Available: https://ww2.arb.ca.gov/our-work/programs/ab-32-climate-change-scoping-plan/2022-scoping-plan-documents. Accessed April 4, 2025.

_____. 2022b. Final 2022 Scoping Plan Update. Available: https://ww2.arb.ca.gov/our-work/programs/ab-32-climate-change-scoping-plan/2022-scoping-plan-documents. Accessed April 4, 2025.

CARB. *See* California Air Resources Board.

APPENDIX F

Greenhouse Gas Reduction Measures Analysis.

IRVINE CLIMATE ACTION AND ADAPTATION PLAN

Memo

1230 Columbia Street, Suite 440
San Diego, CA 92124
619.219.8000

Date: April 7, 2025

To: City of Irvine – CAAP Project Team

From: Andrew Beecher, Hannah Kornfeld, and Poonam Boparai

Subject: Irvine Climate Action and Adaptation Plan: Measures to Reduce Greenhouse Gas Emissions

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This memorandum summarizes the measures to reduce greenhouse gas (GHG) emissions for the City of Irvine's (City's) Climate Action and Adaptation Plan (CAAP) and their associated GHG reduction potential with implementation ,. The measures include a quantified GHG reduction potential for the years 2030 and 2040 (where feasible based on available data, research, and other evidence) to demonstrate technically feasible pathways that could achieve the 2030 and 2040 GHG reduction targets of the CAAP.

QUANTIFYING MEASURES TO REDUCE GHG EMISSIONS BY 2030 AND 2040

The CAAP includes a total of 54 measures to reduce communitywide GHG emissions that are organized under 20 strategies. The measures were analyzed to quantify their GHG emissions reduction potential in 2030 and 2040, where feasible, based on available data, research, and other evidence. In addition to GHG reduction potential, the quantified measures include performance metrics that could feasibly be achieved by the target years, and citations to research, data sources, and other evidence used to substantiate the calculations.

The primary reference for the quantification of GHG emission reduction potential is the California Air Pollution Control Officers Association (CAPCOA) *Handbook for Analyzing Greenhouse Gas Emission Reductions, Assessing Climate Vulnerabilities, and Advancing Health and Equity*. The Handbook provides guidance specifically addressing appropriate procedures to apply quantification methods to achieve accurate and reliable results using the best information available. The Handbook also identifies measures that qualitatively help reduce GHG emissions, but which cannot be reliably quantified at this time. In addition, some measures are quantifiable at a project or site-specific level, but cannot be reliably quantified at the larger scale of an entire city or community. Lastly, the Handbook also provides guidance for calculating the combined reductions from multiple measures that address the same source or activity, so that synergies are accurately and reliably accounted for and potential for double-counting is avoided. This is because there are instances in which certain measures have diminishing returns when implemented together, and other instances in which there is competition among measures (CAPCOA 2021).

A total of 13 measures were quantified for future GHG reduction potential with successful implementation. An overview of the performance metrics and GHG reduction potential for each of the 13 quantified measures is provided for the years 2030 and 2040 in the following sections. Additional detail on GHG reduction quantification methods and calculations can be found in Attachment A.

Summary of 2030 Results

The measure quantification performed for 2030 shows the City reducing emissions to 51% below 2019 levels, which exceeds the GHG reduction target of reducing emissions to 44% below 2019 levels, after considering the GHG reduction impact of current State, federal, and local actions (see *Comparison of GHG Reduction Potential of Measures to GHG Reduction Targets*). A summary of all measures with quantified GHG reduction potential, and their associated performance metrics for the year 2030, is provided in Table 1.

Table 1 Summary of Measures with GHG Reduction Potential in 2030

Strategy	Measure	2030 Performance Metric	2030 GHG Emission Reduction Potential ($MTCO_2e$/year)	Percentage of Total 2030 Reductions
Energy Efficiency and Electrification	BE-1.2 Retrofit existing residential buildings (single family, and multi-family less than 20,000 square feet) to improve energy efficiency and facilitate fuel switching.	14% Target electrification rate for existing residential single-family and existing residential multi-family buildings less than 20,000 square feet	14,737	3%
Energy Efficiency and Electrification	BE-1.3 Retrofit existing multi-family (20,000 square feet and larger) and nonresidential buildings to improve energy efficiency and facilitate fuel switching.	7% Target electrification rate for existing non-residential buildings and existing residential multi-family buildings greater than 20,000 square feet	10,178	2%
Energy Efficiency and Electrification	BE-2.1 Eliminate the use of natural gas in new development.	90% Target electrification rate for new development	4,999	1%
Energy Efficiency and Electrification	BE-3.1 Enroll 100% of communitywide accounts in 100% renewable/zero-carbon option from OCPA.	5% VMT reduction from SB 743 and increased density	111,572	26%
Transportation and Land Use	TR-1.1 Increase high-density, transit-oriented development along primary corridors to reduce time spent traveling.	30% Target EV/PHEV Population (light-duty vehicles)	331	<1%
Transportation and Land Use	TR-2.1 Increase electric vehicle (EV) charging infrastructure.	15% Target EV/PHEV Population (medium/heavy-duty vehicles)	93,012	21%
Transportation and Land Use	TR-3.1 Enhance and expand transit facilities and infrastructure to access a broader ridership.	8% VMT reduction	46,586	11%
Transportation and Land Use	TR-4.1 Develop more protected bikeways.	6% VMT reduction	36,772	8%
Off-Road Vehicles and Equipment	OR-1.1 Reduce emissions from landscaping equipment such as leaf blowers by supporting a transition to electric equipment.	12% ZEV landscaping equipment	79	<1%
Off-Road Vehicles and Equipment	OR-1.2 Reduce emissions from construction equipment by supporting a transition to electric equipment.	10% ZEV construction equipment	1,856	<1%

Solid Waste	SW-1.1 Eliminate the disposal of organic solid waste in landfills to reduce methane emissions.	80% of waste diverted from landfill	111,388	26%
Water and Wastewater	W-1.1 Reduce water consumption in buildings through conservation campaigns and water efficiency measures.	5% Water consumption reduction target	378	<1%
Resilience, Green Economy, and Carbon Sequestration	MS-1.1 Protect and enhance native trees and vegetation.	5,000 Trees planted per year	1,376	<1%
Total			**433,266**	**100%**

Notes: EV = electric vehicle; GHG = greenhouse gas; $MTCO_2e$ = metric tons of carbon dioxide equivalent; OCPA = Orange County Power Authority; PHEV; plug-in hybrid electric vehicle; SB = senate bill; VMT = vehicle miles traveled; ZEV = zero emissions vehicle.

Source: Ascent 2024.

Summary of 2040 Results

The measure quantification performed for 2040 shows the City reducing emissions to 92% below 2019 levels, which exceeds the GHG reduction target of reducing emissions to 90% below 2019 levels, after considering the GHG reduction impact of current State, federal, and local actions (see *Comparison of GHG Reduction Potential of Measures to GHG Reduction Targets*). A summary of all measures with quantified GHG reduction potential, and their associated performance metrics for the year 2040, is provided in Table 2.

Table 2 Summary of Measures with GHG Reduction Potential in 2040

Strategy	Measure	2040 Performance Metric	2040 GHG Emission Reduction Potential ($MTCO_2e$/year)	Percentage of Total 2040 Reductions
Energy Efficiency and Electrification	BE-1.2 Retrofit existing residential buildings (single family, and multi-family less than 20,000 square feet) to improve energy efficiency and facilitate fuel switching.	90% Target electrification rate for existing residential single-family and existing residential multi-family buildings less than 20,000 square feet	116,730	14%
Energy Efficiency and Electrification	BE-1.3 Retrofit existing multi-family (20,000 square feet and larger) and nonresidential buildings to improve energy efficiency and facilitate fuel switching.	90% Target electrification rate for existing non-residential buildings and existing residential multi-family buildings greater than 20,000 square feet	167,554	20%
Energy Efficiency and Electrification	BE-2.1 Eliminate the use of natural gas in new development.	95% Target electrification rate for new development	19,677	2%
Energy Efficiency and Electrification	BE-3.1 Enroll 100% of communitywide accounts in 100% renewable/zero-carbon option from OCPA.	10% VMT reduction from SB 743 and increased density	45,561	5%
Transportation and Land Use	TR-1.1 Increase high-density, transit-oriented development along primary corridors to reduce time spent traveling.	90% Target EV/PHEV Population (light-duty vehicles)	241	<1%
Transportation and Land Use	TR-2.1 Increase electric vehicle (EV) charging infrastructure.	90% Target EV/PHEV Population (medium/heavy-duty vehicles)	294,313	36%
Transportation and	TR-3.1 Enhance and expand transit	10% VMT reduction	11,922	1%

Land Use	facilities and infrastructure to access a broader ridership.			
Transportation and Land Use	TR-4.1 Develop more protected bikeways.	6% VMT reduction	6,867	1%
Off-Road Vehicles and Equipment	OR-1.1 Reduce emissions from landscaping equipment such as leaf blowers by supporting a transition to electric equipment.	90% ZEV landscaping equipment	758	<1%
Off-Road Vehicles and Equipment	OR-1.2 Reduce emissions from construction equipment by supporting a transition to electric equipment.	30% ZEV construction equipment	7,165	1%
Solid Waste	SW-1.1 Eliminate the disposal of organic solid waste in landfills to reduce methane emissions.	90% of waste diverted from landfill	153,933	19%
Water and Wastewater	W-1.1 Reduce water consumption in buildings through conservation campaigns and water efficiency measures.	10% Water consumption reduction target	183	<1%
Resilience, Green Economy, and Carbon Sequestration	MS-1.1 Protect and enhance native trees and vegetation.	5,000 Trees planted per year	3,670	<1%
Total			**828,574**	**100%**

Notes: EV = electric vehicle; GHG = greenhouse gas; $MTCO_2e$ = metric tons of carbon dioxide equivalent; OCPA = Orange County Power Authority; PHEV; plug-in hybrid electric vehicle; SB = senate bill; VMT = vehicle miles traveled; ZEV = zero emissions vehicle.

Source: Ascent 2024.

COMPARISON OF GHG REDUCTION POTENTIAL OF MEASURES TO GHG REDUCTION TARGETS

A comparison of the combined GHG reduction potential of the CAAP Measures to the City's GHG reduction targets shows that implementation of the 13 quantified measures in the CAAP would place the City on a trajectory to reduce communitywide GHG reduction levels to meet the targets for the years 2030 and 2040. Table 3 provides a summary of the combined GHG reduction potential of all measures compared to the City's GHG reduction targets and projected GHG emissions under a legislative-adjusted business-as-usual scenario.[1]

[1] The legislative-adjusted business-as-usual scenario provides an estimate of how future GHG emissions in the City of Irvine would change from baseline levels, considering expected growth in the city and the GHG reduction impact of current State, federal, and local actions.

Table 3 GHG Reduction Potential of Measures Compared to GHG Reduction Targets ($MTCO_2e$/year)

GHG Emissions Scenario	2030	2040
Legislative-Adjusted Business-as-Usual Scenario Forecast	1,512,383	1,013,100
GHG Reductions from CAAP Measures	433,266	828,574
GHG Emissions with Implementation of CAAP Measures	1,079,117	184,526
Target GHG Emissions for CAAP GHG Reduction Targets	1,252,503	224,759
Difference Between GHG Emissions with Implementation of CAAP Measures and Target GHG Emissions	-173,385	-40,233
CAAP GHG Reduction Target Met?	Yes	Yes

Notes: CAAP = Climate Action and Adaptation Plan; GHG = greenhouse gas; $MTCO_2e$ = metric tons of carbon dioxide equivalent.

Source: Ascent 2024.

REFERENCES

California Air Pollution Control Officers Association. 2021. Handbook for Analyzing Greenhouse Gas Emission Reductions, Assessing Climate Vulnerabilities, and Advancing Health and Equity. Available: https://www.caleemod.com/handbook/full_handbook.html. Accessed April 4, 2025.

CAPCOA. *See* California Air Pollution Control Officers Association.

Attachment A

BE-1.2
Building Energy Measures

Retrofit existing residential buildings (single family, and multi-family less than 20,000 square feet) to improve energy efficiency and facilitate fuel switching.	**2030**	**2040**	**Notes**
Gas Usage (therms)	25,871,975	25,871,975	
REDUCTIONS			
Target Electrification Rate [1]	14%	90%	Assumes start date of 1/1/2026 for retrofits. See BE ProrateElectrificationRates tab for more details on this calculation.
Reduced natural gas usage (therms)	3,728,116	23,284,777	
Natural gas emissions factor (MTCO2e/therm)	0.00532	0.00532	
GHG reductions from existing development natural gas savings (MTCO2e)	19,840	123,918	
INCREASES			
Total therms offset by switch to electric heating use	4,779,636	29,852,279	
Total electricity needed to offset natural gas heating (MWh)	140,044	874,675	
Electricity emissions factor (MTCO2e/MWh)	0.0364	0.0082	
Additional GHG emissions from electricity use (MTCO2e)	5,103	7,188	
Net GHG Reductions (MTCO2e)	**14,737**	**116,730**	

Sources:
[1] 2030 rate derived from Mozingo. 2021. Zero-Carbon Buildings in California: A Feasibility Study. 2040 rate set in order to meet 2040 carbon goal.

BE-1.3
Building Energy Measures

Retrofit existing multi-family (20,000 square feet and larger) and nonresidential buildings to improve energy efficiency and facilitate fuel switching.	**2030**	**2040**	**Notes**
Gas Usage (therms)	37,136,580	37,136,580	
REDUCTIONS			
Target Electrification Rate	7%	90%	Assumes start date of 1/1/2026 for retrofits.
Reduced natural gas usage (therms)	2,574,806	33,422,922	
Natural gas emissions factor (MTCO2e/therm)	0.00532	0.00532	
GHG reductions from existing development natural gas savings (MTCO2e)	13,703	177,872	
INCREASES			
Total therms offset from natural gas heating use (therms)	3,301,033	42,849,900	
Total electricity needed to offset natural gas heating (MWh)	96,721	1,255,506	
Electricity emissions factor (MTCO2e/MWh)	0.0364	0.0082	
Additional GHG emissions from electricity use (MTCO2e)	3,524	10,317	
Net GHG Reductions (MTCO2e)	**10,178**	**167,554**	

Sources:
[1] Mozingo. 2021. Zero-Carbon Buildings in California: A Feasibility Study

Calculate weighted average target electrification rates from Mozingo (for 2030 targets only)	
Residential percent electrified	14%
Non-Residential percent electrified	5%
Residential therm usage	19%
Non-residential therm usage	81%
Weighted average electrification rate	7%

BE-2.1
Building Energy Measures

Eliminate the use of natural gas in new development.	**2019**	**2030**	**2040**	**Notes**
Target electrification rate for new development		90%	95%	Assumes 01/2026 start date for measure implementation.
Reduced natural gas usage (therms)		1,264,661	3,925,134	See "BE Calculate Therm Reduction" tab for details
Natural gas emissions factor (MTCO2e/therm)		0.00532	0.00532	
GHG reductions from existing development natural gas savings (MTCO2e)		6,730	20,889	
INCREASES				
Total therms offset from natural gas heating use (therms)		1,621,361	5,032,223	
Total electricity needed to offset natural gas heating (MWh)		47,506	147,445	
Electricity emissions factor (MTCO2e/MWh)		0.0364	0.0082	
Additional GHG emissions from electricity use (MTCO2e)		1,731	1,212	
Net GHG Reductions (MTCO2e)		**4,999**	**19,677**	

BE-3.1
Building Energy Measures

Enroll 100% of communitywide accounts in 100% renewable/zero-carbon option from OCPA.		**2030**	**2040**
Total legislative-adjusted electricity emissions (MTCO2e)		97,101	23,822
Additional electricity emissions from other measures (MTCO2e)			
	BE-1.2	*5,103*	*7,188*
	BE-1.3	*3,524*	*10,317*
	BE 2.1	*1,731*	*1,212*
	TR-2.1	*3,793*	*2,760*
	OR-1.1	*14*	*26*
	OR-1.2	*305*	*236*
Adjusted electricity emissions reductions from 100% carbon-free electricity (MTCO2e)		111,572	45,561
GHG Reductions (MTCO2e)		**111,572**	**45,561**

TR-1.1
Transportation and Land Use Measures

Increase high-density, transit-oriented development along primary corridors to reduce time spent traveling.	**2019**	**2030**	**2040**
Annual passenger vehicle miles traveled (VMT)	2,776,414,419	2,806,331,343	2,833,528,546
New passenger VMT		29,916,924	57,114,128
Percent VMT reduction from SB 743 and increased density [1]		5%	10%
Reduced passenger VMT from SB 743 and increased density [1]		1,495,846	5,711,413
Passenger vehicle emissions factor (g CO2e/mile) - assuming implementation of TR-2.1		221	42
GHG reductions from passenger vehicles (MTCO2e)		331	241
GHG Reductions (MTCO2e)		**331**	**241**

Notes:
[1] Increased density is relative to General Plan growth assumptions used in the GHG emissions projections.

TR-2.1
Transportation and Land Use Measures

Transition to low- and zero-emission vehicles.	**2030**	**2040**	**Notes**
City of Irvine population	317,246	340,993	
Orange County population	3,440,882	3,531,540	
Population ratio (City vs County)	9.2%	9.7%	
Install EV charging stations for LDVs			
EV Forecasts and Targets			
EMFAC2021 ACC II Light Duty Pop - Countywide [1]	2,250,739	2,352,687	
EMFAC2021 ACC II Light Duty Pop - Irvine	207,516	227,167	
EMFAC2021 ACC II Light Duty EV/PHEV Pop - Countywide [1]	476,275	1,595,092	
EMFAC2021 ACC II Light Duty EV/PHEV Pop - Irvine	43,912	154,016	
Calculated EMFAC2021 ACC II Light Duty EV/PHEV percentage	21%	68%	
Targeted EV/PHEV Pop percentage under TR-2.1	30%	90%	
Increased EV/PHEV Pop percentage under TR-2.1	9%	22%	
Targeted EV/PHEV Pop under TR-2.1	62,255	204,450	
Additional EV/PHEV Pop under TR-2.1	18,343	50,434	
EMFAC2021 EV:PHEV Ratio with ACC II adjustments	4.7	8.1	
Additional EV Pop under TR-2.1	15,098	44,905	
Additional PHEV Pop under TR-2.1	3,245	5,529	

Additional GHG emissions from EVs		
Average annual miles per EV (mi/vehicle) [1]	15,818	14,084
New EV VMT under measure	238,812,520	632,444,028
Average Efficiency of EV LDV (kWh/100-mi) [2]	38.60	38.60
Charged amount (kWh)	92,181,633	244,123,395
Charged amount (MWh)	92,182	244,123
Electricity emissions factor (MTCO2e/MWh) (SCE and OCPA weighted average)	0.036	0.008
Additional GHG emissions from EVs (MTCO2e)	3,359	2,006
Additional GHG emissions from PHEVs		
Average annual miles per PHEV (mi/vehicle) [1]	16,388	14,878
New PHEV VMT under measure	53,175,653	82,260,077
Average emissions factor from PHEV (gCO2e/mi) [1]	129	123
Additional PHEV emissions under measure (MTCO2e)	6,836	10,150
Emissions avoided from Equivalent Gasoline/Diesel Vehicles		
Average emissions factor from Gasoline/Diesel mix (gCO2e/mi) [1]	307	300
Average annual miles per Gasoline/Diesel (mi/vehicle) [1]	12,746	9,682
Reduced Gasoline/Diesel VMT (mi)	291,988,173	714,704,106
Reduced Gasoline/Diesel emissions under TR-2.1 (MTCO2e)	89,530	214,302
Total Emission Reductions from Increased LDV EV/PHEV Mix (MTCO2e)	**79,335**	**202,146**
Install EV charging stations for Medium and Heavy-duty vehicles		

State-level EV Forecasts and Targets	2030		2040	Notes
Statewide Medium- and Heavy-Duty Population [3]	5,415,082	**NA**		The method for determining 2040 values differs from the method for 2030.
Statewide Medium- and Heavy-Duty EV population [3]	107,184	**NA**		2040 is set based on a target percentage of EVs to meet the 2040 emissions goal, whereas 2030 is set based on the 2020 Mobile Source Strategy (MSS).
Statewide MDV EV Population Target under 2020 MSS [4]	40,788	**NA**		This is why there are "NA" values in columns B and C.
Statewide HDV EV Population Target under EO N-79-20 [4]	171,176	**NA**		
		NA		
Statewide Target Percent Increase in Commercial EVs	98%	**NA**		
Irvine Target Percent Increase in Commercial EVs	98%	**NA**		
Calculated Medium/Heavy Duty EV/PHEV Pop - Irvine	743	**NA**		
Number of heavy-duty conventional vehicles (leg-adjusted forecast)	**NA**		6,819	
Number of heavy-duty EVs (leg-adjusted forecast)	**NA**		3,301	
Total heavy-duty EVs (leg-adjusted forecast)	**NA**		10,120	
Leg-adjusted percent heavy-duty EVs	**NA**		33%	
Target percent EVs	**NA**		90%	
Increased EV/PHEV Pop percentage under TR-2.1	98%	**NA**		
Targeted EV/PHEV Pop under TR-2.1	1,468	**NA**		
Additional EV/PHEV Pop under TR-2.1	726		5,807	

Additional GHG emissions from EVs		
Average annual miles per EV (mi/vehicle) [1]	19,453	17,114
New EVMT under measure	14,120,840	99,389,468
Average Efficiency of EV medium/heavy duty (kWh/100-mi) [1]	84	92
Charged amount (kWh)	11,911,664	91,770,932
Charged amount (MWh)	11,912	91,771
Electricity emissions factor (MTCO2e/MWh) (SCE and OCPA weighted average)	0.036	0.008
Additional GHG emissions from EVs (MTCO2e)	434	754
Emissions from Equivalent Gasoline/Diesel Vehicles		
Average emissions factor from Gasoline/Diesel mix (gCO2e/mi) [1]	999.24	934.92
Reduced Gasoline/Diesel VMT (mi)	14,120,840	99,389,468
Reduced Gasoline/Diesel emissions under TR-2.1 (MTCO2e)	14,110	92,921
Net GHG emissions avoided from increased MHDV EV chargers (MTCO2e)	**13,676**	**92,167**
Net GHG emissions avoided from increased EV chargers (MTCO2e)	**93,012**	**294,313**

Sources:

[1] EMFAC 2021 results for Orange County adjusted for ACC II ZEV requirements for new vehicles. Requirements pertain to both PHEVs and ZEVs.

[2] https://www.driveclean.ca.gov/pev/Charging.php

[3] EMFAC 2021. Statewide EV population. (EMFAC 2021 does not account for statewide targets under EO N-79-20)

[4] CARB's 2020 Mobile Source Strategy META Tool

TR-3.1, TR-3.2, and TR-3.3 Transportation and Land Use Measures Enhance and expand transit facilities and infrastructure to access a broader ridership. Increase transit ridership through incentives and more frequent, connected transit lines. Implement an on-demand microtransit system, transporting residents from curb to curb (e.g., OC Flex or LA County Micro).	**2030**	**2040**
Annual passenger vehicle miles traveled (VMT) after TR-1.1	2,804,835,496	2,827,817,134
Total percent reduction	7.5%	10.0%
Passenger VMT reduction	210,362,662	282,781,713
Passenger vehicle emissions factor (g CO2e/mi)	221	42
GHG reductions from passenger vehicles (MTCO2e)	46,586	11,922
GHG Reductions from TR-3.1, TR-3.2, and TR-3.3 (MTCO2e)	46,586	11,922

Notes:

In 2030, half of maximum reduction (15 percent) taken for Transit subcategory per CAPCOA 2021. 2040 assumes the maximum reduction of 15 percent.

Sources:

[1] CAPCOA, 2021. Handbook for Analyzing Greenhouse Gas Emission Reductions, Assessing Climate Vulnerabilities, and Advancing Health and Equity-Final Draft.

TR-4.1, TR-4.2, TR-4.3, and TR-4.4 Transportation and Land Use Measures Develop more protected bikeways. Expand bicycling and walking options through infrastructure improvements. Develop more accessible and safer pedestrian infrastructure. Implement a community bikeshare program.		**2030**	**2040**
Annual VMT from passenger vehicles after TR-1.1 and TR-3.1 to 3.3		2,594,472,834	2,545,035,420
Emissions from on-road transportation (passenger vehicles)		574,565	107,294
Percent reduction in GHG emissions by providing Pedestrian Network Improvement (T-18, ND) [1]	6.40%	**6.4%**	**6.4%**
Percent reduction in GHG emissions from displaced vehicles on roadway with bicycle boulevard (T-19-B, ND) [1]	0.60%		
Percent reduction in GHG emissions by expanding bikeway network (T-20, ND) [1]	0.50%		
Percent reduction in GHG emissions by Implementing Electric Bikeshare Program (T-22-B, ND) [1]	0.06%		
Reduction in VMT with TR measures (miles)		**166,046,261**	**162,882,267**
GHG Reductions from TR-4.1, TR-4.2, TR-4.3, and TR-4.4 (MTCO2e)		**36,772**	**6,867**

Sources:

[1] CAPCOA, 2021. Handbook for Analyzing Greenhouse Gas Emission Reductions, Assessing Climate Vulnerabilities, and Advancing Health and Equity-Final Draft.

OR-1.1
Off-Road Vehicles and Equipment Measures

Reduce emissions from landscaping equipment such as leaf blowers by supporting a transition to zero-emission equipment.	**2019**	**2024**	**2030**	**2040**
Landscaping equipment emissions (MTCO2e)	708	739	776	874
Target electrification rate for existing landscaping equipment [1]			12%	90%
GHG reductions from zero-emission landscaping equipment (MTCO2e)			93	784
Additional emissions from electricity use				
Gasoline Emission Factors (lbs CO2e per gal)			19.99	19.99
Reduced Gasoline usage due to transition (gal)			10,274	86,520
Gal/kWh factor for gasoline [2]			36.6	36.6
Increased electricity required to charge transitioned landscaping equipment (kwh)			376,014	3,166,626
Charged amount (MWh)			376.01	3,166.63
Electricity emissions factor (MTCO2e/MWh) (weighted for SCE and OCPA)			0.03644	0.00822
Additional GHG emissions from zero-emission construction equipment (MTCO2e)			14	26
Reduced GHG Emissions (MTCO2e)			**79**	**758**

Sources:

[1] Assuming same proportions as Statewide GHG reduction included in CARB 2020 Mobile Source Strategy; extrapolated for 2045

[2] Convertunits.com

OR-1.2
Off-Road Vehicles and Equipment Measures

Reduce emissions from construction equipment by supporting a transition to zero-emission equipment.	**2019**	**2030**	**2040**
Construction equipment emissions (MTCO2e)	19,536	21,614	24,668
Target zero-emission rate for construction equipment		10%	30%
GHG reductions from zero-emission construction equipment (MTCO2e)		2,161	7,401
Additional emissions from electricity use			
Diesel Emission Factors (lbs per gal)		23.14	23.14
Reduced Diesel usage due to transition (gal)		205,937	705,132
Gal/kWh factor for diesel [2]		40.7	40.7
Electricity required to charge transitioned construction equipment (kwh)		8,381,621	28,698,862
Charged amount (MWh)		8,381.62	28,698.86
Electricity emissions factor (MTCO2e/MWh) (weighted for SCE and OCPA)		3.64E-02	8.22E-03
Additional GHG emissions from transitioned construction equipment (MTCO2e)		305	236
Reduced GHG Emissions (MTCO2e)		**1,856**	**7,165**

Sources:

[1] Convertunits.com

SW-1.1
Solid Waste Measures

Eliminate the disposal of organic solid waste in landfills to reduce methane emissions.	**2019**	**2030**	**2040**
Solid waste emissions (MTCO2e)		175,038	188,141
Waste Diversion Targets [1]	45%	80%	90%
Increased waste diversion		35%	45%
Adjusted forecasted emissions from solid waste (MTCO2e)		63,650	34,207
Reduced GHG Emissions (MTCO2e)		**111,388**	**153,933**

Notes:

From CalRecycle 2021: Of the total materials generated in 2019, 55 percent were sent to landfill, 19 percent were exported as recyclables, 12 percent were composted, anaerobically digested or mulched, and another 6 percent were recycled or source reduced. The remainder of the material, less than 10 percent, went to alternative daily cover (ADC), beneficial reuse, transformation, alternative intermediate cover (AIC), waste-tire derived fuel, and engineered municipal solid waste (EMSW).

Sources:

[1] State of Disposal and Recycling for Calendar Year 2019. CalRecycle 2021. Available: https://www2.calrecycle.ca.gov/Publications/Details/1697

W-1.1 and W-1.2
Water and Wastewater Measures

Reduce water consumption in buildings through conservation campaigns and water efficiency measures. Reduce water consumption for irrigation and landscaping by encouraging drought tolerant landscaping practices.

	2030	2040
Total water-related fuel Use (kWh)	207,267,492	222,782,348
Annual water consumption (AF/year)	136,227	146,424
Rate of Fuel Use (kWh/AF/year)	1,521	1,521
Water consumption reduction target	5%	10%
Reduced water related consumption (AF/year)	6,811	14,642
Reduced Fuel Use (kWh)	10,363,375	22,278,235
kWh / MWh factor	1,000	1,000
Reduced Fuel Use (MWh)	10,363	22,278
Electricity emissions factor (MTCO2e/MWh) (weighted for SCE and OCPA)	0.0364	0.0082
Reduced GHG Emissions (MTCO2e)	**378**	**183**

MS-1.1 **Miscellaneous Measures**		
Protect and enhance native trees and vegetation.	**2030**	**2040**
Annual sequestration rate per tree (MTCO2) [1]	0.046	0.046
Target: Number of net new trees planted each year	5,000	5,000
Number of years (planting begins in 2025)	6	16
Number of trees planted over period in active growing stage in inventory year	30,000	80,000
Reduced GHG Emissions (MTCO2e)	**1,376**	**3,670**
UC Irvine Tree Inventory		
Number of Trees	18,240	
Carbon Sequestered Annually (MTCO2e)	837	
Carbon Sequestered Per Tree Per Year (MTCO2e/tree)	0.045876944	

Sources:

[1] University of California, Irvine. 01.16.18 i-Tree Streets Environmental Benefit Analysis. https://web.archive.org/web/20230811012618/https://www.fm.uci.edu/news/doc_news/TreeAnalysisReport_complete.pdf

Calculate electrification rates [1].

Index	Year	Incremental Residential Rate	Cumulative Residential Rate	Incremental Commercial Rate	Cumulative Commercial Rate
1	2021	3.60%	3.60%	1.30%	1.30%
2	2022	3.60%	7.20%	1.30%	2.60%
3	2023	3.60%	10.80%	1.30%	3.90%
4	2024	3.60%	14.40%	1.30%	5.20%
5	2025	3.60%	18.00%	1.30%	6.50%
6	2026	3.60%	21.60%	1.30%	7.80%
7	2027	3.60%	25.20%	1.30%	9.10%
8	2028	3.60%	28.80%	1.30%	10.40%
9	2029	3.60%	32.40%	1.30%	11.70%
10	2030	3.60%	36.00%	1.30%	13.00%
11	2031	3.60%	39.60%	1.69%	14.69%
12	2032	3.60%	43.20%	1.69%	16.38%
13	2033	3.60%	46.80%	1.69%	18.07%
14	2034	3.60%	50.40%	1.69%	19.76%
15	2035	3.60%	54.00%	1.69%	21.45%
16	2036	3.60%	57.60%	2.20%	23.65%
17	2037	3.60%	61.20%	2.20%	25.84%
18	2038	3.60%	64.80%	2.20%	28.04%
19	2039	3.60%	68.40%	2.20%	30.24%
20	2040	3.60%	72.00%	2.20%	32.44%
21	2041	3.60%	75.60%	2.86%	35.29%
22	2042	3.60%	79.20%	2.86%	38.15%
23	2043	3.60%	82.80%	2.86%	41.00%
24	2044	3.60%	86.40%	2.86%	43.86%
25	2045	3.60%	90.00%	2.86%	46.72%
26	2046	3.60%	93.60%	3.71%	50.43%
27	2047	3.60%	97.20%	3.71%	54.14%
28	2048	3.60%	100.00%	3.71%	57.85%
29	2049	3.60%	100.00%	3.71%	61.57%
30	2050	3.60%	100.00%	3.71%	65.28%

Prorate reductions based on number of years policy will be in effect assuming implementation date of 2026
These calculations apply to 2030 only.

			Number of years	**Percent retrofitted**	
	Start	End	1/1/2030	Res 2030	Nonres 2030
BE 1.2	1/1/2026	1/1/2030	4.00	14.4%	
BE 1.3	1/1/2026	1/1/2030	4.00	14.4%	5.2%

Source:
[1] Mozingo. 2021. Zero-Carbon Buildings in California: A Feasibility Study.
https://crec.berkeley.edu/uploads/16RD004_CREC_ZCB_Final_Report_w__Appendices_(1).pdf

Calculate therm reduction due to electrification.

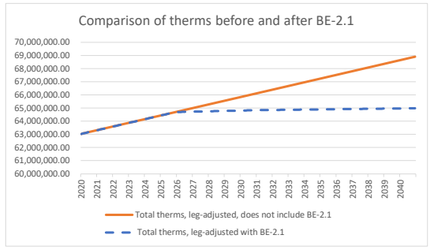
Year	Total leg-adjusted therms / year	Therms / month in new development
2019	63,008,555	
2030	66,099,949	23,420
2040	68,910,308	23,420

Therm reduction due to measure

Date	Year	Live result
12/1/2030	2030	(1,264,661)
12/1/2040	2040	(3,925,134)

1/1/2020 <-first year of forecast horizon

1/1/2026 Measure start date
90% Percent new development electrified by 2030
95% Percent new development electrified by 2040



Month Number	Month	Year	Incremental new development therms, leg-adjusted	% of new therms remaining after new ordinance implemented	New development therms, leg-adjusted with BE-2.1	Total therms, leg-adjusted with BE-2.1	Total therms, leg-adjusted, does not include BE-2.1	Therm reduction due to BE-2.1
1	1/1/2020	2020	23,420	100%	23,420	63,031,975	63,031,974.65	-
2	2/1/2020	2020	23,420	100%	23,420	63,055,394	63,055,394.31	-
3	3/1/2020	2020	23,420	100%	23,420	63,078,814	63,078,813.96	-
4	4/1/2020	2020	23,420	100%	23,420	63,102,234	63,102,233.62	-
5	5/1/2020	2020	23,420	100%	23,420	63,125,653	63,125,653.27	-
6	6/1/2020	2020	23,420	100%	23,420	63,149,073	63,149,072.93	-
7	7/1/2020	2020	23,420	100%	23,420	63,172,493	63,172,492.58	-
8	8/1/2020	2020	23,420	100%	23,420	63,195,912	63,195,912.24	-
9	9/1/2020	2020	23,420	100%	23,420	63,219,332	63,219,331.89	-
10	10/1/2020	2020	23,420	100%	23,420	63,242,752	63,242,751.54	-
11	11/1/2020	2020	23,420	100%	23,420	63,266,171	63,266,171.20	-
12	12/1/2020	2020	23,420	100%	23,420	63,289,591	63,289,590.85	-
13	1/1/2021	2021	23,420	100%	23,420	63,313,011	63,313,010.51	-
14	2/1/2021	2021	23,420	100%	23,420	63,336,430	63,336,430.16	-
15	3/1/2021	2021	23,420	100%	23,420	63,359,850	63,359,849.82	-
16	4/1/2021	2021	23,420	100%	23,420	63,383,269	63,383,269.47	-
17	5/1/2021	2021	23,420	100%	23,420	63,406,689	63,406,689.13	-
18	6/1/2021	2021	23,420	100%	23,420	63,430,109	63,430,108.78	-
19	7/1/2021	2021	23,420	100%	23,420	63,453,528	63,453,528.43	-
20	8/1/2021	2021	23,420	100%	23,420	63,476,948	63,476,948.09	-
21	9/1/2021	2021	23,420	100%	23,420	63,500,368	63,500,367.74	-
22	10/1/2021	2021	23,420	100%	23,420	63,523,787	63,523,787.40	-
23	11/1/2021	2021	23,420	100%	23,420	63,547,207	63,547,207.05	-
24	12/1/2021	2021	23,420	100%	23,420	63,570,627	63,570,626.71	-
25	1/1/2022	2022	23,420	100%	23,420	63,594,046	63,594,046.36	-
26	2/1/2022	2022	23,420	100%	23,420	63,617,466	63,617,466.02	-
27	3/1/2022	2022	23,420	100%	23,420	63,640,886	63,640,885.67	-
28	4/1/2022	2022	23,420	100%	23,420	63,664,305	63,664,305.32	-
29	5/1/2022	2022	23,420	100%	23,420	63,687,725	63,687,724.98	-
30	6/1/2022	2022	23,420	100%	23,420	63,711,145	63,711,144.63	-
31	7/1/2022	2022	23,420	100%	23,420	63,734,564	63,734,564.29	-
32	8/1/2022	2022	23,420	100%	23,420	63,757,984	63,757,983.94	-
33	9/1/2022	2022	23,420	100%	23,420	63,781,404	63,781,403.60	-
34	10/1/2022	2022	23,420	100%	23,420	63,804,823	63,804,823.25	-
35	11/1/2022	2022	23,420	100%	23,420	63,828,243	63,828,242.90	-
36	12/1/2022	2022	23,420	100%	23,420	63,851,663	63,851,662.56	-
37	1/1/2023	2023	23,420	100%	23,420	63,875,082	63,875,082.21	-
38	2/1/2023	2023	23,420	100%	23,420	63,898,502	63,898,501.87	-
39	3/1/2023	2023	23,420	100%	23,420	63,921,922	63,921,921.52	-
40	4/1/2023	2023	23,420	100%	23,420	63,945,341	63,945,341.18	-
41	5/1/2023	2023	23,420	100%	23,420	63,968,761	63,968,760.83	-
42	6/1/2023	2023	23,420	100%	23,420	63,992,180	63,992,180.49	-
43	7/1/2023	2023	23,420	100%	23,420	64,015,600	64,015,600.14	-
44	8/1/2023	2023	23,420	100%	23,420	64,039,020	64,039,019.79	-
45	9/1/2023	2023	23,420	100%	23,420	64,062,439	64,062,439.45	-
46	10/1/2023	2023	23,420	100%	23,420	64,085,859	64,085,859.10	-
47	11/1/2023	2023	23,420	100%	23,420	64,109,279	64,109,278.76	-
48	12/1/2023	2023	23,420	100%	23,420	64,132,698	64,132,698.41	-
49	1/1/2024	2024	23,420	100%	23,420	64,156,118	64,156,118.07	-
50	2/1/2024	2024	23,420	100%	23,420	64,179,538	64,179,537.72	-
51	3/1/2024	2024	23,420	100%	23,420	64,202,957	64,202,957.38	-
52	4/1/2024	2024	23,420	100%	23,420	64,226,377	64,226,377.03	-
53	5/1/2024	2024	23,420	100%	23,420	64,249,797	64,249,796.68	-
54	6/1/2024	2024	23,420	100%	23,420	64,273,216	64,273,216.34	-
55	7/1/2024	2024	23,420	100%	23,420	64,296,636	64,296,635.99	-
56	8/1/2024	2024	23,420	100%	23,420	64,320,056	64,320,055.65	-
57	9/1/2024	2024	23,420	100%	23,420	64,343,475	64,343,475.30	-
58	10/1/2024	2024	23,420	100%	23,420	64,366,895	64,366,894.96	-
59	11/1/2024	2024	23,420	100%	23,420	64,390,315	64,390,314.61	-
60	12/1/2024	2024	23,420	100%	23,420	64,413,734	64,413,734.27	-
61	1/1/2025	2025	23,420	100%	23,420	64,437,154	64,437,153.92	-
62	2/1/2025	2025	23,420	100%	23,420	64,460,574	64,460,573.57	-
63	3/1/2025	2025	23,420	100%	23,420	64,483,993	64,483,993.23	-
64	4/1/2025	2025	23,420	100%	23,420	64,507,413	64,507,412.88	-
65	5/1/2025	2025	23,420	100%	23,420	64,530,833	64,530,832.54	-
66	6/1/2025	2025	23,420	100%	23,420	64,554,252	64,554,252.19	-
67	7/1/2025	2025	23,420	100%	23,420	64,577,672	64,577,671.85	-
68	8/1/2025	2025	23,420	100%	23,420	64,601,092	64,601,091.50	-
69	9/1/2025	2025	23,420	100%	23,420	64,624,511	64,624,511.16	-
70	10/1/2025	2025	23,420	100%	23,420	64,647,931	64,647,930.81	-
71	11/1/2025	2025	23,420	100%	23,420	64,671,350	64,671,350.46	-
72	12/1/2025	2025	23,420	100%	23,420	64,694,770	64,694,770.12	-
73	1/1/2026	2026	23,420	10%	2,342	64,697,112	64,718,189.77	(21,077.69)
74	2/1/2026	2026	23,420	10%	2,342	64,699,454	64,741,609.43	(42,155.38)
75	3/1/2026	2026	23,420	10%	2,342	64,701,796	64,765,029.08	(63,233.07)
76	4/1/2026	2026	23,420	10%	2,342	64,704,138	64,788,448.74	(84,310.76)
77	5/1/2026	2026	23,420	10%	2,342	64,706,480	64,811,868.39	(105,388.44)
78	6/1/2026	2026	23,420	10%	2,342	64,708,822	64,835,288.05	(126,466.13)
79	7/1/2026	2026	23,420	10%	2,342	64,711,164	64,858,707.70	(147,543.82)
80	8/1/2026	2026	23,420	10%	2,342	64,713,506	64,882,127.35	(168,621.51)
81	9/1/2026	2026	23,420	10%	2,342	64,715,848	64,905,547.01	(189,699.20)
82	10/1/2026	2026	23,420	10%	2,342	64,718,190	64,928,966.66	(210,776.89)
83	11/1/2026	2026	23,420	10%	2,342	64,720,532	64,952,386.32	(231,854.58)

84	12/1/2026	2026	23,420	10%	2,342	64,722,874	64,975,805.97	(252,932.27)
85	1/1/2027	2027	23,420	10%	2,342	64,725,216	64,999,225.63	(274,009.96)
86	2/1/2027	2027	23,420	10%	2,342	64,727,558	65,022,645.28	(295,087.65)
87	3/1/2027	2027	23,420	10%	2,342	64,729,900	65,046,064.94	(316,165.33)
88	4/1/2027	2027	23,420	10%	2,342	64,732,242	65,069,484.59	(337,243.02)
89	5/1/2027	2027	23,420	10%	2,342	64,734,584	65,092,904.24	(358,320.71)
90	6/1/2027	2027	23,420	10%	2,342	64,736,925	65,116,323.90	(379,398.40)
91	7/1/2027	2027	23,420	10%	2,342	64,739,267	65,139,743.55	(400,476.09)
92	8/1/2027	2027	23,420	10%	2,342	64,741,609	65,163,163.21	(421,553.78)
93	9/1/2027	2027	23,420	10%	2,342	64,743,951	65,186,582.86	(442,631.47)
94	10/1/2027	2027	23,420	10%	2,342	64,746,293	65,210,002.52	(463,709.16)
95	11/1/2027	2027	23,420	10%	2,342	64,748,635	65,233,422.17	(484,786.85)
96	12/1/2027	2027	23,420	10%	2,342	64,750,977	65,256,841.82	(505,864.54)
97	1/1/2028	2028	23,420	10%	2,342	64,753,319	65,280,261.48	(526,942.22)
98	2/1/2028	2028	23,420	10%	2,342	64,755,661	65,303,681.13	(548,019.91)
99	3/1/2028	2028	23,420	10%	2,342	64,758,003	65,327,100.79	(569,097.60)
100	4/1/2028	2028	23,420	10%	2,342	64,760,345	65,350,520.44	(590,175.29)
101	5/1/2028	2028	23,420	10%	2,342	64,762,687	65,373,940.10	(611,252.98)
102	6/1/2028	2028	23,420	10%	2,342	64,765,029	65,397,359.75	(632,330.67)
103	7/1/2028	2028	23,420	10%	2,342	64,767,371	65,420,779.41	(653,408.36)
104	8/1/2028	2028	23,420	10%	2,342	64,769,713	65,444,199.06	(674,486.05)
105	9/1/2028	2028	23,420	10%	2,342	64,772,055	65,467,618.71	(695,563.74)
106	10/1/2028	2028	23,420	10%	2,342	64,774,397	65,491,038.37	(716,641.43)
107	11/1/2028	2028	23,420	10%	2,342	64,776,739	65,514,458.02	(737,719.11)
108	12/1/2028	2028	23,420	10%	2,342	64,779,081	65,537,877.68	(758,796.80)
109	1/1/2029	2029	23,420	10%	2,342	64,781,423	65,561,297.33	(779,874.49)
110	2/1/2029	2029	23,420	10%	2,342	64,783,765	65,584,716.99	(800,952.18)
111	3/1/2029	2029	23,420	10%	2,342	64,786,107	65,608,136.64	(822,029.87)
112	4/1/2029	2029	23,420	10%	2,342	64,788,449	65,631,556.30	(843,107.56)
113	5/1/2029	2029	23,420	10%	2,342	64,790,791	65,654,975.95	(864,185.25)
114	6/1/2029	2029	23,420	10%	2,342	64,793,133	65,678,395.60	(885,262.94)
115	7/1/2029	2029	23,420	10%	2,342	64,795,475	65,701,815.26	(906,340.63)
116	8/1/2029	2029	23,420	10%	2,342	64,797,817	65,725,234.91	(927,418.32)
117	9/1/2029	2029	23,420	10%	2,342	64,800,159	65,748,654.57	(948,496.00)
118	10/1/2029	2029	23,420	10%	2,342	64,802,501	65,772,074.22	(969,573.69)
119	11/1/2029	2029	23,420	10%	2,342	64,804,842	65,795,493.88	(990,651.38)
120	12/1/2029	2029	23,420	10%	2,342	64,807,184	65,818,913.53	(1,011,729.07)
121	1/1/2030	2030	23,420	10%	2,342	64,809,526	65,842,333.19	(1,032,806.76)
122	2/1/2030	2030	23,420	10%	2,342	64,811,868	65,865,752.84	(1,053,884.45)
123	3/1/2030	2030	23,420	10%	2,342	64,814,210	65,889,172.49	(1,074,962.14)
124	4/1/2030	2030	23,420	10%	2,342	64,816,552	65,912,592.15	(1,096,039.83)
125	5/1/2030	2030	23,420	10%	2,342	64,818,894	65,936,011.80	(1,117,117.52)
126	6/1/2030	2030	23,420	10%	2,342	64,821,236	65,959,431.46	(1,138,195.21)
127	7/1/2030	2030	23,420	10%	2,342	64,823,578	65,982,851.11	(1,159,272.89)
128	8/1/2030	2030	23,420	10%	2,342	64,825,920	66,006,270.77	(1,180,350.58)
129	9/1/2030	2030	23,420	10%	2,342	64,828,262	66,029,690.42	(1,201,428.27)
130	10/1/2030	2030	23,420	10%	2,342	64,830,604	66,053,110.08	(1,222,505.96)
131	11/1/2030	2030	23,420	10%	2,342	64,832,946	66,076,529.73	(1,243,583.65)
132	12/1/2030	2030	23,420	10%	2,342	64,835,288	66,099,949.38	(1,264,661.34)
133	1/1/2031	2031	23,420	5%	1,249	64,836,537	66,123,369.04	(1,286,831.95)
134	2/1/2031	2031	23,420	5%	1,249	64,837,786	66,146,788.69	(1,309,002.55)
135	3/1/2031	2031	23,420	5%	1,249	64,839,035	66,170,208.35	(1,331,173.16)
136	4/1/2031	2031	23,420	5%	1,249	64,840,284	66,193,628.00	(1,353,343.76)
137	5/1/2031	2031	23,420	5%	1,249	64,841,533	66,217,047.66	(1,375,514.37)
138	6/1/2031	2031	23,420	5%	1,249	64,842,782	66,240,467.31	(1,397,684.98)
139	7/1/2031	2031	23,420	5%	1,249	64,844,031	66,263,886.97	(1,419,855.58)
140	8/1/2031	2031	23,420	5%	1,249	64,845,280	66,287,306.62	(1,442,026.19)
141	9/1/2031	2031	23,420	5%	1,249	64,846,529	66,310,726.27	(1,464,196.79)
142	10/1/2031	2031	23,420	5%	1,249	64,847,779	66,334,145.93	(1,486,367.40)
143	11/1/2031	2031	23,420	5%	1,249	64,849,028	66,357,565.58	(1,508,538.01)
144	12/1/2031	2031	23,420	5%	1,249	64,850,277	66,380,985.24	(1,530,708.61)
145	1/1/2032	2032	23,420	5%	1,249	64,851,526	66,404,404.89	(1,552,879.22)
146	2/1/2032	2032	23,420	5%	1,249	64,852,775	66,427,824.55	(1,575,049.83)
147	3/1/2032	2032	23,420	5%	1,249	64,854,024	66,451,244.20	(1,597,220.43)
148	4/1/2032	2032	23,420	5%	1,249	64,855,273	66,474,663.86	(1,619,391.04)
149	5/1/2032	2032	23,420	5%	1,249	64,856,522	66,498,083.51	(1,641,561.64)
150	6/1/2032	2032	23,420	5%	1,249	64,857,771	66,521,503.16	(1,663,732.25)
151	7/1/2032	2032	23,420	5%	1,249	64,859,020	66,544,922.82	(1,685,902.86)
152	8/1/2032	2032	23,420	5%	1,249	64,860,269	66,568,342.47	(1,708,073.46)
153	9/1/2032	2032	23,420	5%	1,249	64,861,518	66,591,762.13	(1,730,244.07)
154	10/1/2032	2032	23,420	5%	1,249	64,862,767	66,615,181.78	(1,752,414.68)
155	11/1/2032	2032	23,420	5%	1,249	64,864,016	66,638,601.44	(1,774,585.28)
156	12/1/2032	2032	23,420	5%	1,249	64,865,265	66,662,021.09	(1,796,755.89)
157	1/1/2033	2033	23,420	5%	1,249	64,866,514	66,685,440.74	(1,818,926.49)
158	2/1/2033	2033	23,420	5%	1,249	64,867,763	66,708,860.40	(1,841,097.10)
159	3/1/2033	2033	23,420	5%	1,249	64,869,012	66,732,280.05	(1,863,267.71)
160	4/1/2033	2033	23,420	5%	1,249	64,870,261	66,755,699.71	(1,885,438.31)
161	5/1/2033	2033	23,420	5%	1,249	64,871,510	66,779,119.36	(1,907,608.92)
162	6/1/2033	2033	23,420	5%	1,249	64,872,759	66,802,539.02	(1,929,779.52)
163	7/1/2033	2033	23,420	5%	1,249	64,874,009	66,825,958.67	(1,951,950.13)
164	8/1/2033	2033	23,420	5%	1,249	64,875,258	66,849,378.33	(1,974,120.74)
165	9/1/2033	2033	23,420	5%	1,249	64,876,507	66,872,797.98	(1,996,291.34)
166	10/1/2033	2033	23,420	5%	1,249	64,877,756	66,896,217.63	(2,018,461.95)
167	11/1/2033	2033	23,420	5%	1,249	64,879,005	66,919,637.29	(2,040,632.56)
168	12/1/2033	2033	23,420	5%	1,249	64,880,254	66,943,056.94	(2,062,803.16)
169	1/1/2034	2034	23,420	5%	1,249	64,881,503	66,966,476.60	(2,084,973.77)
170	2/1/2034	2034	23,420	5%	1,249	64,882,752	66,989,896.25	(2,107,144.37)
171	3/1/2034	2034	23,420	5%	1,249	64,884,001	67,013,315.91	(2,129,314.98)
172	4/1/2034	2034	23,420	5%	1,249	64,885,250	67,036,735.56	(2,151,485.59)
173	5/1/2034	2034	23,420	5%	1,249	64,886,499	67,060,155.22	(2,173,656.19)
174	6/1/2034	2034	23,420	5%	1,249	64,887,748	67,083,574.87	(2,195,826.80)
175	7/1/2034	2034	23,420	5%	1,249	64,888,997	67,106,994.52	(2,217,997.41)
176	8/1/2034	2034	23,420	5%	1,249	64,890,246	67,130,414.18	(2,240,168.01)
177	9/1/2034	2034	23,420	5%	1,249	64,891,495	67,153,833.83	(2,262,338.62)

178	10/1/2034	2034	23,420	5%	1,249	64,892,744	67,177,253.49	(2,284,509.22)
179	11/1/2034	2034	23,420	5%	1,249	64,893,993	67,200,673.14	(2,306,679.83)
180	12/1/2034	2034	23,420	5%	1,249	64,895,242	67,224,092.80	(2,328,850.44)
181	1/1/2035	2035	23,420	5%	1,249	64,896,491	67,247,512.45	(2,351,021.04)
182	2/1/2035	2035	23,420	5%	1,249	64,897,740	67,270,932.11	(2,373,191.65)
183	3/1/2035	2035	23,420	5%	1,249	64,898,990	67,294,351.76	(2,395,362.25)
184	4/1/2035	2035	23,420	5%	1,249	64,900,239	67,317,771.41	(2,417,532.86)
185	5/1/2035	2035	23,420	5%	1,249	64,901,488	67,341,191.07	(2,439,703.47)
186	6/1/2035	2035	23,420	5%	1,249	64,902,737	67,364,610.72	(2,461,874.07)
187	7/1/2035	2035	23,420	5%	1,249	64,903,986	67,388,030.38	(2,484,044.68)
188	8/1/2035	2035	23,420	5%	1,249	64,905,235	67,411,450.03	(2,506,215.29)
189	9/1/2035	2035	23,420	5%	1,249	64,906,484	67,434,869.69	(2,528,385.89)
190	10/1/2035	2035	23,420	5%	1,249	64,907,733	67,458,289.34	(2,550,556.50)
191	11/1/2035	2035	23,420	5%	1,249	64,908,982	67,481,709.00	(2,572,727.10)
192	12/1/2035	2035	23,420	5%	1,249	64,910,231	67,505,128.65	(2,594,897.71)
193	1/1/2036	2036	23,420	5%	1,249	64,911,480	67,528,548.30	(2,617,068.32)
194	2/1/2036	2036	23,420	5%	1,249	64,912,729	67,551,967.96	(2,639,238.92)
195	3/1/2036	2036	23,420	5%	1,249	64,913,978	67,575,387.61	(2,661,409.53)
196	4/1/2036	2036	23,420	5%	1,249	64,915,227	67,598,807.27	(2,683,580.14)
197	5/1/2036	2036	23,420	5%	1,249	64,916,476	67,622,226.92	(2,705,750.74)
198	6/1/2036	2036	23,420	5%	1,249	64,917,725	67,645,646.58	(2,727,921.35)
199	7/1/2036	2036	23,420	5%	1,249	64,918,974	67,669,066.23	(2,750,091.95)
200	8/1/2036	2036	23,420	5%	1,249	64,920,223	67,692,485.89	(2,772,262.56)
201	9/1/2036	2036	23,420	5%	1,249	64,921,472	67,715,905.54	(2,794,433.17)
202	10/1/2036	2036	23,420	5%	1,249	64,922,721	67,739,325.19	(2,816,603.77)
203	11/1/2036	2036	23,420	5%	1,249	64,923,970	67,762,744.85	(2,838,774.38)
204	12/1/2036	2036	23,420	5%	1,249	64,925,220	67,786,164.50	(2,860,944.98)
205	1/1/2037	2037	23,420	5%	1,249	64,926,469	67,809,584.16	(2,883,115.59)
206	2/1/2037	2037	23,420	5%	1,249	64,927,718	67,833,003.81	(2,905,286.20)
207	3/1/2037	2037	23,420	5%	1,249	64,928,967	67,856,423.47	(2,927,456.80)
208	4/1/2037	2037	23,420	5%	1,249	64,930,216	67,879,843.12	(2,949,627.41)
209	5/1/2037	2037	23,420	5%	1,249	64,931,465	67,903,262.77	(2,971,798.02)
210	6/1/2037	2037	23,420	5%	1,249	64,932,714	67,926,682.43	(2,993,968.62)
211	7/1/2037	2037	23,420	5%	1,249	64,933,963	67,950,102.08	(3,016,139.23)
212	8/1/2037	2037	23,420	5%	1,249	64,935,212	67,973,521.74	(3,038,309.83)
213	9/1/2037	2037	23,420	5%	1,249	64,936,461	67,996,941.39	(3,060,480.44)
214	10/1/2037	2037	23,420	5%	1,249	64,937,710	68,020,361.05	(3,082,651.05)
215	11/1/2037	2037	23,420	5%	1,249	64,938,959	68,043,780.70	(3,104,821.65)
216	12/1/2037	2037	23,420	5%	1,249	64,940,208	68,067,200.36	(3,126,992.26)
217	1/1/2038	2038	23,420	5%	1,249	64,941,457	68,090,620.01	(3,149,162.87)
218	2/1/2038	2038	23,420	5%	1,249	64,942,706	68,114,039.66	(3,171,333.47)
219	3/1/2038	2038	23,420	5%	1,249	64,943,955	68,137,459.32	(3,193,504.08)
220	4/1/2038	2038	23,420	5%	1,249	64,945,204	68,160,878.97	(3,215,674.68)
221	5/1/2038	2038	23,420	5%	1,249	64,946,453	68,184,298.63	(3,237,845.29)
222	6/1/2038	2038	23,420	5%	1,249	64,947,702	68,207,718.28	(3,260,015.90)
223	7/1/2038	2038	23,420	5%	1,249	64,948,951	68,231,137.94	(3,282,186.50)
224	8/1/2038	2038	23,420	5%	1,249	64,950,200	68,254,557.59	(3,304,357.11)
225	9/1/2038	2038	23,420	5%	1,249	64,951,450	68,277,977.25	(3,326,527.71)
226	10/1/2038	2038	23,420	5%	1,249	64,952,699	68,301,396.90	(3,348,698.32)
227	11/1/2038	2038	23,420	5%	1,249	64,953,948	68,324,816.55	(3,370,868.93)
228	12/1/2038	2038	23,420	5%	1,249	64,955,197	68,348,236.21	(3,393,039.53)
229	1/1/2039	2039	23,420	5%	1,249	64,956,446	68,371,655.86	(3,415,210.14)
230	2/1/2039	2039	23,420	5%	1,249	64,957,695	68,395,075.52	(3,437,380.75)
231	3/1/2039	2039	23,420	5%	1,249	64,958,944	68,418,495.17	(3,459,551.35)
232	4/1/2039	2039	23,420	5%	1,249	64,960,193	68,441,914.83	(3,481,721.96)
233	5/1/2039	2039	23,420	5%	1,249	64,961,442	68,465,334.48	(3,503,892.56)
234	6/1/2039	2039	23,420	5%	1,249	64,962,691	68,488,754.14	(3,526,063.17)
235	7/1/2039	2039	23,420	5%	1,249	64,963,940	68,512,173.79	(3,548,233.78)
236	8/1/2039	2039	23,420	5%	1,249	64,965,189	68,535,593.44	(3,570,404.38)
237	9/1/2039	2039	23,420	5%	1,249	64,966,438	68,559,013.10	(3,592,574.99)
238	10/1/2039	2039	23,420	5%	1,249	64,967,687	68,582,432.75	(3,614,745.60)
239	11/1/2039	2039	23,420	5%	1,249	64,968,936	68,605,852.41	(3,636,916.20)
240	12/1/2039	2039	23,420	5%	1,249	64,970,185	68,629,272.06	(3,659,086.81)
241	1/1/2040	2040	23,420	5%	1,249	64,971,434	68,652,691.72	(3,681,257.41)
242	2/1/2040	2040	23,420	5%	1,249	64,972,683	68,676,111.37	(3,703,428.02)
243	3/1/2040	2040	23,420	5%	1,249	64,973,932	68,699,531.03	(3,725,598.63)
244	4/1/2040	2040	23,420	5%	1,249	64,975,181	68,722,950.68	(3,747,769.23)
245	5/1/2040	2040	23,420	5%	1,249	64,976,430	68,746,370.33	(3,769,939.84)
246	6/1/2040	2040	23,420	5%	1,249	64,977,680	68,769,789.99	(3,792,110.44)
247	7/1/2040	2040	23,420	5%	1,249	64,978,929	68,793,209.64	(3,814,281.05)
248	8/1/2040	2040	23,420	5%	1,249	64,980,178	68,816,629.30	(3,836,451.66)
249	9/1/2040	2040	23,420	5%	1,249	64,981,427	68,840,048.95	(3,858,622.26)
250	10/1/2040	2040	23,420	5%	1,249	64,982,676	68,863,468.61	(3,880,792.87)
251	11/1/2040	2040	23,420	5%	1,249	64,983,925	68,886,888.26	(3,902,963.48)
252	12/1/2040	2040	23,420	5%	1,249	64,985,174	68,910,307.92	(3,925,134.08)

APPENDIX G

Implementation Actions Matrix.

IRVINE
CLIMATE ACTION
AND ADAPTATION PLAN

Irvine CAAP GHG Reduction Strategies, Measures, and Actions						Implementation Details			
Sector	Strategy	Measure ID	Measure	Action ID	Action	Status	Responsible City Department(s)	Responsible Department Division	Partner(s)
Building Energy	BE-1: Building Energy and Electrification	BE-1.1	Facilitate energy audits for existing buildings to identify energy efficiency retrofit and electrification opportunities.	BE-1.1a	Perform energy audits on City facilities and repeat audits every five years as recommended in the City of Irvine Distributed Energy Resources (DER) Implementation Plan.	In Progress	PWS	Facilities, Sustainability	N/A
Building Energy	BE-1: Building Energy and Electrification	BE-1.1	Facilitate energy audits for existing buildings to identify energy efficiency retrofit and electrification opportunities.	BE-1.1b	Seek public-private partnerships (e.g., BlocPower) to fund energy audits and building electrification in the community.	Not Started	PWS, CD	Sustainability, CD Planning	TBD
Building Energy	BE-1: Building Energy and Electrification	BE-1.1	Facilitate energy audits for existing buildings to identify energy efficiency retrofit and electrification opportunities.	BE-1.1c	Work with the Orange County Power Authority (OCPA), Southern California Edison (SCE), and other partners to provide free energy audits of existing residential and nonresidential buildings, prioritizing low-income neighborhoods.	Not Started	PWS, CD	Sustainability, CD Planning	OCPA, SCE
Building Energy	BE-1: Building Energy and Electrification	BE-1.1	Facilitate energy audits for existing buildings to identify energy efficiency retrofit and electrification opportunities.	BE-1.1d	Work with the Southern California Regional Energy Network (SoCalREN) to expand technical support services for residential and nonresidential buildings communitywide, including energy audits, identifying energy efficiency improvement measures, and energy efficiency performance specifications. (services are only available to public agencies currently)	Not Started	PWS, CD	Sustainability, CD Planning	SoCalREN
Building Energy	BE-1: Building Energy and Electrification	BE-1.1	Facilitate energy audits for existing buildings to identify energy efficiency retrofit and electrification opportunities.	BE-1.1e	Launch partnership with SCE and XeroHomeTM to facilitate and scale residential energy upgrades.	Complete	PWS, CD	Sustainability	SCE, XeroHome

Irvine CAAP GHG Reduction Strategies, Measures, and Actions						Implementation Details			
Sector	Strategy	Measure ID	Measure	Action ID	Action	Status	Responsible City Department(s)	Responsible Department Division	Partner(s)
Building Energy	BE-1: Building Energy and Electrification	BE-1.1	Facilitate energy audits for existing buildings to identify energy efficiency retrofit and electrification opportunities.	BE-1.1f	Support development of OCPA's Online Marketplace for discounted residential smart home devices.	Complete	PWS, CD	Sustainability	OCPA
Building Energy	BE-1: Building Energy and Electrification	BE-1.2	Retrofit existing residential buildings (single family, and multi-Family less than 20,000 square feet) to improve energy efficiency and facilitate fuel switching.	BE-1.2a	Develop a comprehensive energy retrofit program to transition existing residential buildings to all-electric, aiming for a 72% conversion rate by 2045. Begin program providing incentives. Consider point-of-sale and retrofit requirements in the future.	In Progress	PWS, CD	Sustainability, Facilities, CD	N/A
Building Energy	BE-1: Building Energy and Electrification	BE-1.2	Retrofit existing residential buildings (single family, and multi-Family less than 20,000 square feet) to improve energy efficiency and facilitate fuel switching.	BE-1.2b	Connect building owners to funding resources and financing options for energy efficiency retrofits and improvement projects.	Not Started	PWS, CD	Sustainability, CD	N/A
Building Energy	BE-1: Building Energy and Electrification	BE-1.2	Retrofit existing residential buildings (single family, and multi-Family less than 20,000 square feet) to improve energy efficiency and facilitate fuel switching.	BE-1.2c	Secure funding to expand the features of the One Irvine program incentives for home retrofits.	In Progress	CD	Sustainability, CMO	N/A
Building Energy	BE-1: Building Energy and Electrification	BE-1.2	Retrofit existing residential buildings (single family, and multi-Family less than 20,000 square feet) to improve energy efficiency and facilitate fuel switching.	BE-1.2d	Continue implementation of the Switch is On campaign to promote home electrification that provides Irvine residents access to one-on-one advisors, vetted contractors, and information about incentive programs and rebates.	Complete	PWS, CD	Sustainbility	N/A

Irvine CAAP GHG Reduction Strategies, Measures, and Actions						Implementation Details			
Sector	Strategy	Measure ID	Measure	Action ID	Action	Status	Responsible City Department(s)	Responsible Department Division	Partner(s)
Building Energy	BE-1: Building Energy and Electrification	BE-1.2	Retrofit existing residential buildings (single family, and multi-Family less than 20,000 square feet) to improve energy efficiency and facilitate fuel switching.	BE-1.2e	Expand the features of the One Irvine program incentives for home retrofits, including Permit Fee Holiday, Residential Rehabilitation Program, Green Home Grants, and Home Improvement Loans through other programs available to residents (e.g. proposed Climate Resilience Rebate program).	In Progress	PWS, CD	Sustainability, CMO, CD	N/A
Building Energy	BE-1: Building Energy and Electrification	BE-1.2	Retrofit existing residential buildings (single family, and multi-Family less than 20,000 square feet) to improve energy efficiency and facilitate fuel switching.	BE-1.2f	Adopt an ordinance requiring a U.S. Department of Energy (DOE) Home Energy Score (HES) Assessment and energy efficiency upgrades for existing residential building additions or alterations with a permit value of $50,000 or higher. The cost of mandated upgrades should not exceed 5% of the cost of the modification/alteration cost.	Not Started	CD	CD Planning, Permits	N/A
Building Energy	BE-1: Building Energy and Electrification	BE-1.3	Retrofit existing multi-family (20,000 square feet and larger) and nonresidential buildings to improve energy efficiency and facilitate fuel switching.	BE-1.3a	Develop a comprehensive energy retrofit program to transition existing nonresidential buildings to all-electric, aiming for a 46% conversion rate by 2045. Begin program providing incentives then transition to retrofit requirements.	Not Started	CD	CD Planning	N/A
Building Energy	BE-1: Building Energy and Electrification	BE-1.3	Retrofit existing multi-family (20,000 square feet and larger) and nonresidential buildings to improve energy efficiency and facilitate fuel switching.	BE-1.3b	Pilot an all-electric retrofit at a City of Irvine community center.	Not Started	PWS	Sustainability, Facilities, CS	N/A

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Sector	Strategy	Measure ID	Measure	Action ID	Action	Status	Responsible City Department(s)	Responsible Department Division	Partner(s)
Building Energy	BE-1: Building Energy and Electrification	BE-1.3	Retrofit existing multi-family (20,000 square feet and larger) and nonresidential buildings to improve energy efficiency and facilitate fuel switching.	BE-1.3c	Adopt a Building Performance Standard that requires owners of multi-family, commercial and industrial buildings 20,000 square feet and larger to benchmark energy use annually and perform audits and building upgrades for low-performing buildings. Volunteer participants would be allowed to perform audits and quality for voluntary incentive loans to the extent funding is available.	Not Started	CD	CD Planning, Building	N/A
Building Energy	BE-1: Building Energy and Electrification	BE-1.3	Retrofit existing multi-family (20,000 square feet and larger) and nonresidential buildings to improve energy efficiency and facilitate fuel switching.	BE-1.3d	Require benchmarked buildings to display their energy efficiency scores in a visible location near each public entrance.	Not Started	CD	CD Planning, Building	N/A
Building Energy	BE-1: Building Energy and Electrification	BE-1.3	Retrofit existing multi-family (20,000 square feet and larger) and nonresidential buildings to improve energy efficiency and facilitate fuel switching.	BE-1.3e	Eliminate the provision of fossil fuel powered backup generator permits for existing nonresidential development by 2028 where technology alternatives that meet the development's reliability and safety needs are commercially available.	Not Started	CD	CD Planning, Building, Permits	N/A
Building Energy	BE-1: Building Energy and Electrification	BE-1.4	Reduce plug loads in existing buildings.	BE-1.4a	Facilitate the adoption of smart grid and other peak load reduction technologies, such as building energy management systems and smart appliances, within new and existing buildings.	In Progress	PWS, CD	CD Planning, building PWS Development Engineering, PWS Facilities	N/A
Building Energy	BE-1: Building Energy and Electrification	BE-1.4	Reduce plug loads in existing buildings.	BE-1.4b	Use partnerships to promote appliance upgrades to energy-efficient technologies and products through campaigns targeted at residents and local businesses, ENERGY STAR® appliance change out programs, and incentives (e.g., giveaways, federal/state/utility rebates).	In Progress	PWS, CD	PWS Sustainability,	N/A

Irvine CAAP GHG Reduction Strategies, Measures, and Actions						Implementation Details			
Sector	Strategy	Measure ID	Measure	Action ID	Action	Status	Responsible City Department(s)	Responsible Department Division	Partner(s)
Building Energy	BE-2: Low Carbon Development	BE-2.1	Eliminate the use of natural gas in new development.	BE-2.1a	Adopt a Building Electrification Ordinance, in accordance with legal requirements.	In Progress	CD	CD Panning, CD Building	N/A
Building Energy	BE-2: Low Carbon Development	BE-2.1	Eliminate the use of natural gas in new development.	BE-2.1b	Partner with SoCalREN, OCPA, SCE, other cities, and the private sector to develop effective strategies to facilitate electrification implementation.	In Progress	CD, CMO	CD Panning & CMO	SoCalREN, OCPA, SCE
Building Energy	BE-2: Low Carbon Development	BE-2.2	Implement and enforce REACH building codes and Green Building Standards.	N/A	See actions under Measure BE-2.1.	N/A	N/A	N/A	N/A
Building Energy	BE-2: Low Carbon Development	BE-2.3	Eliminate fossil fuel-powered backup energy sources by 2028.	N/A	See actions under Measure BE-1.3.	N/A	N/A	N/A	N/A
Building Energy	BE-2: Low Carbon Development	BE-2.4	Require smart grid technologies to include two-way communication and control capabilities between buildings and the electric grid.	BE-2.4a	Integrate smart grid technologies into City facilities starting with one or more pilot projects at City facilities identified in the City of Irvine Distributed Energy Resources (DER) Implementation Plan.	In Progress	PWS, CD	PWS Facilities	N/A
Building Energy	BE-2: Low Carbon Development	BE-2.4	Require smart grid technologies to include two-way communication and control capabilities between buildings and the electric grid.	BE-2.4b	Expand use of smart grid technologies in Irvine, building from SCE's smart-grid demonstration in Irvine in partnership with U.S. DOE. (See: Demo - IG (epri.com) Expand smart grid deployment to OCPA services and customers.	In Progress	PWS, CD	Sustainability, CD Planning	SCE

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Building Energy	BE-2: Low Carbon Development	BE-2.5	Facilitate net zero energy projects.	BE-2.5a	Transition all existing City facilities to zero net energy by 2035. Require all newly constructed City facilities to be zero net energy by 2030. Implement retrofit projects in municipal buildings and facilities to improve energy efficiency and fuel switch from natural gas to electricity.	In Progress	PWS	PWS Facilities	N/A
Building Energy	BE-2: Low Carbon Development	BE-2.5	Facilitate net zero energy projects.	N/A	See actions under Measures BE-2.1, BE-3.2, and BE-3.3.	N/A	N/A	N/A	N/A
Building Energy	BE-2: Low Carbon Development	BE-2.6	Reduce high-GWP refrigerants.	BE-2.6a	Partner with OCPA and SCE to implement a natural refrigerant incentive program (See Sacramento Municipal Utilities District pilot program here.)	Not Started	PWS, CD	Sustainability, CD Planning	OCPA, SCE
Building Energy	BE-3: Clean Energy	BE-3.1	Enroll 100% of communitywide accounts in 100% renewable/zero-carbon option from OCPA.	BE-3.1a	Conduct outreach to residents and business owners to increase awareness of OCPA's carbon-free electricity supply and encourage retention at 100% renewable service level.	Complete	PWS, CD	Sustainability, CD Planning	OCPA
Building Energy	BE-3: Clean Energy	BE-3.2	Increase renewable energy installations in existing buildings.	BE-3.2a	Continue implementation of Solarize Irvine to provide access to group pricing discounts for solar power and battery storage and disseminate information to community members and HOAs to facilitate installation of solar and storage.	Complete	PWS	Sustainability	N/A

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Building Energy	BE-3: Clean Energy	BE-3.2	Increase renewable energy installations in existing buildings.	BE-3.2b	Implement the City of Irvine Distributed Energy Resources (DER) Implementation Plan to increase energy efficiency and implement DERs at City facilities and community buildings.	In Progress	PWS	Sustainability, PWS Facilities	N/A
Building Energy	BE-3: Clean Energy	BE-3.2	Increase renewable energy installations in existing buildings.	BE-3.2c	Prioritize installation of renewable energy and battery storage at City- owned facilities with the most positive payback period for offsetting 100% of electricity use with a combination of solar and battery storage as identified in the DER Implementation Plan.	In Progress	PWS	Sustainability, PWS Facilities	N/A
Building Energy	BE-3: Clean Energy	BE-3.2	Increase renewable energy installations in existing buildings.	BE-3.2d	Provide incentives for replacing existing swimming pool heaters with renewable energy-powered technologies.	Not Started	CD		N/A
Building Energy	BE-3: Clean Energy	BE-3.2	Increase renewable energy installations in existing buildings.	BE-3.2e	Continue supporting SOMAH Program that provides financial incentives for installing photovoltaic energy systems on multifamily affordable housing in California.	Complete	CD	CD	N/A
Building Energy	BE-3: Clean Energy	BE-3.2	Increase renewable energy installations in existing buildings.	BE-3.2f	Work with regional partner agencies and utilities, such as SoCalREN, OCPA, and SCE to promote State rebates and other incentives and funding opportunities for renewable energy.	In Progress	PWS	Sustainability	SoCalREN, OCPA, SCE

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Building Energy	BE-3: Clean Energy	BE-3.3	Increase renewable energy in new development.	BE-3.3a	Encourage the installation of solar canopies on surface parking lots on private property and consider a resolution for incorporating solar canopies on City properties.	Not Started	CD	CD Planning	N/A
Building Energy	BE-3: Clean Energy	BE-3.3	Increase renewable energy in new development.	BE-3.3b	Adopt a reach code in 2024 that requires all new residential and nonresidential buildings to generate onsite renewable energy to meet anticipated energy consumption of the building.	Not Started	CD	CD Planning, Policy	N/A
Building Energy	BE-3: Clean Energy	BE-3.3	Increase renewable energy in new development.	BE-3.3c	Require all newly built parking structures to have solar generation capabilities.	Not Started	CD	CD Planning, Policy	N/A
Building Energy	BE-3: Clean Energy	BE-3.3	Increase renewable energy in new development.	BE-3.3d	Require the installation of renewable energy heaters for all new residential swimming pools.	Not Started	CD	CD Planning, Policy	N/A
Building Energy	BE-3: Clean Energy	BE-3.4	Develop innovative approaches to energy generation, distribution, and storage.	BE-3.4a	Evaluate opportunities for integrating battery storage readiness in existing homes and businesses at the time of retrofit and/or in conjunction with renewable energy generation installations.	Not Started	CD	CD Planning	N/A
Building Energy	BE-3: Clean Energy	BE-3.4	Develop innovative approaches to energy generation, distribution, and storage.	BE-3.4b	Consider opportunities for alternative energy generation, energy recapture (in-conduit hydropower, co- generation), and distributed energy storage systems, in addition to solar generation and battery storage.	In Progress	PWS	Sustainability, PWS Development Engineering,Facilities	N/A

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Building Energy	BE-3: Clean Energy	BE-3.4	Develop innovative approaches to energy generation, distribution, and storage.	BE-3.4c	Pursue DERs as net energy metering (NEM) aggregates or microgrid models at City facilities that feature a cluster of City buildings identified in the City of Irvine DER Implementation Plan.	In Progress	PWS	Sustainability, PWS Development Engineering,Facilities	N/A
Building Energy	BE-3: Clean Energy	BE-3.4	Develop innovative approaches to energy generation, distribution, and storage.	BE-3.4d	Require battery storage readiness design in new nonresidential construction building types where not already required by the 2022 Energy Code.	Not Started	CD	CD Policy, Planning	N/A
Building Energy	BE-3: Clean Energy	BE-3.4	Develop innovative approaches to energy generation, distribution, and storage.	BE-3.4e	Develop renewable microgrids at fire and police stations and other emergency facilities located in the city in partnership with Orange County Fire Authority.	Not Started	PWS, CD	PWS Sustainability, CD Planning,Policy	OCFA
Building Energy	BE-3: Clean Energy	BE-3.4	Develop innovative approaches to energy generation, distribution, and storage.	BE-3.4f	Collaborate with OCPA, SCE, and partner agencies such as IUSD to encourage non-municipal public service facilities (e.g., local schools and hospitals) to develop renewable microgrids, separate from utility-scale storage systems.	Not Started	PWS	PWS Sustainability	OCPA, SCE, IUSD
Building Energy	BE-4: Energy Education and Awareness	BE-4.1	Strengthen community awareness of energy efficiency, energy conservation, electrification, and clean energy.	BE-4.1a	Develop and implement a comprehensive energy efficiency, energy conservation, electrification, and clean energy outreach and education campaign to support emissions reductions from building energy use, such as Solarize Irvine efforts to provide information on the California Solar Rights Act, especially for Homeowner's Associations (HOAs).	Complete	PWS	PWS Sustainability	N/A

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Building Energy	BE-4: Energy Education and Awareness	BE-4.1	Strengthen community awareness of energy efficiency, energy conservation, electrification, and clean energy.	BE-4.1a	Encourage the installation of battery storage in conjunction with renewable energy generation projects within new and existing buildings through engagement campaigns and state incentives.	Complete	PWS	PWS Sustainability	N/A
Building Energy	BE-4: Energy Education and Awareness	BE-4.1	Strengthen community awareness of energy efficiency, energy conservation, electrification, and clean energy.	BE-4.1b	City facilities to focus on the highest energy-consuming buildings identified in the City of Irvine DER Implementation Plan as an example of clean energy leadership to the community	In Progress	PWS	PWS Sustainability, Facilities	N/A
Building Energy	BE-4: Energy Education and Awareness	BE-4.1	Strengthen community awareness of energy efficiency, energy conservation, electrification, and clean energy.	BE-4.1c	Leverage the Green Business network to increase awareness of energy efficiency examples and resources and provide information on clean energy incentives.	Complete	CMO, PWS	PWS Sustainability	N/A
Transportation and Land Use	TR-1: Sustainable Transportation and Land Use Planning	TR-1.1	Increase high-density, transit-oriented development along primary corridors to reduce time spent traveling.	TR-1.1a	Promote the increase of density and mixed uses in key opportunity areas pursuant to the City's adopted Housing Element, and/or forthcoming General Plan Update, such as Irvine Spectrum and Irvine Business Complex.	In Progress	CD	CD Planning, CD Transportation Planning & T	N/A
Transportation and Land Use	TR-1: Sustainable Transportation and Land Use Planning	TR-1.1	Increase high-density, transit-oriented development along primary corridors to reduce time spent traveling.	TR-1.1b	Encourage development of urban plazas in new development to encourage pedestrian activity and vibrant mixed-use centers that reduce vehicular activity.	In Progress	CD	Sustainability, CDPlanning, CD Transportation,	N/A
Transportation and Land Use	TR-1: Sustainable Transportation and Land Use Planning	TR-1.1	Increase high-density, transit-oriented development along primary corridors to reduce time spent traveling.	TR-1.1c	Support high levels of ridership at the Irvine Station by encouraging higher density (through a residential overlay pursuant to adopted Housing Element), mixed uses, and connectivity along transit corridors and at transit nodes.	In Progress	CD, T	CD Planning, CD Transportation Planning	N/A

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Transportation and Land Use	TR-1: Sustainable Transportation and Land Use Planning	TR-1.1	Increase high-density, transit-oriented development along primary corridors to reduce time spent traveling.	TR-1.1d	Introduce residential uses in targeted retail centers to create mixed-use environments (pursuant to adopted Housing Element).	In Progress	CD	CD Planning, CD Transportation Planning	N/A
Transportation and Land Use	TR-1: Sustainable Transportation and Land Use Planning	TR-1.1	Increase high-density, transit-oriented development along primary corridors to reduce time spent traveling.	TR-1.1e	Expand the residential overlay and unit cap in the Irvine Business Complex to promote mixed-use development.	In Progress	CD	CD Planning, CD Transportation Planning	N/A
Transportation and Land Use	TR-1: Sustainable Transportation and Land Use Planning	TR-1.1	Increase high-density, transit-oriented development along primary corridors to reduce time spent traveling.	TR-1.1f	Develop a study to see if other planning areas could be considered for mixed-use development.	In Progress	CD	CD Planning, CD Transportation Planning	N/A
Transportation and Land Use	TR-1: Sustainable Transportation and Land Use Planning	TR-1.1	Increase high-density, transit-oriented development along primary corridors to reduce time spent traveling.	TR-1.1g	Allow neighborhood-scale commercial uses in or near residential zones to increase opportunities to complete trips by walking or biking.	In Progress	CD	CD Planning, CD Transportation Planning	N/A
Transportation and Land Use	TR-1: Sustainable Transportation and Land Use Planning	TR-1.1	Increase high-density, transit-oriented development along primary corridors to reduce time spent traveling.	TR-1.1h	Promote and allow for an increase in Accessory Dwelling Units throughout the city.	In Progress	CD	CD Planning, CD Transportation Planning	N/A
Transportation and Land Use	TR-1: Sustainable Transportation and Land Use Planning	TR-1.2	Create car-free areas to reduce vehicle use and promote pedestrian use.	TR-1.2a	Build upon Irvine's successful examples of pedestrian- and bike- friendly connections, and expand to other areas in the City, such as Quail Hills trails, Irvine Spectrum, and Irvine Station	In Progress	PWS, T	PW&S Transportation, CD Transportation, CD Planning	N/A

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Transportation and Land Use	TR-1: Sustainable Transportation and Land Use Planning	TR-1.2	Create car-free areas to reduce vehicle use and promote pedestrian use.	TR-1.2b	Facilitate the installation of pedestrian malls in new development projects. A pedestrian mall is characterized as a number of blocks of public streets designated for pedestrian-only use and closed to vehicular traffic. Pedestrian malls are most successful when they are in close proximity to the office/financial core in large cities.	Not Started	CD, T	PW&S Transportation, CD Transportation, CD Planning	N/A
Transportation and Land Use	TR-1: Sustainable Transportation and Land Use Planning	TR-1.2	Create car-free areas to reduce vehicle use and promote pedestrian use.	TR-1.2c	Facilitate alternative street/sidewalk standards to allow for outdoor dining, more pedestrian/bike friendly paths of travel to allow for easy mobility. Rezone uses in pedestrian mall to provide ground floor retail and residential/commercial uses on upper floors.	In Progress	PWS, T	CD Planning, CD Transportation, PWS Transportation	N/A
Transportation and Land Use	TR-1: Sustainable Transportation and Land Use Planning	TR-1.2	Create car-free areas to reduce vehicle use and promote pedestrian use.	TR-1.2d	Explore providing shuttle/microtransit service or similar options to reduce vehicular and parking demand for surrounding streets and neighborhoods (for example, refer to first last mile study for Irvine Spectrum).	In Progress	T	CD Planning, CD Transportation, T Transportation	N/A
Transportation and Land Use	TR-1: Sustainable Transportation and Land Use Planning	TR-1.2	Create car-free areas to reduce vehicle use and promote pedestrian use.	TR-1.2e	Develop an Operation and Maintenance Plan with City dedicated to overseeing the maintenance and landscaping of any new pedestrian malls.	Not Started	PWS	PWS Landscape, open space	N/A
Transportation and Land Use	TR-1: Sustainable Transportation and Land Use Planning	TR-1.2	Create car-free areas to reduce vehicle use and promote pedestrian use.	TR-1.2f	Adopt a Vision Zero Policy to eliminate all traffic fatalities and severe injuries and increase safe, healthy, and equitable mobility for all.	In Progress	T	Unknown	N/A

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Sector	Strategy	Measure ID	Measure	Action ID	Action	Status	Responsible City Department(s)	Responsible Department Division	Partner(s)
Transportation and Land Use	TR-1: Sustainable Transportation and Land Use Planning	TR-1.2	Create car-free areas to reduce vehicle use and promote pedestrian use.	TR-1.2g	Where car-free areas would be infeasible, implement lower speed limits and an array of traffic calming measures, such as speed humps/lumps, roundabouts, curb extensions, channelization islands, and tighter corner radii to promote and increase safety of active transportation and reduce vehicular traffic volumes.	In Progress	T	Public Saftey, PWS Transportation, CD Transportation, CD Planning	N/A
Transportation and Land Use	TR-2: Low- and Zero-Emission Vehicles	TR-2.1	Increase electric vehicle (EV) charging infrastructure.	TR-2.1a	Support installation of EV charging infrastructure on City property and throughout the community.	In Progress	PWS	PWS Sustainability	N/A
Transportation and Land Use	TR-2: Low- and Zero-Emission Vehicles	TR-2.1	Increase electric vehicle (EV) charging infrastructure.	TR-2.1b	Ensure EV charging stations are encouraged and allowed through land use designations that currently permit gas fueling stations.	Not Started	CD	CD Planning/Policy	N/A
Transportation and Land Use	TR-2: Low- and Zero-Emission Vehicles	TR-2.1	Increase electric vehicle (EV) charging infrastructure.	TR-2.1c	Install EV charging stations and preferred parking for EVs at public facilities, parks, and other high-use parking areas throughout the City; provide incentives that lead to installation on private property.	In Progress	PWS	PWS Sustainability, Development Engineering, Facilities	N/A
Transportation and Land Use	TR-2: Low- and Zero-Emission Vehicles	TR-2.1	Increase electric vehicle (EV) charging infrastructure.	TR-2.1d	Provide guidelines for the permit application process for EV charging infrastructure installation in residential and nonresidential development.	Complete	CD	CD Permits/Planning/Policy	N/A

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Transportation and Land Use	TR-2: Low- and Zero-Emission Vehicles	TR-2.1	Increase electric vehicle (EV) charging infrastructure.	TR-2.1e	Implement load management strategies for EV charging at City facilities to lower utility bills and minimize electrical infrastructure upgrades, including shared charging, scheduled charging, and fleet management software, as recommended in the DER	In Progress	PWS	PWS Fleet,, Facilities	N/A
Transportation and Land Use	TR-2: Low- and Zero-Emission Vehicles	TR-2.1	Increase electric vehicle (EV) charging infrastructure.	TR-2.1f	Require all nonresidential development to comply with state regulations to electrify medium and heavy-duty parking stalls, loading docks, and activities related to warehouse operations.	Not Started	CD	CD Planning/policy	N/A
Transportation and Land Use	TR-2: Low- and Zero-Emission Vehicles	TR-2.1	Increase electric vehicle (EV) charging infrastructure.	TR-2.1g	Designate certain curbside locations as commercial loading zones exclusively available for zero-emission commercial delivery vehicles.	Not Started	T	CD Transportation	N/A
Transportation and Land Use	TR-2: Low- and Zero-Emission Vehicles	TR-2.2	Increase EV and low-carbon vehicle adoption through incentives and awareness of existing federal, state, and regional incentives/tax credits.	TR-2.2a	Implement accessible hydrogen fuel cell fueling infrastructure in the City as hydrogen vehicles become commercially available.	Not Started	PWS	PWS Fleet,, Facilities, Transportation	N/A
Transportation and Land Use	TR-2: Low- and Zero-Emission Vehicles	TR-2.2	Increase EV and low-carbon vehicle adoption through incentives and awareness of existing federal, state, and regional incentives/tax credits.	TR-2.2b	Develop a ZEV Vehicle Replacement Policy in which City fleet vehicles are replaced with zero emission technology vehicles at levels above and beyond State requirements.	In Progress	PWS	PWS Fleet,, Facilities	N/A
Transportation and Land Use	TR-2: Low- and Zero-Emission Vehicles	TR-2.2	Increase EV and low-carbon vehicle adoption through incentives and awareness of existing federal, state, and regional incentives/tax credits.	TR-2.2c	Promote awareness of local, regional, and State incentives for low- and zero- emission vehicles, such as those provided by SCE and SCAQMD.	Complete	PWS	Sustainability	SCE, SCAQMD

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Transportation and Land Use	TR-2: Low- and Zero-Emission Vehicles	TR-2.2	Increase EV and low-carbon vehicle adoption through incentives and awareness of existing federal, state, and regional incentives/tax credits.	TR-2.2d	Promote South Coast Air Quality Management District's (SCAQMD's) residential EV charging incentive program to offset Level 2 EV charger hardware costs.	Complete	PWS	Sustainability	SCAQMD
Transportation and Land Use	TR-2: Low- and Zero-Emission Vehicles	TR-2.2	Increase EV and low-carbon vehicle adoption through incentives and awareness of existing federal, state, and regional incentives/tax credits.	TR-2.2e	Promote SCAQMD's Replace Your Ride program that incentivizes replacement of older vehicles with a newer vehicle, upgrade to a hybrid or electric vehicle, or vouchers for car-sharing or public transit passes.	Complete	PWS	Sustainability	SCAQMD
Transportation and Land Use	TR-2: Low- and Zero-Emission Vehicles	TR-2.2	Increase EV and low-carbon vehicle adoption through incentives and awareness of existing federal, state, and regional incentives/tax credits.	TR-2.2f	Develop and implement an electric car share program.	Not Started	T	PWS Transportation	N/A
Transportation and Land Use	TR-2: Low- and Zero-Emission Vehicles	TR-2.2	Increase EV and low-carbon vehicle adoption through incentives and awareness of existing federal, state, and regional incentives/tax credits.	TR-2.2g	Promote SCE's pre-owned electric vehicle rebate program and Charge Ready Program which assists business and property owners with deploying the infrastructure and equipment necessary to support EV charging stations at their locations.	Complete	PWS	Sustainability	SCE
Transportation and Land Use	TR-2: Low- and Zero-Emission Vehicles	TR-2.2	Increase EV and low-carbon vehicle adoption through incentives and awareness of existing federal, state, and regional incentives/tax credits.	TR-2.2h	Support the development of a regional EV collaborative, led by OCPA, or other regional partner to share lessons learned and best practices, and track metrics.	Not Started	PWS, T	Sustainability	OCPA
Transportation and Land Use	TR-2: Low- and Zero-Emission Vehicles	TR-2.3	Support EVs in new development by increasing the number of chargers required.	TR-2.3a	Adopt an EV charging reach code to become effective January 1, 2025, to meet or exceed 2022 CalGreen Code Tier 2 EV Charging Requirements for Residential and Nonresidential Buildings.	Not Started	CD	CD Planning/policy	N/A

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Transportation and Land Use	TR-2: Low- and Zero-Emission Vehicles	TR-2.4	Reduce the use of fossil fuel-powered vehicles.	TR-2.4a	Implement the City of Irvine Zero Emission Vehicles Transition Plan to increase adoption of ZEV technologies in the city, including the installation of chargers on City property identified as high priority in the ZEV Transition Plan.	In Progress	PWS	PWS Fleet, Development Engineering, CIP	N/A
Transportation and Land Use	TR-2: Low- and Zero-Emission Vehicles	TR-2.4	Reduce the use of fossil fuel-powered vehicles.	TR-2.4b	Evaluate feasibility for a cordon pricing scheme that sets a cordon (boundary) around a specified area to charge a toll to enter the area by vehicle. The cordon location is usually the boundary of a central business district or urban center but could also apply to substantial development projects with limited points of access. The toll price can be based on a fixed schedule or be dynamic, responding to real-time congestion levels. (Note: This action is contingent on having an existing, high quality transit infrastructure to reach a significant level of effectiveness. This measure should provide an exception for low-income residents or workers within the pricing zone.)	Not Started	T	CD Transportation,	N/A
Transportation and Land Use	TR-2: Low- and Zero-Emission Vehicles	TR-2.4	Reduce the use of fossil fuel-powered vehicles.	TR-2.4c	Encourage and/or incentivize the use of E-Bikes, including evaluation of the installation of charging infrastructure at bike storage locations.	Not Started	PWS, T	PWS Transportation	N/A
Transportation and Land Use	TR-3: Transit System Improvement	TR-3.1	Enhance and expand transit facilities and infrastructure to access a broader ridership.	TR-3.1a	Explore creating a circulator shuttle service that provides bi-directional frequent, free or low-cost connections between the Irvine Station, other stations, rideshare lots, and key city destinations and the airport as a supplement to OCTA service.	In Progress	T	PWS Transportation	OCTA

Irvine CAAP GHG Reduction Strategies, Measures, and Actions						Implementation Details			
Sector	Strategy	Measure ID	Measure	Action ID	Action	Status	Responsible City Department(s)	Responsible Department Division	Partner(s)
Transportation and Land Use	TR-3: Transit System Improvement	TR-3.1	Enhance and expand transit facilities and infrastructure to access a broader ridership.	TR-3.1b	Evaluate the feasibility of developing a light rail system that connects Irvine residents to key employment, retail, and educational destinations.	In Progress	T	PWS Transportation	N/A
Transportation and Land Use	TR-3: Transit System Improvement	TR-3.1	Enhance and expand transit facilities and infrastructure to access a broader ridership.	TR-3.1c	Improve transit access and safety through sidewalk/crosswalk safety enhancements, bus shelter improvements, improved lighting, and other features. Work with the community to determine barriers to use, most desired improvements, and other access challenges.	In Progress	PWS, T	PWS, Development Engineering, Transportation	N/A
Transportation and Land Use	TR-3: Transit System Improvement	TR-3.1	Enhance and expand transit facilities and infrastructure to access a broader ridership.	TR-3.1d	Provide real-time bus/train arrival time, travel time, alternative routings, or other transit information via electronic message signs, dedicated monitor or interactive electronic displays, websites, or mobile apps.	Complete	T	PWS Transportation, Community Engagement	N/A
Transportation and Land Use	TR-3: Transit System Improvement	TR-3.1	Enhance and expand transit facilities and infrastructure to access a broader ridership.	TR-3.1e	Provide short-term and long-term bicycle parking near rail stations, transit stops, and freeway access points near commuter or rapid bus lines.	Complete	PWS, T	PWS, Development Engineering, Transportation, CD Transportation	N/A
Transportation and Land Use	TR-3: Transit System Improvement	TR-3.1	Enhance and expand transit facilities and infrastructure to access a broader ridership.	TR-3.1f	Implement an electric carshare program at the Irvine Station to provide zero emissions first mile-last mile travel.	Not Started	T	PWS Transportation	N/A

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Sector	Strategy	Measure ID	Measure	Action ID	Action	Status	Responsible City Department(s)	Responsible Department Division	Partner(s)
Transportation and Land Use	TR-3: Transit System Improvement	TR-3.1	Enhance and expand transit facilities and infrastructure to access a broader ridership.	TR-3.1g	Explore developing a City Transportation Authority to implement actions listed.	In Progress	CMO	City Managers Office	N/A
Transportation and Land Use	TR-3: Transit System Improvement	TR-3.1	Enhance and expand transit facilities and infrastructure to access a broader ridership.	TR-3.1h	Develop transportation services (shuttle) to and from train stations or rideshare parking lots to Orange County Airport.	In Progress	T	PWS Transportation	Orange County Airport
Transportation and Land Use	TR-3: Transit System Improvement	TR-3.1	Enhance and expand transit facilities and infrastructure to access a broader ridership.	TR-3.1i	Partner with Amtrak, Metrolink, and Orange County Transportation Authority (OCTA) to expand the Irvine Station with ridership upgrades and broader connectivity with farther lying areas of the City.	Not Started	T	PWS Transportation	Amtrak, Metrolink, OCTA
Transportation and Land Use	TR-3: Transit System Improvement	TR-3.1	Enhance and expand transit facilities and infrastructure to access a broader ridership.	TR-3.1j	Work with OCTA to expand iShuttle service to provide first and last mile services for residents of Irvine.	Not Started	T	PWS Transportation	OCTA
Transportation and Land Use	TR-3: Transit System Improvement	TR-3.1	Enhance and expand transit facilities and infrastructure to access a broader ridership.	TR-3.1k	Work with OCTA to expand on-demand service to underserved areas of the City.	Not Started	T	PWS Transportation	OCTA
Transportation and Land Use	TR-3: Transit System Improvement	TR-3.1	Enhance and expand transit facilities and infrastructure to access a broader ridership.	TR-3.1l	Work with OCTA to expand bus rapid transit throughout the city.	Not Started	T	PWS Transportation	OCTA

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Transportation and Land Use	TR-3: Transit System Improvement	TR-3.1	Enhance and expand transit facilities and infrastructure to access a broader ridership.	TR-3.1m	Collaborate with regional transit providers to increase shading and heat- mitigating materials at transit stops.	Not Started	PWS, T	PWS Transportation, Community Engagement	N/A
Transportation and Land Use	TR-3: Transit System Improvement	TR-3.1	Enhance and expand transit facilities and infrastructure to access a broader ridership.	TR-3.1n	Partner with Irvine Unified School District to explore alternative school transportation modes for students.	In Progress	T, CS	N/A	IUSD
Transportation and Land Use	TR-3: Transit System Improvement	TR-3.2	Increase transit ridership through incentives and more frequent, connected transit lines.	TR-3.2a	Implement transit-supportive treatments on transit routes to incorporate roadway infrastructure improvements and/or traffic signal modifications that improve transit travel times and reliability, such as curb extensions or bus lanes.	Not Started	T	N/A	N/A
Transportation and Land Use	TR-3: Transit System Improvement	TR-3.2	Increase transit ridership through incentives and more frequent, connected transit lines.	TR-3.2b	Create incentives, such as fare reductions and convenient routes, to shift travel to transit from single- occupancy vehicles and other traveling modes.	Not Started	T	N/A	N/A
Transportation and Land Use	TR-3: Transit System Improvement	TR-3.2	Increase transit ridership through incentives and more frequent, connected transit lines.	TR-3.2c	Work with OCTA to provide no-cost bus passes to low-income residents and students, including students enrolled in post-secondary education at the University of California Irvine and Irvine Valley College.	Not Started	T	N/A	OCTA

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Transportation and Land Use	TR-3: Transit System Improvement	TR-3.2	Increase transit ridership through incentives and more frequent, connected transit lines.	TR-3.2d	Expand upon first-last mile partnerships between the City/OCTA and a transportation network company (TNC) for subsidized, shared TNC rides to or from the Irvine Station. Consider providing inclusive mechanisms so people without bank accounts, credit cards, or smart phones can access the incentives.	Not Started	T	N/A	OCTA
Transportation and Land Use	TR-3: Transit System Improvement	TR-3.2	Increase transit ridership through incentives and more frequent, connected transit lines.	TR-3.2e	Work with OCTA to add or modify existing transit service to increase ridership in Irvine, including extending operation hours of transit to accommodate alternative-shift workers.	Not Started	T	N/A	OCTA
Transportation and Land Use	TR-3: Transit System Improvement	TR-3.3	Implement an on-demand microtransit system, transporting residents from curb to curb (e.g., OC Flex or LA County Micro).	TR-3.3a	Consider deployment of ZEV shuttles to provide on-demand service.	Not Started	T	N/A	N/A
Transportation and Land Use	TR-3: Transit System Improvement	TR-3.3	Implement an on-demand microtransit system, transporting residents from curb to curb (e.g., OC Flex or LA County Micro).	TR-3.3b	Provide on-demand public transit services that offers flexible routes and on-demand scheduling through coordination with OCTA or a private entity. Microtransit aims to offer shorter wait times and improved reliability compared to the bus and rail system to further incentivize alternative transportation modes. On-demand public transit services would involve user- friendly smartphone applications for booking on-demand rides.	Not Started	T	N/A	OCTA
Transportation and Land Use	TR-4: Active Transportation	TR-4.1	Develop more protected bikeways.	TR-4.1a	Implement recommendations for improving pedestrian infrastructure identified in the City of Irvine Strategic Active Transportation Plan.	Not Started	PWS,T	N/A	N/A

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Transportation and Land Use	TR-4: Active Transportation	TR-4.1	Develop more protected bikeways.	TR-4.1b	Implement bicycle and pedestrian trail network improvements to close gaps and improve connection with the regional trail network, such as completing the Jeffrey Open Space Trail.	In Progress	PWS	N/A	N/A
Transportation and Land Use	TR-4: Active Transportation	TR-4.1	Develop more protected bikeways.	TR-4.1c	Prioritize the installation and proper maintenance of protected bike lanes that are separated from vehicular traffic with physical barriers.	In Progress	PWS, T	N/A	N/A
Transportation and Land Use	TR-4: Active Transportation	TR-4.2	Expand bicycling and walking options through infrastructure improvements.	TR-4.2a	Implement sidewalk improvements, high-visibility crosswalks, crossing improvements, protected intersections, right-turn restrictions, above- and below-grade pedestrian and bicycle connections, traffic signal priority, and corridor improvements.	In Progress	PWS, T	N/A	N/A
Transportation and Land Use	TR-4: Active Transportation	TR-4.2	Expand bicycling and walking options through infrastructure improvements.	TR-4.2b	Continue ongoing work with Irvine Unified School District to build on its local Suggested Routes to School program to create safe, convenient, and fun opportunities for children to bicycle and walk to and from schools.	In Progress	T	N/A	IUSD
Transportation and Land Use	TR-4: Active Transportation	TR-4.2	Expand bicycling and walking options through infrastructure improvements.	TR-4.2c	Adopt a Walkability Plan and/or Pedestrian Design Guidelines that seek to improve street lighting, safer crosswalks, ADA compliance, and signage.	Not Started	PWS, T	N/A	N/A
Transportation and Land Use	TR-4: Active Transportation	TR-4.2	Expand bicycling and walking options through infrastructure improvements.	TR-4.2d	Develop a City mobility plan.	Complete	T	N/A	N/A

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Sector	Strategy	Measure ID	Measure	Action ID	Action	Status	Responsible City Department(s)	Responsible Department Division	Partner(s)
Transportation and Land Use	TR-4: Active Transportation	TR-4.2	Expand bicycling and walking options through infrastructure improvements.	TR-4.2e	Create a wayfinding program to guide people who walk and bike through safe and improved routes to major destinations.	Not Started	T	N/A	N/A
Transportation and Land Use	TR-4: Active Transportation	TR-4.2	Expand bicycling and walking options through infrastructure improvements.	TR-4.2f	Consider requirements for bicycle parking upgrades at existing commercial centers (specifically adding bike racks to accommodate e- bikes).	Not Started	CD	N/A	N/A
Transportation and Land Use	TR-4: Active Transportation	TR-4.2	Expand bicycling and walking options through infrastructure improvements.	TR-4.2g	Examine opportunities to remove or re-purpose roadway travel lanes devoted to vehicle traffic.	Not Started	T	N/A	N/A
Transportation and Land Use	TR-4: Active Transportation	TR-4.2	Expand bicycling and walking options through infrastructure improvements.	TR-4.2h	Continue ongoing work with Irvine Unified School District to build on its local Suggested Routes to School program to create safe, convenient, and fun opportunities for children to bicycle and walk to and from schools.	In Progress	T	N/A	IUSD
Transportation and Land Use	TR-4: Active Transportation	TR-4.3	Develop more accessible and safer pedestrian infrastructure.	N/A	See actions under Measure TR-4.2.	N/A	N/A	N/A	N/A
Transportation and Land Use	TR-4: Active Transportation	TR-4.4	Implement a community bikeshare program.	TR-4.4a	Build upon previous efforts to implement a docked bikeshare program that provides users with on- demand access to bikes for short-term rentals.	Not Started	T	N/A	N/A

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Sector	Strategy	Measure ID	Measure	Action ID	Action	Status	Responsible City Department(s)	Responsible Department Division	Partner(s)
Transportation and Land Use	TR-4: Active Transportation	TR-4.4	Implement a community bikeshare program.	TR-4.4b	Consider implementation of a docked electric bikeshare and/or scootershare program that provides users with on-demand access to electric pedal assist bikes and electric scooters for short-term rentals.	Not Started	CD	N/A	N/A
Transportation and Land Use	TR-5: Transportation Demand Management	TR-5.1	Reduce vehicle miles traveled (VMT) from local businesses through employee rideshare and transit incentive services such as Spectrumotion.	TR-5.1a	Require large employers in the City to implement commute trip reduction (CTR) program. The CTR program must include commute trip reduction marketing, ridesharing provisions, subsidized or discounted transit passes, end-of-trip bicycle facilities, employer-sponsored vanpool, plus include mandatory trip reduction requirements (including penalties for non-compliance) and regular monitoring and reporting of these program components.	In Progress	CD	N/A	N/A
Transportation and Land Use	TR-5: Transportation Demand Management	TR-5.1	Reduce vehicle miles traveled (VMT) from local businesses through employee rideshare and transit incentive services such as Spectrumotion.	TR-5.1b	Require large employers in the City to offer employee parking cash-out as alternate transit options become available. Cash-out is when employers provide employees with a choice of forgoing their current subsidized/free parking for a cash payment equivalent to or greater than the cost of the parking space.	Not Started	CD	CD Planning	N/A
Transportation and Land Use	TR-5: Transportation Demand Management	TR-5.2	Increase implementation of transportation demand management (TDM) strategies such as high-occupancy vehicle (HOV) lanes or reduced transit fares for students to reduce vehicle emissions.	TR-5.2a	See actions under Measures TR-3.1, TR-3.2, and TR-3.3.	N/A	N/A	N/A	N/A

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Sector	Strategy	Measure ID	Measure	Action ID	Action	Status	Responsible City Department(s)	Responsible Department Division	Partner(s)
Transportation and Land Use	TR-6: Vehicle Idling	TR-6.1	Reduce vehicle idling through education and adoption of EVs and plug-in hybrid electric vehicles (PHEV).	TR-6.1a	See actions under Measures TR-2.1, TR-2.2, TR-2.3, and TR-2.4.	N/A	N/A	N/A	N/A
Transportation and Land Use	TR-7: Parking	TR-7.1	Reduce the amount of parking such that it meets the needs of residents, workers, and visitors in a way that is consistent with the City's sustainability goals.	TR-7.1a	Assess the feasibility on pricing on- street parking in the City, with a focus on parking near Irvine Spectrum, Irvine Business Complex and other central business districts, employment centers, and retail centers.	In Progress	CD, T	N/A	N/A
Transportation and Land Use	TR-7: Parking	TR-7.1	Reduce the amount of parking such that it meets the needs of residents, workers, and visitors in a way that is consistent with the City's sustainability goals.	TR-7.1b	Explore pilot program to reduce parking minimums in areas of high- density residential and residential mixed use located in areas within ½ mile of high quality transit station and/or high quality fixed transit stop, and update the Zoning Ordinance parking requirements to reflect update.	Not Started	CD, T	CD Planning, CD Transportation	N/A
Transportation and Land Use	TR-7: Parking	TR-7.1	Reduce the amount of parking such that it meets the needs of residents, workers, and visitors in a way that is consistent with the City's sustainability goals.	TR-7.1c	Require new developments to unbundle, or separate, a residential project's parking costs from property costs, requiring those who wish to purchase parking spaces to do so at an additional cost.	Not Started	CD	CD Planning, CD Transportation	N/A
Transportation and Land Use	TR-7: Parking	TR-7.2	Implement fees for parking in high-traffic areas.	N/A	See actions under Measure TR-7.1.	N/A	N/A	N/A	N/A

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Sector	Strategy	Measure ID	Measure	Action ID	Action	Status	Responsible City Department(s)	Responsible Department Division	Partner(s)
Off-Road Vehicles and Equipment	OR-1: Electrification and Clean Alternatives	OR-1.1	Reduce emissions from landscaping equipment such as leaf blowers by supporting a transition to electric equipment.	OR-1.1a	Incentivize developers to install sufficient exterior electrical outlets to assist with charging electric-powered landscaping equipment.	Not Started	CD	CD Planning	N/A
Off-Road Vehicles and Equipment	OR-1: Electrification and Clean Alternatives	OR-1.1	Reduce emissions from landscaping equipment such as leaf blowers by supporting a transition to electric equipment.	OR-1.1b	Research incentives for landscapers to purchase additional batteries and facilitate conversion to all- electric equipment.	In Progress	PWS, C&E	PWS Sustainability, C&E Engagement	N/A
Off-Road Vehicles and Equipment	OR-1: Electrification and Clean Alternatives	OR-1.1	Reduce emissions from landscaping equipment such as leaf blowers by supporting a transition to electric equipment.	OR-1.1c	Promote SCAQMD's residential Electric Lawn Mower Rebate Program which provides incentives to replace gas- powered landscape equipment with an electric alternative.	In Progress	PWS, C&E	PWS Sustainability, C&E Engagement	SCAQMD
Off-Road Vehicles and Equipment	OR-1: Electrification and Clean Alternatives	OR-1.1	Reduce emissions from landscaping equipment such as leaf blowers by supporting a transition to electric equipment.	OR-1.1d	Promote SCAQMD's Commercial Electric Lawn and Garden Equipment Incentive & Exchange Program available to commercial landscapers and gardeners and local governments, school districts, colleges and non-profits.	In Progress	PWS	PWS Sustainability, C&E Engagement	SCAQMD
Off-Road Vehicles and Equipment	OR-1: Electrification and Clean Alternatives	OR-1.1	Reduce emissions from landscaping equipment such as leaf blowers by supporting a transition to electric equipment.	OR-1.1e	Adopt an ordinance to require business owners (including landscaping businesses) to convert or replace their gasoline-powered gardening equipment, such as lawn mowers, leaf blowers, and hedge trimmers, with electric equipment.	Complete	CD	PWS Sustainability	N/A
Off-Road Vehicles and Equipment	OR-1: Electrification and Clean Alternatives	OR-1.1	Reduce emissions from landscaping equipment such as leaf blowers by supporting a transition to electric equipment.	OR-1.1f	Require all new development to install sufficient exterior electrical outlets to charge electric-powered landscaping equipment.	Not Started	CD	CD Planning	N/A

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Off-Road Vehicles and Equipment	OR-1: Electrification and Clean Alternatives	OR-1.2	Reduce emissions from construction equipment by supporting a transition to electric equipment.	OR-1.2a	Encourage the use of electric- powered construction equipment in all discretionary projects.	Not Started	N/A	N/A	N/A
Off-Road Vehicles and Equipment	OR-1: Electrification and Clean Alternatives	OR-1.2	Reduce emissions from construction equipment by supporting a transition to electric equipment.	OR-1.2b	Prohibit the use of fossil fuel- powered generators at construction sites in all discretionary projects.	Not Started	N/A	N/A	N/A
Off-Road Vehicles and Equipment	OR-1: Electrification and Clean Alternatives	OR-1.2	Reduce emissions from construction equipment by supporting a transition to electric equipment.	OR-1.2c	Require all construction projects starting in 2024 to consider decarbonizing fuels and require the use of Tier 4 construction equipment.	Not Started	CD	CD Planning, Sustainability	N/A
Solid Waste	SW-1: Zero Waste	SW-1.1	Eliminate the disposal of organic solid waste in landfills to reduce methane emissions.	SW-1.1a	Implement and enforce the requirements of Senate Bill 1383 and eliminate disposal of compostable organic materials to landfills.	Complete	PWS	Sustainability	N/A
Solid Waste	SW-1: Zero Waste	SW-1.1	Eliminate the disposal of organic solid waste in landfills to reduce methane emissions.	SW-1.1b	Coordinate with waste haulers to expand existing organic waste collection routes and drop-off sites to improve composting services for interested residents and businesses.	Complete	PWS	Sustainability	N/A
Solid Waste	SW-1: Zero Waste	SW-1.1	Eliminate the disposal of organic solid waste in landfills to reduce methane emissions.	SW-1.1c	Seek partnerships with schools to develop school composting programs and education.	In Progress	PWS	Sustainability	IUSD

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Solid Waste	SW-1: Zero Waste	SW-1.1	Eliminate the disposal of organic solid waste in landfills to reduce methane emissions.	SW-1.1d	Partner or contract with local food recovery organizations to redistribute food waste to disadvantaged communities.	Complete	PWS	Sustainability	N/A
Solid Waste	SW-1: Zero Waste	SW-1.2	Increase recycling and the diversion of other inorganic solid waste through the expansion of public recycling bins.	SW-1.2a	Continue to increase participation in, while simultaneously reducing contamination of, curbside and drop-off recycling programs for all residential, commercial, industrial, and institutional uses. Identify new drop-off opportunities and additional items that can be recycled curbside.	In Progress	PWS	Sustainability	N/A
Solid Waste	SW-1: Zero Waste	SW-1.2	Increase recycling and the diversion of other inorganic solid waste through the expansion of public recycling bins.	SW-1.2b	Provide education, audits, and other technical assistance to increase waste diversion rates. Develop waste reduction and diversion behavior campaigns in partnership with local organizations.	Complete	PWS	Sustainability	N/A
Solid Waste	SW-1: Zero Waste	SW-1.2	Increase recycling and the diversion of other inorganic solid waste through the expansion of public recycling bins.	SW-1.2c	Adopt an ordinance that requires the use of only recyclable and compostable materials by vendors, and adequate staff to ensure proper disposal and recycling at events that require a city-issued permit.	In Progress	CS	Community Services Events Teams (All,)Sustainability	N/A
Solid Waste	SW-1: Zero Waste	SW-1.2	Increase recycling and the diversion of other inorganic solid waste through the expansion of public recycling bins.	SW-1.2d	Partner with waste haulers to expand the diversion of non- food, non-construction, and non-demolition solid waste.	Complete	PWS	Sustainability	N/A

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Sector	Strategy	Measure ID	Measure	Action ID	Action	Status	Responsible City Department(s)	Responsible Department Division	Partner(s)
Solid Waste	SW-1: Zero Waste	SW-1.3	Reduce the generation of waste from residents and businesses through waste-reduction measures such as single-use plastic restrictions and bans.	SW-1.3a	Continue outreach, cost analysis, policy review, and education throughout the city on single-use plastic waste reduction.	In Progress	PWS	Sustainability	N/A
Solid Waste	SW-1: Zero Waste	SW-1.3	Reduce the generation of waste from residents and businesses through waste-reduction measures such as single-use plastic restrictions and bans.	SW-1.3b	Enhance education and enforcement of AB 1276 that requires provision of single use plastic (and bioplastic) straws, utensils, and condiment packets only upon the request of the customer.	Not Started	PWS	Sustainability	N/A
Solid Waste	SW-1: Zero Waste	SW-1.4	Reduce the generation of construction and demolition waste.	SW-1.4a	Adopt a comprehensive construction and demolition ordinance to reach a 75 percent diversion rate.	Complete	CD	Sustainability	N/A
Solid Waste	SW-1: Zero Waste	SW-1.5	Facilitate repair and reuse of consumer products.	SW-1.5a	Evaluate the feasibility of creating a reuse facility that makes building materials available to customers and acts as an outlet for reusable items otherwise destined for the landfill.	Not Started	PWS	N/A	N/A
Solid Waste	SW-1: Zero Waste	SW-1.5	Facilitate repair and reuse of consumer products.	SW-1.5b	Create and support or enter into contracts with third parties to provide “fix-it clinics” at Parks and Facilities and other city facilities that can build skills among local businesses and residents in innovation, repair, and reuse.	Not Started	CS	Community Services Parks	N/A
Solid Waste	SW-2: Landfill Emissions	SW-2.1	Dispose waste at innovative facilities such as waste-to-energy and reuse facilities.	N/A	See actions under Measures SW-1.5 and SW-2.2.	N/A	N/A	N/A	N/A

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Solid Waste	SW-2: Landfill Emissions	SW-2.2	Support waste-to-energy facilities that turn trash into fuel.	SW-2.2a	Establish a local facility (in partnership with OC Sanitation District, OC Waste & Recycling, or others) that can process organic waste local to Irvine.	Complete	PWS	Sustainability	OC San, OC Waste & Recycling
Solid Waste	SW-2: Landfill Emissions	SW-2.2	Support waste-to-energy facilities that turn trash into fuel.	SW-2.2b	Work with Orange County Waste & Recycling to evaluate feasibility of organic waste-to-energy production at local landfills.	Not Started	PWS	Sustainability	OC Waste & Recycling
Solid Waste	SW-2: Landfill Emissions	SW-2.2	Support waste-to-energy facilities that turn trash into fuel.	SW-2.2c	Work with Orange County Waste & Recycling to evaluate feasibility of hydrogen generation from organic waste at local landfills.	Not Started	PWS	Sustainability	OC Waste & Recycling
Solid Waste	SW-2: Landfill Emissions	SW-2.3	Engage with waste-related policy making.	SW-2.3a	Track State legislation regarding solid waste and advocate for actions that reduce emissions from this sector.	Complete	PWS	Sustainability	N/A
Water and Wastewater	W-1: Water Conservation	W-1.1	Reduce water consumption in buildings through conservation campaigns and water efficiency measures.	W-1.1a	Facilitate and respond to reports of water waste and violations of local water use restrictions.	Not Started	PWS	CD Water Quality	IRWD
Water and Wastewater	W-1: Water Conservation	W-1.1	Reduce water consumption in buildings through conservation campaigns and water efficiency measures.	W-1.1b	Require ultra-low-flow fixtures in new development to reduce water consumption.	Complete	CD	CD Water Quality	N/A

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Water and Wastewater	W-1: Water Conservation	W-1.1	Reduce water consumption in buildings through conservation campaigns and water efficiency measures.	W-1.1c	Establish ultra-low-flow water fixture retrofit-upon-sale requirements for residential and nonresidential buildings.	Not Started	CD	CD Water Quality	N/A
Water and Wastewater	W-1: Water Conservation	W-1.1	Reduce water consumption in buildings through conservation campaigns and water efficiency measures.	W-1.1d	Adopt a Building Performance Standard that requires owners of multi-family, commercial and industrial buildings 20,000 square feet and larger to benchmark their water consumption and perform audits and building upgrades for low- performing buildings.	Not Started	CD	CD Advance Planning & Building Planning	N/A
Water and Wastewater	W-1: Water Conservation	W-1.1	Reduce water consumption in buildings through conservation campaigns and water efficiency measures.	W-1.1e	Require benchmarked buildings to display their water scores label in a conspicuous location near each public entrance.	Not Started	PWS	Sustainability	IRWD
Water and Wastewater	W-1: Water Conservation	W-1.1	Reduce water consumption in buildings through conservation campaigns and water efficiency measures.	W-1.1f	Promote water conservation incentives such as appliance and plumbing rebates and water conservation kits in partnership with Irvine Ranch Water District and other local partners.	Not Started	PWS	Sustainability	N/A
Water and Wastewater	W-1: Water Conservation	W-1.2	Reduce water consumption for irrigation and landscaping by encouraging drought tolerant/low-water use landscaping practices.	W-1.2a	Continue efforts to reduce consumption of water, electricity, and fossil fuels in the construction, operations and maintenance of parks and recreation facilities where possible through use of low- water use landscaping, water conservation technology, and continued use of recycled water.	In Progress	PWS, CD	PWS Facilities, Landscape, CD Planning	N/A

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Water and Wastewater	W-1: Water Conservation	W-1.2	Reduce water consumption for irrigation and landscaping by encouraging drought tolerant/low-water use landscaping practices.	W-1.2b	Install low-water use landscaping that is adapted to recycled water in the public right of way and City-owned buildings and facilities.	In Progress	PWS, CD	PWS Facilities, Landscape	N/A
Water and Wastewater	W-1: Water Conservation	W-1.2	Reduce water consumption for irrigation and landscaping by encouraging drought tolerant/low-water use landscaping practices.	W-1.2c	Require drought-tolerant, water- conserving, and/or native landscaping in new development and redevelopment projects (low- water use landscaping for areas served with recycled water).	In Progress	PWS, CD	PWS Facilities, Landscape	N/A
Water and Wastewater	W-1: Water Conservation	W-1.2	Reduce water consumption for irrigation and landscaping by encouraging drought tolerant/low-water use landscaping practices.	W-1.2d	Continue to promote landscape water conservation incentives in partnership with Irvine Ranch Water District and through the Cool Irvine program.	In Progress	PWS, CD	PWS Sustainability, CD Permitting	IRWD
Water and Wastewater	W-2: Recycled Water	W-2.1	Increase the use of recycled water.	W-2.1a	Implement IRWD's requirements for dual-plumbed systems in new nonresidential development.	Complete	PWS, CD	PWS Sustainabiity, CD Advanced Planning	IRWD
Water and Wastewater	W-2: Recycled Water	W-2.1	Increase the use of recycled water.	W-2.1b	Encourage the use of onsite rainwater harvesting and recycled water systems, consistent with applicable environmental, health, and safety regulations and requirements.	Not Started	PWS, CD	PWS Sustainability, CD Water Quality	IRWD
Water and Wastewater	W-2: Recycled Water	W-2.1	Increase the use of recycled water.	W-2.1c	Encourage the use of rainwater capture and onsite recycled water for landscaping use.	Not Started	PWS, CD	PWS Sustainability, CD Water Quality	N/A

Irvine CAAP GHG Reduction Strategies, Measures, and Actions						Implementation Details			
Sector	Strategy	Measure ID	Measure	Action ID	Action	Status	Responsible City Department(s)	Responsible Department Division	Partner(s)
Water and Wastewater	W-2: Recycled Water	W-2.1	Increase the use of recycled water.	W-2.1d	Update the City's list of drought- tolerant and native plants to reflect indigenous tribal knowledge.	In Progress	PWS, CD	PWS Sustainability, PWS Open Space/Landscape	N/A
Water and Wastewater	W-2: Recycled Water	W-2.1	Increase the use of recycled water.	W-2.1e	Collaborate with IRWD on drought-ready policies to require greywater readiness in new residential construction and alterations.	Not Started	PWS, CD	PWS Sustainability, CD Water Quality, CD Planning	IRWD
Resilience, Green Economy, and Carbon Sequestration	MS-1: Urban Forestry and Open Space	MS-1.1	Protect and enhance native trees and vegetation.	MS-1.1a	Use tools such as CalEnviroScreen to determine priority pollution-burdened areas of the city that may benefit most from vegetative barriers and plant drought-tolerant vegetative barriers in these areas.	Not Started	PWS, CD	N/A	N/A
Resilience, Green Economy, and Carbon Sequestration	MS-1: Urban Forestry and Open Space	MS-1.1	Protect and enhance native trees and vegetation.	MS-1.1b	Develop a free residential yard tree program that prioritizes homes in low-income communities.	Not Started	PWS, CD	N/A	N/A
Resilience, Green Economy, and Carbon Sequestration	MS-1: Urban Forestry and Open Space	MS-1.1	Protect and enhance native trees and vegetation.	MS-1.1c	Establish and implement a residential tree planting and replacement program for single-family homeowners.	Not Started	PWS, CD	PWS Landscape, Open Space, CD Planning	N/A
Resilience, Green Economy, and Carbon Sequestration	MS-1: Urban Forestry and Open Space	MS-1.1	Protect and enhance native trees and vegetation.	MS-1.1d	Maximize tree potential in parking lot standards by amending the city's Landscaping Standards to require one tree to every 4 parking spaces.	Not Started	PWS, CD, CMO	PWS Landscape, CD Traffic Division, CD Transportation Planning, CMO	N/A

Irvine CAAP GHG Reduction Strategies, Measures, and Actions						Implementation Details			
Sector	Strategy	Measure ID	Measure	Action ID	Action	Status	Responsible City Department(s)	Responsible Department Division	Partner(s)
Resilience, Green Economy, and Carbon Sequestration	MS-1: Urban Forestry and Open Space	MS-1.1	Protect and enhance native trees and vegetation.	MS-1.1e	Create an Urban Forest Master Plan, including a tree inventory and maintenance plan. Assess the current composition and distribution of the city's trees and include information about tree characteristics, maintenance history, and management needs. Assess community needs for new trees for an enhanced urban tree canopy to ensure adequate shade and air pollution buffers.	In Progress	PWS, CD	PWS Landscape Division, CD Planning	N/A
Resilience, Green Economy, and Carbon Sequestration	MS-1: Urban Forestry and Open Space	MS-1.1	Protect and enhance native trees and vegetation.	MS-1.1f	Amend the zoning ordinance to create tree planting standards for new and renovated development, consistent with the Urban Forest Management Plan.	Not Started	CD, CMO	CMO Economic Development, CD Planning	N/A
Resilience, Green Economy, and Carbon Sequestration	MS-1: Urban Forestry and Open Space	MS-1.1	Protect and enhance native trees and vegetation.	MS-1.1g	Support restoration projects by neighborhood groups.	Not Started	PWS, CD	N/A	N/A
Resilience, Green Economy, and Carbon Sequestration	MS-1: Urban Forestry and Open Space	MS-1.2	Expand and protect city parks and open spaces.	MS-1.2a	Promote connectedness between communities and parks by improving transition points.	In Progress	PWS	PWS Traffic	N/A
Resilience, Green Economy, and Carbon Sequestration	MS-1: Urban Forestry and Open Space	MS-1.2	Expand and protect city parks and open spaces.	MS-1.2b	Provide more shade in local parks through planting and maintenance of trees.	In Progress	PWS	PWS Landscape, Open Space, Facilities	N/A

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Resilience, Green Economy, and Carbon Sequestration	MS-1: Urban Forestry and Open Space	MS-1.2	Expand and protect city parks and open spaces.	MS-1.2c	Revitalize and invest in parks near disadvantaged communities.	Not Started	CS	N/A	N/A
Resilience, Green Economy, and Carbon Sequestration	MS-1: Urban Forestry and Open Space	MS-1.2	Expand and protect city parks and open spaces.	MS-1.2d	Support the creation of community gardens on public and private lands by community groups by amending the zoning ordinance to allow for urban agricultural uses.	Not Started	CD, CS	N/A	N/A
Resilience, Green Economy, and Carbon Sequestration	MS-1: Urban Forestry and Open Space	MS-1.2	Expand and protect city parks and open spaces.	MS-1.2e	Require that the site planning, construction, and maintenance of new development preserve existing healthy trees and native vegetation on site to the maximum extent feasible. Replace trees and vegetation not able to be saved.	Not Started	PWS	N/A	N/A
Resilience, Green Economy, and Carbon Sequestration	MS-2: Urban Heat Island Reduction	MS-2.1	Reduce the urban heat island effect with urban forestry, shade structures, and cool roofs to conserve energy.	MS-2.1a	Expand the Cool Pavements Pilot Project by continuing to apply high-albedo treatments to roadways during CIP projects.	In Progress	PWS	N/A	N/A
Resilience, Green Economy, and Carbon Sequestration	MS-2: Urban Heat Island Reduction	MS-2.1	Reduce the urban heat island effect with urban forestry, shade structures, and cool roofs to conserve energy.	MS-2.1b	Require new development to use high-albedo materials for walls, surfaces, driveways, parking lots, walkways, patios, and roofs.	Not Started	CD	N/A	N/A

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Sector	Strategy	Measure ID	Measure	Action ID	Action	Status	Responsible City Department(s)	Responsible Department Division	Partner(s)
Resilience, Green Economy, and Carbon Sequestration	MS-3: Green Infrastructure	MS-3.1	Increase the use of green infrastructure.	MS-3.1a	Identify funding opportunities to support and implement a green infrastructure program to improve stormwater management, support biodiversity such as with pollinator gardens, reduce air pollution exposure, and increase access to natural spaces.	Not Started	PWS	N/A	N/A
Resilience, Green Economy, and Carbon Sequestration	MS-3: Green Infrastructure	MS-3.1	Increase the use of green infrastructure.	MS-3.1b	Develop permitting guidelines and best practices for green and vegetative roofs.	Not Started	CD	N/A	N/A
Resilience, Green Economy, and Carbon Sequestration	MS-3: Green Infrastructure	MS-3.1	Increase the use of green infrastructure.	MS-3.1c	Fund and implement a green infrastructure program for the installation and maintenance of projects and existing civic resources such as the parks system and public spaces, to improve stormwater management, support biodiversity, reduce air pollution exposure, and increase access to natural spaces, including trees.	Not Started	PWS	N/A	N/A
Resilience, Green Economy, and Carbon Sequestration	MS-3: Green Infrastructure	MS-3.1	Increase the use of green infrastructure.	MS-3.1d	Support the use of green roofs to reduce runoff flow rates and volume, absorb and filter pollutants, supply green habitat and nesting areas, and help lower the urban heat island effect.	Not Started	CD	N/A	N/A
Resilience, Green Economy, and Carbon Sequestration	MS-4: Green Business and Jobs	MS-4.1	Incentivize and promote eco-friendly operations, habits, and business practices through programs such as the Green Business Program.	MS-4.1a	Expand certification and recognition of green businesses in Irvine and continue sharing of resources and State rebates.	Complete	CMO	N/A	N/A

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Resilience, Green Economy, and Carbon Sequestration	MS-4: Green Business and Jobs	MS-4.1	Incentivize and promote eco-friendly operations, habits, and business practices through programs such as the Green Business Program.	MS-4.1b	Support the development and deployment of carbon capture and storage technologies in industrial uses throughout the city.	Not Started	CD	N/A	N/A
Resilience, Green Economy, and Carbon Sequestration	MS-4: Green Business and Jobs	MS-4.1	Incentivize and promote eco-friendly operations, habits, and business practices through programs such as the Green Business Program.	MS-4.1c	Partner with local educational institutions and private sector partners to coordinate the planning and development of a technology park to serve as a focal point for clean technologies such as mobility innovation, renewable energy development, and carbon management.	Not Started	CMO	N/A	N/A
Resilience, Green Economy, and Carbon Sequestration	MS-4: Green Business and Jobs	MS-4.2	Support the creation of green jobs and businesses in the City.	MS-4.2a	Support local educational institutions in providing and expanding sustainability entrepreneurship training to include emerging clean technologies.	Not Started	CMO	N/A	N/A
Resilience, Green Economy, and Carbon Sequestration	MS-4: Green Business and Jobs	MS-4.2	Support the creation of green jobs and businesses in the City.	MS-4.2b	Attract green industries through tax incentives, low-cost loan and grant programs, and regulatory guidance.	Not Started	CMO	N/A	N/A
Resilience, Green Economy, and Carbon Sequestration	MS-4: Green Business and Jobs	MS-4.2	Support the creation of green jobs and businesses in the City.	MS-4.2c	Continue implementation of The Innovation Council's Strategic & Action plan for attracting, retaining, and supporting high-growth technology businesses to help position Irvine as a regional hub of innovation and technology.	In Progress	CMO	N/A	N/A

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Resilience, Green Economy, and Carbon Sequestration	MS-4: Green Business and Jobs	MS-4.2	Support the creation of green jobs and businesses in the City.	MS-4.2d	Work with local partners to create an in-person and on- demand energy workforce training program.	Not Started	CMO, PWS	N/A	N/A
Resilience, Green Economy, and Carbon Sequestration	MS-4: Green Business and Jobs	MS-4.2	Support the creation of green jobs and businesses in the City.	MS-4.2e	Partner with SoCalREN and regional energy agencies to support contractor training and resident education on electric appliances and their installation and maintenance.	In Progress	CMO, PWS	N/A	SoCalREN
Resilience, Green Economy, and Carbon Sequestration	MS-5: Carbon Sequestration and Embodied Emissions	MS-5.1	Increase soil carbon content to mitigate greenhouse gases and increase climate resiliency.	MS-5.1a	Promote awareness of the State's Healthy Soils Initiative and tips for residents and businesses to increase soil carbon content.	Not Started	PWS	N/A	N/A
Resilience, Green Economy, and Carbon Sequestration	MS-5: Carbon Sequestration and Embodied Emissions	MS-5.1	Increase soil carbon content to mitigate greenhouse gases and increase climate resiliency.	MS-5.1b	Continue the City's existing use of a "soil health first" approach to landscaping on City property.	In Progress	PWS	N/A	N/A
Resilience, Green Economy, and Carbon Sequestration	MS-5: Carbon Sequestration and Embodied Emissions	MS-5.1	Increase soil carbon content to mitigate greenhouse gases and increase climate resilience.	MS-5.1c	Continue partnership with UCI climate grant application to develop a tool kit for residents and agencies with carbon sequestration, wildfire, and other nature-based solutions.	In Progress	PWS	Sustainability	UCI

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Sector	Strategy	Measure ID	Measure	Action ID	Action	Status	Responsible City Department(s)	Responsible Department Division	Partner(s)
Resilience, Green Economy, and Carbon Sequestration	MS-5: Carbon Sequestration and Embodied Emissions	MS-5.2	Use low- carbon and carbon-sequestering construction materials in new development.	MS-5.2a	Adopt a reach code with the 2026 code cycle that requires new residential and nonresidential construction to use low-carbon concrete, steel, and other key impact materials, in coordination with the framework for measuring and reducing the average carbon intensity of materials used in construction of new buildings to be prepared by the California Air Resources Board pursuant to AB 2446 (2022).	Not Started	CD	Sustainability, CD	N/A

Irvine CAAP Adaptation Strategies and Actions				Implementation Details			
Focus Area	Strategy	Action ID	Action	Status	Responsible City Department(s)	Responsible Department Division	Partner(s)
Citywide	CW-1: Prioritize Climate Change Planning	CW-1a	Continue to update the climate vulnerability assessment and Local Hazard Mitigation Plan as required to comprehensively plan for current and future natural and human-caused hazards within the City.	In progress	Public Safety	Office of Emergency Management	N/A
Citywide	CW-1: Prioritize Climate Change Planning	CW-1b	Integrate climate science and projected climate-related impacts in all City planning documents, policies, programs, and ordinances as they are reviewed or updated.	Not started	Public Works and Sustainability	Sustainability	N/A
Citywide	CW-2: Collaborate with Local, Regional, State, and Federal Partners to Support Social and Economic Resilience	CW-2a	Establish relationships with FEMA and CDC in preparation for extreme weather events or natural disasters.	In progress	Public Safety	Office of Emergency Management	FEMA, CDC
Citywide	CW-2: Collaborate with Local, Regional, State, and Federal Partners to Support Social and Economic Resilience	CW-2b	Coordinate with surrounding municipalities and Orange County to enhance evacuation and emergency management protocols, agreements, and processes.	In progress	Public Safety	Office of Emergency Management	Orange County, Cities
Citywide	CW-2: Collaborate with Local, Regional, State, and Federal Partners to Support Social and Economic Resilience	CW-2c	Provide residents, businesses, and neighborhood organizations with evacuation procedures and shelter-in-place guidelines to grow community resilience.	In progress	Public Safety	Office of Emergency Management	N/A
Citywide	CW-2: Collaborate with Local, Regional, State, and Federal Partners to Support Social and Economic Resilience	CW-2d	Coordinate with regional healthcare facilities to ensure effective care for all City residents and regional travelers during an emergency.	In progress	Public Safety	Office of Emergency Management	Healthcare Facilities
Citywide	CW-3: Strengthen Community Resilience through Collaboration and Education	CW-3a	Collaborate with local community organizations to develop a climate change education outreach program that identifies gaps in community resilience planning and engages vulnerable community members.	In progress	Public Works and Sustainability	Sustainability	CBOs
Citywide	CW-3: Strengthen Community Resilience through Collaboration and Education	CW-3b	Expand participation in the Irvine Community Emergency Response Team (CERT) program for residents and businesses.	In progress	Public Safety	Office of Emergency Management	N/A

Irvine CAAP Adaptation Strategies and Actions				Implementation Details			
Focus Area	Strategy	Action ID	Action	Status	Responsible City Department(s)	Responsible Department Division	Partner(s)
Citywide	CW-3: Strengthen Community Resilience through Collaboration and Education	CW-3c	Evaluate and enhance existing preparedness and evacuation programs (e.g., Prepare Irvine, AlertOC) to better educate, inform, and engage the public about emergency preparedness in the case of a disaster.	In progress	Public Safety	Office of Emergency Management	N/A
Citywide	CW-3: Strengthen Community Resilience through Collaboration and Education	CW-3d	Identify gaps in current communication pathways with vulnerable community members during planned (e.g., Public Safety Power Shutoff events) or unplanned power outages.	In progress	Public Safety	Office of Emergency Management	N/A
Citywide	CW-4: Colaborate with Local Businesses on Economic and Community Resilience	CW-4a	Collaborate with local businesses and organizations to conduct regular workplace emergency preparedness drills.	In progress	Public Safety	Office of Emergency Management	Local Businesses, CBOs
Citywide	CW-4: Colaborate with Local Businesses on Economic and Community Resilience	CW-4b	Develop agreements with hotels to designate them as Red Cross facilities in case of an emergency.	In progress	Public Safety	Office of Emergency Management	Hotels
Citywide	CW-5: Collaborate with School Districts to Develop Emergency Preparedness Programs	CW-5a	Continue agreements with local school districts to ensure that school facilities can function as evacuation sites during major emergencies.	In progress	Public Safety	Office of Emergency Management	Schools
Citywide	CW-5: Collaborate with School Districts to Develop Emergency Preparedness Programs	CW-5b	Identify opportunities to use school facilities as evacuation centers, cooling centers, and charging stations, during extreme heat or weather events.	In progress	Public Safety	Office of Emergency Management	Schools
Citywide	CW-6: Coordinate with Regional and Local Transportation and Transit Agencies to Ensure Coordinated Access and Movement in the Event of an Emergency	CW-6a	Coordinate with regional and state transportation agencies to assess the vulnerability of transportation infrastructure to hazardous climate-related events.	In progress	Public Safety	Office of Emergency Management	Caltrans

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Citywide	CW-7: Coordinate with Regional Utilities to Assess the Vulnerability of Critical Infrastructure to Hazardous Climate-Related Events	CW-7a	Coordinate with regional utilities to assess the vulnerability of critical infrastructure to hazardous climate-related events.	In progress	Public Safety	Office of Emergency Management	N/A
Extreme Heat	EH-1: Prepare the Community for Extreme Heat Events	EH-1a	Work with regional and local health agencies to evaluate extreme heat warning thresholds and protocols and incorporate enhanced extreme heat preparedness into local operations.	In progress	Public Safety	Office of Emergency Management	N/A
Extreme Heat	EH-1: Prepare the Community for Extreme Heat Events	EH-1b	Establish a City-wide Heat Alert Program (HAP) when weather forecasts predict heat waves or extreme heat days.	In progress	Public Safety	Office of Emergency Management	N/A
Extreme Heat	EH-1: Prepare the Community for Extreme Heat Events	EH-1c	Educate vulnerable community members (e.g., aging, elderly, ill) and their caregivers to detect signs and symptoms of, and to prevent heat-related illness. Emphasize the importance of immediate medical assistance for heat-related illnesses.	In progress	Public Safety	Office of Emergency Management	N/A
Extreme Heat	EH-2: Develop Facilities and Resources to Reduce the Effects of Extreme Heat Events	EH-2a	Expand the number of publicly operated cooling centers based on the needs of vulnerable populations.	In progress	Public Safety	Office of Emergency Management	N/A
Extreme Heat	EH-2: Develop Facilities and Resources to Reduce the Effects of Extreme Heat Events	EH-2b	Collaborate with local businesses and institutions to provide a “Cool Zone” area network (i.e., cooling centers).	In progress	Public Safety	Office of Emergency Management	Local Businesses, Schools
Extreme Heat	EH-2: Develop Facilities and Resources to Reduce the Effects of Extreme Heat Events	EH-2c	Develop a tree and shade master plan with a particular focus on climate-resilient tree species.	In progress	Public Works and Sustainability	Landscape Maintenance	N/A

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Drought	D-1: Collaborate with Agency Partners to Prepare for Future Drought Conditions	D-1a	Continue to support and participate in the development of a regional and local drought contingency plan.	In progress	Public Safety	Office of Emergency Management	N/A
Drought	D-1: Collaborate with Agency Partners to Prepare for Future Drought Conditions	D-1b	Collaborate with federal, State, and local agencies and organizations to explore alternative sources (e.g., desalination) and improve capacity.	N/A	N/A	N/A	N/A
Drought	D-2: Develop and Implement Citywide Efforts to Reduce Water Usage	D-2a	Promote nature-based methods and best practices (e.g., bioswales, natural ground cover) through the City's stormwater program.	In progress	Community Development	Water Quality	N/A
Drought	D-2: Develop and Implement Citywide Efforts to Reduce Water Usage	D-2b	Update "Division 7 - Sustainability in Landscaping" of the Irvine Municipal Code of Ordinances and the Master Streetscape & Landscape Design Manual to reflect the latest advances in best practices in landscape design that reduce water use within the City.	In progress	Public Works and Sustainability	Landscape Maintenance	N/A
Drought	D-3: Promote Community Water Conservation Measures	D-3a	Support regional partners in education and outreach efforts focused on water conservation measures (e.g., water reuse, water use, and irrigation efficiency) for City residents.	In progress	Public Works and Sustainability	Sustainability	N/A
Drought	D-3: Promote Community Water Conservation Measures	D-3b	Encourage drought tolerant/low-water use native landscaping, and low-flow water fixtures, and apply daytime watering restrictions on properties throughout the City to reduce water consumption.	Not started	Public Works and Sustainability	Landscape Maintenance	N/A
Wildfire	WF-1: Collaborate with Regional Partners to Reduce Impacts of Wildfire	WF-1a	Routinely participate in the update of the Orange County Community Wildfire Preparedness Plan for areas within the Very High, High, and Moderate Fire Hazard Severity Zones.	In progress	Public Safety	Office of Emergency Management	N/A

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Wildfire	WF-1: Collaborate with Regional Partners to Reduce Impacts of Wildfire	WF-1b	Continue to promote and implement the Orange County Vegetation Management program to reduce wildfire risk.	In progress	Public Works and Sustainability	Landscape Maintenance	N/A
Wildfire	WF-1: Collaborate with Regional Partners to Reduce Impacts of Wildfire	WF-1c	Coordinate with regional partners to explore and deploy fire detection cameras as part of a wildfire monitoring network.	In progress	Public Safety	Office of Emergency Management	N/A
Wildfire	WF-2: Implement Actions to Reduce Flammable Materials in Wildfire Zones	WF-2a	Remove highly flammable vegetation in Very High, High, and Moderate Fire Hazard Severity Zones and replant with fire-adapted specimens.	In progress	Public Works and Sustainability	Open Space and Parks	N/A
Wildfire	WF-2: Implement Actions to Reduce Flammable Materials in Wildfire Zones	WF-2b	Replant bare or disturbed hillside areas after wildfires to reduce erosion that may lead to landslides.	In progress	Public Works and Sustainability	Open Space and Parks	N/A
Wildfire	WF-3: Educate the Community about Wildfire for Improved Public Safety and Resilience	WF-3a	Work with Orange County Fire Authority on home preparedness assessments to assist more residents in understanding and addressing their wildfire risk.	In progress	Public Safety	Office of Emergency Management	OCFA
Wildfire	WF-3: Educate the Community about Wildfire for Improved Public Safety and Resilience	WF-3b	Expand the fire hazard prevention awareness campaign to residents in the High and Very High Fire Hazard Severity Zones.	In progress	Public Safety	Office of Emergency Management	N/A
Wildfire	WF-3: Educate the Community about Wildfire for Improved Public Safety and Resilience	WF-3c	Support regional partners (e.g., Orange County Fire Authority's Ready, Set, Go Program) in their efforts to educate residents about defensible space, vegetation management, and home hardening efforts.	In progress	Public Safety	Office of Emergency Management	OCFA
Flooding	F-1: Coordinate with Relevant Agencies to Better Plan and Prepare Emergency Services Required for Flooding Events	F-1a	Monitor stormwater management infrastructure and identify changes in flooding patterns and locations related to changing climatic conditions.	In progress	Public Safety	Office of Emergency Management	N/A

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Flooding	F-2: Develop or Update Long-Term Public Works Plans for Critical Facilities to Address Current and Future Flood Risks	F-2a	Require that future transportation infrastructure projects consider current and future flood risk and align the projected lifespan of the project with the best available science.	In progress	Public Works and Sustainability	Engineering	N/A
Flooding	F-2: Develop or Update Long-Term Public Works Plans for Critical Facilities to Address Current and Future Flood Risks	F-2b	Explore and implement Low Impact Development standards for new development to reduce the amount of stormwater runoff.	In progress	Community Devleopment	Water Quality	N/A
Flooding	F-3: Educate the Community about Flooding for Improved Public Safety and Resilience	F-3a	Implement a public outreach program to increase public awareness of flooding, stormwater management, and drought management issues and techniques for residents to mitigate those challenges on their property.	In progress	Community Devleopment	Water Quality	N/A
Flooding	F-3: Educate the Community about Flooding for Improved Public Safety and Resilience	F-3b	Partner with Orange County Public Works to proactively disseminate information from the "H2OC Stormwater Program" to educate home and small business owners on regulations and highlight the role that engaged residents can play in assisting with community-based stormwater management.	In progress	Community Devleopment	Water Quality	Orange County
Flooding	F-4: Ensure Resilience and Long-Term Functionality of Stormwater and Sewer Systems	F-4a	Update the City's Master Plan of Drainage regularly to incorporate new data and/or address emerging issues.	In progress	Public Works and Sustainability	Engineering	N/A
Flooding	F-4: Ensure Resilience and Long-Term Functionality of Stormwater and Sewer Systems	F-4b	Conduct comprehensive visual and functional test monitoring and asset condition assessments. Model potential impacts on utility infrastructure under future flooding scenarios.	Not started	Public Works and Sustainability	Operations	N/A
Flooding	F-4: Ensure Resilience and Long-Term Functionality of Stormwater and Sewer Systems	F-4c	Conduct frequent cleanings of storm drain intakes, especially before and during the rainy season.	In progress	Public Works and Sustainability	Landscape Maintenance	N/A

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Focus Area	Strategy	Action ID	Action	Status	Responsible City Department(s)	Responsible Department Division	Partner(s)
Liquefaction/ Landslide	L-1: Coordinate with Local and Regional Partners to Prepare and Respond to Liquefaction and Landslide Events	L-1a	Coordinate with Irvine Ranch Water District on subsidence monitoring in areas of active groundwater extraction and work with water utilities to develop strategies based on the amount and severity of subsidence occurring.	Not started	Public Safety	Office of Emergency Management	IRWD
Liquefaction/ Landslide	L-1: Coordinate with Local and Regional Partners to Prepare and Respond to Liquefaction and Landslide Events	L-1b	Coordinate with Irvine Ranch Water District and Orange County Water District on emergency water storage and distribution following a liquefaction or landslide event.	Not started	Public Safety	Office of Emergency Management	IRWD, Orange County
Liquefaction/ Landslide	L-1: Coordinate with Local and Regional Partners to Prepare and Respond to Liquefaction and Landslide Events	L-1c	Coordinate with Caltrans and Orange County Transit Authority for inspection and maintenance of primary evacuation routes.	Not started	Public Safety	Office of Emergency Management	Caltrans, OCTA
Liquefaction/ Landslide	L-2: Educate the Community about Liquefaction or Landslide Events for Improved Public Safety and Resilience	L-2a	Provide information to community groups and businesses about how to prepare for and recover from a liquefaction or landslide event.	In progress	Public Safety	Office of Emergency Management	N/A
Liquefaction/ Landslide	L-2: Educate the Community about Liquefaction or Landslide Events for Improved Public Safety and Resilience	L-2b	Promote retrofits of key community facilities not owned by the City.	In progress	Community Devleopment	Building and Safety	N/A
Liquefaction/ Landslide	L-3: Design Facilities to be Resilient to a Liquefaction or Landslide Event	L-3a	To the extent feasible, construct all new and significantly retrofitted City-owned facilities to remain operational in the event of a major liquefaction or landslide event.	In progress	Public Works and Sustainability	Landscape Maintenance	N/A
Liquefaction/ Landslide	L-3: Design Facilities to be Resilient to a Liquefaction or Landslide Event	L-3b	In coordination with Caltrans, update facilities condition assessments for bridges along evacuation routes to identify bridges that need seismic retrofitting.	In progress	Public Works and Sustainability	Engineering	Caltrans