City of Berkeley
Rincon Consultants Inc.

Disaster Preparedness and Safety Existing Conditions Report

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Rincon Consultants, Inc. (hereinafter referred to as "Rincon") prepares vulnerability assessments that evaluate climate change hazards, including wildfire, based on numerous sources, including third party consultants, State and Federal mapping resources, and various software modeling programs that are considered industry standard best practices. The vulnerability assessment prepared for this Disaster Preparedness and Safety Existing Conditions Report evaluated wildfire hazards based on CAL FIRE's Fire Hazard Severity Zones. Wildfire is unpredictable, and the specific conditions of wildfire could result in fire behavior that diverges from the assumptions used in this analysis. There is no guarantee that wildfire behavior and specific treatment to avoid such behavior will follow or prevent wildfire impacts. Rincon is not responsible for any damage to life or property that might occur based on the results of the vulnerability analyses in the Disaster Preparedness and Safety Existing Conditions Report, and any accompanying recommendations.

Table of Contents

1 Introduction 1
2 Vulnerability Assessment 2
2.1 Methodology and Approach 2
2.1.1 California Adaptation Planning Guide 2
2.1.2 California Resource Guide for Defining Vulnerable Communities 3
2.2 Climate Change Vulnerability Assessment 4
2.3 Social Vulnerability Assessment 6
2.3.1 Communities Facing Social Vulnerability 7
2.3.2 Summary of Social Vulnerability 11
2.3.3 Cumulative Social Vulnerability 12
3 Hazards in Berkeley 15
3.1 Geologic and Seismic Hazards 15
3.1.1 Earthquakes 16
3.1.2 Earthquake-induced Landslides and Liquefaction Hazards 20
3.1.3 Tsunami 23
3.2 Wildfire and Poor Air Quality 26
3.3 Sea Level Rise 34
3.4 Groundwater Rise 38
3.5 Extreme Heat 43
3.6 Storm Drain Overflow and Creek Flooding 48
3.7 Drought 56
4 Human-Made Hazards 58
5 Public Safety Services 60
5.1 Fire Protection 60
5.2 Police Protection 61
5.3 Public Health and Environmental Health 62
6 Disaster Readiness 63
6.1 Critical Facilities and Services 63
6.2 Emergency Evacuation 66
7 Cascading Impacts 67
7.1 Energy Systems 67
7.2 Water Systems 67

7.3 Transportation System 68
7.4 Communication System 69
7.5 Food Systems 69
7.6 Healthcare Systems 69
7.7 Hazardous/Toxic Materials 70
8 Summary 71
9 References 76

Tables

Table 1 Summary of Social Vulnerability 11
Table 2 Cumulative Vulnerability Classification Methodology 12
Table 3 Priority Sites by Sea Level Rise Scenario 40
Table 4 Fire Stations 60

Figures

Figure 1 California Adaptation Planning Guide Phases 3
Figure 2 Vulnerability Assessment Process (Phase 2) 3
Figure 3 Berkeley Cumulative Social Vulnerability Map 13
Figure 4 Berkeley Highest Cumulative Social Vulnerability Map 14
Figure 5 Faults in Berkeley and the Surrounding Area 18
Figure 6 Alquist Priolo Fault Zones 19
Figure 7 Seismically Triggered Landslide and Liquefaction Hazard Zones in Berkeley 21
Figure 8 Berkeley Tsunami Inundation 25
Figure 9 Wildfire Hazard Severity Zones in Berkeley 28
Figure 10 Density of Structures in Berkeley Fire Zones 2 and 3, 2024 29
Figure 11 Sea Level Rise in Berkeley with 100-year Storm Event 35
Figure 12 Groundwater Rise Current Conditions 41
Figure 13 Groundwater Rise with 0.8 feet of Sea Level Rise 42
Figure 14 Groundwater Rise with 2.5 feet of Sea Level Rise 43
Figure 15 Annual Average Maximum Temperature in Berkeley 45
Figure 16 Extreme Heat Days in Berkeley 45
Figure 17 100-Year and 500-Year Floodplains in Berkeley 52
Figure 18 Critical Facilities in Berkeley 65

Appendices

Appendix A Social Vulnerability Analysis Methodology
Appendix B Groundwater Rise and Contaminated Site Analysis
Appendix C Access Impaired Neighborhood Analysis
Appendix D Evacuation Route Safety, Capacity, and Viability Analysis
Appendix E Evacuation Time Study

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1 Introduction

The following report provides a desktop analysis of natural and human-made hazards that impact the Berkeley community. It was developed to provide guidance on the creation of safety policies and programs within the City of Berkeley's (City) Disaster Preparedness and Safety Element of the General Plan.

State Government Code Section 65302(g) requires cities to include a safety element in their general plan that has goals, policies and programs that seek to protect the community from unreasonable risks associated with natural and human-made hazards. Hazards that must be considered in a safety element include seismically induced surface rupture, ground shaking, ground failure, tsunami, seiche, dam failure, slope instability leading to mudslides and landslides, subsidence, liquefaction, and other seismic hazards. The safety element must also address wildfire and flooding hazards.

In accordance with California Government Code Section 65302(g), as amended by Senate Bill 379 and Senate Bill 1035, climate change adaptation and resilience strategies must also be included in a city's Safety Element. Senate Bill 1035 specifically requires that this information be regularly updated, at minimum every 8 years or upon each revision of the Housing Element or Local Hazard Mitigation Plan. The review and update must consist of the following components:

1. A vulnerability assessment that identifies the risks climate change poses to the local jurisdiction and the geographic areas at risk from climate change.
2. A set of adaptation and resilience goals, policies, and objectives based on the information specified in the vulnerability assessment.
3. A set of feasible implementation measures designed to carry out the goals, policies, and objectives identified in the adaptation objectives.

2 Vulnerability Assessment

State law (California Government Code Section 65302 (as amended by Senate Bills 379 and 1035)) requires a Safety element to include an assessment of exposure to hazards and an evaluation of how climate change may affect the risk of each hazard. In addition, a Safety Element must identify populations and assets that are most at-risk. The purpose of this assessment is to identify risks that climate change poses to Berkeley as a whole, and to areas and populations within the City that are most at risk from climate change impacts.

While this report identifies vulnerability disparities across communities, it is essential to recognize that these disparities are not random, but are the result of long-standing institutional policies, planning practices, and systemic disinvestment based on racial and income biases. Research has shown that structural causes, such as exclusionary zoning, inequitable transportation funding, and biased enforcement practices, have historically marginalized certain populations and increased their vulnerabilities to hazards. This report aims to support policy development that not only mitigates harm but also begins to dismantle the systems that perpetuate inequities in the built environment.

2.1 Methodology and Approach

As described below, the City followed guidance from the California Governor's Office of Emergency Services and the Office of Land Use and Climate Innovation (LCI), as well as community input to identify populations and assets most at risk from hazards and climate change-related impacts.

2.1.1 California Adaptation Planning Guide

To assist local cities and counties to comply with these requirements, the Governor's Office of Emergency Services published the California Adaptation Planning Guide (Cal APG). The Cal APG recommends a four-phase planning process that is outlined in ***Figure 1*** below. Phase 1 and 2 of the process consist of conducting a vulnerability assessment. This report aligns with relevant components of Phase 1 and all components of Phase 2 (shown in ***Figure 2***). The adaptation strategies defined during Phase 3 will be incorporated into the City's General Plan Disaster Preparedness and Safety Element. Phase 4 involves implementation of the policies and programs identified in the Safety Element, which will occur on an ongoing basis. Implementation efforts will be re-evaluated and refined during the next update to the General Plan.

Figure 1 California Adaptation Planning Guide Phases

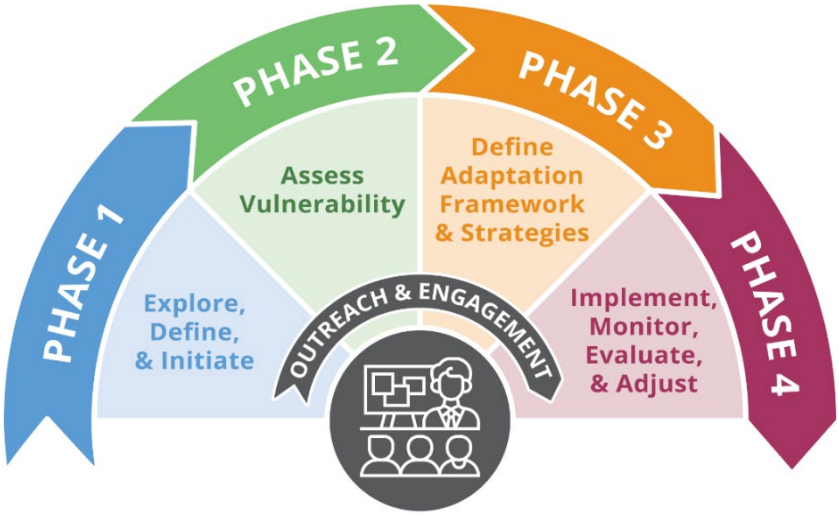
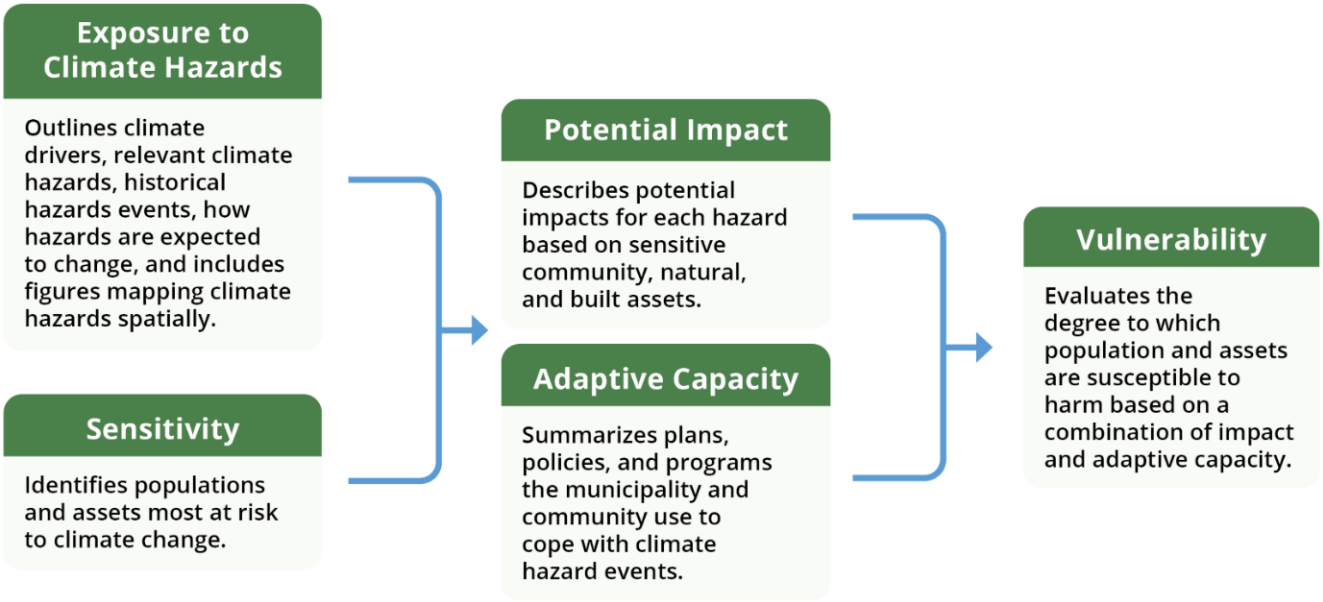


Figure 2 Vulnerability Assessment Process (Phase 2)



2.1.2 California Resource Guide for Defining Vulnerable Communities

In 2018, LCI published a resource guide through the Integrated Climate Adaptation and Resiliency Program (ICARP) that includes information to help define vulnerable communities in the context of climate change adaptation.[1] This resource guide, along with several other sources, was consulted to support this assessment and to describe the vulnerable communities identified within it. These include the California Department of Public Health's

[1] https://lci.ca.gov/docs/20180723-Vulnerable_Communities.pdf

CalBrace Project,[2] LCI's Vulnerable Communities Descriptions, and the City of Berkeley Sixth Cycle Housing Element.

2.2 Climate Change Vulnerability Assessment

Climate change is primarily driven by human activities that release gases such as carbon dioxide and methane into the atmosphere. These gases, known as greenhouse gases (GHGs), absorb and re-emit heat from the Earth's surface, thereby trapping heat and enhancing the natural greenhouse effect. Since the 1800s, human activities have been accumulating GHGs in the atmosphere, leading to a continuous rise in global temperatures. Climate change is expected to exacerbate the impacts of all hazards in Berkeley. Considering the geography and topography of Berkeley, climate change-related impacts that pose a particular risk include a heightened risk of wildfires and deteriorating air quality, along with rising sea and groundwater levels. Berkeley will also face increased extreme heat events and more severe storms because of climate change, that could in turn, lead to storm drain overflow, creek flooding, or prolonged droughts.

The climate change vulnerability assessment uses the following data sources and tools, many of which are recommended within the California Adaptation Planning Guide:

- **Alameda County Heat Vulnerability Map** was developed for Alameda County by Four Twenty Seven and StopWaste.Org in 2019. The map identifies the social and environmental factors contributing to community heat vulnerability in Alameda County. It was utilized in this report to explore tree canopy and heat vulnerability in Berkeley (Alameda County 2019).
- **Cal-Adapt (Version 2.0) Local Climate Change Snapshot** is an online tool that presents historic and modeled climate projections based on 10 different global climate models as part of California's Fourth Climate Change Assessment (see bullet below). The tool was developed and is maintained by the University of California, Berkeley Geospatial Innovation Facility with funding and oversight by the California Energy Commission (CEC). This tool was used for this report to present projection data related to extreme heat, and drought (CEC). The Cal-Adapt Analytics Engine houses downscaled climate projections in support of California's Fifth Climate Change Assessment. At the time this report was written access to the Analytics Engine JupyterHub service was limited to a small group of alpha testers, and therefore was not used for this report.
- **California's Fourth Climate Change Assessment** was developed by the CEC and other State of California coordinating agencies to present up-to-date climate science, projections and potential impacts associated with climate change. The CEC and coordinating agencies developed nine reports to provide regional-scale climate information to support local planning and action. The San Francisco Bay Area Region

[2] CalBRACE Project - Climate Change & Health Equity, https://www.cdph.ca.gov/Programs/OHE/Pages/CalBRACE.aspx

Summary Report (2018) presents an overview of climate science, regional projections, specific strategies to adapt to climate impacts, and key research gaps needed to spur additional progress on safeguarding the San Francisco Bay Area from climate change. The San Francisco Bay Area Region Summary Report was used in developing this report to understand regional changes that may affect Berkeley both directly and indirectly (Ackerly et al. 2018). As of the writing of this report in September 2025, the CEC is preparing the Fifth Climate Change Assessment, which is anticipated to be available in the summer of 2026.

- City of Berkeley 2024 Local Hazard Mitigation Plan (LHMP) serves four functions:
  1. Documents the current understanding of hazards present in Berkeley, along with Berkeley's vulnerabilities to each hazard – the ways that the hazard could impact Berkeley's buildings, infrastructure, community, and environment.
  2. Presents the City's Mitigation Strategy for the next five years. The Mitigation Strategy reflects a wide variety of both funded and unfunded actions, each of which can contribute to reducing Berkeley's hazard vulnerabilities.
  3. Outlines actions that Berkeley community members can take at the household level to reduce their own vulnerabilities to hazards in Berkeley.
  4. Fulfills requirements of the Disaster Mitigation Act (2000), ensuring that Berkeley will remain eligible to apply for mitigation grant funding before disasters, and to receive federal mitigation funding and additional State recovery funding after disasters.

Information from the 2024 LHMP was used in this report to identify recent historical events, determine hazard exposure, and characterize the vulnerability of certain assets. It was also used in this report to understand existing and planned efforts to offset impacts of climate hazards in Berkeley.

- **The Intergovernmental Panel on Climate Change (IPCC)**, a United Nations body dedicated to advancing and communicating climate change knowledge, has developed several scenarios to project future GHG emissions and associated warming. The scenarios used to assess Berkeley's vulnerability to climate change hazards (including wildfire, sea level rise, groundwater rise, extreme heat, creek flooding, and drought) consistent with guidance from the California Government Office of Emergency Services (Cal OES) California Adaptation Planning Guide, are:[3]
  - **Representative Concentration Pathway (RCP) 4.5:** This "medium emissions" scenario assumes that emissions will peak around 2040 and then decline by the end of the century, contingent on global agreement and implementation of GHG reduction strategies.

[3] The latest climate models are now using Shared Socioeconomic pathways (SSPs), which model how socioeconomic factors may change over the next century. These include considerations such as population, economic growth, education, urbanization and the rate of technological development.

- **Representative Concentration Pathway (RCP) 8.5:** This "high emissions" scenario assumes that emissions will continue to rise throughout the 21st century.

2.3 Social Vulnerability Assessment

Social vulnerability, or “sensitivity’ to climate change risks can be described as the degree to which human systems are susceptible to harm based on a number of factors. This assessment is complex since certain factors can make specific populations more sensitive than others. These factors include, but are not limited to:

- Inequities in educational opportunities and attainment;
- Inequities in environmental and living conditions and health status;
- Institutional bias and exclusion from decision-making power; or
- Differences in individual health, age and ability.

Historical and ongoing environmental injustices have created conditions in the built environment that make some populations more susceptible to climate change risks than others in the community. For example discriminatory housing practices, such as redlining, concentrate pollution, hazardous environments, and vulnerability to climate change impacts in communities of color and low-income areas. These policies restrict access to safe housing and healthy neighborhoods, leading to unequal exposure to environmental burdens and exacerbating health disparities. The purpose of this social vulnerability assessment is to identify these communities and work collaboratively to rectify these harms, and in doing so build climate resilience in a way that best addresses the needs of the communities most at risk.

While vulnerable populations are distributed throughout Berkeley, the Social Vulnerability Map identifies neighborhoods with the highest concentrations of individuals at heightened risk from climate impacts. These communities often face multiple, overlapping challenges, such as economic insecurity, limited access to healthcare, and language barriers, which cumulatively can intensify and complicate their vulnerability to climate-related hazards. The analysis in this report focuses on these high-vulnerability areas to help guide policy prioritization, ensuring that resources and interventions are directed where they are most urgently needed.

Individuals and communities can be affected by more than one factor at once, and individuals in the community who are exposed to a higher number of these factors may be particularly vulnerable. This section describes the methodology to identifying populations and assets that are highly vulnerable to natural hazards and climate change impacts in Berkeley. It is important to note that the existence of highly vulnerable groups is an indication of the shortcomings of social, economic, and political systems to provide adequate support, respect and protection to all community members. It is not an indication of any individual failure or

weakness (Thomas et al., 2018). The City of Berkeley is also in the process of preparing a new Environmental Justice Element to its General Plan, pursuant to the requirements of Senate Bill 1000. This effort includes a related assessment to identify areas in the City that are disproportionately impacted by pollution exposure and adverse health impacts, in addition to socioeconomic vulnerability. This Environmental Justice assessment is described in more detail in the Environmental Justice Existing Conditions Report: https://berkeleyca.gov/your-government/our-work/adopted-plans/general-plan.

2.3.1 Communities Facing Social Vulnerability

This section describes each of the factors that are included in the social vulnerability assessment for the City of Berkeley's Disaster Preparedness and Safety Element. The data source for this information is the American Community Survey 5-Year estimates (2018-2022). Recognizing that local knowledge and context is critical to identifying communities that face social vulnerability in Berkeley, the City incorporated additional community-specific data in its analysis based on feedback from the project's Community Advisory Committee (see Summary of Community Engagement Activities for more information about the Community Advisory Committee: https://berkeleyca.gov/your-government/our-work/adopted-plans/general-plan).

Age (Children Under Age 5)

Vulnerability to climate change risks among children is especially high because of physiological and development factors: their lungs are developing, they breathe at a higher rate than adults, and they spend more time outdoors (California Building Resilience against Climate Effects (CalBRACE) Project, n.d.). In addition, children are more likely to experience negative consequences as a result of extreme weather events, such as injury, stress, and death (Executive Order B-30-15 Resiliency Guidebook, n.d.). According to 2022 American Community Survey (ACS) 5-year estimates, about 3.2 percent of Berkeley's population is under 5 years of age.

Age (Adults 65 Years and Older Living Alone)

Factors that contribute to vulnerability among older adults include health status, economic situation and level of social isolation. Older adults are more likely to have chronic health conditions that require medication and/or assistance with daily activities. Older adults with limited incomes may be more vulnerable to the effects of extreme heat events due to the high cost of air conditioning. In addition, almost one-quarter of Americans aged 65 and older are socially isolated, which can impact an individual's ability to cope with climate-related stressors, receive emergency information and/or ask for help (The Impact of Climate Change: Why Older Adults Are Vulnerable Research Report, n.d.). According to 2022 American Community Survey (ACS) 5-year estimates, about 12 percent of Berkeley households include a member who is 65 years or older and living alone.

Disability

Disability is a broad term that refers to any condition or impairment of the body or mind that limits a person's ability to do certain activities. Vulnerability to climate risks are heightened among this group due to factors such as lower income, educational attainment, and employment status. Limited mobility, reliance on medical equipment and public transportation contribute to vulnerability, especially during emergency events that require evacuation or cause power interruption (California Building Resilience against Climate Effects (CalBRACE) Project Short Title: Disability, n.d.) (Executive Order B-30-15 Resiliency Guidebook, n.d.). According to 2022 American Community Survey (ACS) 5-year estimates, about 19 percent of Berkeley households include a person with a disability.

Income

Income is the largest determinant of health in the United States. Higher income is associated with greater life expectancy. This is due in part to access to quality health care, but more so due to social determinants of health, such as environmental quality, social and economic situations, and the built environment, which influence stress levels and behaviors. The lower health status of lower-income people exacerbates climate change risks, as these groups have fewer resources to cope with emergencies and respond to rising prices. Additionally, groups with lower incomes are more likely to live in housing that is substandard, and therefore more susceptible to damage from disasters (Executive Order B-30-15 Resiliency Guidebook, n.d.).

According to 2022 American Community Survey 5-Year estimates, about 40.3 percent of Berkeley households are considered very low income, meaning a two-person household earning no more than 50 percent of the area median income for Alameda County, or $62,300 (California Department of Housing and Community Development, 2024). Some types of families are more likely to have lower income than others. These include families headed by a single parent (13.5 percent of whom earn below $62,300) and families with heads of household who have less than a high school degree (4.6 percent of whom earn below $62,300).

Housing Cost

Availability of safe, sanitary and affordable housing reduces vulnerability to climate-related impacts and supports recovery. High housing costs can limit financial resources needed to prepare for and recover from climate-related impacts, while a lack of safe and secure housing can increase vulnerability to impacts.

Factors including household income, market rents and home prices, available unit sizes, and household size can all contribute to cost burden. A household is considered to have a housing cost burden if it spends more than 30 percent of gross income on housing expenses (rent or mortgage payments and utilities). A household is considered as having asevere cost burden if expenses make up more than 50 percent of gross income (City of Berkeley(d)).

According to the City of Berkeley Housing Element (Sixth Cycle), 23 percent of all Berkeley households are severely cost-burdened. Cost burden is more prevalent among renter households than among households who own their home (32 percent versus 12 percent) (City of Berkeley(d)).

Housing conditions impact health, and availability of safe and secure housing can impact vulnerability to climate related risks by exposure to environmental hazards caused by climate change, such as extreme heat (Cartwright et al., 2025). Building improvements such as ventilation, window shades, insulation, roof and wall materials can all reduce impacts from climate-related risks. According to the Housing Element, structures over 30 years old are likely to have significant rehabilitation needs, which may include a new roof, foundation repairs, or new plumbing. Over 95 percent of Berkeley's housing stock is over 30 years old. Lack of sufficient plumbing and kitchen facilities is another indicator of substandard housing conditions. Although units without sufficient plumbing or kitchens are rare in Berkeley, less than 5 percent, renter households are more likely to reside in a unit with at least one of these issues in the City of Berkeley(d)). While most of Berkeley's housing stock remains functional, its age and the presence of some substandard conditions, particularly among renter-occupied units, suggest a need for continued attention to housing maintenance and rehabilitation.

Linguistic Isolation

Linguistic isolation refers to a household in which all persons 14 years of age or older speak a language other than English and no one speaks English very well. Many immigrants are linguistically isolated. Linguistic isolation may hinder protective behaviors during extreme weather events or disasters by limiting access to or understanding of emergency warnings. Studies have shown that people who live in linguistically isolated households are more likely to make heat-related calls to 911 during extreme heat events (Cartwright et al., 2025).

According to the 2022 American Community Survey (ACS) 5-Year Estimates, about 3.8percent of households (or about 1,740 households) in Berkeley are considered "Limited English-Speaking Households", meaning that no member 14 years old and over (1) speaks only English or (2) speaks a non-English language and speaks English "very well." About 1.3 percent of those households speak Chinese (including Mandarin and Cantonese), about 0.7 percent speak an Indo-European language (French, German, Hindi, and Persian), and another 0.7 percent speak an Asian and Pacific Island language (Chinese, Japanese, Telugu, and Hawaiian). About 0.3 percent speak Spanish.

Communities of Color

Structural racism creates racial disparities in educational attainment, income and wealth, which in turn contribute to increased vulnerability to climate risks (Thomas et al., 2018). Communities of color also experience greater vulnerabilities due to compounding factors such as income, educational attainment, health, language barriers, social isolation, occupational exposures and less access to air conditioning. Differences in vulnerability may be linked to

social and economic disparities. For example, due to discrimination, communities of color (Black, Indigenous, Hispanic/Latino, Asian American, Pacific Islander, Middle Eastern, and North African) are more likely to have lower incomes and live in areas with more risks from pollution and fewer health-promoting features (e.g., parks, grocery stores). Also, communities of color may have less access to information about risk mitigation, as well as resources to prepare for, adapt to, and recover from climate-related events (Executive Order B-30-15 Resiliency Guidebook, n.d.). According to the 2022 American Community Survey (ACS) 5-Year Estimates, approximately 48 percent of Berkeley residents identify as people of color. The racial and ethnic breakdown is as follows: 21 percent identify as Asian, 12 percent as Hispanic or Latino, 8 percent as Black or African American, 7 percent as multiracial, 1 percent as another racial identity not listed, 0.2 percent as American Indian or Alaska Native, and 0.2 percent as Native Hawaiian or Pacific Islander.

Vehicle Ownership

Vehicle ownership is an indicator of access to personal transportation, which is a critical resource during extreme weather events or in scenarios requiring evacuation. Access within a household to a personal vehicle is important because it can be a source of shelter from wildfire, air pollution, heat or flooding (Executive Order B-30-15 Resiliency Guidebook, n.d.). Approximately 20 percent of households in Berkeley do not have access to a vehicle.

Immigrants and Refugees

Immigrant and refugee populations may be more vulnerable to climate change impacts due to potentially experiencing displacement due to previous climate change impacts or disasters. These populations may also be overrepresented among low-income groups but underrepresented in public benefits enrollment. The most vulnerable immigrants and refugees include people with low socioeconomic status, people who are experiencing homelessness, single mothers with young children, and people with limited English. These individuals are less likely to ask for help from government officials and tend to be linguistically isolated. Many people in this group work in conditions that leave them vulnerable to exposure to climate change impacts, such as extreme heat. Because many undocumented immigrants or refugees do not have adequate access to services, they may receive lower levels of support to address climate stresses (Executive Order B-30-15 Resiliency Guidebook, n.d.). According to the ACS 5-year estimates, about 24 percent of residents are of voting age and are not U.S. citizens. While citizenship status alone does not determine vulnerability, it can intersect with other factors—such as income level, refugee or asylum status, and access to services—which compound climate-related risks.

2.3.2 *Summary of Social Vulnerability*

Each of the factors explained in the previous section were recorded by census block group and analyzed to identify communities facing social vulnerability per the methodology outlined in Section 2.3.3 Cumulative Social Vulnerability. ***Table 1*** below provides a summary of results, showing the percentage of Berkeley's population that is determined to experience social vulnerability.

Table 1 Summary of Social Vulnerability

Population	Size of Community in Berkeley	Data Source (ACS Table)
Individuals without a high school degree	3%	Population 25 years and over – no high school diploma (ACS 2022, Table B15003: Educational Attainment for the Population 25 Years and Over)
Very low-income households	40%	Households earning less than $62,300 per year, or 50% of Area Median Income (AMI) for a 2-person household in Alameda County (ACS 2022, Table B19001: Household Income in the Past 12 Months and California Department of Housing and Community Development, 2024 State Income Limits, Alameda County, 2-person household, very-low income)
Severely housing cost burdened households	23%	Households spending >50% of income on housing – Severely Housing Cost-Burdened (ACS 2022, Tables B25070: Gross Rent as a Percentage of Household Income & B25091: Monthly Owner Costs as a Percentage of Income)
Communities of color	48%	People of Color – Communities of Color (ACS 2022, Table B03002: Hispanic or Latino Origin by Race)
Single parent families	9%	Families comprised of a parent/caregiver and one or more dependent children without the presence and support of a spouse or adult partner who is sharing the responsibility of parenting. ACS Census DP02 - Added Male and Female heads of household with children
Residents with Limited English proficiency	3.8%	Limited English Proficiency – Limited English-Speaking Households (ACS 2022, Table B16002: Household Language by Household Limited English-Speaking Status)
Residents who are not U.S citizens	24%	Not U.S. Citizens (Population Aged 18+) (ACS 2022, Tables B01001: Total Population by Age & B29001: Citizen Voting-Age Population)
Residents who are under the age 5	3.2%	Population Under 5 Years (ACS 2022, Table B01001: Sex by Age)
Households with a member who is 65 years and over living alone	12%	Households with 1 or more people 65 years and over – 65 and Over Living Alone (ACS 2022, Table B11007: Households by Presence of People 65 Years and Over)
Households with a person with a disability	19%	Households with 1 or More Persons with a Disability – People with a Disability (ACS 2022, Table B22010: Receipt of Food Stamps/SNAP by Disability Status)
Renter households	57%	Renter-Occupied Households – Renters (ACS 2022, Table B25003: Tenure)
Zero-vehicle households	20%	Households Without a Vehicle – Without a Vehicle (ACS 2022, Table B25044: Tenure by Vehicles Available

2.3.3 Cumulative Social Vulnerability

Individuals can belong to more than one vulnerable group and may experience especially complex forms of climate change vulnerability as a result of overlapping population characteristics. Berkeley's cumulative vulnerability map (See ***Figure 3***) was created using the San Francisco Bay Conservation and Development Commission (BCDC) 2020 Community Vulnerability Index – overlapping the many factors that affect social vulnerability – to account for this complexity.

The Berkeley Cumulative Social Vulnerability Map (***Figure 3***) includes all the indicators presented in ***Table 1*** above. Census block groups were identified and classified as low, moderate, high, and very high as a measure of cumulative vulnerability using the data in ***Table 2***.

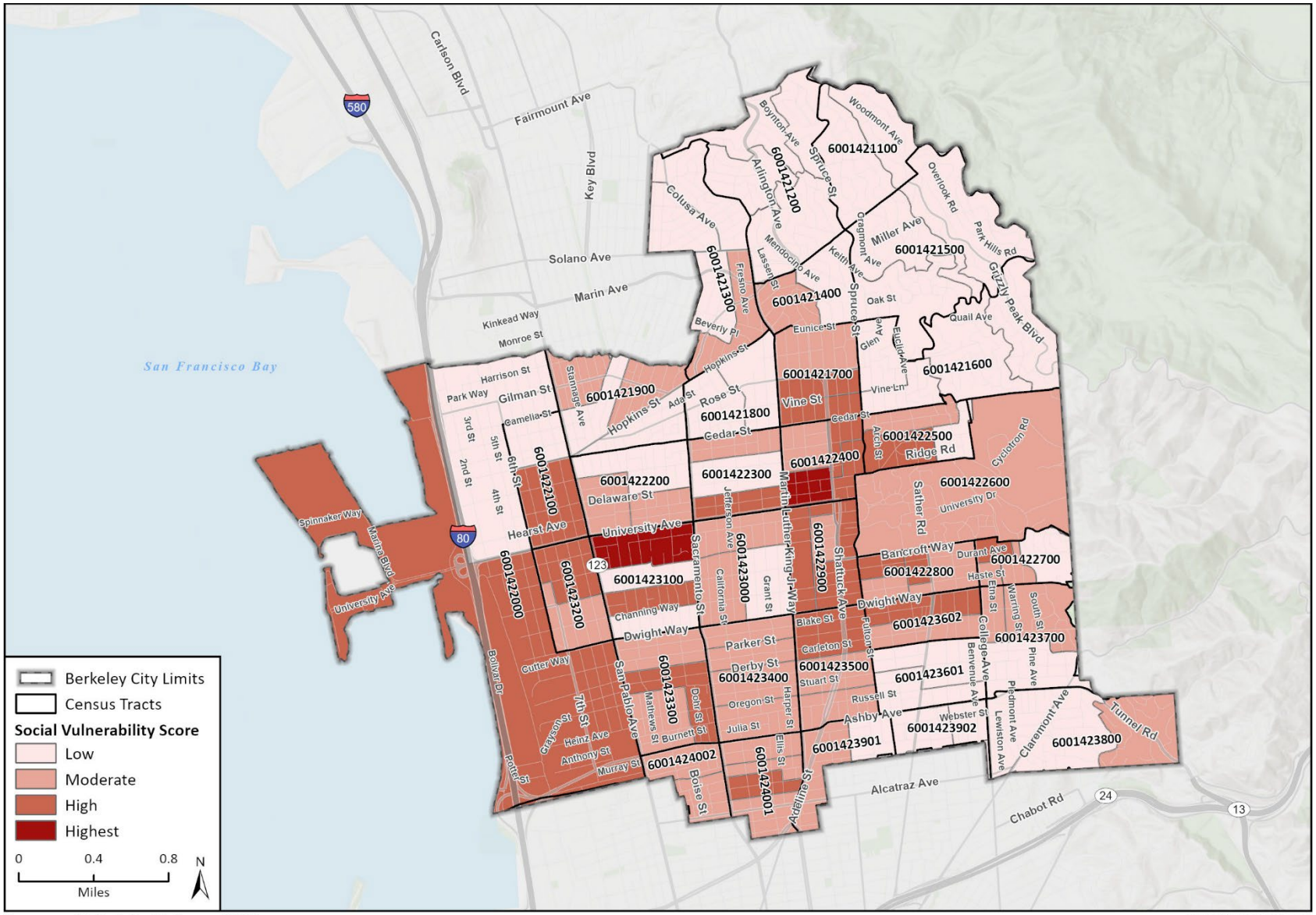
A second map, (***Figure 4)*** the Berkeley Highest Cumulative Social Vulnerability Map, adjusts the threshold for indicators to identify more communities at risk. For this map, a block group is classified as an area of social vulnerability if there are seven or more indicators (see ***Table 1*** above) at or above the 70th percentile.

Setting the threshold for "very high" social vulnerability at the 70th percentile reflects the unique characteristics of the Berkeley population, and ensures that areas exhibiting moderate to high vulnerability, which are important to present for policy considerations, are not overlooked. The full Social Vulnerability Analysis Methodology can be found in Appendix A.

Table 2 Cumulative Vulnerability Classification Methodology

Number of indicators above 70th percentile	Cumulative Social Vulnerability Score
0 - 2	Low
3 - 5	Moderate
6 - 8	High
9 - 11	Very High

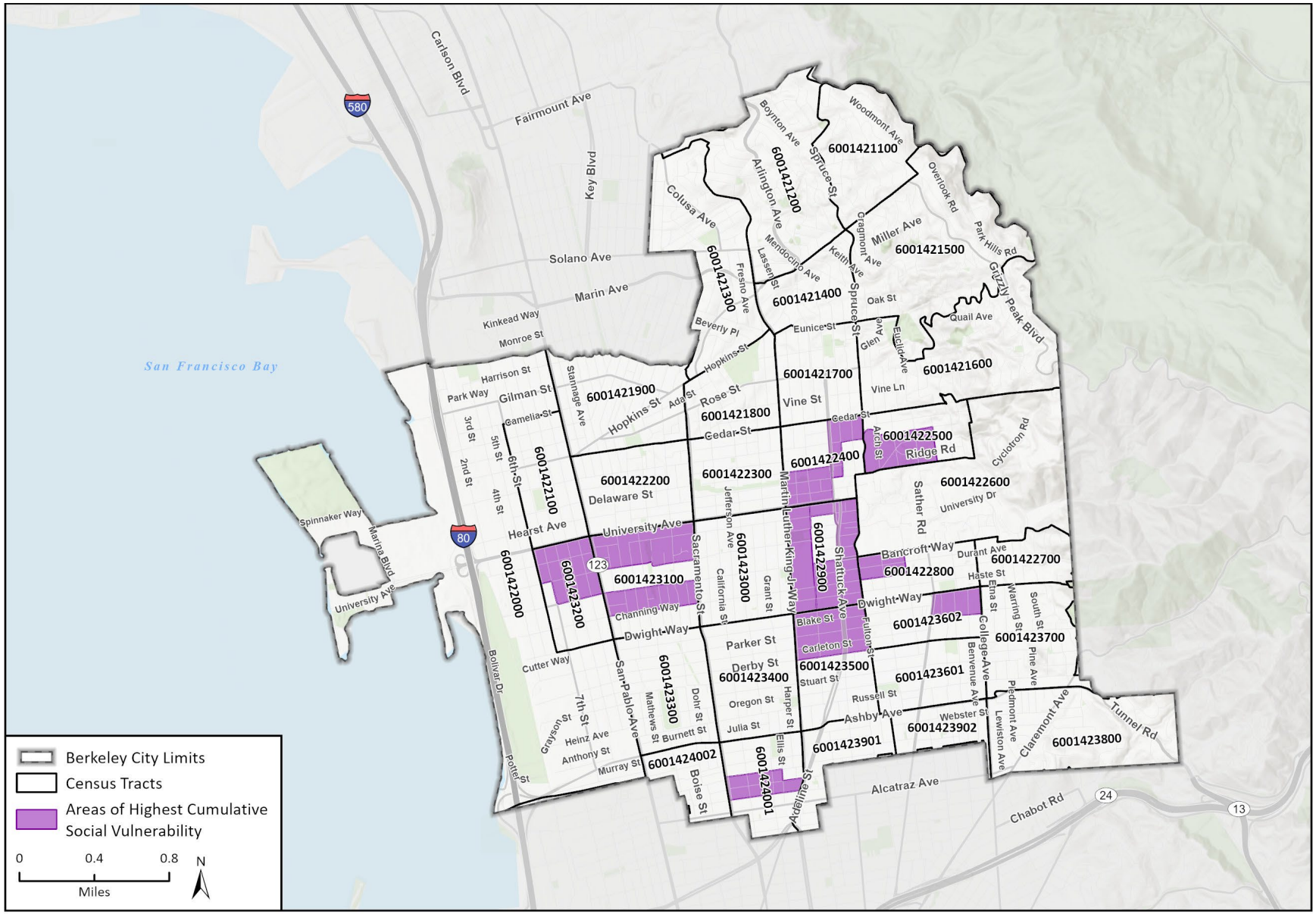
Figure 3 Berkeley Cumulative Social Vulnerability Map



Basemap provided by Esri and its licensors © 2025.
Social Vulnerability Score provided by City of Berkeley, 2025.

23-15392 EPS Safety Element
Fig X Social Vulnerability Index

Figure 4 Berkeley Highest Cumulative Social Vulnerability Map



Basemap provided by Esri and its licensors © 2025.
Social Vulnerability Index and Critical Facilities provided by City of Berkeley, 2025.

23-15392 EPS Safety Element
Fig X Social Vulnerability Index

3 Hazards in Berkeley

The following sub-sections include descriptions of the historical impacts of hazards in Berkeley, projected climate changes, and potential impacts of these climate change hazards on communities and the built and natural environment. This section also describes existing programs that can mitigate impacts, along with a summary of the overall vulnerability to these climate change hazards.

3.1 Geologic and Seismic Hazards

An earthquake is caused by a sudden slip on a fault, releasing energy in waves that travel through the earth's crust and cause ground shaking. The strength and duration of this shaking depend on factors such as soil type, and the distance, size, depth, and direction of the fault rupture. The strongest shaking occurs near the fault, with horizontal shaking causing the most damage due to inadequate structural resistance (City of Berkeley 2024(a)).

Earthquakes often strike without warning and can result in damage ranging from minimal, with few or no injuries, to catastrophic, with extensive casualties. The severity of an earthquake is measured using the Modified Mercalli Intensity (MMI) scale, which assesses the intensity at a specific location based on observed impacts such as structural damage, changes in the earth's surface, and personal experiences. The MMI scale uses Roman numerals to indicate increasing intensity, with lower numbers representing effects on people and higher numbers indicating greater levels of structural damage. Additionally, Peak Ground Acceleration (PGA) is used to quantify earthquake intensity by measuring how strongly the ground shakes at a given location.

Earthquakes can lead to ground failure in several ways:

- **Surface Fault Rupture**: When a fault movement breaks through to the surface, it can severely damage structures like buildings, roads, and pipelines.
- **Liquefaction**: In wet, sandy, or silty soils, shaking causes soil grains to consolidate, pushing water to the surface and weakening the soil, leading to sinking or lateral spreading.
- **Seismically-Triggered Landslides**: Earthquake-induced shaking can trigger landslides, with ground displacements ranging from a few inches to tens of feet, enough to break typical foundations.

In addition to these geologic hazards, certain building types are especially vulnerable to seismic impacts. Soft-story buildings, typically multi-story structures with a weak or open ground floor, such as those with tuck-under parking, are at high risk of collapse during strong shaking. These structures are common in older residential areas and pose a significant threat to life safety and structural stability in the event of a major earthquake.

In Berkeley, the City has identified a significant number of vulnerable structures through its official inventory of potentially hazardous soft, weak, or open front buildings. As of September 2023, 291 soft-story buildings had completed seismic retrofits and were removed from the City's inventory. An additional 62 were removed for other reasons, such as not meeting the criteria for inclusion. However, 8 buildings obtained permits for a seismic retrofit, and 8 buildings remained out of compliance with the City's seismic safety requirements.

3.1.1 Earthquakes

Figure 5 shows Berkeley and its proximity to known active geologic faults in the San Francisco Bay Region. This map shows most of the San Francisco Bay Area, with Berkeley outlined and shaded in gray. Many red lines are displayed across the map in a northwest to southeast direction:

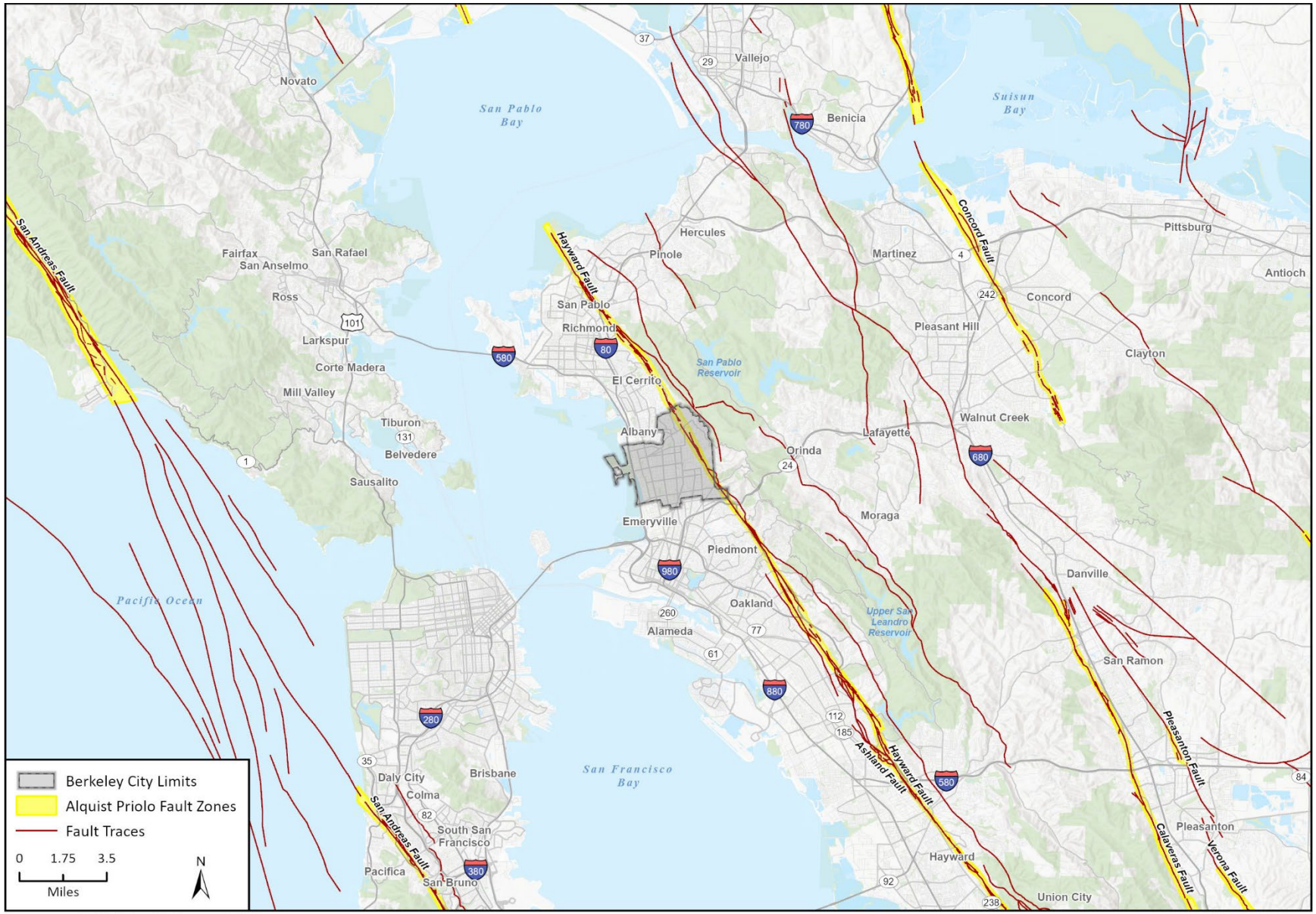
- On the western side of the figure, in the Pacific Ocean, multiple red lines move along the coast, starting and stopping. One of these lines begins in Marin, stretches through the ocean, and then continues through Daly City and down the peninsula, extended beyond the map boundaries. This is the San Andreas Fault.
- On the eastern side of the figure, another set of red lines show earthquake faults in the East Bay. One of these lines stretches from the middle of San Pablo Bay, crosses directly through the eastern section of Berkeley, and continues down the East Bay past Union City. This is the Hayward fault, which stretches to Milpitas, and is of particular concern in Berkeley.

Figure 5 and ***Figure 6*** also show the Alquist-Priolo Earthquake Fault Zones in yellow highlights, which are regulatory zones in California designed to mitigate the risks associated with surface fault ruptures. These zones surround the surface traces of active faults, which are faults that have shown movement within the last 11,000 years. The Alquist-Priolo Earthquake Fault Zoning Act was enacted in 1972 following the destructive 1971 San Fernando earthquake. The primary goal of the Alquist-Priolo Earthquake Fault Zoning Act is to prevent the construction of buildings intended for human occupancy directly on the surface traces of active faults. Structures must be set back a minimum distance from these faults, typically fifty feet. The Alquist-Priolo Earthquake Fault Zoning Act requires geologic investigations before new construction projects are permitted to ensure buildings are not placed on active faults. The California Geological Survey maps these zones, and the maps are used by the City to regulate land use and construction. The Alquist-Priolo Earthquake Fault Zone runs through Census Tract 2500 which contains communities facing social vulnerability.

A large earthquake on any of the illustrated faults could significantly impact communities throughout Berkeley. For example, the 1989 M 6.9 Loma Prieta earthquake was a rupture of the San Andreas fault, and the 2014 M 6.0 South Napa earthquakes occurred along the West Napa fault.

The Bay Area experienced its most recent significant earthquakes in 2022, with a magnitude 5.1 near San Jose in October and a magnitude 3.6 near El Cerrito in December, both causing minimal damage. There have been no federally-declared earthquake disasters in Berkeley since the last update to the Disaster Preparedness and Safety Element. Historically, destructive earthquakes in the Bay Area occurred in 1838, 1868, 1898, 1906, 1911, 1989, and 2014. The 2014 South Napa Earthquake (magnitude 6.0) caused significant damage, killing two people, injuring 300, and damaging over 2,000 structures. The 1989 Loma Prieta earthquake resulted in 62 deaths, primarily from the collapse of a highway in Oakland, with minor damage in Berkeley. The 1906 San Francisco Earthquake also caused structural damage in Berkeley, including chimney collapses and damage to public buildings. Smaller earthquakes over the years have caused slight damage in Berkeley.

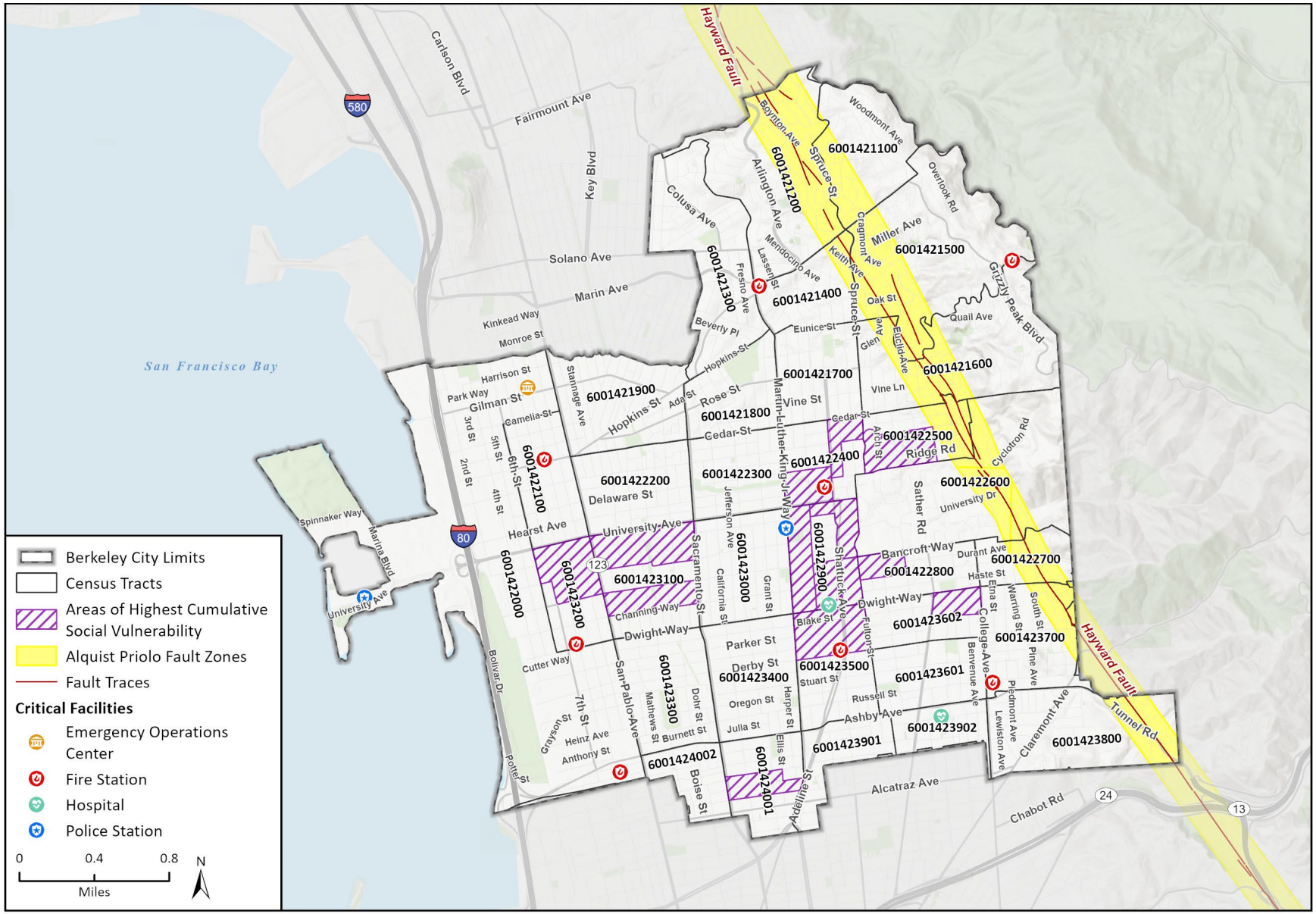
Figure 5 Faults in Berkeley and the Surrounding Area



Basemap provided by Esri and its licensors © 2025.
Additional data provided by CGS, 2024; USGS, 2022.

23-15392 EPS Safety Element
Fig X Faults Zoomed Out

Figure 6 Alquist Priolo Fault Zones



Basemap provided by Esri and its licensors © 2025. Additional data provided by CGS, 2017.
Social Vulnerability Index and Critical Facilities provided by City of Berkeley, 2025.

23-15392 EPS Safety Element
Fig X Social Vulnerability and Faults

3.1.2 Earthquake-induced Landslides and Liquefaction Hazards

The USGS classified sediments in the Bay Area based on their susceptibility to liquefaction. ***Figure 7*** depicts the areas in Berkeley where soil types and groundwater conditions are more susceptible to liquefaction.

The following areas are shown in deep green, meaning they are in the liquefaction zone and experience liquefaction risk:

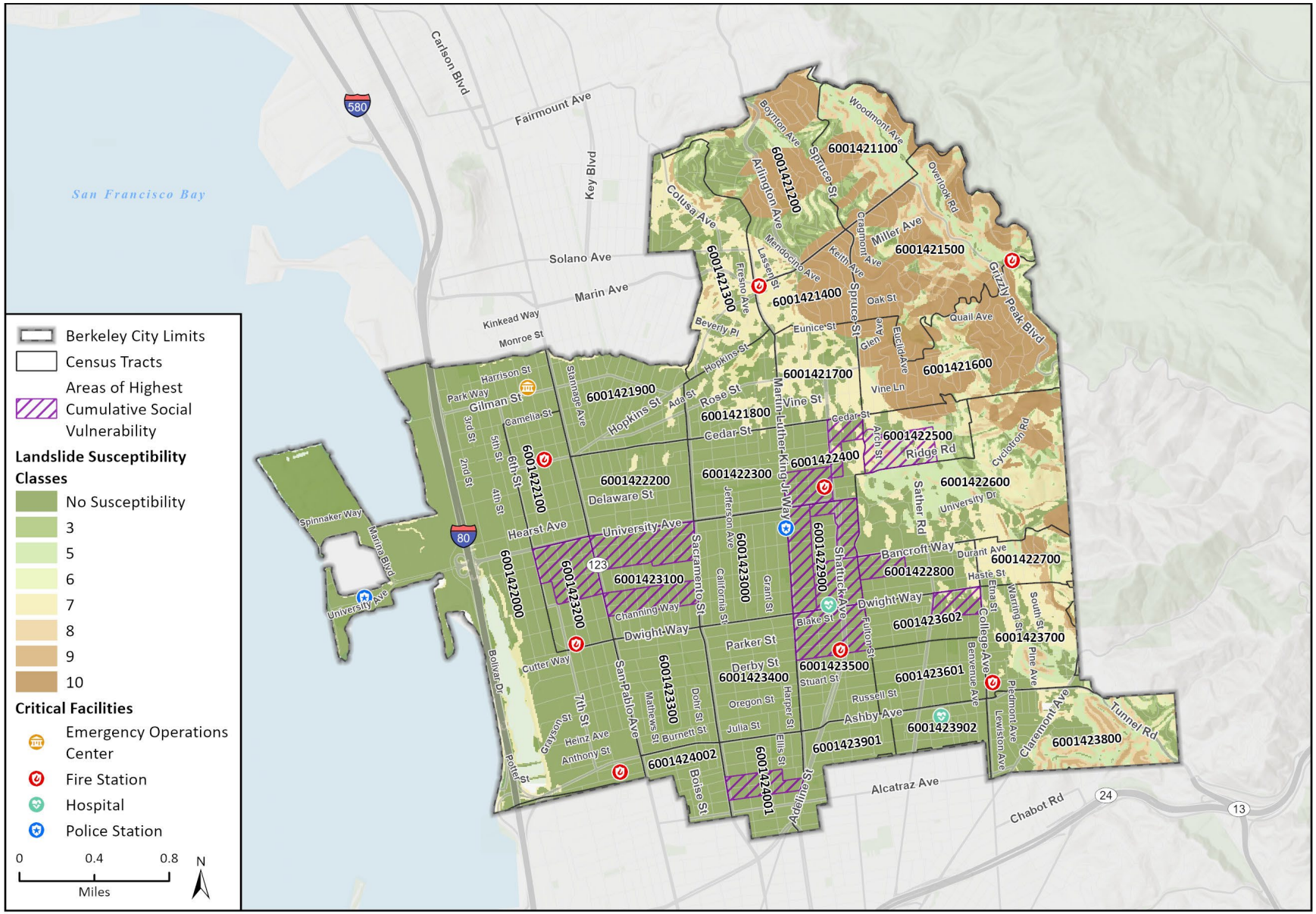
- The entire Berkeley Marina and Eastshore State Park
- Interstate 80
- Aquatic Park
- Codornices Creek and Strawberry Creek.
- In Northwest Berkeley, the zone begins at the shoreline and ends at San Pablo Ave
- In Southwest Berkeley, the zone begins at the shoreline and ends at McGee Ave

The California Geological Survey has identified the areas of Berkeley with potential to experience earthquake-induced landslide. All areas underlain by known active or dormant landslides are included in the zone. These areas are identified by combining information on rock or soil strength, slope gradient (steepness), and anticipated future shaking levels. In Berkeley, the potential for landslide from seismic activity is high in the hill areas and along creek banks. ***Figure 7*** indicates that significant portions of the Berkeley Hills have the potential to experience earthquake-induced landslide. These areas are shown in light brown on ***Figure 7*** throughout the Berkeley Hills (City of Berkeley 2024(a)).

Communities facing social vulnerability in Census Tracts 3200, 3100, 4001, and 2900 are at risk of liquefaction. In West Berkeley, three fire stations, both police stations, and the skilled nursing facilities, Chaparral House and Silverado Berkeley Memory Care are also susceptible to liquefaction. Additionally, one fire station in the Berkeley Hills, just east of Grizzly Peak Boulevard, is at risk of landslides.

The City of Berkeley offers transfer tax rebates for seismic work to encourage property owners to undertake voluntary seismic upgrades. Current or former owners of residential buildings, or mixed-use buildings with at least two residential units, can receive a rebate of up to one-third of the city's base 1.5 percent transfer tax for seismic strengthening work completed prior to or within a year of the property's sale. Eligible seismic improvements include bolting foundations, installing shear walls, securing chimneys, and other measures that significantly enhance building safety during earthquakes. To qualify, the work must comply with specific standards and guidelines, and property owners must obtain a building permit and confirm eligibility with the Berkeley Building & Safety Division (City of Berkeley n.d.(c)).

Figure 7 Seismically Triggered Landslide and Liquefaction Hazard Zones in Berkeley



Basemap provided by Esri and its licensors © 2025. Additional data provided by CGS, Map Sheet 58, 2018.
Social Vulnerability Index and Critical Facilities provided by City of Berkeley, 2025.

23-15392 EPS Safety Element
Fig X Social Vulnerability and Landslide Susceptibility

Potential Impacts

A catastrophic earthquake on the Hayward Fault would cause severe and violent shaking and three types of ground failure in Berkeley. Surface fault rupture could occur in the Berkeley hills along the fault, damaging infrastructure and utilities that cross the fault. Landslides are expected in the Berkeley hills during the next major earthquake, particularly if the earthquake occurs during the rainy winter months. Landslide movement could range from a few inches to tens of feet. Ground surface displacements as small as a few inches are enough to break typical foundations. Liquefaction is very likely in the westernmost parts of the city and could occur in much of the Berkeley flats. Liquefaction can destroy pavement, dislodge foundations, and damage underground and aboveground infrastructure.

Shaking and ground failure are likely to create impacts that ignite post-earthquake fires. Firefighting efforts will be simultaneously challenged due to broken water mains and damage to electrical, transportation, and communication infrastructure.

In a 6.9 magnitude earthquake on the Hayward Fault, the City estimates that over 600 buildings in Berkeley will be completely destroyed and over 20,000 more will be damaged. One thousand to 4,000 families may need temporary shelter. Depending on the disaster scenario, 100 people could be killed in Berkeley alone, and many more would be injured. Commercial buildings, utilities, and public roads will be disabled or destroyed. This plan estimates that building damage in Berkeley alone could exceed $2 billion, out of a multi-billion-dollar regional loss, with losses to business activities and infrastructure adding to this figure.

Low-income housing units are expected to be damaged at a higher rate than other residences. Other types of housing, such as condominiums, may replace them when land owners rebuild. This could lead to profound demographic shifts in Berkeley.

Existing Programs to Offset Impacts

The City of Berkeley is implementing various programs to offset the impacts of seismic hazards in Berkeley. The list below provides information on Berkeley's existing programs.

- **Mandatory Earthquake Retrofit Programs:** The City of Berkeley requires owners of Unreinforced Masonry Buildings (URM) and Soft, Weak or Open Front Buildings (SWOF) to retrofit their property to make them safer in case of an earthquake. The City maintains inventories of URM and SWOF buildings per Berkeley Municipal Code Sections 19.38 and 19.39.
- **Funding for Seismic Retrofits:** The City offers programs to help property owners fund seismic retrofits of various building types including commercial buildings and multi-family and single-family residential buildings. These programs include the Earthquake Soft Story Retrofit Program for owner-occupied single-family homes, the Earthquake Brace and Bolt Program for owner-occupied residential buildings containing 1-4

dwelling units and the Retrofit Grants Program which reimburses property owners of eligible building types a portion of their design and/or construction costs for seismic retrofits. Additionally, new owners of residential buildings, including single-family homes, or mixed-use buildings with at least two residential units can receive a refund of their real estate transfer tax for voluntary seismic upgrades.

3.1.3 Tsunami

A tsunami occurs when a rapid disturbance vertically displaces water, causing a series of surges. This can be triggered by an underwater fault rupture or underwater landslides, typically caused by earthquakes. Tsunamis affecting the Bay Area can originate from offshore earthquakes within the region or from distant events, commonly from faults in Washington and Alaska. Local tsunamis can also be generated from underwater faults, such as the small tsunami triggered by the 1906 earthquake. The San Andreas Fault runs along the coast off the Peninsula, and the Hayward Fault runs partially through San Pablo Bay (City of Berkeley 2024(a)).

In 2021, the California Geological Survey and Cal OES updated the tsunami inundation maps for Alameda County, including Berkeley. The updated boundaries reflect the latest science and local geographic features impacting evacuation safety. ***Figure 8***, shaded in blue, shows the potential tsunami inundation zone along Berkeley's shoreline. The zone includes areas from Fifth Street to Seventh Street at various points, capturing landmarks such as Golden Gate Fields, the Tom Bates Regional Sports Complex, Eastshore State Park, the Berkeley Marina, portions of Interstate 80, the San Francisco Bay Trail, the Amtrak Station, Aquatic Park, and the Fourth Street Business District. The Police Station at the Berkeley Marina is at risk to tsunami inundation. Communities living or working near the shoreline, including those in recreational, commercial, and transit areas, may be at elevated risk during a tsunami event. Individuals with limited mobility, limited access to transportation, or language barriers may face additional challenges evacuating quickly and safely.

In January 2023, an underwater volcano erupted near Tonga, leading to a tsunami advisory for Berkeley. Residents evacuated from boats, docks, and the shoreline, but no damage was reported despite noticeable swells and strong currents at the Berkeley Marina. The most recent damaging tsunami in Berkeley occurred after the March 2011 earthquake off the coast of Japan, causing a half-meter surge in Oakland and $158,000 in damage to docks and boats at the Berkeley Marina. Tsunamis generally impact the Pacific Coast of California, with rare occurrences in the San Francisco Bay. Local tsunamis, or seiches, can be generated within the Bay by the Hayward fault, such as the seiche reported after the 1868 Hayward fault earthquake. The 1964 Alaska earthquake caused extensive tsunami damage in northern California near Crescent City, but data on impacts to Berkeley is unavailable

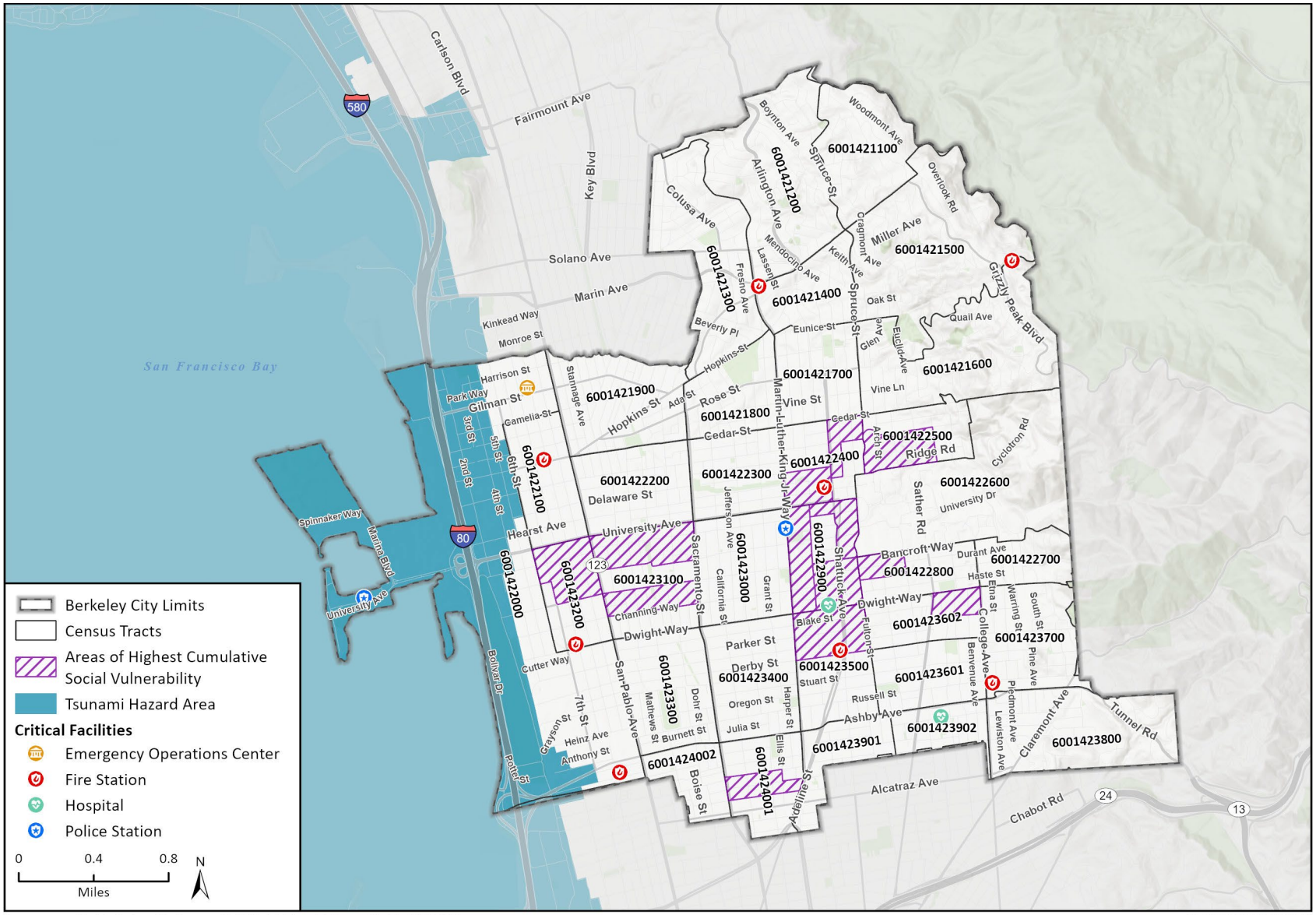
Potential Impacts

The March 2011 Japan earthquake generated a devastating tsunami, which reached the Bay Area and caused minor damage to docks and floats in the Berkeley Marina. A larger tsunami could impact much more of Berkeley's western shores. Berkeley's maritime community, which would be greatly impacted, includes low income individuals and households. Buildings, infrastructure, and roadways could be damaged, and debris and hazardous materials could cause post-tsunami fires. Deaths are possible if individuals choose not to evacuate hazardous areas, do not understand tsunami warnings, or are unable to evacuate.

Existing Programs to Offset Impacts

- **City of Berkeley 2024 Local Hazard Mitigation Plan (LHMP):** The 2024 LHMP outlines plans and strategies to offset the impacts of Tsunami. These plans include the repair of Berkeley Marina infrastructure, collaboration with state and federal agencies including the California Office of Emergency Services, the California Geological Survey, and the Federal Emergency Management Agency and community readiness efforts.

Figure 8 Berkeley Tsunami Inundation



Basemap provided by Esri and its licensors © 2025. Additional data provided by CGS, 2017.
Social Vulnerability Index and Critical Facilities provided by City of Berkeley, 2025.

23-15392 EPS Safety Element
Fig X Social Vulnerability and Tsunami Hazards

3.2 Wildfire and Poor Air Quality

Background, Historical Impacts, and Climate Change Exposure

Wildfires have historically played a crucial role in maintaining the ecological balance in California and the East Bay, including Berkeley. However, the introduction of housing, invasive vegetation, and fire suppression in hillside areas has disrupted this balance, leading to catastrophic fires. A key concern in Berkeley is wildland-urban interface fires, which occur where natural landscapes and urban environments meet. Berkeley has a significant history of wildland-urban interface fires, including the 2017 Grizzly Fire, the 1991 Tunnel Fire, and the 1923 Berkeley Fire. The Grizzly Fire burned 20 acres in the Berkeley and Oakland hills, suspected to be caused by arson. The Tunnel Fire, fueled by strong winds, spread rapidly across Oakland and Berkeley, destroying neighborhoods and resulting in 25 deaths. The Berkeley Fire of 1923, driven by Diablo winds, burned 130 acres and left 4,000 people homeless. These historical fires highlight the vulnerability of Berkeley to wildland-urban interface fires, especially in areas where urban development meets natural landscapes (City of Berkeley 2024(a)).

Everyone in Berkeley can be affected by poor air quality from wildfires. Some neighborhoods experience moderate or unhealthy air quality on a regular basis due to proximity to pollution sources like highways and industry, and wildfire smoke can compound this chronic exposure, further worsening health risks for residents in these areas. There have also been several extreme examples of poor air quality that impacted the entire city due to nearby wildfires. In September and October of 2017, the wildfires in North Bay sent smoke to Berkeley, causing unhealthy air for sensitive groups, including infants, young children, people with respiratory illnesses, and people who live or work outside. In November 2018, smoke from the Camp Fire brought very unhealthy air quality. Schools were cancelled, and there were calls for the entire population to avoid outdoor activities for multiple days. In October 2019, smoke from the Kincade Fire brought unhealthy air to Berkeley for a few days. In September and October of 2020, multiple northern California wildfires brought very unhealthy air to the Bay Area for over twenty consecutive days. In August and September 2021, smoke from northern California wildfires created moderate air quality in the Bay Area for a few days. In December 2022, the Bay Area had unhealthy air mostly due to local residential wood burning and active wildfires in the state (City of Berkeley 2024(a)).

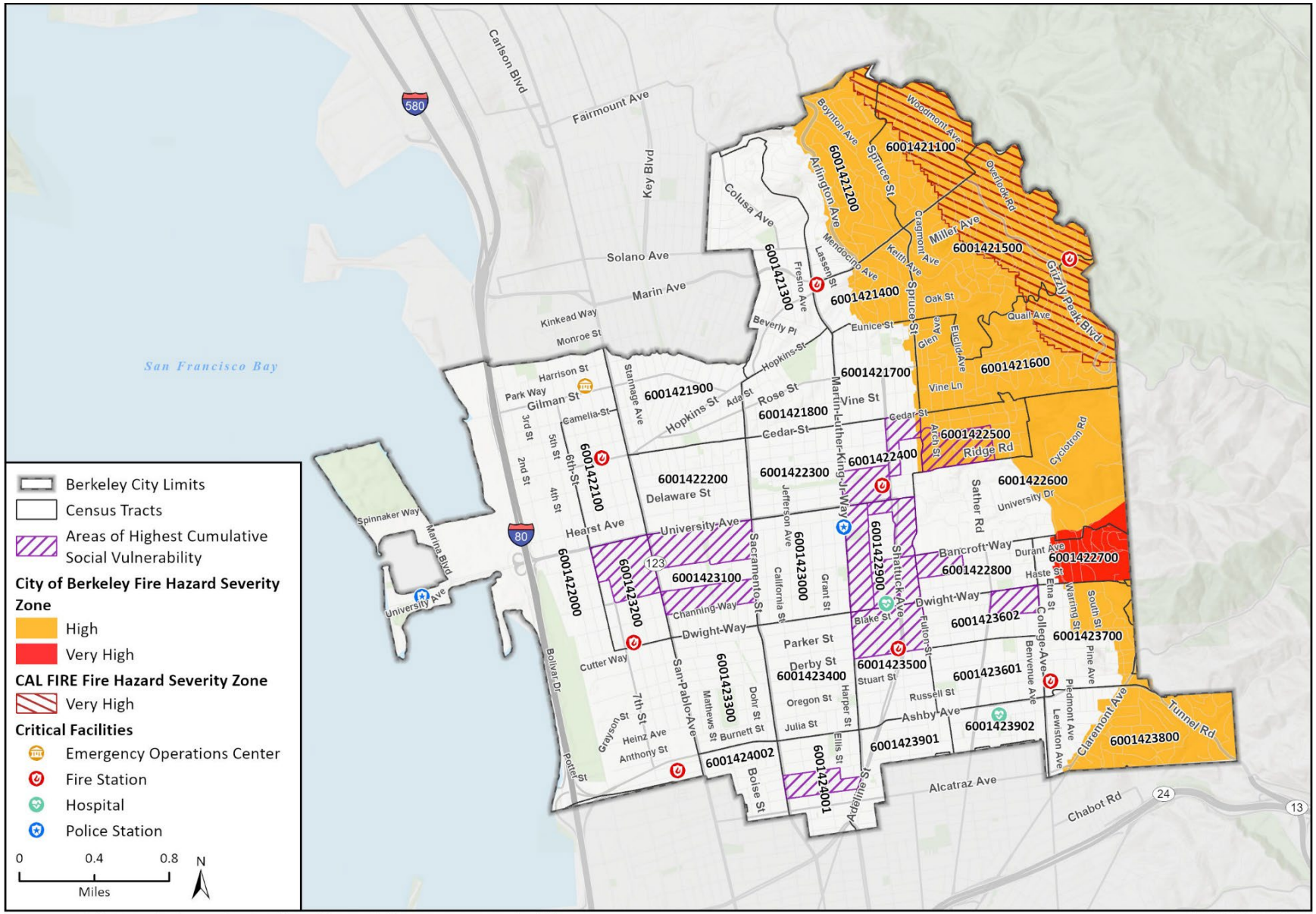
The State Fire Marshal is mandated to classify lands within State Responsibility Areas into Fire Hazard Severity Zones (FHSZ). Fire Hazard Severity Zones fall into one of the following classifications: Moderate, High, and Very High. In addition to State Responsibility Areas, the State Fire Marshal is also mandated to recommend maps of Very High Fire Hazard Severity Zones in Local Responsibility Areas in Berkeley. As shown in ***Figure 9***, the State Fire Marshal designated Very High Fire Hazard Severity Zones in the northeast portion of Berkeley, along the entire eastern border of the City, and southwest of the University of California, Berkeley

campus. Following receipt of the State recommendation of Very High Fire Hazard Severity Zones, the City further interpreted the hazard and divided Berkeley into High and Very High Fire Hazard Severity Zones. These zone boundaries are adopted by the City Council, along with updates to the Fire Code.

Increased structure density exacerbates the fire risk in wildland-urban interface areas. The rate of structure-to-structure ignitions rises with a higher number of structures per acre. The National Institute of Standards and Technology defines high structural density of wildland urban interface areas as more than two structures per acre. ***Figure 10*** illustrates that most regions of the Berkeley Hills have at least two structures per acre, classified as high structural density and depicted in dark orange. Additionally, areas marked in red, primarily in the north Berkeley Hills and around Panoramic Hill, represent the highest structural density in Berkeley's wildland urban interface areas, with more than four structures per acre (City of Berkeley 2024(a)). Areas in orange indicate high structural density with more than two structures per acre, while light orange areas show medium structural density with one or fewer structures per acre. ***Figure 10*** demonstrates that the structural density of Berkeley's hills areas will be a critical factor in fire spread.

Berkeley is particularly vulnerable to wind-driven fires originating from adjacent areas, posing significant risks to the community (City of Berkeley 2025). Based on climate change projections, by mid-century, the area burned in Alameda County is projected to increase between 13 percent (RCP 8.5) and 15 percent (RCP 4.5) (CEC n.d.). By end-century, the increase is expected to be between 4 percent (RCP 8.5) and 13 percent (RCP 4.5) (CEC n.d.). Changes in temperature, precipitation, and human development patterns will influence future fire frequency, potentially leading to more frequent and intense fires in Berkeley (Krawchuk 2012).

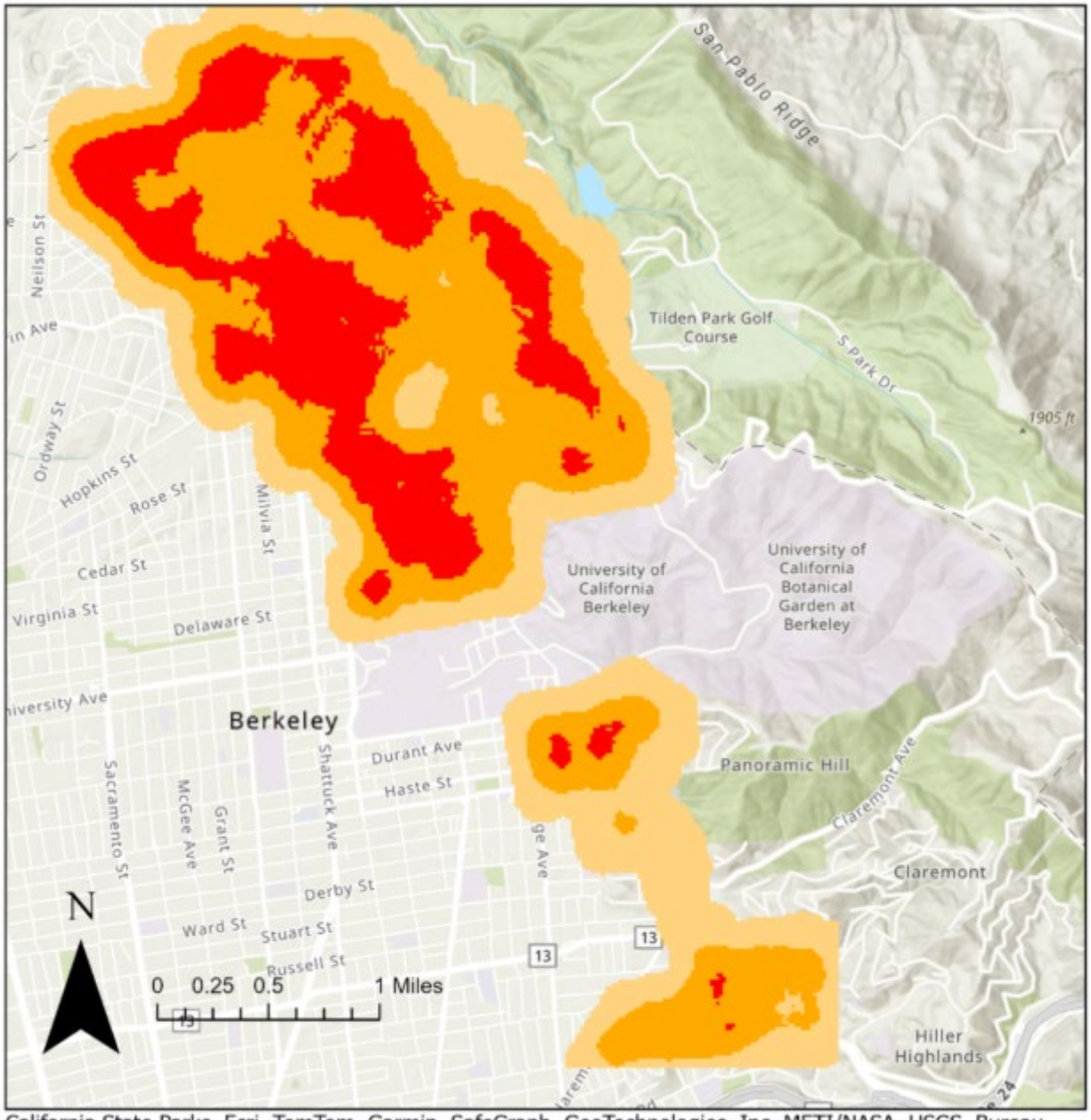
Figure 9 Wildfire Hazard Severity Zones in Berkeley



Basemap provided by Esri and its licensors © 2025. Additional data provided by CALFIRE, 2025; City of Berkeley, 2025.
Social Vulnerability Index and Critical Facilities provided by City of Berkeley, 2025.

23-15392 EPS Safety Element
Fig X Social Vulnerability and Fire Hazard Severity Zones

Figure 10 Density of Structures in Berkeley Fire Zones 2 and 3, 2024



California State Parks, Esri, TomTom, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, USDA, USFWS, Esri, NASA, NGA, USGS, FEMA

Structure density per acre

- 0.001 - 2
- 2.001 - 4
- Greater than 4

Potential Impacts

Wildfires pose serious risks to people in Berkeley, both from direct threats like fast-moving, wind-driven flames that can cause injuries or fatalities, and from widespread smoke that degrades air quality, especially harming sensitive groups such as children, seniors, and individuals with respiratory conditions (City of Berkeley 2024(a)). Wildfires significantly impact air quality by releasing a complex mixture of toxic fumes and particulate matter. Urban fires, in particular, pose an even greater risk, as they often involve the combustion of synthetic materials, plastics, treated wood, and industrial chemicals, producing more hazardous airborne toxins than vegetation alone. The smoke produced contains harmful pollutants such as carbon monoxide, volatile organic compounds, and fine particulate matter (PM2.5), which can penetrate deep into the lungs and even enter the bloodstream (U.S. EPA 2025). These pollutants contribute to respiratory and cardiovascular issues, aggravate existing health conditions like asthma, and increase the risk of heart and lung diseases (U.S. EPA 2025). Additionally, the spread of smoke can affect air quality far from the fire site, leading to hazardous conditions for communities miles away (Western Fire Chiefs Association 2024). These dangers are compounded in communities facing social vulnerability, which include communities of color (e.g., Black, African American, Indigenous, Native, Latinx, Hispanic, Asian, East Asian, Pacific Islander and other people of color), such as tracts 2400 and 2500, where residents may face additional barriers to evacuation, limited access to healthcare, fewer financial resources to prepare for or recover from disasters, and higher rates of pre-existing health conditions that increase sensitivity to smoke exposure.

Evacuation during wildfire events is particularly challenging in the Berkeley Hills, where narrow, winding roads can become quickly congested, delaying both residents trying to flee and emergency responders trying to reach people in need. These risks are even more severe for individuals with disabilities or limited mobility. Panoramic Hill is especially vulnerable due to its single, narrow access road that is difficult for fire apparatus to navigate and can be easily blocked by traffic, parked vehicles, or landslides, potentially trapping residents during an emergency (City of Berkeley 2024(a)).

Wildfires pose a significant threat to Berkeley's built environment, particularly in the wildland-urban interface. Intense heat from wildfire can rapidly damage or destroy homes and infrastructure, including roads, sidewalks, and drainage systems. Utility systems are especially at risk, as aboveground electrical, telephone, and cable lines, along with streetlights and traffic signals, can be destroyed by flames or heat. Fires can also compromise water infrastructure, leading to contamination and disruption of drinking water supplies, and can severely impact transportation and communication networks that residents, businesses, and institutions rely on daily (City of Berkeley 2024(a)). One fire station is located just east of Grizzly Peak Boulevard, in the City's High Fire Hazard Severity Zone.

Wildfires pose a serious threat to Berkeley's natural and cultural landscapes, including its parks, open spaces, and recreational areas. The East Bay Regional Parks, located just beyond the city's eastern edge, offer vital recreational and ecological value but are highly susceptible to wildfire damage. Similarly, Berkeley's overnight camps—set in scenic natural areas outside city limits—face increasing risk from wildfires, which could limit community access to outdoor experiences and cause long-term harm to sensitive ecosystems. These natural assets not only support biodiversity but also contribute to the city's environmental quality and residents' well-being (City of Berkeley 2024(a)).

Existing Programs to Offset Impacts

The Berkeley Fire Department is implementing various programs and protocols that help to offset the impacts of wildfire in Berkeley. The list below provides information on the programs in place to help offset wildfire impacts in Berkeley.

- **EMBER (Effective Mitigations for Berkeley's Ember Resilience).** Focuses on reducing the risk of structures igniting from wind-driven embers. A key requirement is Zone 0, the five foot buffer around a structure.
- **City of Berkeley Community Wildfire Protection Plan.** This citywide plan includes a set of wildfire mitigation policies and programs, including workforce training for fire inspectors and vegetation removal crews, annual defensible space inspections, and risk assessments for individual properties. Public awareness and education campaigns are conducted in multiple languages, with partnerships involving community groups like Firewise[4] and Homeowner Associations (HOAs)[5]. The plan also includes fire weather information dissemination, community readiness exercises, and the development of safe road passages and evacuation procedures. Vegetation management around homes, including incentives for creating defensible space and home hardening retrofits, is emphasized. Fire ignition detection and enforcement measures, regional pre-attack coordination, and mutual aid agreements are also part of the plan. Additionally, the plan promotes hazardous tree and vegetation removal, urban forest health, and collaboration with partner departments to maintain public open spaces and disrupt fuel continuity in key fire pathways.

[4] Firewise USA is a national program designed to help communities reduce wildfire risks. It provides guidelines and resources for homeowners to create defensible spaces around their properties, manage vegetation, and improve home resilience against wildfires. Firewise communities work together to implement these strategies, often holding meetings and volunteer activities to enhance their preparedness

[5] HOAs are organizations within subdivisions, planned communities, or condominium buildings that enforce rules and guidelines for properties and residents. HOAs are typically run by a board of directors and collect fees to maintain common areas and facilities. They play a crucial role in community management, including aspects like landscaping, property maintenance, and sometimes even wildfire preparedness.

- **City of Berkeley 2024 Local Hazard Mitigation Plan (LHMP).** The 2024 LHMP outlines several high-priority actions to mitigate wildfire risks. These actions include updating and enforcing fire codes, managing vegetation to reduce fire risk, and promoting pedestrian evacuation routes in Fire Zones 2 and 3. The plan also focuses on improving responder access and community evacuation through roadway maintenance and parking restrictions, as well as researching and implementing infrastructure improvements to facilitate emergency evacuations. Additionally, the 2024 LHMP aims to mitigate wildfire risks at Berkeley's overnight camps, reduce fire hazards through utility undergrounding, and ensure an adequate water supply during emergencies by working with EBMUD. Coordination of regional wildfire mitigation strategies with key partners and stakeholders is also emphasized.
- **Berkeley Watershed Management Plan (2012).** This plan includes a program to have an integrated approach to fire safety. It emphasizes water quality protection, urban flooding reduction, natural waterways and habitat preservation, and rainwater re-use promotion. By enhancing the health of natural habitats and reducing urban flooding, the plan helps create conditions less conducive to severe wildfires.
- **EBMUD Climate Change Monitoring and Response Plan (2020).** This plan calls for improved fire protection measures to reduce demand for fire suppression. These measures are intended to be implemented by EBMUD on its own lands, and also in coordination with local jurisdictions, including Berkeley, and residents, who are encouraged to adopt fire-safe practices through land use planning, defensible space maintenance, and community preparedness efforts.
- **PG&E Climate Strategy Report (2022).** This report includes an incentive-based program for PG&E business and residential customers to promote the installation of equipment to generate and store energy, preparing customers for extreme weather events and possible Public Safety Power Shutoffs.
- **PG&E Climate Adaptation and Vulnerability Assessment (2024).** This assessment is designed to address the impacts of climate-driven natural hazards on PG&E's operations and infrastructure. This comprehensive plan analyzes how wildfires may affect PG&E's ability to provide safe and reliable energy. The assessment identifies potential vulnerabilities and outlines adaptation options to enhance resilience. It includes community engagement efforts to understand the specific needs of vulnerable populations and integrates climate risk into decision-making processes to ensure a clean and resilient energy system for all.
- **Berkeley Resilience Strategy (2016).** This strategy includes a program to prepare for wildfires in the Berkeley Hills. It focuses on building a connected and prepared community through initiatives like Community Emergency Response Training (CERT) classes, public awareness campaigns, and neighborhood emergency supply caches. The strategy also emphasizes adapting to the changing climate, enhancing regional resilience, and promoting reliable and clean energy. Additionally, it includes measures

for fire weather information dissemination, community readiness exercises, and the development of safe road passages and evacuation procedures.

- **Public Health Emergency Preparedness.** The City of Berkeley's Public Health Emergency Preparedness team implements the following plans and programs through messaging, alerts and Health Officer orders.
    1. Public Health Messaging and Alerts. The City's Health Officer has the authority to issue health orders, such as masking mandates or shelter-in-place advisories, to mitigate the effects of smoke, poor air quality, or infectious disease outbreaks. These orders are communicated through coordinated messaging systems to ensure timely and accessible information reaches all residents, including individuals with limited English proficiency or access to digital platforms.

- **Crisis & Risk Communications Plan Crisis & Emergency Risk Communication (CERC).** Developed by the U.S Centers for Disease Control and Prevention (CDC), the CERC helps communicators and emergency responders better reach people with information about disasters and other public emergencies. The City's Health Officer may issue a masking mandate or advise staying indoors, which can mitigate the effects of smoke and poor air quality. Further, personal protection equipment (PPE) can be distributed throughout the community, with a focus on communities that face social vulnerability.
- **Alameda County Public Health Smoke Response Program.** The City uses resources developed by Alameda County related to wildfire smoke communications. https://www.acgov.org/sustain/what/resilience/smoke.htm
- **Medical Countermeasures Plan.** Developed by the U.S Food & Drug Administration (FDA), medical countermeasures (MCMs) are FDA-regulated products (such as PPE or vaccines) that may be distributed in the event of a public health emergency. The City's Health Officer may coordinate distribution at mobile sites throughout the city.

Wildfire and Poor Air Quality Vulnerability

Berkeley is significantly vulnerable to wildfires due to its topography, dense development in the wildland-urban interface, and the presence of communities facing social vulnerability. Fast-moving fires threaten lives, homes, infrastructure, and natural areas, while smoke exposure poses serious health risks, especially for sensitive groups. Evacuation challenges in hillside neighborhoods and limited mobility among some residents further increase risk. However, the City has taken significant steps to reduce these vulnerabilities through coordinated wildfire mitigation, emergency preparedness, public health protections, and regional partnerships aimed at improving resilience and response capacity related to wildfire and poor air quality.

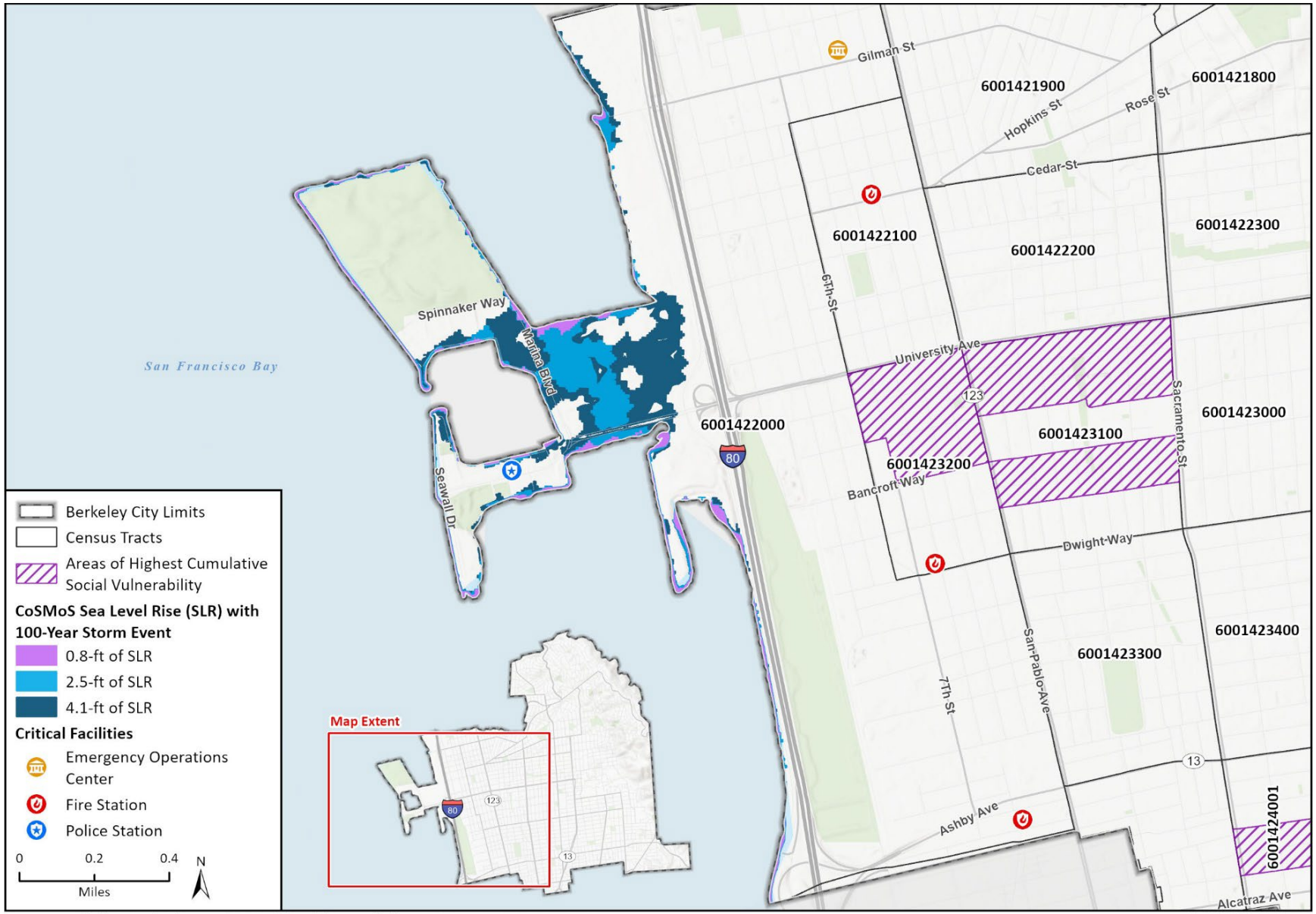
3.3 Sea Level Rise

Background, Historical Impacts, and Climate Change Exposure

Historically, sea level rise has already impacted Berkeley by increasing the volume of ocean water due to melting ice and thermal expansion, which has directly influenced the San Francisco Bay. This rise in sea levels in Berkeley has led to flooding in low-lying coastal areas, infiltrating sewer systems, flooding basements, and damaging underground infrastructure. Additionally, the increased sea levels have heightened the risk of liquefaction during earthquakes, particularly in areas that have been filled for development (see section 3.1.2 Earthquake-induced Landslides and Liquefaction Hazards for more information on liquefaction hazards in Berkeley). It is estimated that the San Francisco Bay has already risen approximately 8 inches since 1900. These historical impacts underscore the vulnerability of Berkeley's shoreline and low-lying inland areas to sea level rise and its associated hazards (City of Berkeley 2024(a)).

Climate change projections indicate that sea levels could rise between 0.9 feet (2060 intermediate scenario and 2050 intermediate-high scenario) and 2.8 feet (2100 intermediate scenario and 2080 intermediate-high scenario) (California Sea Level Rise Guidance 2024). In extreme projections, sea level rise could approach 10 feet by the end of the century (BCDC 2024). This rise in sea level will exacerbate flooding risks, particularly in low-lying areas. ***Figure 11*** shows the inundation that may occur based on sea level rise of 0.8 feet, 2.5 feet, and 4.1 feet with a 100-year storm event using data from the Coastal Storm Modeling System (CoSMoS), which most closely aligns with the scenarios recommended by the California Ocean Protection Council 2024 California Sea Level Rise Guidance. Sea level rise is expected to mainly affect the shoreline areas of Berkeley, including Marina Boulevard and University Avenue west of the 580 Highway. The Berkeley Waterfront is the most vulnerable.

Figure 11 Sea Level Rise in Berkeley with 100-year Storm Event



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Social Vulnerability Index and Critical Facilities provided by City of Berkeley, 2025.

23-15392 EPS Safety Element
Fig X Social Vulnerability and Sea Level Rise

Potential Impacts

The Berkeley Waterfront, a critical community asset for recreation, education, and local businesses, faces potential financial impacts from sea level rise, including damage to buildings and infrastructure, loss of public resources and habitats, and reduced berth rental revenue (City of Berkeley 2024(a)). Although communities that face social vulnerability in Berkeley are not directly at risk from sea level rise inundation, the loss or degradation of shoreline parks, trails, and educational spaces can disproportionately affect residents with limited access to private transportation, low-income families who rely on free or low-cost outdoor spaces, youth programs, and older adults who benefit from accessible recreational areas. These groups may experience reduced opportunities for physical activity, social connection, and environmental education as a result of climate-driven changes to the waterfront.

Sea level rise threatens structures and infrastructure. The 2019 Draft Berkeley Marina Area Sea Level Rise Assessment identifies specific locations at the Berkeley Waterfront susceptible to future inundation. Consistent with ***Figure 11***, the 2019 Draft Berkeley Marina Area Sea Level Rise Assessment identifies three locations in the Berkeley Waterfront that are most susceptible to intermittent inundation in the future due to Sea Level Rise: (1) Virginia Street Extension (north shore of McLaughlin Eastshore State Seashore) intersection with Marina Boulevard (2) South Shore of University Avenue (3) North-East side of the Berkeley Inner Harbor. Key transportation routes, such as underpasses and roads accessing Highway 80, are at risk of frequent flooding, impacting regional transportation. Additionally, Berkeley's stormwater and sanitary sewer systems, as well as natural gas pipelines, are vulnerable to inundation, potentially leading to service disruptions and methane leaks, which exacerbate climate change (City of Berkeley 2024(a)). None of the identified critical facilities are within the sea level rise inundation areas.

Cultural and natural resources are also at risk. The degradation of the revetment[6] protecting the shoreline could lead to erosion and loss of landmass at César E. Chávez Park, impacting trails, recreational areas, and habitats, including Western Burrowing Owl habitat. Sea level rise will inundate beaches and shoreline habitats, altering the Bay ecosystem, reducing wetlands, and affecting water quality and wildlife. Land subsidence, common in the Bay Area, can expand areas susceptible to sea level rise. Additionally, climate change and nutrient pollution could increase harmful algal blooms, endangering human health, the environment, and the economy (City of Berkeley 2024(a)).

[6] A revetment is a sloped structure placed on banks or shorelines made of materials such as rock, concrete, or geotextiles. Its purpose is to absorb and deflect the energy of incoming water, helping to prevent erosion and protect the land behind it.

Existing Programs to Offset Impacts

The City has two plans and one Study that include sea level rise mitigation programs, policies, and projects. The City's energy and natural gas provider is also evaluating their vulnerability to sea level rise impact. The list below provides information on the programs in place to help offset sea level rise impacts in Berkeley:

- **Berkeley Climate Action Plan (2009).** This plan calls for partnership with local, regional, and state agencies to reduce property damage associated with flooding and coastal erosion caused by sea level rise and more severe storm surge.
- **City of Berkeley LHMP (2024)**. This plan includes a medium-priority mitigation strategy to mitigate the impacts of sea level rise in Berkeley.
- **Sea Level Rise Assessment Study for the Berkeley Marina (2019)**. This study identifies three mitigation projects to mitigate sea level rise impacts in the Berkeley Marina. These include The Marina Boulevard Revetment Upgrade Project, University Avenue Shoreline Stabilization Project, and Collaborations with the East Bay Regional Park District for areas adjacent to or within their jurisdiction. The study projects sea level rise of 0.3 - 0.5 feet by 2030, 0.6 - 1.1 feet by 2050, and 3.4 feet by 2100 under high emission scenarios. The study also states that all current and upcoming capital projects in the Berkeley Marina near the shoreline will be designed to be resilient to mid-century sea-level rise and adaptable to end-of-century conditions.
- **PG&E Climate Adaptation and Vulnerability Assessment (2024).** This assessment is designed to address the impacts of climate-driven natural hazards on PG&E's operations and infrastructure. This comprehensive plan analyzes how sea level rise may affect PG&E's ability to provide safe and reliable energy. The assessment identifies potential vulnerabilities and outlines adaptation options to enhance resilience. It includes community engagement efforts to understand the specific needs of vulnerable populations and integrates climate risk into decision-making processes to ensure a clean and resilient energy system for all.

Sea Level Rise Vulnerability

While communities facing social vulnerability are not located directly within projected sea level rise inundation zones, they may still experience significant indirect impacts. These include reduced access to essential services, recreational spaces, and transportation routes, as well as economic disruptions tied to affected local businesses and employment centers. These communities often have fewer resources to adapt to or recover from such disruptions, due to systemic barriers such as underinvestment in infrastructure, limited mobility options, and historical exclusion from decision-making processes.

Although critical facilities are not currently located within areas projected to be directly inundated by sea level rise, they remain vulnerable to service disruptions caused by flooding of surrounding infrastructure, such as roads and utilities. These disruptions could hinder emergency response, healthcare access, and continuity of essential services.

Sea level rise poses a direct threat to the Berkeley Waterfront's natural resources. Public facilities, marinas, trails, and transportation infrastructure along the shoreline are at risk of flooding and long-term damage. In addition, coastal erosion and inundation could degrade sensitive habitats, reduce biodiversity, and limit access to recreational areas that support community well-being. Wetlands and shoreline ecosystems, which provide natural flood protection and carbon sequestration, are particularly at risk.

Existing programs aim to mitigate these impacts through various projects and partnerships, though most are broad in scope. However, there has been investment in localized studies to identify specific mitigation projects.

3.4 Groundwater Rise

Background, Historical Impacts, and Climate Change Exposure

Sea level rise can cause groundwater rise in coastal areas like Berkeley because rising sea levels exert pressure on the groundwater table, pushing it upwards. Sea level rise can cause marine flooding in coastal areas, and groundwater rise can cause the groundwater table to rise towards the ground surface or can cause groundwater inundation at the ground surface in low lying areas. Rising groundwater can mobilize contaminants at existing contaminated sites, dissolving them into the groundwater and transporting them with its flow. This can increase exposure for human and ecological receptors through several pathways:

- Bringing contaminants to the surface, increasing direct contact exposure.
- Bringing contaminants closer to or into building basements, increasing exposure through inhalation of vapors and direct contact.
- Flowing through more permeable soil, allowing contaminants to migrate more easily and increasing exposure through inhalation of vapors or direct contact.

Preferential pathways for this rising groundwater to flow in Berkeley include backfill materials for utility corridors, the utilities themselves, and historical creek alignments. Rising groundwater may also discharge into creeks and the San Francisco Bay, further increasing exposure for human and ecological receptors through direct contact.

The Shallow Groundwater Mapping project, conducted by the San Francisco Estuary Institute and Pathways Climate Institute, focuses on understanding the impact of sea-level rise on shallow groundwater levels in Alameda, Marin, San Francisco, and San Mateo counties. The project produced depth-to-groundwater maps for current conditions and ten future sea-level

rise scenarios. These maps highlight areas where groundwater may emerge or rise within 6 feet of the ground surface, posing risks to underground infrastructure (SFEI 2025).

In 2025, Rincon prepared the Groundwater Rise and Contaminated Site Analysis (Appendix B) for the City, which provides a detailed assessment and maps of current groundwater depth and contaminated sites within Berkeley. The report uses data from the Coastal Storm Modeling System (CoSMoS) to map the current groundwater levels across Berkeley. The groundwater table depth varies significantly across Berkeley, with some areas experiencing emergent groundwater at the surface, while others have groundwater depths ranging from 0 to 15 feet below ground surface. The hydraulic conductivity of the subsurface soil, which affects groundwater movement, was assumed to be moderate for purposes of the analysis (1 meter/day). This is important to note because higher hydraulic conductivity means contaminants can be more easily mobilized and transported by groundwater.

A total of 427 contaminated sites were identified within Berkeley using the GeoTracker and EnviroStor databases. These sites are categorized into several types, including:

- **Cleanup Program Sites:** 60 sites regulated under the SWRCB's Site Cleanup Program.
- **DTSC Cleanup Sites:** 46 sites including National Priorities List (Superfund), state response, voluntary cleanup, and corrective action sites.
- **DTSC Hazardous Waste Sites:** 2 sites.
- **Leaking Underground Storage Tank (LUST) Cleanup Sites:** 239 sites, primarily fuel-contaminated.
- **Land Disposal Site:** 1 site, the former Berkeley Landfill.
- **Non-Case Information Sites:** 42 sites with minimal impact or pending evaluation.
- **Permitted Underground Storage Tanks (USTs):** 33 sites.
- **Single-Walled UST Sites:** 4 sites required to be permanently closed by December 31, 2025.

As groundwater levels rise, contaminants at existing sites may be dissolved and transported more easily, posing new risks to human and ecological receptors. Rising groundwater levels associated with sea level rise will increase the risk of emergent groundwater at the surface, particularly in low-lying areas. Appendix B highlights that the hydraulic conductivity of the soil, which determines how easily groundwater can move through the subsurface, will play a crucial role in the extent of groundwater rise and the potential mobilization of contaminants. ***Table 3*** shows high, medium, and low priority contaminated sites for current conditions and sea level rise scenarios. The contaminated sites are ranked based on the potential risks posed by groundwater rise:

- **High Priority:** Sites where groundwater is at the surface or within 6 feet of the ground surface.

- **Medium Priority:** Sites where groundwater is deeper than 6 feet from the ground surface.
- **Low Priority:** Closed LUST sites, considered low threat due to natural attenuation of petroleum contaminants.

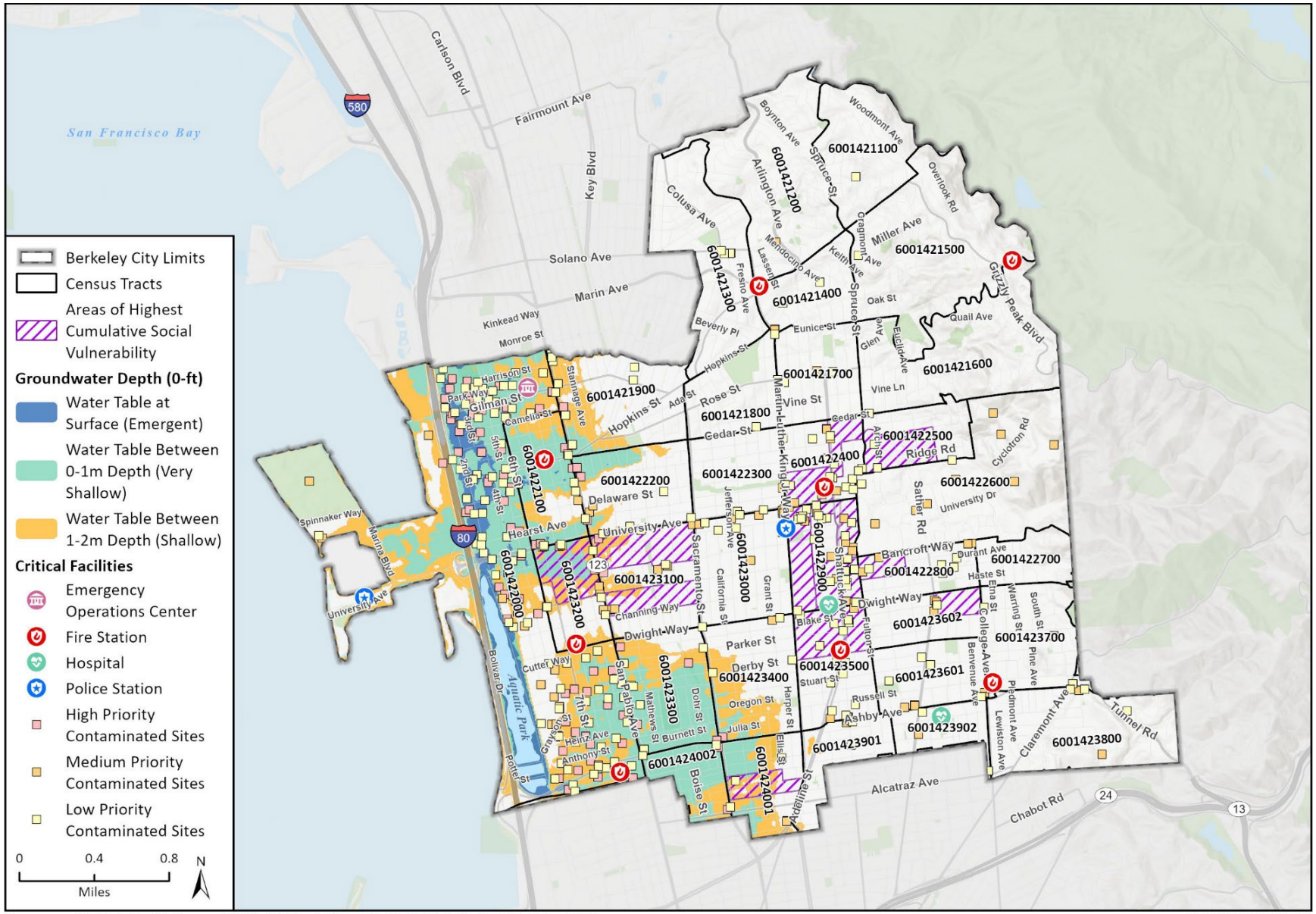
The rankings help guide policy decisions for disaster preparedness and environmental justice in Berkeley. Under current conditions, of the 427 contaminated sites within Berkeley, 100 are ranked as high priority, 100 as medium priority, and 227 as low priority. Going from current conditions to the 0.8 feet (25 cm) sea level rise scenario, only two sites change ranking from medium priority to high priority (the number of low priority sites remains the same). Going from the 0.8 feet (25 cm) sea level rise scenario to the 2.5 feet (75 cm) sea level rise scenario, no additional sites change ranking. ***Figure 12*** shows the locations of these sites and current conditions. As shown on ***Figure 13*** and ***Figure 14***, the known contaminated sites are in areas where there is not projected to be a lot of change in GWR using the 0.8 feet (25 cm) and 2.5 feet (75 cm) sea level rise scenarios. For more details on the methodology and results of this analysis, refer to Appendix B.

There are high and medium priority sites currently located in areas with shallow groundwater depths (surface to 2 meter depth) within communities that face social vulnerability in Census Tract 3200, 4001, and 3100. These communities face increased health risks due to the potential mobilization of contaminants by rising groundwater. Communities that face social vulnerability often have higher rates of chronic health conditions, limited access to healthcare, and inadequate infrastructure as a result of long-standing, systems-driven inequities. These conditions contribute to higher rates of chronic health issues and increased exposure to environmental hazards, making communities that face social vulnerability disproportionately impacted by climate and public health risks. Additionally, three fire stations are located near these high and medium priority sites, which are also in areas with shallow groundwater depths.

Table 3 Priority Sites by Sea Level Rise Scenario

Projected Groundwater Depth From CoSMoS Groundwater Model	High Priority Contaminated Sites	Medium Priority Contaminated Sites	Low Priority Contaminated Sites
Current Conditions	100	100	227
0.8 feet (25 cm)Sea Level Rise Scenario	102	98	227
2.5 feet (75 cm) Sea Level Rise Scenario	102	98	227

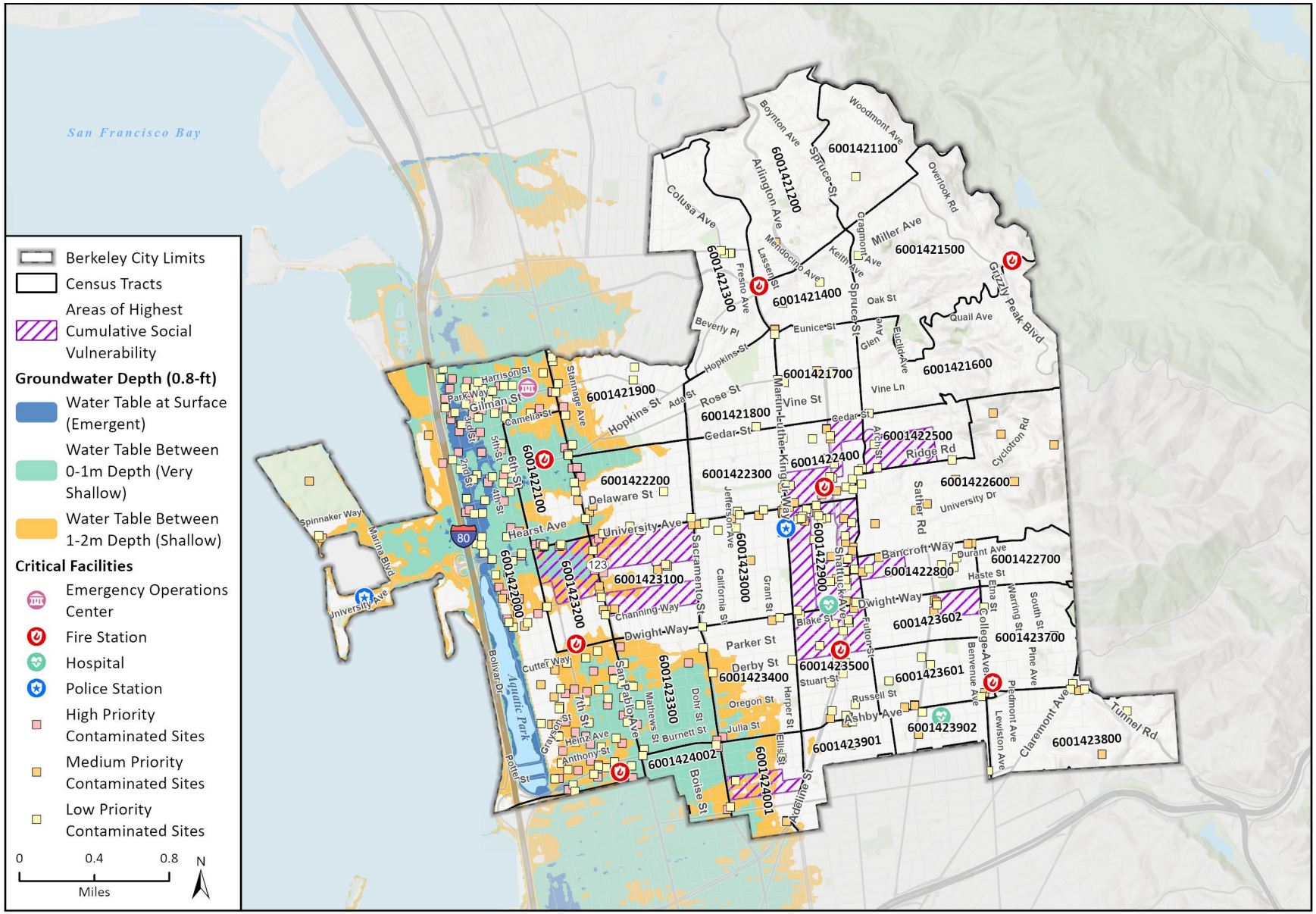
Figure 12 Groundwater Rise Current Conditions



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Social Vulnerability Index and Critical Facilities provided by City of Berkeley, 2025.

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Fig X Social Vulnerability Index and Groundwater Current

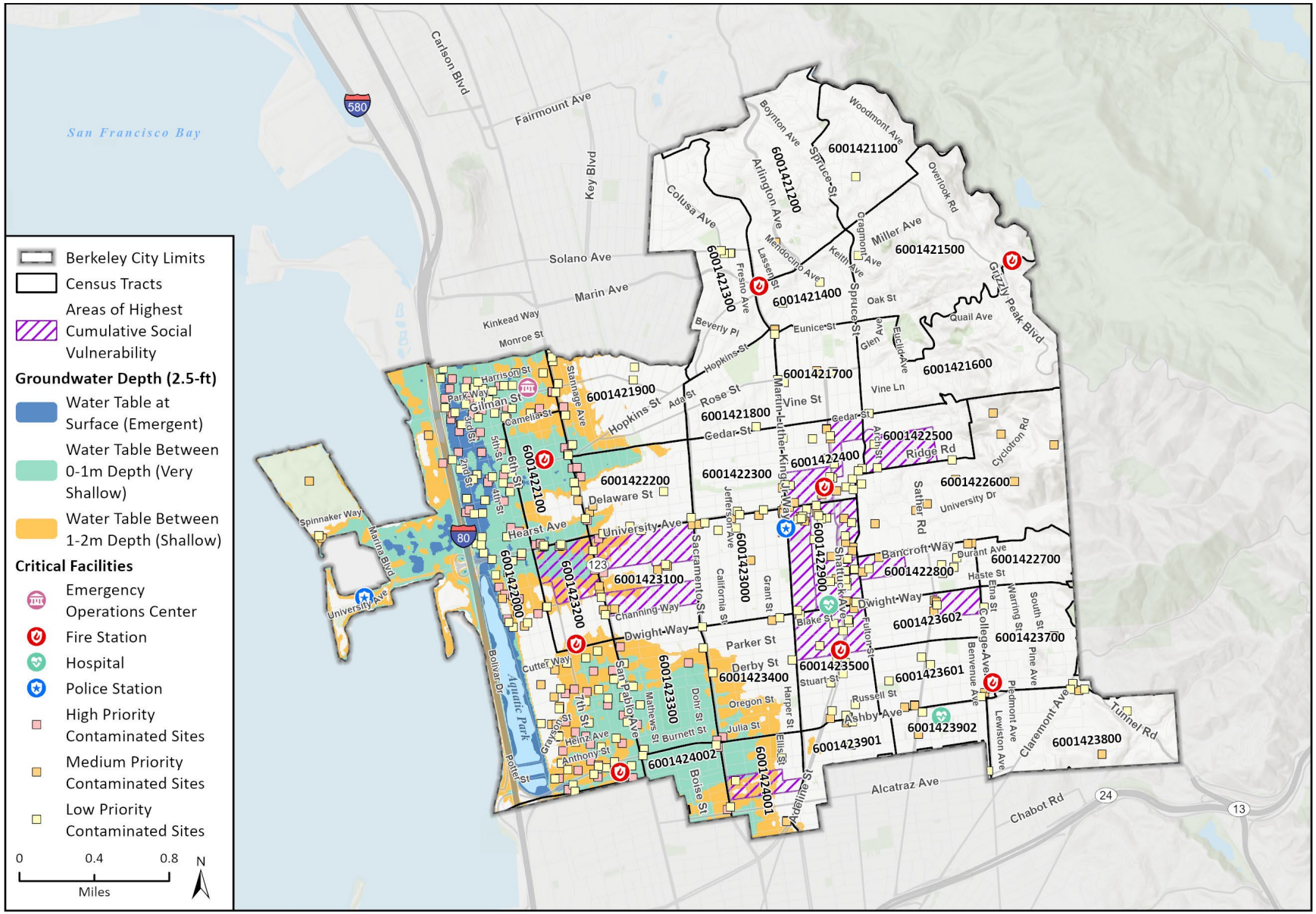
Figure 13 Groundwater Rise with 0.8 feet of Sea Level Rise



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Social Vulnerability Index and Critical Facilities provided by City of Berkeley, 2025.

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Fig X Social Vulnerability Index and Groundwater 0.8 ft

Figure 14 Groundwater Rise with 2.5 feet of Sea Level Rise



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Social Vulnerability Index and Critical Facilities provided by City of Berkeley, 2025.

23-15392 EPS Safety Element
Fig X Social Vulnerability Index and Groundwater 2.5 ft

Potential Impacts

Communities facing social vulnerability have increased health risks due to the potential mobilization of contaminants by rising groundwater. Such communities often have higher rates of chronic health conditions, limited access to healthcare, and inadequate infrastructure, making them particularly susceptible to environmental hazards. These communities are already at risk of exposure to harmful contaminants due to groundwater rise. Future sea level rise is expected to worsen this issue, increasing the likelihood that contaminants will migrate into homes and public spaces in already-affected areas. However, under the 0.8 feet (25 cm) and 2.5 feet (75 cm) sea level rise scenarios, no new communities that face social vulnerability are projected to become newly exposed to this hazard. In other words, while the severity of exposure may increase in areas already at risk, the geographic extent of exposure remains largely unchanged under these modeled scenarios.

Groundwater rise can impact the built environment by increased flooding and infrastructure damage. Roadways may be eroded from below and home foundations could crack. Additionally, rising groundwater can infiltrate underground utility systems, such as gas lines, electrical conduits, and telecommunication infrastructure, leading to corrosion, short circuits, and potential service disruptions (MIT Technology Review 2021). There are three fire stations located near these high and medium priority sites, which are in areas where projected groundwater rise is within 6 feet (approximately 2 meters) of the ground surface. These shallow groundwater depths indicate a high potential for emergent groundwater or interaction with underground infrastructure under current and future sea level rise scenarios. In addition, two skilled nursing facilities, Chaparral House and Silverado Berkeley Memory Care, are also located in these areas and within communities that face social vulnerability. These facilities serve individuals requiring ongoing medical support who may face serious health risks if exposed to service disruptions or environmental hazards. Given the potential for groundwater rise to compromise roads, utilities, and building systems, there is an elevated risk that these sites may require evacuation or resident relocation, an especially complex process. No additional critical facilities are exposed under the 0.8 feet (25 cm) and 2.5 feet (75 cm) sea level rise scenarios.

Increased groundwater levels can impact the natural environment through contamination of freshwater sources, affecting both surface water and aquifers. This can disrupt local ecosystems, leading to habitat loss and reduced biodiversity. For example, coastal aquifers may experience seawater intrusion, impacting aquatic habitats (IISD 2020). Additionally, changes in groundwater levels can alter the hydrology of wetlands and other sensitive ecosystems, further stressing native plant and animal species (Davamani et al. 2024).

Existing Programs to Offset Impacts

Currently, there are no programs in place to mitigate the impacts of groundwater rise in Berkeley. However, the City has conducted the analysis presented in Appendix B as an initial step towards developing such programs. Appendix B includes recommended strategies for the City to deploy to limit impacts.

Groundwater Rise Vulnerability

West Berkeley, especially the communities facing social vulnerability in Census Tracts 3200, 4001, and 3100, is significantly vulnerable to groundwater rise due to current exposure and the absence of programs to mitigate these impacts. Communities in these areas are currently at risk of contaminant exposure due to groundwater rise. Additionally, three fire stations located west of San Pablo Avenue are also vulnerable to groundwater rise due to current exposure. These fire stations are located in areas with potential for emergent groundwater or interaction with underground infrastructure under current and future sea level rise scenarios.

3.5 Extreme Heat

Background, Historical Impacts, and Climate Change Exposure

Extreme heat in Berkeley is characterized by days above 87.6°F (CEC n.d.). Warm nights are defined as nights that do not cool below 60.0°F (CEC n.d.). The urban heat island (UHI) effect exacerbates these conditions, particularly in densely built areas with limited vegetation and abundant dark surfaces that absorb and release heat. The urban heat island effect can worsen air quality, particularly ground-level ozone, in urban environments.[7] Berkeley's tree canopy, which varies significantly across different areas, helps mitigate the UHI effect by providing shade and cooling. Although the Berkeley Hills have a greater tree canopy, temperatures are often higher there than in the rest of Berkeley, due to thermal belting. Thermal belting occurs when heat absorbed by the ground during the day radiates upward at night, causing cooler air to sink into the valley and warmer air to rise and become trapped on the hilltop. In Berkeley, this results in the hills being hotter at night during extreme heat events compared to the rest of Berkeley (City of Berkeley 2024(a)). However, communities in the Berkeley Hills may be better resourced to cope with these conditions, with access to higher-quality housing, air conditioning, and healthcare, resources that are often limited in communities facing social vulnerability, where residents may live in older housing stock and face additional barriers to climate resilience.

[7] For more information on the impacts of poor air quality in Berkeley, refer to the City of Berkeley Environmental Justice Existing Conditions Report.

Berkeley has experienced regular extreme heat events from 2019 to 2023, though none have been federally declared disasters (City of Berkeley 2024(a)). Notable events include:

- **July 2006:** 5 days above 110°F in the Bay Area, resulting in approximately 75 heat-related deaths.
- **August 2017:** Record-setting temperatures, with a high of 108.5°F in Berkeley and six heat-related deaths in nearby counties.
- **June 2019:** An early season heat wave caused multiple power outages and three fatalities.
- **August 2020:** A prolonged heat wave with record-breaking temperatures, dry thunderstorms, and the worst air quality in the world due to wildfires.
- **September 2020:** Excessive heat and dry conditions broke numerous records, flared up wildfires, and caused widespread smoke and ash.
- **July 2021:** High temperatures up to 110°F, warm overnight lows, and the Diablo Fire due to dry conditions and breezy winds (City of Berkeley 2024(a)).

Climate change is expected to increase the frequency, duration, and seasonal occurrence of extreme heat events, worsening air quality, increasing fire risk, and straining utilities, potentially leading to power outages (City of Berkeley 2024(a)). In Berkeley, average maximum temperatures are expected to rise between 3.9°F (RCP 4.5) and 6.7°F (RCP 8.5) by the end of the century, while average minimum temperatures are projected to increase by 3.8°F (RCP 4.5) to 6.6°F (RCP 8.5) (CEC n.d.).[8] Historically, the region experienced an average of 3 extreme heat days per year between 1961-1990. By the end of the century, this number is expected to increase by 5 days per year under RCP 4.5 and approximately 12 days per year under RCP 8.5 (CEC n.d.). ***Figure 15*** and ***Figure 16*** show changes in average maximum temperature and extreme heat days, with purple lines representing high emissions scenarios (RCP 8.5), blue lines showing medium emissions scenarios (RCP 4.5), and grey lines indicating current trends. The shaded areas represent the range of data for each emissions scenario.

[8] Compared to the 1961 - 1990 baseline.

Figure 15 Annual Average Maximum Temperature in Berkeley

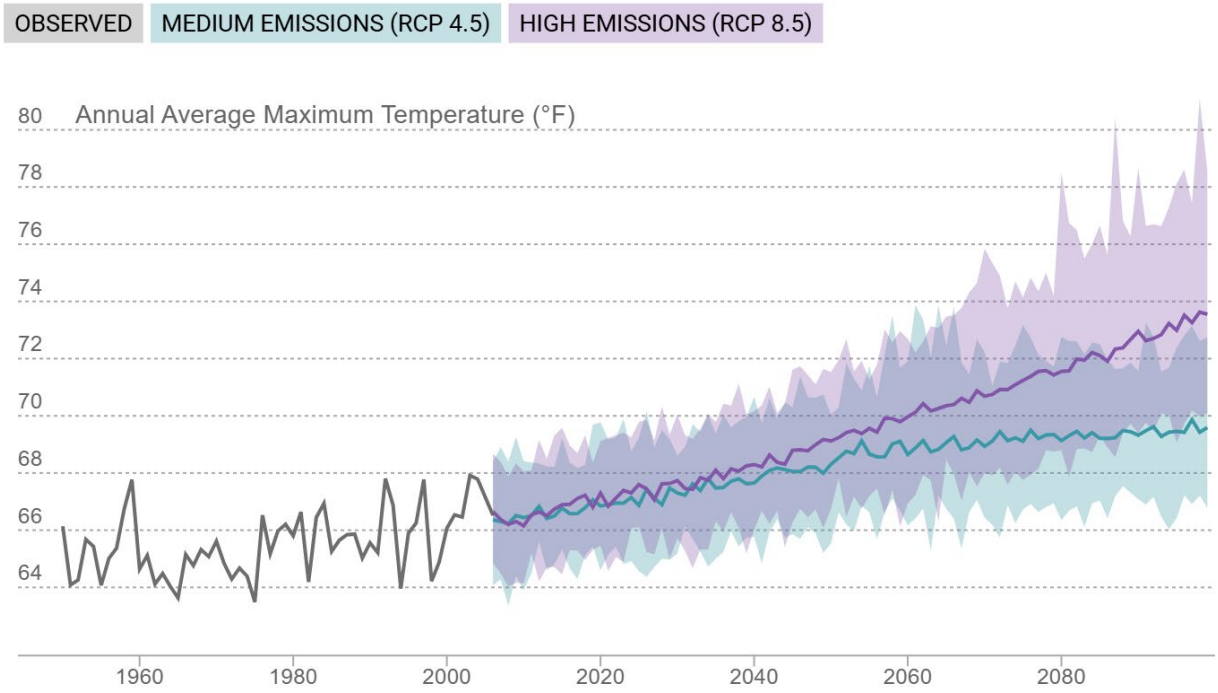
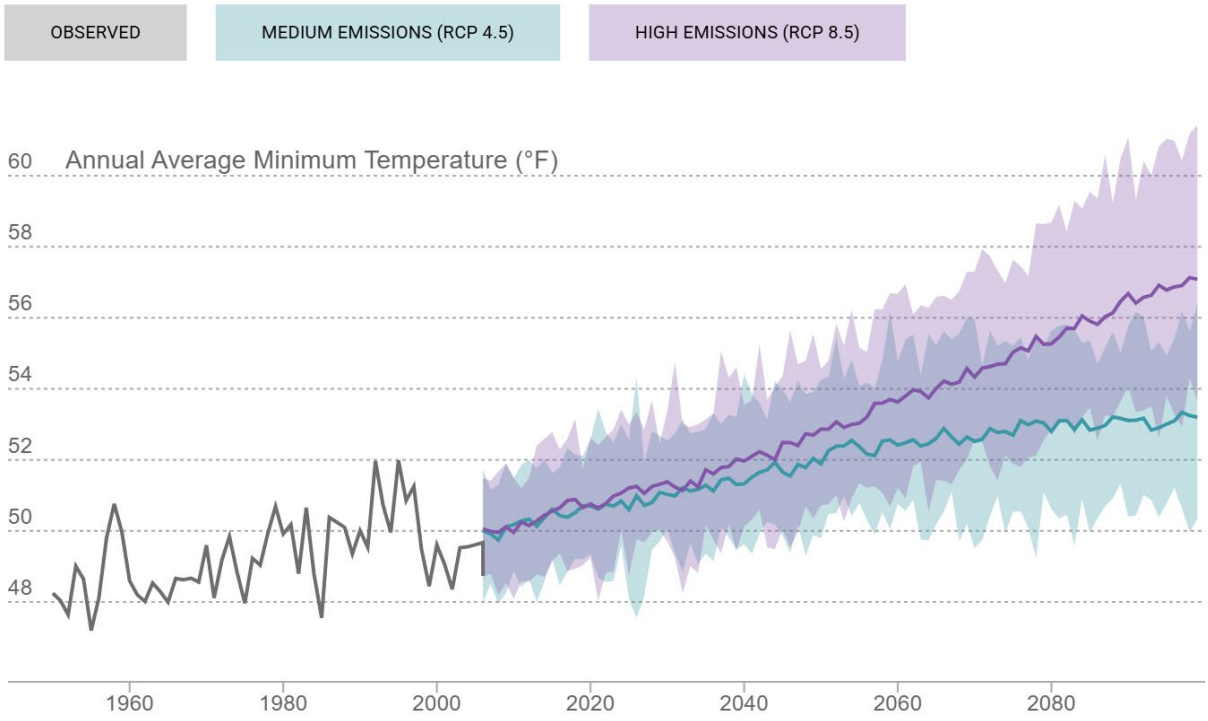


Figure 16 Extreme Heat Days in Berkeley



Potential Impacts

Extreme heat poses significant health risks to communities facing social vulnerabilities such as outdoor workers, people experiencing homelessness, seniors, young children, and individuals with chronic health conditions. These groups are at higher risk of heat-related illnesses, including heat stress, heat stroke, and dehydration, all of which can be life-threatening. Limited access to air conditioning and cooling centers exacerbates these risks. Communities experiencing social vulnerability, including communities of color (e.g., Black, African American, Indigenous, Native, Latinx, Hispanic, Asian, East Asian, Pacific Islander and other people of color) often live in housing with insufficient protection against extreme heat, further increasing their susceptibility to health impacts (Stanford Report 2023). In Berkeley, people experiencing homelessness are especially vulnerable due to their high exposure to heat and limited access to cooling resources. Unhoused individuals in urban areas like Berkeley face significant challenges in coping with extreme heat, including limited access to shade, water, and air-conditioned spaces (Gabbe et al. 2023). These individuals often experience heat-related illnesses such as dehydration, heat stroke, and exacerbation of pre-existing conditions like cardiovascular disease and diabetes (Gabbe et al. 2023). Additionally, barriers such as lack of information, transportation barriers, and restrictive policies at cooling centers further complicate their ability to seek relief (Gabbe et al. 2023).

The City of Berkeley has existing public facilities with air conditioning such as libraries and Senior Centers. In Berkeley, barriers to accessing these resources include reduced hours on weekends and holidays and limited hours of operation on weekday afternoons when temperatures peak. A lack of awareness of the danger of extreme heat and the availability of these facilities results in underutilization of these resources.

Extreme heat can strain hospitals and cooling centers, which are essential for providing relief during extreme heat events. Increased demand for medical services during extreme heat events can overwhelm healthcare facilities, leading to longer wait times and reduced capacity to treat patients (OASH 2023). Emergency responders may also face increased workloads, impacting their ability to respond effectively to other emergencies (DHS 2023). Extreme heat can lead to infrastructure damage and increased energy consumption. When temperatures exceed approximately 90°F, materials like asphalt and concrete can expand and buckle, causing damage to roads, railways, and bridges. This can result in transportation disruptions, increased maintenance costs, and safety hazards (CalHeatScore, 2024; Sustainable Earth Reviews, 2024). Additionally, cooling systems, including air conditioning units, become less efficient when temperatures rise above 95°F, leading to higher energy consumption and costs for building owners and occupants (U.S. EPA, 2023; ASID, 2023).

Extreme heat can impact the natural environment in Berkeley, including parks, forests, and wildlife habitats. High temperatures can cause heat stress and dehydration in wildlife, disrupting reproductive cycles and increasing mortality rates (State of California 2022). Plants may suffer from heat stress and drying, leading to reduced growth and increased susceptibility to pests and diseases (California Climate Adaptation Strategy n.d.). The timing of seasonal

warmth may not align with food availability, causing further stress to dependent species (State of California 2022). In Berkeley, areas with urban parks, green spaces, and coastal habitats are particularly vulnerable to these impacts (California Climate Adaptation Strategy n.d.).

Existing Programs to Offset Impacts

The City has several plans that include extreme heat mitigation programs, policies, and projects. The list below provides information on the programs to help offset extreme heat impacts in Berkeley.

- **2009 Berkeley Climate Action Plan.** This plan includes several policies and programs to offset extreme heat impacts. Key initiatives involve expanding urban tree canopy to provide shade and reduce heat island effects, promoting green building standards that incorporate cool roofs and energy-efficient designs, and enhancing green infrastructure such as rain gardens and permeable pavements to improve urban cooling. Additionally, the plan emphasizes community outreach and education on heat resilience and the benefits of green spaces. These measures collectively aim to create a cooler, more sustainable urban environment in Berkeley.
- **City of Berkeley 2024 LHMP.** This plan includes a high-priority mitigation strategy to reduce Berkeley's vulnerability to extreme heat events and associated hazards.
- **2012 Berkeley Watershed Management Plan.** This plan includes several policies and programs that indirectly contribute to mitigating extreme heat. Key initiatives include the use of green infrastructure measures such as bioretention cells, permeable paving, and vegetated swales, which help manage stormwater runoff and reduce urban heat island effects by increasing vegetation and permeable surfaces. Low impact development strategies aim to mimic natural hydrologic processes through conservation and small-scale stormwater controls, including rainwater harvesting and green roofs, which provide shade and cooling through evapotranspiration. The plan also emphasizes the importance of maintaining a healthy tree canopy to intercept rainwater and provide shade, thereby reducing heat stress in urban areas. Additionally, public outreach and education efforts are included to raise awareness about water resources and pollution prevention, which can also encompass the benefits of green spaces and vegetation in mitigating heat. These programs collectively contribute to creating a cooler, more resilient urban environment in Berkeley.
- **PG&E Climate Adaptation and Vulnerability Assessment.** This assessment includes specific considerations for extreme heat and maximum temperatures. The assessment analyzes how rising average and extreme temperatures can impact PG&E's infrastructure and operations. Extreme heat poses a threat to the electric system by increasing energy demand as customers use more electricity to cool their homes and businesses. Additionally, upgrades may be necessary to protect the company's infrastructure from heat damage and operational constraints.

- **Berkeley Resilience Strategy (2016).** This strategy includes a program to enhance community partners with preparedness tools, supplies and equipment to serve the communities that have been made the most vulnerable during events like extreme heat.

Extreme Heat Vulnerability

Extreme heat poses significant health risks to Berkeley's communities, especially communities facing social vulnerability such as outdoor workers, people experiencing homelessness, seniors, young children, and individuals with chronic health conditions. These groups are at higher risk of heat-related illnesses like heat stress, heat stroke, and dehydration. Limited access to air conditioning and cooling centers exacerbates these risks. Communities facing social vulnerability, including communities of color (e.g., Black, African American, Indigenous, Native, Latinx, Hispanic, Asian, East Asian, Pacific Islander and other people of color), often live in housing with insufficient protection against extreme heat as a result of systemic barriers such as discriminatory housing policies, underinvestment in infrastructure, and limited access to affordable, climate-resilient housing. These conditions increase exposure to heat-related health risks and reflect broader patterns of environmental and social inequity.

Extreme heat can also strain critical facilities, damage infrastructure, and impact the natural environment. Existing City programs, such as the 2009 Berkeley Climate Action Plan, the 2024 LHMP, and the 2012 Watershed Management Plan, include initiatives to mitigate extreme heat impacts through urban tree canopy expansion, green building standards, and green infrastructure enhancements.

3.6 Storm Drain Overflow and Creek Flooding

Background, Historical Impacts, and Climate Change Exposure

Floods occur when there is an overflow of water in areas that are normally dry. In Berkeley, three types of flooding typically occur: coastal flooding (described in section 3.3 Sea Level Rise), storm drain overflow, and creek flooding. Groundwater rise, driven by sea level rise and also capable of causing flooding, is detailed in section 3.4 Groundwater Rise.

Storm Drain Overflow

Berkeley's storm drainage infrastructure collects urban runoff and directs it to the Bay or nearby watercourses. Overflow can occur due to rainfall exceeding storm drain design thresholds, blockages, or damage to the infrastructure. Most of the system is designed to handle a 10-year storm, which is cost-effective and guides the sizing of drainage facilities. However, many components are over 90 years old, with eroded concrete pipes, corroded metal pipes, and sinkholes forming due to soil entering through cracks and defects (City of Berkeley 2024(a)).

The City maintains approximately 93 miles of storm drain pipelines and appurtenant structures in the public right-of-way and in easements. The City is responsible for the maintenance of approximately 0.5 miles of open creeks and nearly 4 miles of creek culverts running in the right of way or in City owned properties. A majority of the City's stormwater assets are nearing or past their expected useful life and others require an evaluation of hydraulic capacity.

During storms and flooding, community members call Berkeley's 3-1-1 service to report locations of storm drain backup or other locations where water is pooling. From January through June of 2023, which included two federally-declared storm emergencies, community members throughout Berkeley reported issues with storm drain overflow (City of Berkeley 2024(a)).

Creek Flooding

Like many urban areas, Berkeley's creeks have been impacted by urban development. Some stretches of creeks are completely contained within culverts, while open channel segments are often interrupted by shorter culverts to accommodate streets and development. Creeks in West Berkeley flow year-round, whereas the upper reaches of creeks only flow briefly after rainfall. When runoff exceeds a creek's capacity, floodwaters can overtop the banks, inundating properties and streets. Creek flooding in Berkeley typically originates on private property. To mitigate this, the City increases cleaning efforts in public rights-of-way before and during significant rainfall events. Residents are responsible for maintaining creeks and related infrastructure within their property.

The 100-year floodplain represents areas with a 1 percent chance of experiencing creek flooding in any given year, while the 500-year floodplain has a 0.2 percent chance of flooding annually. Areas within the 100-year Floodplain are also expected to flood during a 500-year flood scenario. Due to the rarity of floods reaching the 500-year Floodplain level, they are less researched, and specific impacts are less understood.

As shown in ***Figure 17*** in blue, in Berkeley the 100-year Floodplain is located:

- Along the edge of the Bay
- Along the interior edge of the Aquatic Park lagoon
- Along Cordonices Creek in northwest Berkeley
- Along Strawberry Creek in central Berkeley (on the University of California campus).

The following street segments are in the 100-year Floodplain:

- Along Cordonices Creek: 580 Highway, 2nd St., 5th St., 6th St., 8th St., 9th St., 10th St., Sacramento St., Monterey Ave.
- Potter St.
- Bay St.

- West Frontage Rd.
- On the UC Berkeley campus: Frank Schlessinger Way, West Entrance, Wickson Rd.

As shown in ***Figure 17*** in orange, the 500-year Floodplain both expands on areas in the 100-year floodplain, and adds more area to show:

- Additional inundation along the edge of the Bay
- Significant inundation of the McLaughlin Eastshore State Park in the land north of University Ave.
- Significant inundation of the Marina in the land west of Marina Blvd. and south of Spinnaker Way
- Inundation in West Berkeley between Interstate 80 and approximately 4th St.
- Inundation along Strawberry Creek in Central Berkeley, from Sacramento St. west to Strawberry Creek Park
- Inundation along Claremont Creek in the Temescal area, on Claremont between Hazel Rd. to Berkeley's southern border.

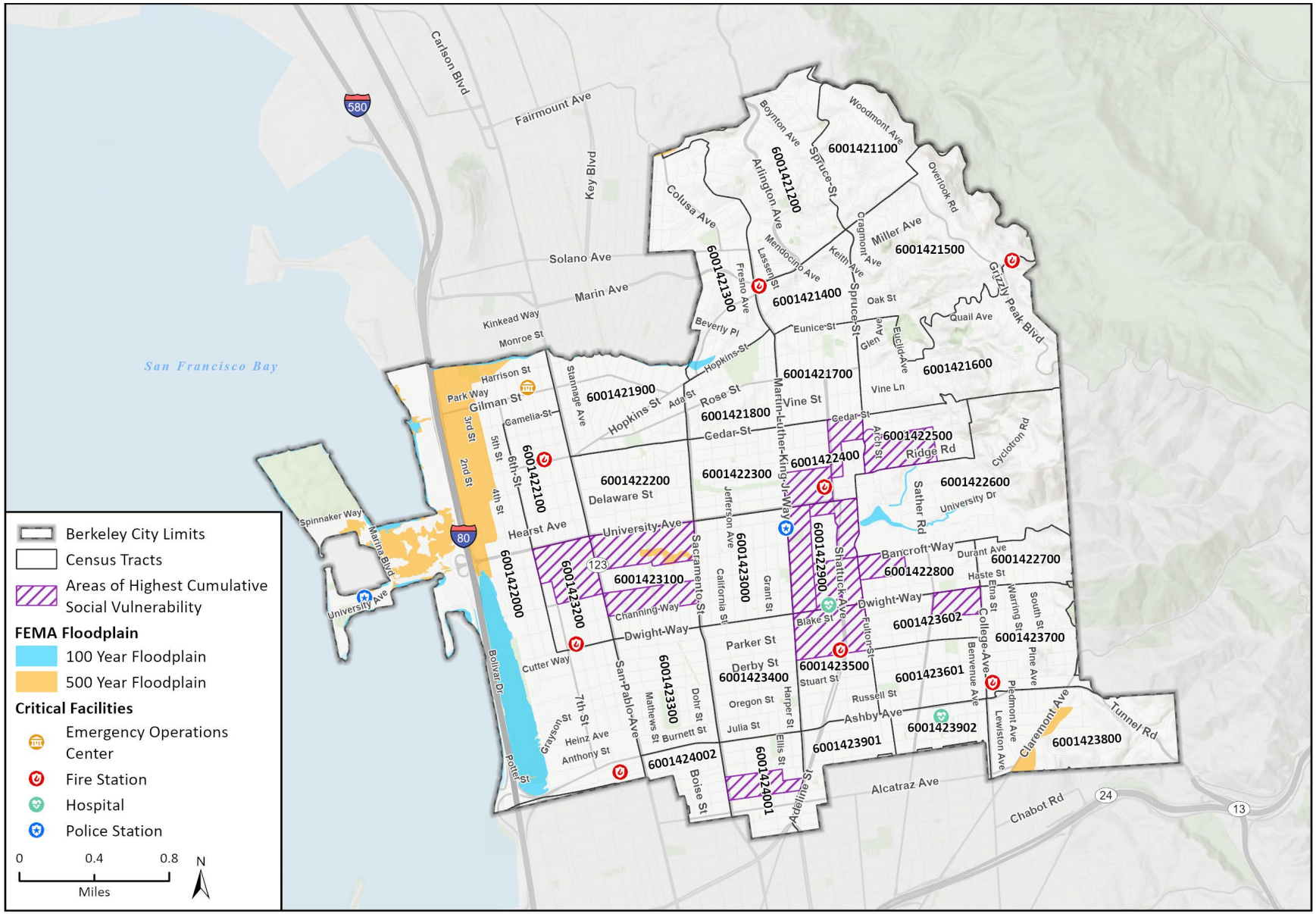
The following street segments are in the 500-year Floodplain:

- West Berkeley:
  - I-80
  - 1st St. (from Harrison St. to Addison St.)
  - 2nd St. (from Harrison St. to Addison St.)
  - 3rd St. (from Harrison St. to Addison St.)
  - 4th St. (from Harrison St. to Addison St.)
  - 5th St. (from Harrison St. to Addison St.)
  - University Ave. (Near the Marina)
- North Berkeley:
  - Colusa Ave. (along Cerrito Creek)
- Central Berkeley:
  - Allston Way (from North Valley St. to Sacramento St.)
  - Bonar St. (between Addison St. and Allston Way)
  - West St. (between Addison St. and Allston Way)
  - North Valley St.
  - Acton Crescent
  - Acton Circle
  - Acton St. (from Addison St. to Acroft Ct.)

- Claremont:
  - Claremont Ave. (between Hazel Rd. and Mystic St.)
  - Alcatraz Ave. (from Lewiston Ave. to Claremont Ave.)
  - Eton Ave.
  - Eton Ct.
  - Brookside Ave.
  - Hillcrest Rd. (only near Claremont Creek)
  - Woolsey St. (between Eton Ave. and Claremont Ave.)
  - The Uplands (only Near Claremont Creek)
  - Encina Pl.
  - The Plaza Dr.
  - Prince St. (from College Ave. to Claremont St.)
  - Oakvale Ave.
  - Hazel Rd.
  - Webster St. (between Pine Ave. and Claremont Ave.)

As shown in ***Figure 17*** census tracts within the 100-year Floodplain include 2000, 1300, and 2600. None of these are home to communities facing social vulnerability. Census tracts within 500-year Floodplain include 2000, 3100, and 3800. Census Tract 3100 includes communities that face social vulnerabilities. There are no critical facilities within the 100-year Floodplain or 500-year Floodplain.

Figure 17 100-Year and 500-Year Floodplains in Berkeley



Basemap provided by Esri and its licensors © 2025. Additional data provided by FEMA, 2025.
Social Vulnerability Index and Critical Facilities provided by City of Berkeley, 2025.

23-15392 EPS Safety Element
Fig X Social Vulnerability and Flood Hazards

Berkeley experienced significant flooding in December 2022 and January 2023 due to powerful storm systems that brought over 15 inches of rain in 20 days, an event that occurs only once every 50 years according to the National Oceanic and Atmospheric Administration (NOAA). The winter of 2023 saw severe storms with flooding, high winds, and landslides, leading to three federally declared disasters in Alameda County. In October 2022, an atmospheric river caused heavy rains, nuisance flooding, and downed trees and powerlines. Historical flooding events include widespread flooding in 2004, the 1997-1998 El Niño season, and the early 1960s when Strawberry and Codornices Creeks overflowed, causing short-duration, shallow flooding in small areas, including some buildings on the UC Berkeley campus (City of Berkeley 2024(a)).

Climate Change Exposure

Climate change is projected to increase the intensity and frequency of extreme precipitation events in the San Francisco Bay Area. This will result in more severe storm drain overflow and creek flooding. The region's largest winter storms, known as atmospheric rivers, are expected to become more intense, contributing to heavy rainfall and substantial flood risk. Increased precipitation variability, with more frequent "boom and bust" cycles, will exacerbate these conditions. The combination of higher rainfall and rising sea levels will challenge existing stormwater management systems, leading to increased overflow and flooding (Ackerly 2018). Given the climate projections, relying on a 10-year storm design is inadequate. This standard, which is commonly used in stormwater management, may not account for the increased intensity and frequency of extreme precipitation events. Additionally, culvert sizing may be deficient, given climate change projections, and could lead to exacerbated creek overflows and heightened flood risks. More information on the climate change exposure and impacts of sea level rise can be found in Section 3.3 Sea Level Rise and Section 3.4 Groundwater Rise.

Potential Impacts

Flooding can disrupt daily life and pose health risks to residents. Communities facing social vulnerabilities, including communities or individuals experiencing poverty and homelessness, are particularly vulnerable. These individuals often live in flood-prone areas and lack the resources to evacuate or recover from flood damage. Flooding can lead to injuries, loss of personal belongings, and displacement, exacerbating existing inequities. Additionally, damage to hospitals and healthcare facilities can limit access to medical care, exacerbating health impacts during and after flooding (City of Berkeley 2024(a)). Flooding can also cause mold and mildew to grow on damp surfaces, posing health risks to humans and animals (City of Berkeley 2024(a)).

Critical facilities such as fire stations, police stations, and emergency operations centers are essential for community safety and functioning. Climate change-induced flooding can damage these facilities, disrupting essential services and emergency response capabilities. For example, inundation of fire stations can impede rescue operations during flood events. The

built environment, including residential and commercial buildings, transportation infrastructure, and utilities, is susceptible to flood damage. Flooding can cause structural damage to buildings, leading to costly repairs and potential displacement of residents and businesses.

Flooding can also impact the natural environment, including parks. Floodwaters can erode soil, damage vegetation, and alter habitats, impacting biodiversity and ecosystem services. Aquatic species may be particularly vulnerable to changes in water quality and flow patterns. Flooding can also lead to sedimentation in waterways, affecting water quality and aquatic habitats.

Existing Programs to Offset Impacts

The City has several plans that include storm drain overflow or creek flooding mitigation programs, policies, or projects. The list below provides information on the programs in place to help offset extreme precipitation events and flooding impacts in Berkeley

- **City of Berkeley 2024 Local Hazard Mitigation Plan Update.** The LHMP update includes one high-priority mitigation strategy to maintain City participation in the National Flood Insurance Program and a medium-priority mitigation strategy to reduce Berkeley's vulnerability to severe storms and associated hazards through proactive research and planning, zoning regulations, and improvements to stormwater drainage facilities.
- **City of Berkeley Green Infrastructure Plan.** The purpose of this Green Infrastructure Plan is to guide the identification, implementation, tracking, and reporting of green infrastructure projects within the City of Berkeley. "Green infrastructure" refers to a sustainable system that slows runoff by dispersing it to vegetated areas, harvests and uses runoff, promotes infiltration and evapotranspiration, and/or uses bioretention and other low impact development practices to improve the water quality of stormwater runoff.
- **Berkeley Vision 2050: Sustainable and Resilient Infrastructure.** Former Berkeley Mayor Jesse Arreguin launched Vision 2050, an initiative to encourage long-term planning to meet the serious challenges to our infrastructure, including climate change, inequality, population increases, and obsolescence. The Vision 2050 Task Force was formed in Spring 2018 and included over 40 Berkeley community members with technical expertise and in-depth knowledge.
- **2012 Berkeley Watershed Management Plan.** This plan includes several policies and programs aimed at flood mitigation. Key initiatives involve enhancing stormwater infrastructure to manage runoff and reduce flooding risks by upgrading drainage systems and implementing green infrastructure like rain gardens and permeable pavements. Additionally, the plan focuses on updating floodplain maps to better understand flood risks and inform planning and development decisions. Community engagement is also a priority, with efforts to educate residents about flood risks and encourage participation in flood preparedness activities. Emergency response plans are

being developed and refined to ensure quick and effective action during flood events. Collectively, these measures aim to reduce the impact of flooding on Berkeley's communities and infrastructure.

- **Berkeley Stormwater Master Plan (in progress).** The purpose of this plan is to identify key deficiencies in the stormwater system, prioritize capital improvement projects, identify funding needs, develop City specific drainage design standards, and update maintenance and inspection plans for stormwater facilities. The Plan would also analyze potential funding mechanisms to supplement current funding levels for the program as needed to support enhanced operations, regulatory compliance implementation, and capital improvements identified.
- **PG&E Climate Adaptation and Vulnerability Assessment.** This assessment is designed to address the impacts of climate-driven natural hazards on PG&E's operations and infrastructure. This comprehensive plan analyzes how extreme storms and flooding may affect PG&E's ability to provide safe and reliable energy. The assessment identifies potential vulnerabilities and outlines adaptation options to enhance resilience. It includes community engagement efforts to understand the specific needs of vulnerable populations and integrates climate risk into decision-making processes to ensure a clean and resilient energy system for all.

Storm Drain Overflow and Creek Flooding Vulnerability

Flooding in Berkeley disrupts daily life and poses serious health risks, particularly for communities facing social vulnerability in Census Tract 3100. These communities reside in flood-prone areas due to a legacy of exclusionary land use policies, discriminatory housing practices, and economic disinvestment that have limited access to safer, climate-resilient neighborhoods. These systemic factors have concentrated risk in specific geographies, often without adequate infrastructure or emergency planning support. As a result, residents may lack the resources to evacuate safely or recover after a disaster, leading to disproportionate risks of injury, loss of personal belongings, and displacement. Flooding can also damage hospitals and healthcare facilities, limiting access to medical care, and cause mold growth, posing health risks. Although there are no critical facilities located within the 100-year or 500-year Floodplains, they may be vulnerable to storm drain overflow, which has occurred throughout Berkeley. Critical facilities such as fire stations and police stations are crucial for public safety but can be disrupted by flood damage. The built environment, including homes, businesses, and infrastructure, is susceptible to costly repairs and displacement. Additionally, flooding affects the natural environment by eroding soil, damaging vegetation, and altering habitats, impacting biodiversity and ecosystem services. To mitigate these impacts, the City has implemented several programs. The Local Hazard Mitigation Plan (LHMP) includes strategies to maintain participation in the National Flood Insurance Program and reduce vulnerability to severe storms through proactive research, planning, zoning regulations, and improvements to stormwater drainage facilities. The Berkeley Watershed Management Plan

focuses on enhancing stormwater infrastructure, upgrading drainage systems, implementing green infrastructure, updating floodplain maps, and engaging the community in flood preparedness activities. These measures aim to reduce the impact of flooding on Berkeley's communities and infrastructure.

3.7 Drought

Background, Historical Impacts, and Climate Change Exposure

Drought is defined as a prolonged period of deficient rainfall relative to the statistical multi-year average for a region, resulting in water shortages that affect ecosystems, agriculture, and human activities. Historically, Berkeley has experienced impacts from droughts, particularly multi-year droughts. These droughts have led to diminished water supplies, necessitating stringent water conservation measures and the development of diversified and resilient water supply portfolios to ensure long-term water reliability. For instance, the 1987-1992 drought period was a critical time that highlighted the need for improved water management and infrastructure to mitigate the effects of future droughts. EBMUD's response to these challenges includes implementing a comprehensive drought management program and investing in infrastructure improvements to enhance water supply reliability during drought conditions (EBMUD 2020(a)).

Climate change is expected to lead to more intense droughts in Berkeley. Rising temperatures will increase evaporation rates, reducing water availability and exacerbating drought conditions. Additionally, changes in precipitation patterns, with more frequent and severe dry spells, will further strain water resources (Ackerly 2018). In Berkeley, the maximum length of days without rain is expected to increase by 8 days (RCP 4.5) and 11 days (RCP 8.5) by the end of the century.[9]

Potential Impacts

For communities facing social vulnerability, including low-income households and individuals experiencing homelessness, drought can exacerbate existing inequities. Limited access to water can lead to health issues, reduced hygiene, and increased stress, further straining these communities (Pacific Institute 2016). Water shortages can also lead to increased water rates, making it more difficult for low-income households to afford their water bills.

Critical facilities such as fire stations are essential for community safety and functioning. Drought can strain these facilities by reducing water availability for firefighting (Association of Bay Area Governments n.d.). This can hinder emergency response capabilities and compromise public health and safety during drought conditions.

[9] Compared to the 1961 - 1990 baseline of 102 consecutive days without rain each year.

Drought also significantly impacts the natural environment. Reduced water levels can lead to habitat loss, affecting biodiversity and ecosystem services (The Climate Reality Project n.d.). Aquatic species are particularly vulnerable to changes in water quality and flow patterns, which can lead to population declines (Pacific Institute 2022). Additionally, drought can increase the risk of wildfires, further threatening natural habitats and species (The Climate Reality Project n.d.). Soil erosion and vegetation loss due to drought can alter landscapes, reducing the resilience of ecosystems to future climate events.

Existing Programs to Offset Impacts

Drought mitigation efforts for Berkeley are led by EBMUD. EBMUD has implemented a comprehensive set of policies and programs to mitigate the impacts of drought within its service area. The district's Water Shortage Contingency Plan outlines staged responses to drought conditions, including demand reduction measures, customer conservation incentives, and supply augmentation strategies. Key programs include mandatory and voluntary water use restrictions, expanded public outreach and education campaigns, and rebate programs for water-efficient appliances and landscaping. Additionally, EBMUD actively pursues water recycling projects and regional water transfers to supplement supply during shortages. The 2020 Urban Water Management Plan further supports these efforts by incorporating long-term resilience planning, including investments in infrastructure improvements and groundwater banking partnerships. Together, these measures help EBMUD respond to drought conditions while maintaining reliable water service for its customers.

Drought Vulnerability

Berkeley faces limited drought vulnerability. Communities who face social vulnerability, particularly low-income households and individuals experiencing homelessness, are disproportionately affected, as limited water access can exacerbate health issues, reduce hygiene, and increase financial strain due to rising water costs. Critical facilities, such as fire stations, may also experience reduced water availability, potentially hindering emergency response efforts and public safety. Additionally, drought poses severe risks to the natural environment, leading to habitat loss, declining aquatic species populations, and an increased risk of wildfires, which further degrade ecosystems.

To address these challenges, EBMUD has implemented a range of drought mitigation programs, including water conservation incentives, public outreach, and supply augmentation strategies such as water recycling and regional transfers. The district’s long-term resilience planning, outlined in the 2020 Urban Water Management Plan, further strengthens Berkeley’s ability to adapt to drought conditions through infrastructure investments and underground water storage, known as groundwater banking.

4 Human-Made Hazards

Hazardous materials release could harm community members by exposing people to vapors that are toxic, suffocating, cause burns or are irritating. Hazardous materials release can threaten not only life and property, but also the environment, in areas such as creeks, the Aquatic Park lagoons and the San Francisco Bay.

The impacts of a release depend on its chemical characteristics, the amount and rate of substance spilled, the location, and its dispersion. Flammable and combustible materials can cause fires in areas that are largely constructed of wood; they may also cause explosions. Wind speed and direction, as well as topography, can greatly impact the dispersion plume of a release.

A hazardous materials release can occur throughout the city near where hazardous materials are manufactured, stored, used, or transported. Hazardous materials release can occur as a result of a natural hazard, such as earthquake shaking, or can happen accidentally. In Berkeley, a hazardous material event is more likely to occur in the City's industrial area in West Berkeley where there is a concentration of industrial sites and transportation routes.

Airborne toxic plumes, including smoke, can travel into Berkeley from surrounding cities. Petrochemical refineries and other large chemical facilities in Contra Costa County could release hazardous materials that could impact the Berkeley community.

Hazardous materials also travel through Berkeley by truck and rail.

There are 528 facilities within Berkeley that are regulated by the Toxics Management Division.[10] The majority of the 528 facilities in Berkeley are Level 3 automotive- or medically-related facilities with limited quantities of hazardous materials and hazardous waste.

Berkeley has not recently experienced significant hazardous materials releases secondary another natural hazard. However, the city has experienced industrial accidents from both mobile and fixed sources.

Existing Programs to Offset Impacts

Over the last 25 years, Berkeley has seen a more than 90 percent reduction in the number of facilities with extremely hazardous materials. The City carefully tracks hazardous materials within its borders, and works closely with companies using large amounts of potentially dangerous materials.

[10] Of the 528 facilities indicated, 469 meet chemical minimums; the remainder are smaller hazardous waste only generators that do not meet volume thresholds quotes. There are many more facilities that have some sort of hazardous materials on their sites, but they are not regulated by the City's Toxics Management Division (per City of Berkeley Toxics Management Division, August 2023).

Potential Impacts

According to the Environmental Protection Agency, hazardous materials may irritate the skin or eyes, make it difficult to breath, cause headaches and nausea, or result in other types of illness. Some hazardous substances can cause far more severe health effects, including: behavior abnormalities, cancer, genetic mutations, physiological malfunctions, physical deformations, and birth defects.

In the wildland-urban interface (WUI) in the Berkeley hills, there are two major sources of dangerous chemicals: UC Berkeley and the Berkeley Lab. Both have significant amounts of flammable and toxic chemicals, including radioactive chemicals. While both sites have active disaster preparedness programs, WUI fires are notoriously difficult to fight and hazardous materials could be released in a major conflagration.

Outside of the WUI, the Bayer facility located in West Berkeley operates a large ammonia refrigeration system. Bayer is considered Berkeley's highest-risk industrial facility and is regulated under CalARP. Risks associated with the Bayer facility could include release of hazardous materials due to seismic activity or accident.

Roadway or railroad closures during a transportation-related hazardous material release could have serious impacts on the local economy and the ability to provide essential services. Hazardous materials can also contaminate water systems, impacting service and public health.

Hazardous materials can be devastating to animals and the natural environment. Hazardous materials can kill organisms, destroy plants and animals, causing health complications in animals, and or limit the ability of the ecosystem to survive.

5 Public Safety Services

5.1 Fire Protection

The City operates its own Fire Department. The Berkeley Fire Department provides 24-hour response to fires, medical emergencies, hazardous materials events, water rescues, disasters, and other life-threatening situations. Its dedicated personnel prevent and prepare for these emergencies through training, fire prevention, disaster preparedness, and public education programs (Berkeley Fire Department n.d.). There are seven fire stations, a Division of Training facility, Fire Administration Office, Fire Warehouse, and Water Rescue facility located in Berkeley (City of Berkeley n.d.(a)). Station locations and apparatus assigned to each station are listed in ***Table 4***.

Table 4 Fire Stations

Station & Address	Apparatus Assigned
Station 1 2442 Eighth Street 94710 (510) 981-5510	• Engine One • Ambulance (Medic 1) • Ambulance (Reserve)
Station 2 2029 Berkeley Way 94704 (510) 981-5520	• Battalion Chief • Truck Two • Engine Two • Ambulance (Medic 2) • Type VI 4x4 • Hazardous Materials Vehicle • Reserve Truck • Reserve Ambulance • Utility Vehicle
Station 3 2710 Russell Street 94705 (510) 981-5530	• Engine Three • Ambulance (Medic 3) • Reserve Ambulance
Station 4 1900 Marin Avenue 94707 (510) 981-5540	• Engine Four • Reserve Engine
Station 5 2680 Shattuck Avenue 94704 (510) 981-5550	• Engine Five • Truck Five • Ambulance (Medic 5) • Reserve Engine Type III
Station 6 999 Cedar Street 94710 (510) 981-5560	• Engine Six • Reserve Engine

Station & Address	Apparatus Assigned
Station 7 3000 Shasta Road 94708 (510) 981-5570	• Engine Seven • Reserve Engine • Quick Response Vehicle • EBRPD Engine (Seasonal)
Division of Training 997 Cedar Street 94710 (510) 981-5595	• Training Tower & Classroom • Division of Training • Division of Emergency Medical Services (EMS)
Fire Administration 2100 Martin Luther King Jr. Way 94704 (510) 981-FIRE (3473)	• Office of the Fire Chief • Division of Fire Prevention • Administrative Support Staff • Office of Emergency Services
Fire Warehouse 1011 Folger Ave 94710 (510) 981-FIRE (3473)	• Storage for fire response equipment, including Above Ground Water System
Water Rescue Berkeley Marina (510) 981-FIRE (3473)	• “Confidence” Fire boat and rescue watercraft

The City of Berkeley Fire Department has established several mutual aid agreements to enhance its emergency response capabilities. These agreements include partnerships with CAL FIRE for wildfire response, the City of Albany and the City of Oakland for fire protection and emergency medical services, and participation in the Alameda County Mutual Aid system. Additionally, Berkeley collaborates with the Alameda County Fire Chiefs for structural, wildland, and hazardous materials response. These agreements enable Berkeley to effectively mobilize resources and personnel during emergencies, providing comprehensive support and enhancing community safety.

5.2 Police Protection

The City also operates its own Police Department. The Berkeley Police Department is a professional full-service law enforcement agency providing public safety for community members by engaging with the public, keeping the peace and responding to emergencies (City of Berkeley n.d.(b)). The Berkeley Police Headquarters is located at 2100 Martin Luther King, Jr. Way, Berkeley and the Berkeley Police Traffic Bureau Substation is located at 125 University Avenue, Berkeley. In 2020 the City also began the Reimagining Public Safety (RPS) Initiative. The goal of the RPS initiative is to foster an equitable, holistic, and community-centered approach to safety, transforming traditional public safety models to prioritize health, wellness, and security for all residents. Through a collaborative, multidisciplinary strategy, the RPS initiative seeks to reshape the scope of a traditional police-centered model, address systemic inequities, and enhance community trust and wellbeing. The multi-year initiative includes a

comprehensive and inclusive process that is unfolding in three main phases from 2020 to 2026. (City of Berkeley 2024(b)).

As part of Phase 2 implementation, the Diversity, Equity and Inclusion (DEI) Officer position was established. The DEI Officer leads the Diversity, Equity and Inclusion Division within the City Manager's Office. The primary vision guiding the DEI Division is to centralize and embed equity and justice practices within the City's infrastructure. By adopting this approach, the City aspires to not only address present disparities but also to cultivate strong alliances with community organizations. The overarching goal is for City Departments to continue to evolve into entities that are both responsive and truly accountable to the diverse communities they serve.

5.3 Public Health and Environmental Health

The City of Berkeley Public Health Emergency Preparedness (PHEP) program is responsible for the administration of the PHEP and Pandemic Influenza grants. The PHEP program provides strategic planning and training to strengthen the Health, Housing and Community Services Department to respond to a range of public health threats, including infectious diseases, natural disasters, and biological, chemical, nuclear, and radiological events. The PHEP program leads the medical and health planning efforts for emergency response to disasters that impact the health of our community. PHEP collaborates with many different stakeholder groups, including healthcare facilities, community-based organizations, law enforcement, fire personnel, other programs within the City's Department of Health, Housing and Community Services and many more to ensure a coordinated and effective response for the whole community.

The City's Planning and Development Department, Toxics Management Division (TMD) is the City's regulatory agency and a State-Certified Unified Program Agency (CUPA), responsible for implementing, inspecting and enforcing California Environmental Protection Agency and hazardous materials codes associated with the Governor's Office of Emergency Services and State Fire Marshall within the City of Berkeley. TMD also responds to community complaints, assists the City with toxicological concerns, and inspects industrial sites for storm water pollution prevention.

6 Disaster Readiness

The State of California mandates that all municipal governments prepare and plan for potential emergencies, including natural, human-made, and health-related events. The City and agencies that serve Berkeley aim to protect residents, property, and infrastructure in the event of a disaster through comprehensive land use controls, effective hazard mitigation, robust emergency response efforts, and proactive community programs.

Major disaster readiness efforts in Berkeley include:

- Implementation of mitigation measures identified in the City of Berkeley LHMP, including regular updates to the LHMP
- Implementation of the City of Berkeley Community Wildfire Protection Plan
- Establishment and implementation of policies, authorities, structures, and responsibilities of the departments and the Emergency Operations Center in the City of Berkeley Emergency Operations Plan
- Implementation of urban flood reduction policies and programs in the City of Berkeley Watershed Management Plan
- Water conservation measures and programs identified in the EBMUD Urban Water Management Plan (2020), including regular updates to the Urban Water Management Plan
- Operation of AC Alert, Genasys Protect, and the outdoor warning system three tools among others thatkeep residents informed about emergencies
- Provision of emergency skills training for the community through the Community Emergency Response Training (CERT) and other disaster preparedness and fire safety training through the City of Berkeley Fire Department
- Upgrades to buildings and infrastructure to comply with building and fire codes
- Incentive program for residential structures to seismically upgrade buildings

The City deploys several other programs to increase readiness for the Berkeley community. More information can be found here: https://berkeleyca.gov/safety-health/disaster-preparedness

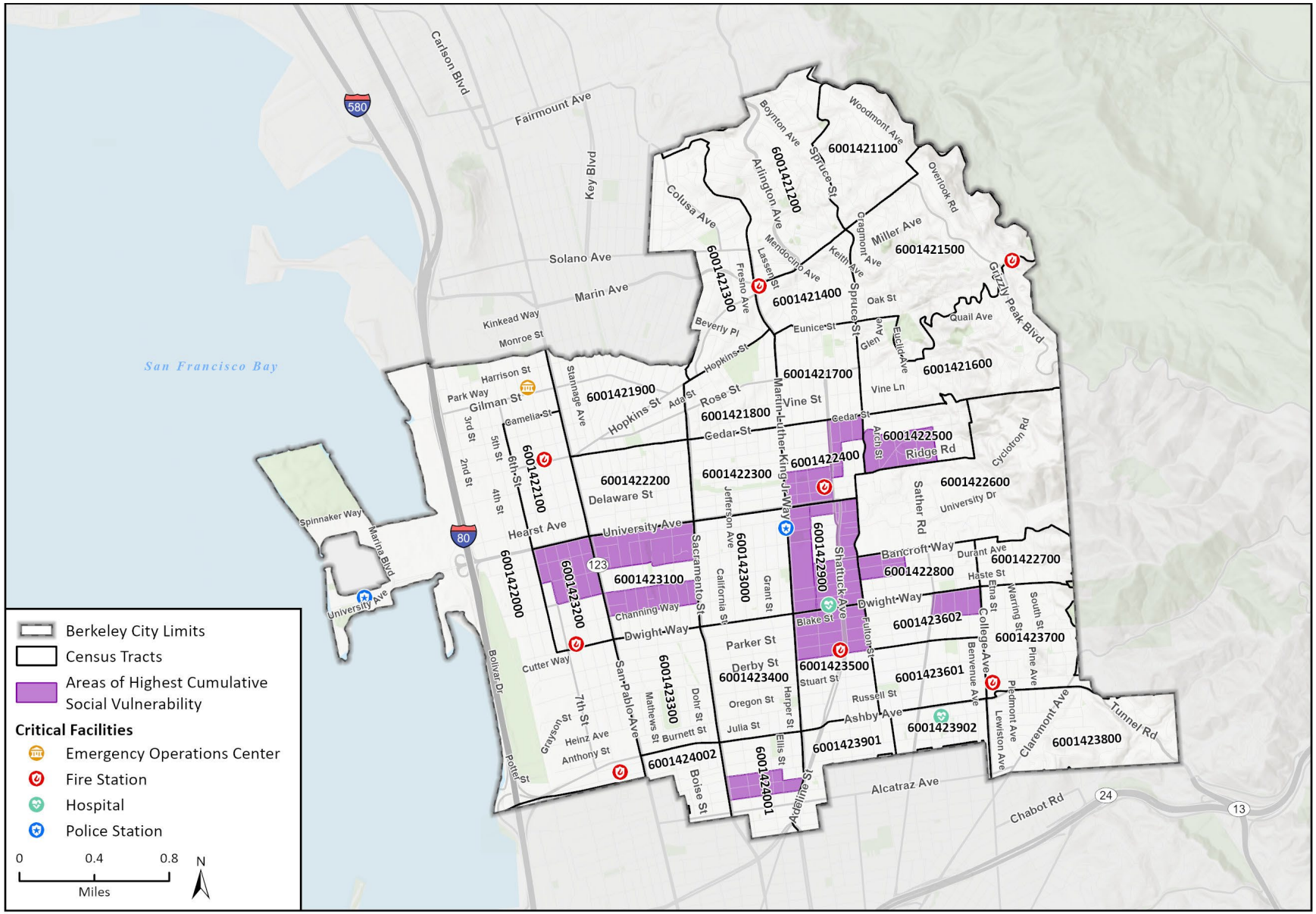
6.1 Critical Facilities and Services

Figure 18 shows the critical facilities identified in Berkeley as part of the Disaster Preparedness and Safety Element update process. Critical facilities include eight fire facilities, two police facilities, two emergency operations centers, and two hospitals. Fire facilities are distributed throughout Berkeley. The police stations are centrally located near the intersection of Martin Luther King Jr. Way and University Avenue, and at the Berkeley Marina off University

Avenue. The hospitals are situated in south Berkeley, one on Ashby Avenue and the other on Dwight Way.

Critical facilities are generally well-distributed across the City, with several located within or near census tracts identified as having high cumulative social vulnerability. These vulnerable areas, concentrated primarily in the central and southern parts of the City, benefit from the proximity of essential services that can support emergency response and public safety during wildfire events. While some facilities, like the Emergency Operations Center, are situated outside the most vulnerable zones, others, such as fire stations and hospitals, are positioned to provide more immediate access to communities with heightened needs.

Figure 18 Critical Facilities in Berkeley



Basemap provided by Esri and its licensors © 2025.
Social Vulnerability Index and Critical Facilities provided by City of Berkeley, 2025.

23-15392 EPS Safety Element
Fig X Critical Facilities

6.2 Emergency Evacuation

State government code mandates cities to identify residential developments in hazard areas with fewer than two emergency evacuation routes. In February 2024, the City prepared the Access Impaired Neighborhood Analysis, fulfilling the requirements of California Government Code Section 65302(g)(5) and Senate Bill 99. The Access Impaired Neighborhood Analysis relied on various data sources, including CAL FIRE Fire Hazard Severity Zones, FEMA flood zones, tsunami zones, earthquake zones, and street centerline data, to locate Access Impaired Neighborhoods. The analysis also identified Berkeley's most narrow and winding roads with conditions that can exacerbate challenges for evacuation. For more results of this detailed analysis and information on methodology, see Appendix C.

State government code mandates cities to identify evacuation routes and their capacity, safety, and viability under various emergency scenarios. In March 2024, following the completion of the Access Impaired Neighborhood Analysis (mentioned above and provided as Appendix C), the City completed the Evacuation Route Safety, Capacity, and Viability Analysis, addressing the requirements of California Government Code Section 65302.15 and Assembly Bill 747. The analysis utilized multiple data sources, including crash data, pavement conditions, flood zones, earthquake zones, and fire hazard severity zones, to evaluate the safety, capacity, and viability of evacuation routes within the City of Berkeley. The report identifies evacuation routes with the highest capacity, safety, and viability and evacuation routes that are more vulnerable during emergency evacuation events due to narrow, winding roads and exposure to hazards like flooding and landslides. For more information on the methodology and results of the analysis, see Appendix D.

Including the two analyses mentioned above, the City of Berkeley conducted a comprehensive Evacuation Time Study. This study was completed in July 2025. The study models how evacuation might unfold during a wildfire, tsunami, or other emergency situation, and analyzes factors such as roadway capacity, transportation resource needs, and expected evacuee behavior. The study identified evacuation time estimates, compared evacuation times to how quickly hazards like wildfires or Tsunamis could impact the community, and other factors that could inform emergency response strategies, including housing policy, public alert systems, transportation planning, and roadway design. For more information on the Evacuation Time Study methodology and results, see Appendix E.[11]

[11] Additional information is also available on the City of Berkeley Office of Emergency Services webpage at: https://berkeleyca.gov/community-recreation/news/study-stresses-need-household-fire-and-evacuation-plans.

7 Cascading Impacts

Berkeley's critical facilities, services, and infrastructure are vulnerable to climate change and natural hazards. Cascading impacts refer to a chain reaction of consequences that occur when one system or infrastructure failure leads to subsequent failures in other interconnected systems. For example, a power outage can disrupt communication networks, water supply systems, transportation, and emergency services, creating a ripple effect that broadens the scope of impact beyond the initial failure. These interconnected failures can affect multiple subsystems and populations, exacerbating the overall impact of the initial event.

Communities facing social vulnerability, such as low-income households, people with disabilities, seniors, and communities of color, often have fewer resources to prepare for, respond to, and recover from these disruptions. For example, a power outage may disproportionately affect individuals who rely on medical devices, lack access to backup power, or depend on public transit for evacuation. These compounding effects can deepen existing inequities and prolong recovery timelines for already marginalized populations. Below are summaries of the key cascading impacts in Berkeley.

7.1 Energy Systems

Cascading impacts on energy systems include power outages caused by wildfire, extreme heat, flooding, and earthquakes. Loss of power in homes would prevent community members from running their air conditioning or gas or electric heaters, and gas and electric kitchen appliances. For individuals who rely on in-home medical and/or mobility devices, power disruption could directly impact health and safety. If the power outages occur during bad air quality days from regional wildfire smoke, people with underlying health conditions could experience worsening health conditions. Traffic signals, cell-towers without back-up power, and critical facilities that lack backup power would cease to function. Losing many of these energy dependent amenities during events like heatwaves and wildfires can create increased risks to public health, including heat related illness, food access constraints, evacuation challenges, overloaded emergency services, and increased hazard exposure.

7.2 Water Systems

The East Bay Municipal Utility District (EBMUD) provides water service in Berkeley. The EBMUD water supply system collects, transmits, treats, and distributes high-quality water from its primary source, the Mokelumne River, to its customers. EBMUD’s secondary water source is local runoff from the East Bay area watersheds, which is stored in the terminal reservoirs outside city limits and within EBMUD’s service area (EBMUD 2020(a)).

EBMUD maintains two key long-term planning documents, updated at least every 5 years in accordance with the Urban Water Management Planning Act (California Water Code Section 10610-10657): the Urban Water Management Plan and the Water Shortage Contingency Plan.

In the 2020 Urban Water Management Plan, EBMUD assesses water supplies against expected demands over a 30-year planning horizon. The plan outlines actions to address future uncertainties, including a diversified and resilient water portfolio, as well as recycled water and conservation programs (EMBUD 2020(a)). The 2020 Water Shortage Contingency Plan provides a framework to address potential water shortages, exploring a range of scenarios to test assumptions and adapt to changes such as climate impacts, population growth, and other uncertainties. These plans are crucial components of EBMUD's long-range strategy to ensure reliable water service, particularly during multi-year drought periods (EBMUD 2020(b)).

Berkeley's water systems could face significant challenges due to higher water usage and lower availability during extended drought and extreme heat conditions. Wildfire mitigation during droughts further depletes water resources. These issues can raise water rates and impact public health, especially for people who are unable to afford higher costs. Water shortages also affect power generation and firefighting efforts, and insufficient water can harm Berkeley's tree canopy, which helps cool the area and manage stormwater.

Sea level rise can cause saltwater to contaminate freshwater sources and increase coastal flooding, damaging water infrastructure. Rising groundwater levels can lead to flooding from below, impacting underground water infrastructure. Extreme heat boosts water demand for cooling and landscaping, speeds up evaporation, and raises wildfire risk. Heavy rains and flooding can damage water facilities and contaminate sources, overwhelming stormwater systems. Earthquakes can break pipelines and reservoirs, disrupt water supply, and trigger fires, increasing water demand for firefighting and disrupting water supplies.

7.3 Transportation System

Several freeways and major arterial routes run directly through wildfire, landslide, liquefaction, and earthquake hazard zones in Berkeley, creating broad transportation system and infrastructure vulnerabilities. There are many resulting cascading impacts from transportation sector disruptions which could result in mobility isolation for the community, reduced ability for emergency services to respond, and constrained evacuation routes. Transportation impacts can occur from a wide range of causes including direct physical damage associated with climate hazards within city limits or external climate impacts afflicting regional transportation networks and services. Power outages could cause traffic signal failures. Transit system failures could place the community in increased danger with inability to evacuate or seek medical attention.

Interstate 80 and State Route 13, as well as University Avenue and Ashby Avenue, overlap multiple hazard zones and simultaneously serve as major evacuation routes. This type of infrastructure exposure can result in both city-wide and regional cascading impacts, limiting evacuation and emergency service accessibility.

7.4 Communication System

Communication networks, which consist of utility, telephone, and broadband infrastructure, can experience disruptions and service failures from exposure to extreme heat, wildfires, landslides, and flooding. The viability of a communication network is greatly improved with redundant communication networks, backup power, and alternative forms of communication (e.g., radio) to help minimize the extent of impact to community members. The cascading impacts resulting from downed communications can vary from interrupted evacuation communications to general isolation and heightened risk due to inability to receive hazard information. Areas across Berkeley that fall within hazard zones, such as portions of West Berkeley near the shoreline, hillside neighborhoods prone to landslides, and areas with aging infrastructure, are more likely to experience communication service interruptions. These disruptions can trigger cascading impacts, including delayed emergency response, isolation of communities facing social vulnerability, and breakdowns in coordination among critical services.

7.5 Food Systems

Food supply chains, including transportation, storage, and distribution infrastructure, can experience disruptions and service failures from exposure to extreme heat, wildfires, landslides, and flooding. The viability of food systems is greatly improved with redundant supply chains, backup power for storage facilities, and alternative distribution methods to help minimize the extent of impact to community members. The cascading impacts resulting from disrupted food systems can vary from interrupted food deliveries to increased food insecurity and heightened risk due to inability to access safe and nutritious food.

Climate hazards can also significantly impact food production. Extreme heat can stress crops and livestock, reducing yields and productivity. Wildfires can destroy agricultural land and contaminate water sources, while landslides can bury crops and disrupt irrigation systems. Flooding can lead to soil erosion and waterlogging, making land unsuitable for farming. Drought can reduce water availability and quality, leading to crop failure and pasture losses, and can also contribute to insect outbreaks and increased wildfire risk. These impacts can result in decreased food availability and increased prices regionally, further exacerbating food insecurity.

7.6 Healthcare Systems

Healthcare systems are impacted by various climate hazards, including wildfires, extreme heat, flooding, and earthquakes. Wildfires can lead to increased respiratory issues and cardiovascular problems due to smoke inhalation, causing a surge in emergency visits and straining healthcare facilities. Additionally, wildfires can directly damage healthcare infrastructure and necessitate evacuations, disrupting services and reducing access to care.

Extreme heat events result in a higher patient load with heat-related illnesses such as heatstroke, dehydration, and kidney damage, often overwhelming hospitals and clinics and leading to overcrowding. The strain on infrastructure, including power outages affecting cooling systems and medical equipment, further exacerbates the situation. Flooding due to extreme precipitation can damage healthcare facilities, increase demand for services due to injuries and infections, and disrupt transportation routes, making it difficult for patients and healthcare workers to reach facilities. The stress associated with flooding can also lead to long-term mental health issues. Earthquakes pose a severe threat to healthcare systems by causing structural damage to facilities, increasing trauma cases, and disrupting utilities such as water, electricity, and telecommunications. Evacuations may be necessary, further straining the healthcare system. Each of these hazards requires robust emergency preparedness and response plans to mitigate their impacts and ensure continuity of care. The recovery process for any disaster will impact the communities that have been made the most vulnerable at disproportionate rates (SAMSA, 2017). The stress associated with disasters can also lead to long-term mental health issues which may require an increased level of services provided by the city and its partners.

7.7 Hazardous/Toxic Materials

Climate hazards such as wildfires, sea level rise, groundwater rise, and flooding can have cascading impacts on hazardous and toxic materials, posing risks to public health and the environment. Wildfires can lead to the release of toxic materials from burned structures, including asbestos, lead, mercury, and chemicals from household products. These materials can contaminate the air and soil, posing health risks if inhaled or managed improperly. Sea level rise threatens coastal hazardous waste facilities, potentially leading to the release of toxic substances into the environment. Rising tides can inundate these facilities, causing incalculable damages and environmental harm if not addressed. Groundwater rise, driven by sea level rise, can infiltrate polluted sites, including contaminated sites, and spread hazardous substances such as heavy metals, pesticides, and industrial chemicals. This can expose nearby communities to significant health risks. Flooding from extreme precipitation can trigger chemical spills from industrial sites, sewage systems, and household waste. Floodwaters can carry these toxic materials, leading to health issues such as dermatitis, rashes, burns, headaches, and nausea.

8 Summary

Berkeley faces significant challenges related to hazard risks, which require comprehensive planning and mitigation strategies to ensure community safety and resilience. The key findings from this report are summarized below. These findings highlight the need for robust emergency preparedness, mitigation strategies, and community engagement to address the diverse challenges posed by hazards in Berkeley.

Equity Considerations

- **Equity Gaps:** Across all topics assessed, there is a need to center policies and programs on communities facing social vulnerability. Current plans and strategies lack sufficient data, analysis, and clarity on how equity—particularly cultural responsiveness, language access, and geographic service distribution—is integrated into climate resilience, public safety, and disaster readiness efforts.

Hazards

- **Geologic and Seismic Hazards:** Berkeley is at risk from earthquakes due to its proximity to active faults like the Hayward Fault. Earthquakes can cause ground shaking, surface fault rupture, liquefaction, and landslides. Specific areas at risk include the Berkeley Marina and Eastshore State Park, which are susceptible to liquefaction, and the Berkeley Hills, which are at risk of landslides. In West Berkeley, three fire stations, both police stations, and the skilled nursing facilities, Chaparral House and Silverado Berkeley Memory Care are also susceptible to liquefaction. Additionally, one fire station in the Berkeley Hills, just east of Grizzly Peak Boulevard, is at risk of landslides. The LHMP outlines mitigation strategies to address these risks. The City offers grant opportunities and transfer tax rebates for seismic work to encourage property owners to undertake voluntary seismic updates.
- **Tsunami:** Tsunamis can impact Berkeley's shoreline, with updated inundation maps identifying vulnerable areas. Specific areas at risk include the Berkeley Marina, portions of Interstate 80, the San Francisco Bay Trail, the Amtrak Station, Aquatic Park, and the Fourth Street Business District. The City has measures in place to manage tsunami risks outlined in the LHMP.
- **Wildfire and Poor Air Quality:** Berkeley is vulnerable to wildland-urban interface fires, exacerbated by factors such as low humidity, high winds, climate change, and development patterns near fire-prone areas. Historical fires like the 2017 Grizzly Fire, 1991 Tunnel Fire, and 1923 Berkeley Fire highlight Berkeley’s susceptibility. Certain areas face elevated risk, particularly Census Tract 2500, which includes communities that face social vulnerability and lies within a High Fire Hazard Severity Zone. The Berkeley Hills, are also at heightened risk due to their combination of dense housing and proximity to flammable natural landscapes. Within this area, North Berkeley Hills

and Panoramic Hill are particularly vulnerable due to their high housing density, which housing density exceeding four structures per acre, well above the two-structure-per-acre threshold identified by the National Institute of Standards and Technology as indicative of high structural density in wildland urban interface zones. Across the City, all residents are exposed to poor air quality from wildfires, but communities facing social vulnerability (located in Census Tracts 2500, 2400,2900, 2800, 3602, 3500, 4001, 3100, 3200) are disproportionately at risk from its health and economic impacts. Programs like the Community Wildfire Protection Plan and LHMP help to mitigate these risks.

    - **Policy Gaps:** The City has established strong implementation programs and protocols to mitigate wildfire impacts. However, there is a need to center these policies and programs more explicitly around communities experiencing social vulnerability, as highlighted under the Equity Considerations and Gaps bullet above.

- **Sea Level Rise:** Rising sea levels threaten Berkeley's shoreline and low-lying areas, leading to flooding, infrastructure damage, and increased liquefaction risk. Specific areas at risk include the Berkeley Waterfront, which is most vulnerable to sea level rise, with potential for frequent flooding and infrastructure damage. Key transportation routes, such as underpasses and roads accessing Highway 80, are at risk of frequent flooding. César E. Chávez Park is at risk of erosion and loss of landmass, impacting trails, recreational areas, and habitats. The LHMP and Berkeley Marina Area Sea Level Rise Assessment identifies mitigation strategies and projects to address these impacts.
    - **Policy Gaps:** Existing programs aim to mitigate sea level rise impacts through projects and partnerships that are broad in scope. There has been investment in a localized study to identify specific mitigation projects for sea level rise and it would be beneficial to conduct more of these studies to address the needs of specific communities identified as vulnerable for geographic and equity considerations.

- **Groundwater Rise:** Sea level rise can cause groundwater rise in coastal areas like Berkeley because rising sea levels exert pressure on the groundwater table, pushing it upwards. Rising groundwater can mobilize contaminants at existing contaminated sites, dissolving them into the groundwater and transporting them with its flow. This can increase exposure for human and ecological receptors through several pathways. Specific areas at risk include West Berkeley, which is particularly vulnerable due to shallow groundwater depths and the presence of contaminated sites. Communities that face social vulnerability in Census Tracts 3200, 4001, and 3100 face increased health risks due to potential contaminant mobilization. Three fire stations are located near high and medium priority contaminated sites. In addition, two skilled nursing facilities located in communities that face social vulnerability may face elevated risks from groundwater rise, which could impact health, disrupt infrastructure, and require complex evacuations of residents who rely on ongoing medical support.

- **Policy Gaps:** The City does not currently have policies or programs to mitigate groundwater rise. However, the findings of the Groundwater Rise and Contaminated Site Analysis (Appendix B) and this report will serve as a foundation for developing new policies and programs to address this issue.

- **Extreme Heat:** Extreme heat in Berkeley is characterized by days above 87.6°F. The urban heat island (UHI) effect exacerbates these conditions, particularly in densely built areas with limited vegetation and abundant dark surfaces that absorb and release heat. Berkeley has experienced regular extreme heat events from 2019 to 2023, though none have been federally declared disasters. Across the City, all residents are exposed to extreme heat, but communities facing social vulnerability (located in Census Tracts 2500, 2400,2900, 2800, 3602, 3500, 4001, 3100, 3200) face disproportionate health and economic risks due to limited resources and adaptive capacity. The Berkeley Hills, which experience higher temperatures at night during extreme heat events due to thermal belting, are also at risk though residents may be better equipped to cope due to greater access to resources and higher-quality housing. Areas with limited tree cover, such as neighborhoods identified during the City of Berkeley Safety Element Update Community Workshop #1 (February, 2025), are also at risk.
    - **Policy Gaps:** Most of the City's extreme heat mitigation policies and programs are broadly written, making implementation challenging. It would benefit the City to explore specific policy recommendations addressing extreme heat and the impacts of climate change, especially in areas of Berkeley with communities facing social vulnerability.

- **Storm Drain Overflow and Creek Flooding:** Floods occur when there is an overflow of water in areas that are normally dry. In Berkeley, three types of flooding typically occur: coastal flooding, storm drain overflow, and creek flooding. Increased precipitation and aging infrastructure contribute to storm drain overflow and creek flooding. Specific areas at risk include the 100-year Floodplain, which includes areas along the edge of the Bay, Aquatic Park lagoon, Codornices Creek, and Strawberry Creek. The 500-year Floodplain expands on the 100-year Floodplain, including additional areas in West Berkeley, McLaughlin Eastshore State Park, and the Marina. Census Tracts within floodplains include 2000, 1300, and 2600 (100-year floodplain); 2000, 3100, and 3800 (500-year floodplain), with Census Tract 3100 including communities facing social vulnerability.
    - **Policy Gaps:** Approximately half of the City's existing policies and programs aimed at mitigating flood risks are underfunded. Additionally, the current flood mitigation policies do not explicitly address the impacts of climate change, which is crucial for developing effective and resilient strategies.

- **Drought:** Droughts lead to water shortages, impacting communities and ecosystems. EBMUD's drought management programs and infrastructure improvements aim to enhance water supply reliability.
    - **Policy Gaps:** The City does not currently have a Water Action Plan which could guide work to mitigate impacts of future droughts, and to reduce water use by municipal operations, residents and businesses and improve stormwater management. This type of a Plan could work in tandem with the Watershed Management Plan, EBMUD Plans, Green Infrastructure Plans, and more.

Public Safety Services

- **Fire and Police Protection:** Berkeley operates its own Fire and Police Departments, providing essential services including fire response, medical emergencies, hazardous materials management, and law enforcement. The Fire Department has seven stations and various specialized facilities, while the Police Department has two main locations.
- **Reimagining Public Safety:** Berkeley is shifting towards community-based solutions and alternative response teams to address issues like mental health crises, homelessness, and traffic enforcement, aiming to enhance community trust and wellbeing.
- **Water Service:** Water service is provided by EBMUD, which has long-term planning documents to ensure reliable water supply, including the Urban Water Management Plan and the Water Shortage Contingency Plan.

Disaster Readiness

- **Disaster Readiness:** Berkeley has implemented various disaster readiness measures, including the City's LHMP, Community Wildfire Protection Plan, Emergency Operations Plan, Watershed Management Plan, Public Health Emergency Preparedness program, and water conservation programs. The City also operates emergency alert systems and provides community emergency response training.

Cascading Impacts

Hazards do not impact all communities equally. Communities already facing systemic challenges, such as limited access to healthcare, economic insecurity, or inadequate housing, are often the most affected by cascading impacts. These interconnected disruptions can compound existing vulnerabilities, making it even harder for communities already facing systemic challenges to prepare for, respond to, and recover from climate-related events.

- **Energy Systems:** Climate hazards can cause power outages, affecting homes, medical devices, traffic signals, and critical facilities. Backup power and alternative communication methods are essential to minimize impacts.

- **Water Systems:** Drought, extreme heat, sea level rise, and flooding can strain water systems, leading to shortages, contamination, and infrastructure damage.
- **Transportation System:** Major evacuation routes overlap hazard zones, creating vulnerabilities. Transportation disruptions can isolate communities and hinder emergency response.
- **Communication System:** Areas across Berkeley that fall within hazard zones, such as portions of West Berkeley near the shoreline, hillside neighborhoods prone to landslides, and areas with aging infrastructure, are more likely to experience communication service interruptions. These disruptions can trigger cascading impacts, including delayed emergency response, isolation of communities facing social vulnerability, and breakdowns in coordination among critical services.
- **Food Systems:** Disruptions to food supply chains can lead to food insecurity. Climate hazards can impact food production, reducing availability and increasing prices.
- **Healthcare Systems:** Wildfires, extreme heat, flooding, and earthquakes can strain healthcare facilities, increase patient loads, and disrupt services. The stress associated with disasters can also lead to long-term mental health issues which may require an increased level of services provided by the city and its partners.
- **Hazardous/Toxic Materials:** Climate hazards can lead to the release of toxic materials, posing health risks and environmental damage.

9 References

Ackerly, David, Andrew Jones, Mark Stacey, Bruce Riordan. (University of California, Berkeley). 2018. San Francisco Bay Area Summary Report. California's Fourth Climate Change Assessment. Publication number: CCCA4-SUM-2018-005.

American Society for Interior Designers (ASID). (2023). Effects of Extreme Heat Explored in New Design Brief. https://www.asid.org/news/effects-of-extreme-heat-explored-in-new-design-brief. Accessed April 2, 2025.

Association of Bay Area Governments. n.d. Drought. https://abag.ca.gov/our-work/resilience/data-research/drought. Accessed April 2, 2025

Berkeley, City of. 2023. Inventory of Potentially Hazardous Soft, Weak or Open Front Buildings, Status as of 01/11/2023. https://berkeleyca.gov/sites/default/files/2022-03/Soft-Story-Inventory.pdf. Accessed July 8, 2025.

Berkeley, City of. 2024(a). Local Hazard Mitigation Plan. Accessed March 27, 2025.

Berkeley, City of. 2024(b). Reimagining Public Safety Status Update and Report Out. https://berkeleyca.gov/sites/default/files/documents/Reimagining%20Public%20Safety%20Spring%202024%20Report.pdf and https://berkeleyca.gov/sites/default/files/documents/2024-10-29%20Special%20Item%2001%20Reimagining%20Public%20Safety%20Status.pdf. Accessed March 13 and April 16, 2025.

Berkeley, City of. n.d.(a). Fire Stations. https://berkeleyca.gov/safety-health/fire/fire-stations. Accessed March 13, 2025.

Berkeley, City of. n.d.(b). Police Department. https://berkeleyca.gov/your-government/about-us/departments/police-department. Accessed March 13, 2025.

Berkeley, City of. n.d.(c). Transfer Tax Rebates for Seismic Work. https://berkeleyca.gov/construction-development/seismic-safety/funding-seismic-retrofits/transfer-tax-rebates-seismic-work. Accessed April 3, 2025.

Berkeley Fire Department. n.d. https://www.berkeleyfire.com/. Accessed March 13, 2025.

Berkeley, City of. n.d.(d) Sixth Cycle Housing Element (2023-2031), Section 3.5.5, Housing Costs and Affordability. https://berkeleyca.gov/sites/default/files/documents/Berkeley_2023-2031%20Housing%20Element_02-17-2023v2_0.pdf. Accessed May 2, 2025.

CalHeatScore. (2024). About Heat and Its Impact on Communities. https://calheatscore.calepa.ca.gov/about-heat-and-its-impact-communities. Accessed April 2, 2025.

California Building Resilience Against Climate Effects (CalBRACE) Project Short Title: Children < 5 years Full Title: Percent of population aged less than 5 years CalBRACE Domain: Population Sensitivity. (n.d.). https://www.cdph.ca.gov/Programs/OHE/CDPH%20Document%20Library/CHVIs/Children0to4_788_Narrative.pdf. Accessed May 2, 2025.

California Building Resilience Against Climate Effects (CalBRACE) Project Short Title: Disability Full Title: Percent of population with a disability. (n.d.). https://www.cdph.ca.gov/Programs/OHE/CDPH%20Document%20Library/CHVIs/BRACE_Disability_Narrative_795_11-16-2016.pdf. Accessed May 2, 2025.

California Climate Adaptation Strategy. n.d. Summary of Projected Climate Change Impacts on California. https://climateresilience.ca.gov/overview/impacts.html. Accessed April 2, 2025.

California Department of Housing and Community Development (HCD). n.d. 2024 State Income Limits, 2-person household in Alameda County. (2024, May 9). https://www.hcd.ca.gov/sites/default/files/docs/grants-and-funding/income-limits-2024.pdf. Accessed May 2, 2025.

California Energy Commission (CEC). n.d. Cal-Adapt Local Climate Change Snapshot for the City of Berkeley. https://cal-adapt.org/tools/local-climate-change-snapshot. Accessed March 14, 2025.

California Sea Level Rise Guidance: 2024 Science and Policy Update. 2024. California Sea Level Rise Science Task Force, California Ocean Protection Council California Ocean Science Trust. Cartwright, A., Khalatbari-Soltani, S., & Zhang, Y. (2025). Housing conditions and the health and wellbeing impacts of climate change: A scoping review. Environmental Research, 270, 120846. https://doi.org/10.1016/j.envres.2025.120846

Cybersecurity & Infrastructure Security Agency (CISA). (2023). Extreme Heat. https://www.cisa.gov/topics/critical-infrastructure-security-and-resilience/extreme-weather/extreme-heat. Accessed April 2, 2025.

Davamani, V., John, J.E., Poornachandhra, C., Gopalakrishnan, B., Arulmani, S., Parameswari, E., Santhosh, A., Srinivasulu, A., Lal, A., & Naidu, R. (2024). A Critical Review of Climate Change Impacts on Groundwater Resources: A Focus on the Current Status, Future Possibilities, and Role of Simulation Models. Atmosphere, 15(1), 122. https://doi.org/10.3390/atmos15010122

East Bay Municipal Utility District (EBMUD). 2020(a). Urban Water Management Plan. https://www.ebmud.com/water/about-your-water/water-supply/urban-water-management-plan. Accessed March 13, 2025.

East Bay Municipal Utility District (EBMUD). 2020(b). Water Shortage Contingency Plan. https://www.ebmud.com/water/about-your-water/water-supply/urban-water-management-plan. Accessed March 13, 2025.

Executive Order B-30-15 Resiliency Guidebook. (n.d.). https://lci.ca.gov/docs/20180312-Vulnerable_Communities_Descriptions.pdf

Gabbe, C.J., Chang, J.S., Kamson, M., & Seo, E. (2023). Reducing heat risk for people experiencing unsheltered homelessness. *International Journal of Disaster Risk Reduction, 96*, 103904. https://doi.org/10.1016/j.ijdrr.2023.103904Krawchuk, M. A., and M. A. Moritz. 2012. Fire and Climate Change in California. California Energy Commission. Publication number: CEC-500-2012-026.

IISD. (2020). The Effects of Climate Change on Groundwater: An Out-of-Sight Crisis. https://www.iisd.org/articles/insight/effects-climate-change-groundwater-out-sight-crisis. Accessed April 4, 2025.

MIT Technology Review. (2021). How rising groundwater caused by climate change could devastate coastal communities. https://www.technologyreview.com/2021/12/13/1041309/climate-change-rising-groundwater-flooding/. Accessed April 4, 2025.

Office of Climate Change and Health Equity (OASH). (2023). Impact of Extreme Heat on Health Care
Facilities. https://toolkit.climate.gov/sites/default/files/Hazard_Extreme_Heat_3.0_0.pdf. Accessed April 2, 2025.

Pacific Institute. 2016. Drought and Equity in the San Francisco Bay Area. https://pacinst.org/wp-content/uploads/2016/06/drought_and_equity_in_the_san_francisco_bay_area-5-1.pdf. Accessed April 2, 2025.

Pacific Institute. 2022. New Pacific Institute Report Finds California Drought Worsening Long-Term Decline of Fish Populations. https://pacinst.org/announcement/new-pacific-institute-report-finds-california-drought-worsening-long-term-decline-of-fish-populations/. Accessed April 2, 2025.

San Francisco Bay Conservation and Development Commission (BCBD). 2024. Regional Shoreline Adaptation Plan: One Bay Vision, Strategic Regional Priorities, and Subregional Shoreline Adaptation Plan Guidelines. https://www.bcdc.ca.gov/wp-content/uploads/sites/354/2024/12/regional-shoreline-adaptation-plan-spreads.pdf. Accessed March 28, 2025.

San Francisco Estuary Institute (SFEI). 2025. Shallow Groundwater Mapping. https://www.sfei.org/data/shallow-groundwater-mapping. Accessed March 27, 2025.

SAMHSA (Substance Abuse and Mental Health Services Administration). (2017, July). Disaster Technical Assistance Center Supplemental Research Bulletin; Greater Impact: How Disasters Affect People of Low Socioeconomic Status. https://www.samhsa.gov/sites/default/files/dtac/srb-low-ses_2.pdf. Accessed April 8, 2025. Stanford Report. (2023). How heat affects the most vulnerable. https://news.stanford.edu/stories/2023/08/heat-affects-vulnerable.

State of California. (2022). Protecting Californians From Extreme Heat: Extreme Heat Action Plan. https://resources.ca.gov/-/media/CNRA-Website/Files/Initiatives/Climate-Resilience/2022-Final-Extreme-Heat-Action-Plan.pdf. Accessed April 2, 2025.

Sustainable Earth Reviews. (2024). Understanding the synergy between heat waves and the built environment. https://sustainableearthreviews.biomedcentral.com/articles/10.1186/s42055-024-00094-7. Accessed April 2, 2025.

The Climate Reality Project Bay Area Chapter. n.d. Navigating the State's Water Crisis: New CA Laws Will Impact the Bay Area. https://www.climaterealitybayarea.org/blog/navigating-the-states-water-crisis-new-ca-laws. Accessed April 2, 2025.

The Impact of Climate Change: Why Older Adults are Vulnerable Research Report. (n.d.). https://ltsscenter.org/reports/The_Impact_of_Climate_Change_Why_Older_Adults_are_Vulnerable.pdf

Thomas, K., Hardy, R. D., Lazrus, H., Mendez, M., Orlove, B., Rivera-Collazo, I., Roberts, J. T., Rockman, M., Warner, B. P., & Winthrop, R. (2018). Explaining differential vulnerability to climate change: A social science review. *Wiley Interdisciplinary Reviews: Climate Change*, *10*(2), 1–18. https://doi.org/10.1002/wcc.565. Accessed May 2, 2025.

United States Department of Homeland Security (DHS). (2023). Implications of Extreme Weather Events. https://www.dhs.gov/sites/default/files/2023-09/23_0906_oia_IEWE%20508.pdf. Accessed April 2, 2025.

United States Environmental Protection Agency (U.S. EPA). (2023). Climate Change Impacts on the Built Environment. https://www.epa.gov/climateimpacts/climate-change-impacts-built-environment Accessed April 2, 2025.

United States Environmental Protection Agency (U.S. EPA). (2025). Why Wildfire Smoke is a Health Concern. https://www.epa.gov/wildfire-smoke-course/why-wildfire-smoke-health-concern. Accessed April 4, 2025.

Western Fire Chiefs Association. (2024). How Do Wildfires Affect the Atmosphere? https://wfca.com/wildfire-articles/wildfires-atmosphere/. Accessed April 4, 2025.

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Appendix A

Social Vulnerability Analysis Methodology

Social Vulnerability Analysis Methodology

City of Berkeley

State Law and Policy Guidance

California Government Code Section 65302 (as amended by Senate Bills 379 and 1035)) requires Berkeley to include climate adaptation and resiliency information in the Safety Element of its General Plan. The purpose of this assessment is to identify risks that climate change poses to Berkeley as a whole, and to the specific areas at risk from climate change impacts. The assessment must describe how climate change may affect each of the risks addressed in the Safety Element.

California Adaptation Planning Guide

To assist local cities and counties to comply with these requirements, the Governor's Office of Emergency Services published the California Adaptation Planning Guide (Cal APG). The Cal APG recommends a planning process that is outlined in **Figure 1** below. Phase 1 and 2 of the four-phase process consist of conducting a vulnerability assessment. This Memorandum aligns with relevant parts of Phase 1 and all of Phase 2; it also includes the steps shown in **Figure 2.** Climate adaptation strategies will be developed and included in the General Plan Disaster Preparedness and Safety Element during Phase 3. Implementation of the policies and programs in the General Plan Disaster Preparedness and Safety Element will occur in Phase 4 and on an ongoing basis, and will be re-evaluated and refined during the next update to the Element.

Figure 1 California Adaptation Planning Guide Phases

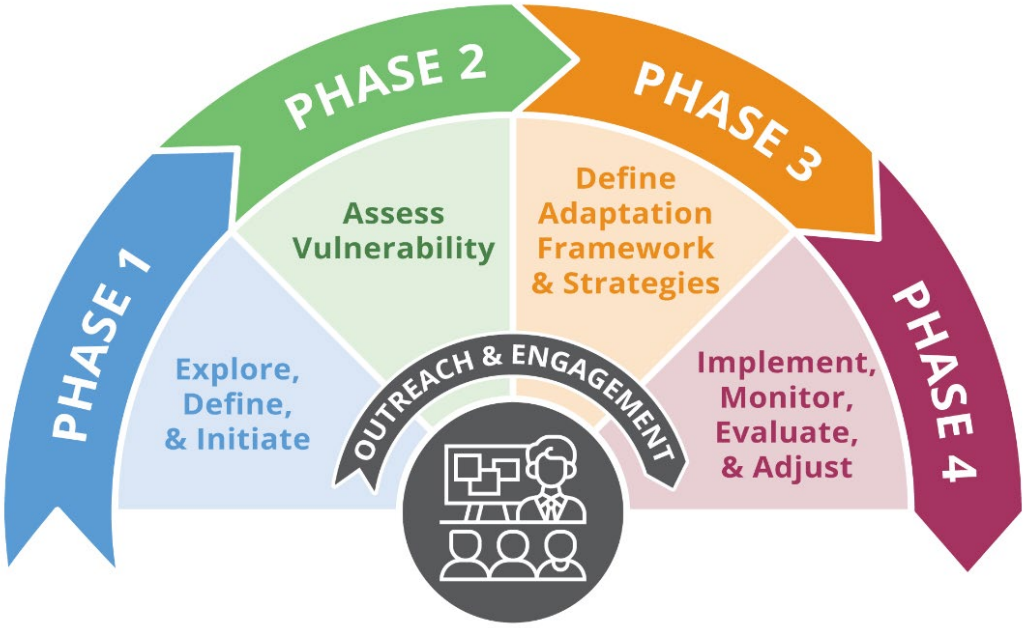
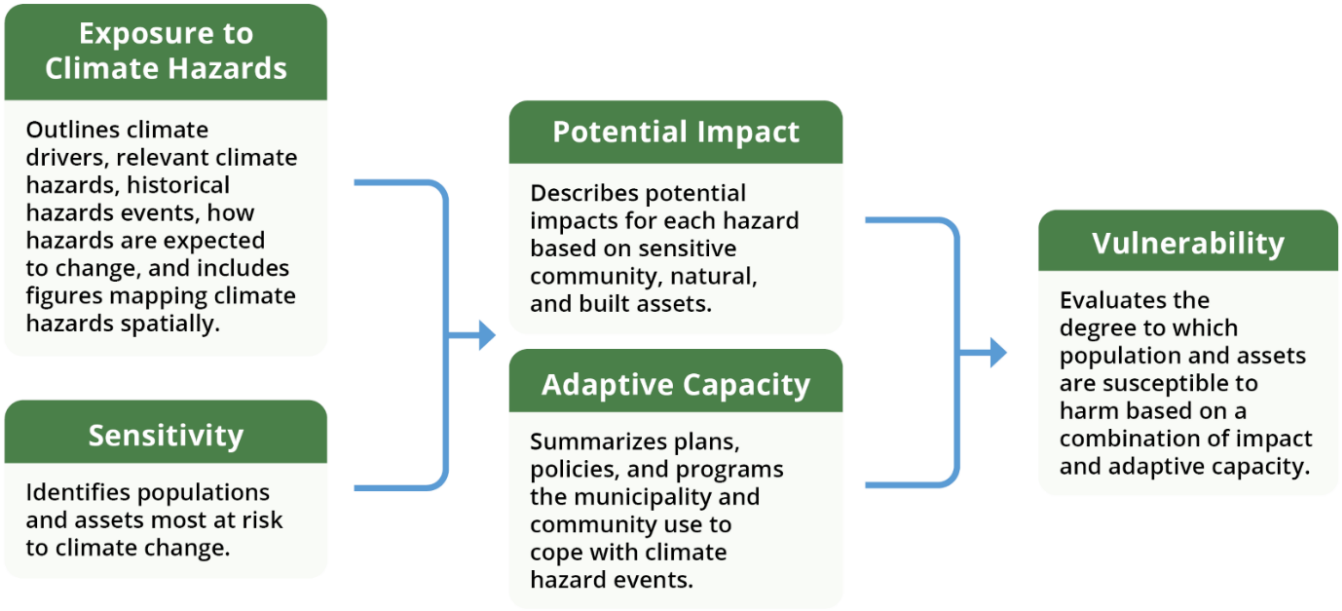


Figure 2 Vulnerability Assessment Process (Phase 2)



Resource Guide for Defining Vulnerable Communities

In 2018, the Governor's Office of Land Use and Climate Innovation (LCI) published a resource guide through the Integrated Climate Adaptation and Resiliency Program (ICARP) that includes information to help define vulnerable communities in the context of climate change adaptation.[1] This resource guide was consulted as part of this assessment. In addition, several resources were consulted to describe vulnerable communities identified in this assessment. These include the California Department of Public Health's CalBrace Project,[2] LCI's Vulnerable Communities Descriptions, and the City of Berkeley Sixth Cycle Housing Element.

Identifying Vulnerable Communities

Social vulnerability, or "sensitivity' to climate change risks can be described as the degree to which human systems are susceptible to harm based on a number of factors. Certain factors can make certain populations more sensitive than others. These factors include, but are not limited to:

- Inequities in educational opportunities and attainment
- Inequities in environmental and living conditions and health status
- Institutional bias and exclusion from decision-making power
- Differences in individual health, age and ability

Historical and ongoing environmental injustices such as housing discrimination have created conditions in the built environment that make some populations more susceptible to climate change risks than others in the community. The purpose of this social vulnerability assessment is to identify these communities and work collaboratively to rectify these harms, and in doing so build climate resilience in a way that best addresses the needs of the communities most at risk.

Individuals and communities can be affected by more than one factor at once, and those in the community who are exposed to a higher number of these factors may be particularly vulnerable. This section identifies groups that are highly vulnerable to the impacts of climate change risks, or hazards. It is important to note that the existence of highly vulnerable groups is an indication of the shortcomings of social, economic, and political systems to provide

[1] https://lci.ca.gov/docs/20180723-Vulnerable_Communities.pdf
[2] CalBRACE Project - Climate Change & Health Equity, https://www.cdph.ca.gov/Programs/OHE/Pages/CalBRACE.aspx

adequate support, respect and protection to all community members. It is not an indication of any individual failure or weakness.[3]

This section describes each of the factors that are included in the social vulnerability analysis for the City of Berkeley's climate vulnerability assessment. The data source for this information is the American Community Survey 5-Year estimates (2018-2022).

Age (Children Under Age 5)

Vulnerability to climate change risks among children is especially high because of physiological and development factors: their lungs are developing, they breathe at a higher rate than adults, and they spend more time outdoors. [4] In addition, children are more likely to experience negative consequences as a result of extreme weather events, such as injury, stress, and death.[5] According to 2022 American Community Survey (ACS) 5-year estimates, about 3.2 percent of Berkeley's population is under 5 years of age.

Age (Adults 65 Years and Older Living Alone)

Factors that contribute to vulnerability among older adults include health status, economic situation and level of social isolation. Older adults are more likely to have a chronic health condition that requires medication, and may need assistance with daily activities. Older adults with limited incomes may more vulnerable to the effects of extreme heat events due to the high cost of air conditioning. In addition, almost one-quarter of Americans aged 65 and older are socially isolated, which can impact an individual's ability to cope with climate-related stressors, and they may not receive emergency information or ask for help.[6] According to 2022 American Community Survey (ACS) 5-year estimates, about 12 percent of households in Berkeley include a member who is 65 years or older and living alone.

[3] Thomas, K., Hardy RD., Lazrus H., Mendez M., Orlove B., Rivera-Collazo, I., Roberts JT., Rockman M., Warner BP., Winthrop R., Explaining differential vulnerability to climate change: A social science review (December 2018) https://wires.onlinelibrary.wiley.com/doi/full/10.1002/wcc.565
[4] CalBrace, "Children <5 years." November 8, 2019. https://www.cdph.ca.gov/Programs/OHE/CDPH%20Document%20Library/CHVIs/Children0to4_788_Narrative.pdf
[5] https://lci.ca.gov/docs/20180312-Vulnerable_Communities_Descriptions.pdf
[6] https://ltsscenter.org/reports/The_Impact_of_Climate_Change_Why_Older_Adults_are_Vulnerable.pdf

Disability

Disability is a broad term that refers to any condition or impairment of the body or mind that limits a person's ability to do certain activities. Vulnerability to climate risks are heightened among this group due to factors such as lower income and educational attainment and employment. Limited mobility, reliance on medical equipment and public transportation contribute to vulnerability, especially during emergency events that would require evacuation or cause power interruption.[7] [8] According to 2022 American Community Survey (ACS) 5-year estimates, about 19 percent of Berkeley households include a person with a disability.

Income

Income is the largest determinant of health in the United States. Higher income is associated with greater life expectancy. This is due in part to access to quality health care, but more so due to social determinants of health – environmental quality, social and economic situations, and the built environment – which influence stress levels and behaviors. The lower health status of lower-income people exacerbates climate change risks, as these groups have fewer resources to cope with emergencies and respond to rising prices. Additionally, groups with lower incomes are more likely to live in housing that is substandard, and therefore more susceptible to damage from disasters.[9]

According to 2022 American Community Survey 5-Year estimates, about 40.3 percent of Berkeley households are considered very low income, meaning a two-person household earning no more than 50 percent of the area median income for Alameda County, or $62,300.[10] Some types of families are more likely to be lower income than others. These include families headed by a single parent (13.5 percent of those below $62,300, and those who have less than a high school degree (4.6 percent of those below $62,300).

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[7] https://www.cdph.ca.gov/Programs/OHE/CDPH%20Document%20Library/CHVIs/BRACE_Disability_Narrative_795_11-16-2016.pdf

[8] https://lci.ca.gov/docs/20180312-Vulnerable_Communities_Descriptions.pdf

[9] https://lci.ca.gov/docs/20180312-Vulnerable_Communities_Descriptions.pdf

[10] California Department of Housing and Community Development, 2024 State Income Limits, 2-person household in Alameda County, https://www.hcd.ca.gov/sites/default/files/docs/grants-and-funding/income-limits-2024.pdf

Housing Cost

Availability of safe, sanitary and affordable housing reduces vulnerability to climate related impacts, and supports recovery. High housing costs can limit financial resources needed to prepare for and recover from climate-related impacts, while a lack of safe and secure housing can increase vulnerability to impacts.

Factors including household income, market rents and home prices, available unit sizes, and household size can all contribute to cost burden. A household is considered to have a housing cost burden if it spends more than 30 percent of gross income on housing expenses (rent or mortgage payments and utilities). A household is considered as having a severe cost burden if expenses make up more than 50 percent of gross income.[11]

According to the City of Berkeley Housing Element (Sixth Cycle), 23 percent of all Berkeley households are severely cost-burdened. Cost burden is more prevalent among renter households than among households who own their home (32 percent versus 12 percent).[12]

Housing conditions impact health, and availability of safe and secure housing can impact vulnerability to climate related risks by exposure to environmental hazards caused by climate change, such as extreme heat.[13] Building improvements such as ventilation, window shades, insulation, roof and wall materials can all reduce impacts from climate related risks. According to the Housing Element, over 95 percent of Berkeley's housing stock is over 30 years old. Less than five percent of the housing stock needs rehabilitation.[14]

[11] City of Berkeley Sixth Cycle Housing Element, Section 3.5.5, Housing Costs and Affordability, Berkeley_2023-2031 Housing Element_02-17-2023v2_0.pdf
[12] https://berkeleyca.gov/sites/default/files/documents/Berkeley_2023-2031%20Housing%20Element_02-17-2023v2_0.pdf
[13] Cartwright, A., Khalatbari-Soltani, S., Zhang, Y., Housing conditions and the health and wellbeing impacts of climate change: A scoping review (April 2025). https://www.sciencedirect.com/science/article/pii/S0013935125000970
[14] https://berkeleyca.gov/sites/default/files/documents/Berkeley_2023-2031%20Housing%20Element_02-17-2023v2_0.pdf

Linguistic Isolation

Linguistic isolation refers to a household in which all persons 14 years of age or older speak a language other than English and no one speaks English very well. Many immigrants are linguistically isolated. Linguistic isolation may hinder protective behaviors during extreme weather events or disasters by limiting access to or understanding of emergency warnings. Studies have shown that people who live in linguistically isolated households are more likely to make heat-related calls to 911 during extreme heat events.[15]

According to the 2022 American Community Survey (ACS) 5-Year Estimates, about 3.8% of households (or about 1,740 households) in Berkeley are considered “Limited English-Speaking Households”, meaning that no member 14 years old and over (1) speaks only English or (2) speaks a non-English language and speaks English "very well." About 1.3 percent of those households speak Chinese (including Mandarin and Cantonese), about 0.7 percent speak an Indo-European language (French, German, Hindi, and Persian), and another 0.7 percent speak an Asian and Pacific Island language (Chinese, Japanese, Telugu, and Hawaiian). About 0.3 percent speak Spanish.

Communities of Color

Structural racism creates racial disparities in educational attainment, income and wealth, which in turn contributes to increased vulnerability to climate risks.[16] Communities of color also experience greater vulnerabilities due to compounding factors such as income, educational attainment, health, language barriers, social isolation, occupational exposures and less access to air conditioning. Differences in vulnerability may be linked to social and economic disparities. For example - Due to discrimination, people in communities of color are more likely to have lower incomes and live in areas with more risks from pollution and fewer health-promoting features (e.g., parks, grocery stores). Also, communities of color may have decreased access to information about risk mitigation, as well as resources to prepare for, adapt to, and recover from climate related events.[17] According to the 2022 American Community Survey (ACS) 5-Year Estimates, about 48 percent of residents identify as a person of color. The racial and ethnic breakdown is as follows: 21 percent identify as Asian, 12 percent as Hispanic or Latino, 8 percent as Black or African American, 7 percent as multiracial, 1 percent as another racial identity not listed, 0.2 percent as American Indian or Alaska Native, and 0.2 percent as Native Hawaiian or Pacific Islander.

[15] ibid
[16] https://wires.onlinelibrary.wiley.com/doi/full/10.1002/wcc.565
[17] https://lci.ca.gov/docs/20180312-Vulnerable_Communities_Descriptions.pdf

Vehicle Ownership

Vehicle ownership is an indicator of access to personal transportation, which is a critical resource during extreme weather events or in a scenario that requires evacuation. Access within a household to a personal vehicle is important because it can be a source of shelter from wildfire, air pollution, heat or flooding.[18] Approximately 20 percent of households in Berkeley do not have access to a vehicle.

Immigrants and Refugees

Immigrant and refugee populations may be more vulnerable to climate change impacts due to potentially experiencing displacement due to previous climate change impacts or disasters, as well as being overrepresented among low-income groups but underrepresented in public benefits enrollment. The most vulnerable immigrants and refugees include people with low socioeconomic status, or who are experiencing houselessness, single mothers and young children, and people with limited English. Further, they are less likely to ask for help from government officials, and tend to be linguistically isolated. Many people in this group work in conditions that leave them vulnerable to exposure to climate change impacts, such as extreme heat. Because many undocumented immigrants or refugees do not have adequate access to services, they may receive lower levels of support to address climate stresses.[19] According to the ACS 5-year estimates, about 24 percent of residents are of voting age and not a citizen.

Summary of Social Vulnerability

There are various publicly-available tools and datasets available to identify vulnerable communities. Indicators were selected based on best-practice methodologies. The data source for this analysis is the American Community Survey (ACS) 5-Year estimates (2018-2022). **Table 1** provides a summary of the indicators, size of community in Berkeley, and data source.

[18] ibid
[19] ibid

Table 1 Summary of Social Vulnerability

Population	Size of Community in Berkeley	Data Source (ACS Table)
Individuals without a high school degree	3%	Population 25 years and over – no high school diploma (ACS 2022, Table B15003: Educational Attainment for the Population 25 Years and Over)
Very low-income households	40%	Households earning less than $62,300 per year, or 50% of Area Median Income (AMI) for a 2-person household in Alameda County (ACS 2022, Table B19001: Household Income in the Past 12 Months and California Department of Housing and Community Development, 2024 State Income Limits, Alameda County, 2-person household, very-low income)
Severely housing cost burdened households	23%	Households spending >50% of income on housing – Severely Housing Cost-Burdened (ACS 2022, Tables B25070: Gross Rent as a Percentage of Household Income & B25091: Monthly Owner Costs as a Percentage of Income)
Communities of color	48%	People of Color – Communities of Color (ACS 2022, Table B03002: Hispanic or Latino Origin by Race)
Single parent families	10%	Families comprised of a parent/caregiver and one or more dependent children without the presence and support of a spouse or adult partner who is sharing the responsibility of parenting. ACS Census DP02 - Added Male and Female heads of household with children
Residents with Limited English proficiency	3.8%	Limited English Proficiency – Limited English-Speaking Households (ACS 2022, Table B16002: Household Language by Household Limited English-Speaking Status)
Residents who are not U.S citizens	24%	Not U.S. Citizens (Population Aged 18+) (ACS 2022, Tables B01001: Total Population by Age & B29001: Citizen Voting-Age Population)
Residents who are under age 5	3.2%	Population Under 5 Years (ACS 2022, Table B01001: Sex by Age)
Households with a member who is 65 years and over living alone	12%	Households with 1 or more people 65 years and over – 65 and Over Living Alone (ACS 2022, Table B11007: Households by Presence of People 65 Years and Over)
Households with a person with a disability	19%	Households with 1 or More Persons with a Disability – People with a Disability (ACS 2022, Table B22010: Receipt of Food Stamps/SNAP by Disability Status)
Renter households	57%	Renter-Occupied Households – Renters (ACS 2022, Table B25003: Tenure)
Zero-vehicle households	20%	Households Without a Vehicle – Without a Vehicle (ACS 2022, Table B25044: Tenure by Vehicles Available

Cumulative Social Vulnerability

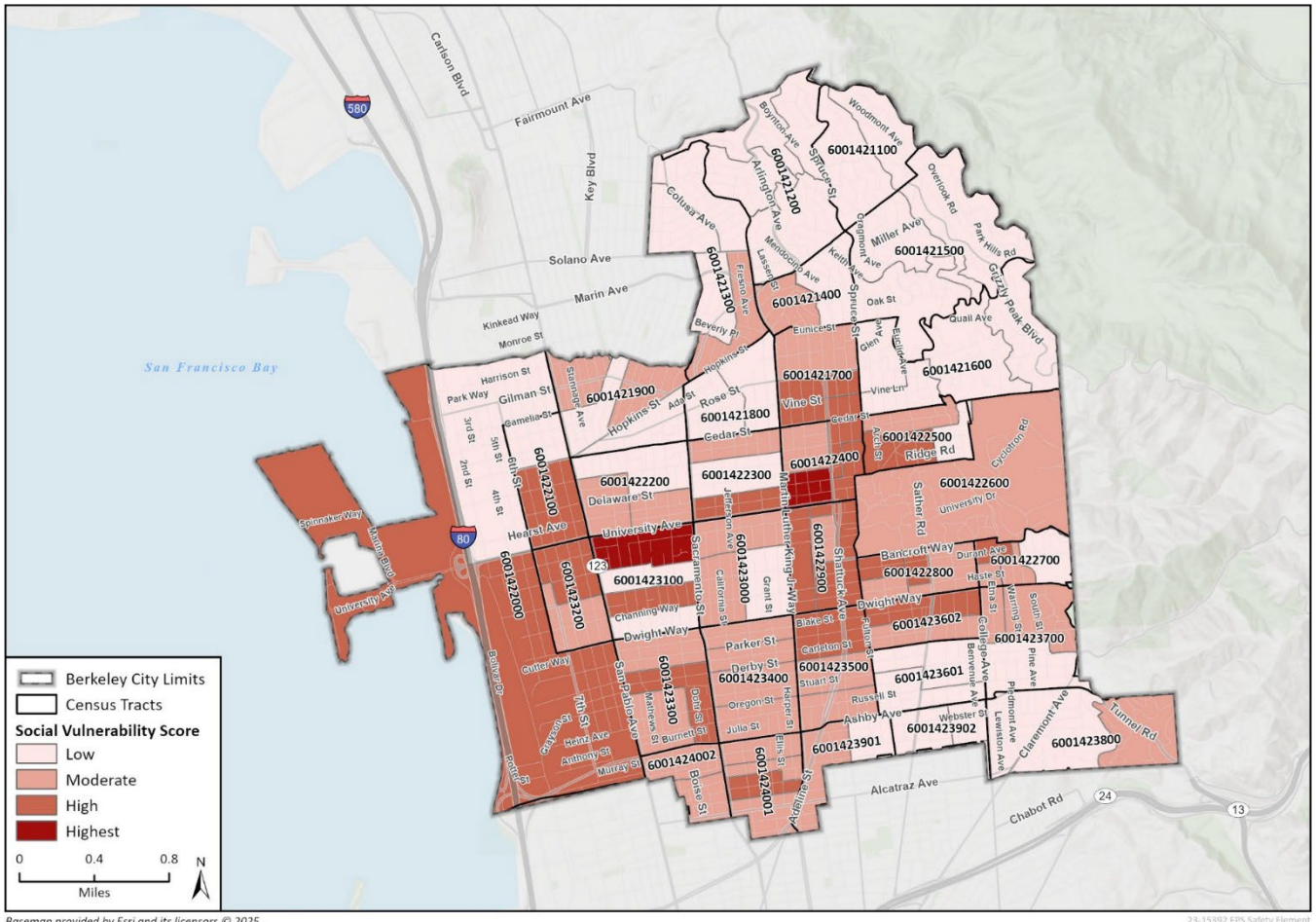
Individuals can belong to more than one vulnerable group and may experience especially complex forms of climate change vulnerability in the aggregate. To ensure that the social vulnerability analysis accounts for this fact, a cumulative vulnerability map (See **Figure 3**) was created using the San Francisco Bay Conservation and Development Commission (BCDC) 2020 Community Vulnerability Index. The cumulative vulnerability map includes all of the vulnerable populations presented in **Table 1** above. Census block groups were identified and classified as low, moderate, high, and very high cumulative vulnerability according to **Table 2**. A block group is classified as having "very high" social vulnerability if there are seven or more indicators (see **Table 1** above) at or above the 70th percentile. In other words, that particular block group ranks in the top 30 percent citywide across at least seven vulnerability factors. This threshold is above the mean (3.65) and more than one standard deviation (2.47) above the mean, placing these block groups in the upper tail of the distribution, where compounding social vulnerabilities are most concentrated.

This analysis sets the threshold for determining "very high" social vulnerability at the 70th percentile. Based on the characteristics of the Berkeley population, setting the threshold at this level ensures that areas exhibiting moderate to high vulnerability, which are important to present for policy considerations, are included on the map.

Table 2 Cumulative Vulnerability Classification Methodology

Number of indicators above 70th percentile	Cumulative Social Vulnerability Score
0 - 2	Low
3 - 5	Moderate
6 - 8	High
9 - 11	Very High

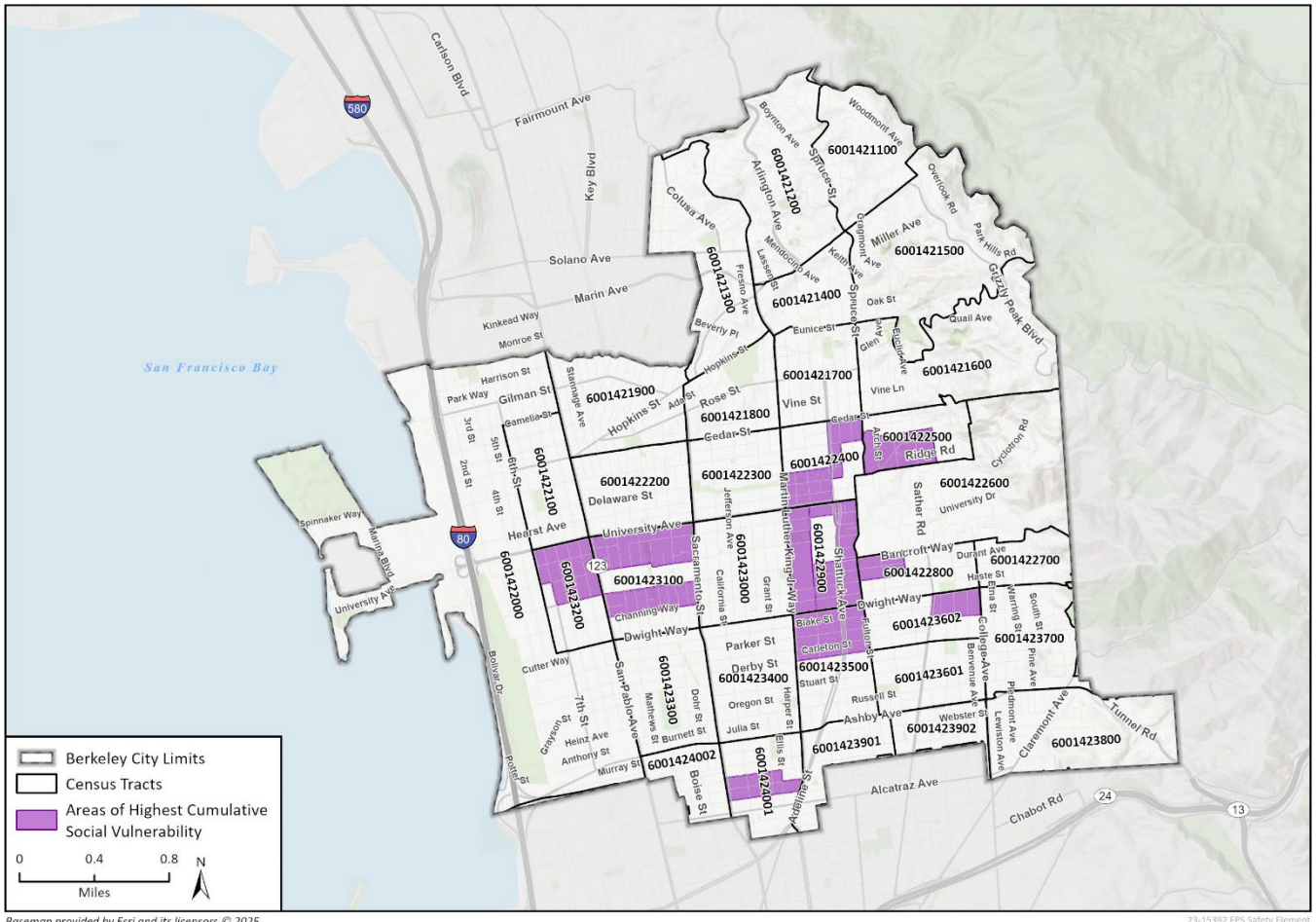
Figure 3 Berkeley Cumulative Social Vulnerability Map



Basemap provided by Esri and its licensors © 2025.
Social Vulnerability Score provided by City of Berkeley, 2025.

23-15392 EPS Safety Element
Fig X Social Vulnerability Index

Figure 4 Berkeley Highest Cumulative Social Vulnerability Map



Basemap provided by Esri and its licensors © 2025.
Social Vulnerability Index and Critical Facilities provided by City of Berkeley, 2025.

23-15392 EPS Safety Element
Fig X Social Vulnerability Index

Community Input and Ground-Truthing

The Social Vulnerability Analysis map development process is iterative. Staff and community will continually refine the methodology to ensure that the final Social Vulnerability Analysis map included in the adopted Safety Element reflects community lived experience. To date, this draft Social Vulnerability Analysis map includes feedback received from the project Community Advisory Committee (CAC), facilitated by the Ecology Center. Additionally, the CAC members suggested the analysis be conducted at the Census Block Group-level, rather than the Census Tract-level. By analyzing each indicator at a smaller scale than originally envisioned, the final map provides a more fine-grained, nuanced picture of social vulnerability in the city. The existing conditions memo provides a more detailed summary of feedback received.

Connection to Environmental Justice

The purpose of the Cumulative Social Vulnerability Map is to assist the City and community in identifying areas in Berkeley that are particularly vulnerable to the impacts of climate change. This map has been prepared in close coordination with the Environmental Justice (EJ) Areas Map. The EJ Areas map identifies areas of the city that are low-income areas and are disproportionately impacted by pollution, socioeconomic vulnerability, and adverse health impacts. The EJ Areas Map includes this set of indicators as a separate layer to reflect social vulnerability as part of the EJ analysis. The Cumulative Social Vulnerability Map and EJ Areas Map work together to help prioritize equitable outcomes in projects and programs across the city, and reduce impacts from pollution exposure, especially in areas of the city that are most vulnerable.

Appendix B

Groundwater Rise and Contaminated Site Analysis

CITY OF BERKELEY
Rincon Consultants, Inc.

Groundwater Rise and Contaminated Site Analysis

February 2025

2180 Milvia Street, Berkeley, CA 94704
berkeleyca.gov

Table of Contents

Background and Purpose 1
Relationship of Sea Level Rise, Groundwater Rise, and Contaminated Sites 1
Methodology 3
Data Considered 3
Contaminated Site Inventory 3
Projected Future Sea Level Rise 3
Projected Future Groundwater Rise 4
Exposure Pathways 6
Method of Analysis 7
Results 8
Recommendations 10

Attachments

Figure 1a Contaminated Sites Rankings - Current Conditions Northeast Berkeley
Figure 1b Contaminated Sites Rankings - Current Conditions West Berkeley
Figure 1c Contaminated Sites Rankings - Current Conditions East Berkeley
Figure 1d Contaminated Sites Rankings - Current Conditions Southwest Berkeley
Figure 1e Contaminated Sites Rankings - Current Conditions Southeast Berkeley
Figure 2a Contaminated Sites Rankings - 0.8 feet (25 cm) SLR Scenario Northeast Berkeley
Figure 2b Contaminated Sites Rankings - 0.8 feet (25 cm) SLR Scenario West Berkeley
Figure 2c Contaminated Sites Rankings - 0.8 feet (25 cm) SLR Scenario East Berkeley
Figure 2d Contaminated Sites Rankings - 0.8 feet (25 cm) SLR Scenario Southwest Berkeley
Figure 2e Contaminated Sites Rankings - 0.8 feet (25 cm) SLR Scenario Southeast Berkeley
Figure 3a Contaminated Sites Rankings - 2.5 feet (75 cm) SLR Scenario Northeast Berkeley
Figure 3b Contaminated Sites Rankings - 2.5 feet (75 cm) SLR Scenario West Berkeley
Figure 3c Contaminated Sites Rankings - 2.5 feet (75 cm) SLR Scenario East Berkeley
Figure 3d Contaminated Sites Rankings - 2.5 feet (75 cm) SLR Scenario Southwest Berkeley
Figure 3e Contaminated Sites Rankings - 2.5 feet (75 cm) SLR Scenario Southeast Berkeley
Table 1 Contaminated Sites Information and Rankings

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Introduction

Rincon Consultants, Inc. (Rincon) has prepared a Groundwater Rise and Contaminated Site Analysis (analysis) for the City of Berkeley (City). This analysis ranks known contaminated sites within the City based on the potential for new risks to people and the environment (i.e., human and ecological receptors) from projected groundwater rise (GWR) due to sea level rise (SLR). This report presents the background and purpose of the analysis; the relationship between SLR, GWR, and contaminated sites; the methodology and results of the analysis, and recommendations for mitigating the identified risks from GWR.

Background and Purpose

The City of Berkeley is updating the Disaster Preparedness and Safety Element and creating a new Environmental Justice Element of the General Plan. The General Plan serves as a guide for all policies, programs, and decisions related to how land is used. The Disaster Preparedness and Safety Element and the Environmental Justice Element aim to ensure that everyone in Berkeley is safe and healthy, especially underserved communities. One of the main goals in updating the General Plan is to identify how climate change and environmental justice issues affect the City and to create strategies that build a more inclusive and resilient community for everyone.

The purpose of this analysis is to rank known contaminated sites in the City based on the potential for new risks to human and ecological receptors from projected GWR due to SLR as a result of climate change. These rankings can help guide policy decisions presented within the Disaster Preparedness and Safety Element and Environmental Justice Element of the City's General Plan.

Relationship of Sea Level Rise, Groundwater Rise, and Contaminated Sites

SLR can cause GWR in coastal areas like the San Francisco Bay area and the City because rising sea levels exert pressure on the groundwater table, pushing it upwards (see the figure below). SLR can cause marine flooding (i.e., marine inundation) in coastal areas, and GWR can cause the groundwater table to rise towards the ground surface or can cause groundwater inundation at the ground surface (i.e., emergent groundwater) in low lying areas.

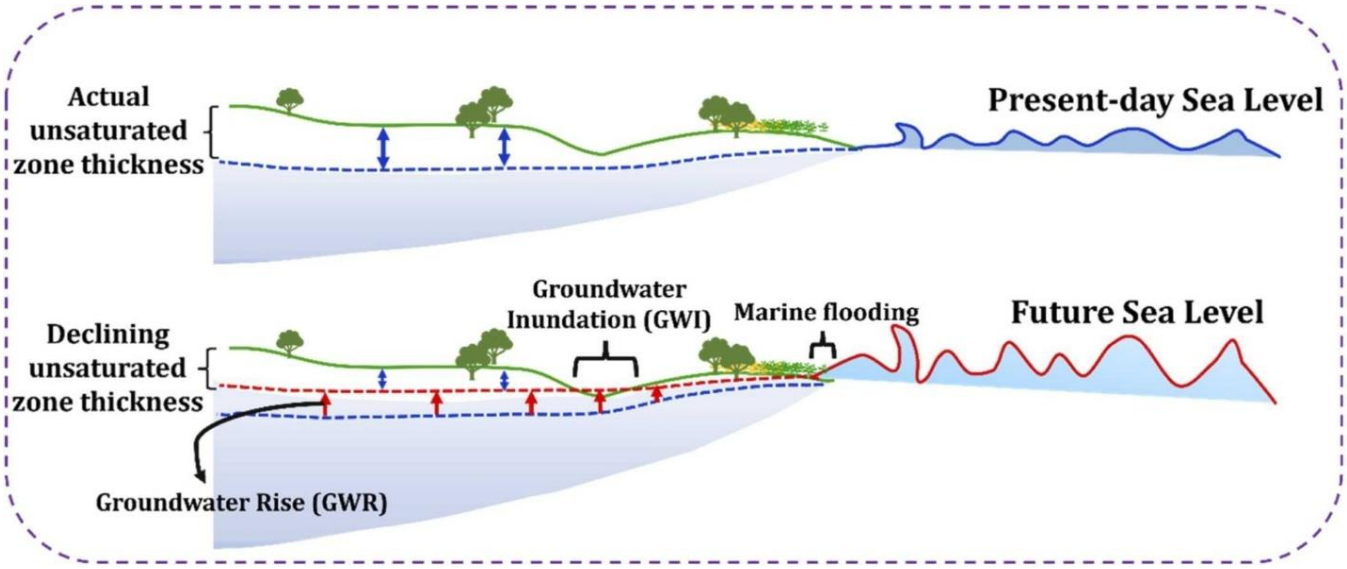


Figure from Visvalingam et al. 2024 (https://www.sciencedirect.com/science/article/abs/pii/S2352485524000343)

Rising groundwater can potentially mobilize contaminants at contaminated sites. The rising groundwater can dissolve contaminants into groundwater (depending on the solubility of the contaminant), and those contaminants may be transported with groundwater movement (i.e., flow). The potential pathways for contact between human and ecological receptors and contaminants in groundwater (i.e., exposure pathways) include:

- Rising groundwater can bring contaminants to the surface, potentially increasing the exposure for human and ecological receptors (e.g., aquatic life, ecosystems) through direct contact with the groundwater.
- Rising groundwater can bring contaminants closer to the surface or into building basements, potentially increasing the exposure for human receptors through inhalation of vapors and direct contact.
- Rising groundwater can flow through soil that has higher permeability than the surrounding soil (a preferential pathway), which allows contaminants to move more easily through the subsurface and migrate, potentially increasing the exposure for human receptors through inhalation of vapors or direct contact with the groundwater and for ecological receptors through direct contact. Preferential pathways in the City include:
    - The backfill material used for utility corridors (e.g., sewers, storm drains, creek culverts, oil and gas pipelines)
    - The utility itself (e.g., sewers, storm drains, creek culverts)
    - The historical creek alignments within the City.

- Rising groundwater may eventually flow and discharge into creeks and the San Francisco Bay, potentially increasing the exposure for human and ecological receptors through direct contact with the groundwater.

Methodology

Data Considered

Contaminated Site Inventory

Using GeoTracker[1] and EnviroStor[2] databases, Rincon mapped listed contaminated sites (open and closed) within the City limits in an ArcGIS database. GeoTracker is a database tool developed by the California State Water Resources Control Board (SWRCB) to track and manage data related to contaminated sites and other environmental assessments across the state of California. EnviroStor is another environmental database, developed by the California Department of Toxic Substances Control (DTSC), designed to provide comprehensive information about sites contaminated by hazardous substances and to facilitate the management of environmental cleanup and assessment efforts. From these databases, Rincon gathered the site name, site type, status, address, latitude, and longitude data for each site. In some cases, GeoTracker and EnviroStor listed the same contaminated site. In these cases, duplicate sites were removed from the final ArcGIS database. One site did not have latitude and longitude, nor was there enough information to determine the exact location of the site, so it was not included in the analysis.[3] The contaminated sites downloaded from GeoTracker and EnviroStor included in the analysis are listed in Table 1 (attached to this report).

Projected Future Sea Level Rise

To determine projected future SLR in the City, we used SLR scenarios presented by the Ocean Protection Council (OPC) in the *State of California Sea Level Rise Guidance: 2024 Science and Policy Update*[4] document. The SLR scenarios in this guidance document are based on the probabilistic projections developed by the Intergovernmental Panel on Climate Change (IPCC)

[1] https://geotracker.waterboards.ca.gov/
[2] https://www.envirostor.dtsc.ca.gov/public/
[3] The site/facility name is the Berkeley Landfill Company. The EnviroStor database lists the site as between I-80, Frontage Road, and Marina. The U.S. Environmental Protection Agency website lists this site at Virgina Street and the foot of University (https://cumulis.epa.gov/supercpad/CurSites/csitinfo. cfm?id=0902087).
[4] https://opc.ca.gov/wp-content/uploads/2024/01/SLR-Guidance-DRAFT-Jan-2024-508.pdf

Sixth Assessment Report (AR6)[5] and reflect the most up-to-date scientific understanding of the physical drivers of SLR. Of the five probabilistic sea level scenarios modeled for California in the *2024 California Sea Level Rise Guidance* (i.e., Low, Intermediate-Low, Intermediate, Intermediate-High, and High), the guidance document recommended evaluating the Intermediate, Intermediate-High, and High scenarios to inform appropriate SLR planning and project decisions.

In the *2024 California Sea Level Rise Guidance*, SLR projections are provided for 14 active tide gauge stations along the California coastline. The Alameda tide gauge is the tide gauge nearest the City and is the tide station used to determine the SLR projections for this analysis (Table 7, Appendix 2 of the *California Sea Level Rise Guidance: 2024 Science and Policy Update*). Consistent with City direction, Rincon selected for this analysis Intermediate and Intermediate-High SLR scenarios from the *California Sea Level Rise Guidance* using the following time horizons:

- 0.9 feet (27 cm), which represents:
  - Year 2060 Intermediate scenario
  - Year 2050 Intermediate-High scenario
- 2.8 feet (85 cm), which represents:
  - Year 2100 Intermediate scenario
  - Year 2080 Intermediate-High scenario

Projected Future Groundwater Rise

To determine projected future GWR in the City, we used data from the Coastal Storm Modeling System (CoSMoS) groundwater model prepared by the U.S. Geological Service (USGS).[6] According to the compendium prepared in November 2019[7] comparing CoSMoS and the Pathways Climate Institute (Pathways) and San Francisco Estuary Institute (SFEI) model, CoSMoS offers projections of sea level and groundwater level rise that are more likely to lead to longer-term (e.g., weeks to months) or chronic emergent groundwater flooding, making it a more appropriate tool for informing long-term planning (e.g., General Plan), as well as for developing policies to help mitigate the negative impacts along the City's shoreline. In

[5] https://www.ipcc.ch/report/ar6/syr/
[6] https://ourcoastourfuture.org/hazard-map/
[7] https://www.adaptingtorisingtides.org/wp-content/uploads/2020/03/GW_ModelComparison_Compendium_ADA.pdf

contrast, Pathways and SFEI data,[8] while valuable for design purposes (such as foundations and stormwater systems), is less suitable for longer-term planning because the Pathways and SFEI data estimates the amount of sea level rise that is likely to result in emergent groundwater flooding on a temporary (e.g., hours to days), seasonal basis, not a longer-term basis. A summary of both model approaches is presented below.[9]

Pathways and SFEI Model	CoSMoS Groundwater Model
Predicts the annual high, wet weather groundwater conditions	Predicts daily groundwater conditions
Data-driven, based on 10,000+ well observation locations	Model-driven, validated by observations
Assumes linear response to sea level rise	Assumes homogenous sub-surface geology
San Fransico Bay Area coverage	California statewide coverage, including the San Fransico Bay Area

For the analysis, the SLR values listed above (i.e., 0.9 feet [27 cm] and 2.8 feet [85 cm]) were selected in CoSMoS. The CoSMoS groundwater model shows the predicted present day and future groundwater table depth with SLR from 0 to 9.8 feet (0 to 3 meters) for areas along the California coast, including the City. For a given SLR scenario, the CoSMoS groundwater model provides the following ranges of predictions:

- Marine inundation (mean higher high water [MHHW] sea level)
- Groundwater table at surface (emergent)
- Groundwater table between 0 and 1 meter (0 and approximately 3 feet) depth
- Groundwater table between 1 and 2 meters (approximately 3 and 6 feet) depth
- Groundwater table between 2 and 5 meters (approximately 6 and 15 feet) depth.

Rincon used the polygon layers from the CoSMoS groundwater model to map in ArcGIS the current groundwater level and projected future groundwater table levels across the City. Because SLR scenario values in the *California Sea Level Rise Guidance* and the CoSMoS groundwater model are not exactly equal, the closest values were chosen and considered equivalent. The following SLR scenarios in the CoSMoS groundwater model were used:

[8] sfei.org/projects/shallowgroundwater-response-sea-level-rise
[9] https://www.adaptingtorisingtides.org/wp-content/uploads/2020/03/GW_ModelComparison_Compendium_ADA.pdf

- 0 feet (0 cm) in CoSMoS – equivalent to current conditions to be used as a baseline
- 0.8 feet (25 cm) in CoSMoS – equivalent to 0.9 feet (27 cm) from the *California Sea Level Rise Guidance*
- 2.5 feet (75 cm) in CoSMoS – equivalent to 2.8 feet (85 cm) from the *California Sea Level Rise Guidance*.

Subsurface soil lithology plays a key role in determining how easily groundwater can move through connected pore spaces in the soil; this is a property known as hydraulic conductivity. For example, in more permeable materials like gravel, groundwater flows easily compared to less permeable materials like clay. The CoSMoS groundwater model has three options for conductivity values, which represent less permeable (0.1 meter/day), moderate (1 meter/day), and more permeable (10 meters/day) soil. Of these three, Rincon used the value of 1 meter/day, which is the default option in the CoSMoS groundwater model and represents a moderately permeable subsurface soil lithology, comparable to a fine- to medium-grained sand.

Exposure Pathways

The pathways through which human and ecological receptors may be exposed to contamination due to GWR considered in the analysis were:

- Marine inundation
- Groundwater inundation at the ground surface (i.e., emergent groundwater)
- Preferential pathways in the City: sewers, storm drains, creek culverts, historical creek alignments, and oil and gas pipelines.

Marine inundation (MHHW sea level) and emergent groundwater projections are provided in the CoSMoS groundwater model.

Rincon also relied on the following GIS layers provided by the City to inform our methodology:

- Sewers: laterals, maintenance holes, pump stations
- Storm drains: inlets, maintenance holes, culverts, discharge points
- Historical creek alignments.

Sewers and storm drain features are along most roads throughout the City. Therefore, most of the known contaminated sites in the City are adjacent to these features, which can be preferential pathways for contaminant migration. However, limited to no depth information was provided with the GIS layers from the City. Where there were depth data, primarily for the

sewer maintenance holes, the data were limited. For example, 94 out of 7,600 sewer maintenance holes had depth data (approximately 1 percent) and those depths ranged from 3 to 13 feet below ground surface (bgs).

Oil and gas pipeline locations were downloaded from the National Pipeline Mapping System.[10] No depth information was available for the pipelines.

Because of the limited localized depth information available for sewers, storm drains, historical creek alignments, and oil and gas pipelines within the City, and because this analysis is a screening tool to be used by the City, we assumed utility corridors in the City were at a depth of 6 feet (approximately 2 meters) bgs. This assumption is based on the limited available depth data from the City (discussed above), general knowledge of typical utility corridor and basement depths,[11] [12] and the output of the CoSMoS groundwater model, which groups projections for less than 6 feet (approximately 2 meters) bgs and deeper than 6 feet (approximately 2 meters) bgs.

Method of Analysis

Using the available data, Rincon developed an approach for ranking contaminated sites in the City based on the potential for new risks to human and ecological receptors due to GWR. Using ArcGIS, we overlayed the known contaminated sites and the marine inundation and GWR projections from the CoSMoS groundwater model for baseline and the two SLR scenarios (0 feet [0 cm], 0.8 feet [25 cm], and 2.5 feet [75 cm]). As noted above, sewers and storm drain features are along most roads in the City; therefore, we made the conservative assumption that all known contaminated sites are adjacent to at least one of these features (preferential pathways). We also assumed that all utility corridor and basement depths are 6 feet (2 meters) bgs. Using this information and these assumptions, we developed the following ranking framework for contaminated sites in the City:

- **High Priority** – projected GWR at a contaminated site is at the ground surface (marine inundation, emergent groundwater) or within 6 feet (approximately 2 meters) of the ground surface (i.e., 0 to 6 feet [0 to 2 meters] bgs).
    - We assumed that exposure pathways exist at contaminated sites where projected groundwater rise is within 6 feet (approximately 2 meters) or less of the ground surface, and these contaminated sites are considered high priority in this analysis.

[10] https://www.npms.phmsa.dot.gov/
[11] https://www.pge.com/assets/pge/docs/account/service-requests/greenbook-manual-full.pdf
[12] https://www.sfei.org/sites/default/files/biblio_files/Shallow%20Groundwater_Sea%20Level%20Rise_Pathways_SFEI_2022_v2_2.pdf

- **Medium Priority** - projected groundwater rise at a contaminated site is deeper than 6 feet (approximately 2 meters) from the ground surface (greater than 6 feet [2 meters] bgs).
    - While we assumed that exposure pathways exist at contaminated sites where projected groundwater rise is more than (deeper) 6 feet (approximately 2 meters) from the ground surface, these contaminated sites are considered medium priority in this analysis.
- **Low Priority** - closed Leaking Underground Storage Tank (LUST) sites, which consist almost entirely of fuel-(petroleum) contaminated LUST sites.[13]
    - Natural attenuation slows and limits the migration of dissolved petroleum plumes in groundwater and many petroleum release cases pose a low threat to human health and the environment;[14] therefore, closed LUST sites are considered low priority due to the nature and fate of the contaminants.

It should be noted that this is a screening analysis and is appropriate for the available information and chosen assumptions.

Results

A total of 427 contaminated sites (open and closed) were identified within the City limits using the GeoTracker and EnviroStor databases (Table 1 attached to this report). Rincon used the site categories in the GeoTracker database to group the contaminated sites. The site categories, number of sites, and a brief description of the categories are:

- Cleanup Program Sites – 60 in the City. Cleanup Program Sites are from the GeoTracker database. These sites are all non-federally owned sites regulated under the SWRCB's Site Cleanup Program and/or similar programs conducted by each of the nine Regional Water Quality Control Boards in the State.
- DTSC Cleanup Sites – 46 in the City. DTSC Cleanup Sites are from the EnviroStor database. These sites include National Priorities List (NPL, aka Superfund), state response, voluntary cleanup, corrective action, school cleanup and investigation, evaluation, and tiered permit sites.
- DTSC Hazardous Waste Sites – 2 in the City. DTSC Hazardous Waste Sites are from the EnviroStor database.
- LUST Cleanup Sites – 239 in the City. LUST Cleanup Sites are from the GeoTracker database and consist almost entirely of fuel-contaminated LUST sites. These sites are underground storage tank (UST) sites that have had an unauthorized release (i.e., leak or

[13] https://geotracker.waterboards.ca.gov/site_type_definitions
[14] https://www.waterboards.ca.gov/board_decisions/adopted_orders/resolutions/2012/rs2012_0016atta.pdf

spill) of a hazardous substance (usually fuel hydrocarbons) and are being (or have been) cleaned up.

- Land Disposal Site – 1 in the City. The Land Disposal Site in the City is the former Berkeley Landfill (now Ceasar Chavez Park).
- Non-Case Information Sites – 42 in the City. Non-Case Information Sites are from the GeoTracker database. These are sites that either have no unauthorized release, had a release to the environment with minimal impact, or are currently being evaluated for impacts and may result in the activation of a new case.
- Permitted USTs – 33 in the City. Permitted UST sites are from the GeoTracker database. These sites are facilities that are associated with permitted USTs from the California Environmental Reporting System (CERS) database, which is managed by the California Environmental Protection Agency (CalEPA).
- Single-Walled UST Sites – 4 in the City. Single-Walled UST Sites are from the GeoTracker database. These sites are those identified with USTs constructed with non-exempt single-walled components and include both operating and recently closed sites. Single-walled USTs are required to be permanently closed on or before December 31, 2025.

Figures showing the contaminated sites rankings for 1) current conditions are presented on Figures 1a through 1e, 2) the 0.8 feet (25 cm) SLR scenario are presented on Figures 2a through 2e, and 3) the 2.5 feet (75 cm) SLR scenario are presented on Figures 3a through 3e (figures are attached to this report). Figures show the City limits, the GWR projections from the CoSMoS groundwater model for the SLR scenario (note that GWR projections where the water table is projected to be deeper than 6 feet bgs [2 meters] are not shown on the figures), the location of known contaminated sites, the category of contaminated site (e.g., Cleanup Program Sites, DTSC Cleanup Sites, etc.), and the contaminated site ranking (i.e., high, medium, low). Utility corridors (i.e., sewers, storm drains, and oil and gas pipelines) and historical creek alignments within the City (preferential pathways) are not shown on the figures because, as noted above, we made the conservative assumption that all known contaminated sites are adjacent to at least one of these features.

Table 1 (attached to this report) presents the ranking for each of the 427 contaminated sites identified within the City for current conditions and the two SLR scenarios. The table below summarizes the number of high, medium, and low priority sites by SLR scenario.

Projected Groundwater Depth from CoSMoS Groundwater Model	High Priority Contaminated Sites	Medium Priority Contaminated Sites	Low Priority Contaminated Sites
Current Conditions	100	100	227
0.8 feet (25 cm) SLR Scenario	102	98	227
2.5 feet (75 cm) SLR Scenario	102	98	227

Notes:
Low priority contaminated sites are LUST Cleanup Sites are from the GeoTracker database and consist almost entirely of fuel-contaminated LUST sites that are being, or have been, cleaned up.
cm – centimeter
CoSMoS – Coastal Storm Modeling System
SLR – sea level rise

Under current conditions, of the 427 contaminated sites within the City (open and closed), 100 are ranked as high priority, 100 as medium priority, and 227 as low priority (closed LUST sites). Going from current conditions to the 0.8 feet (25 cm) SLR scenario, only two sites change ranking from medium priority to high priority (the number of low priority sites remains the same). Going from the 0.8 feet (25 cm) SLR scenario to the 2.5 feet (75 cm) SLR scenario, no additional sites change ranking. As shown on Figures 1a through 1e, Figures 2a through 2e, and Figures 3a through 3e, the known contaminated sites are in areas where there is not projected to be a lot of change in GWR using the 0.8 feet (25 cm) and 2.5 feet (75 cm) SLR scenarios.

Recommendations

Recommended actions based on this analysis are:

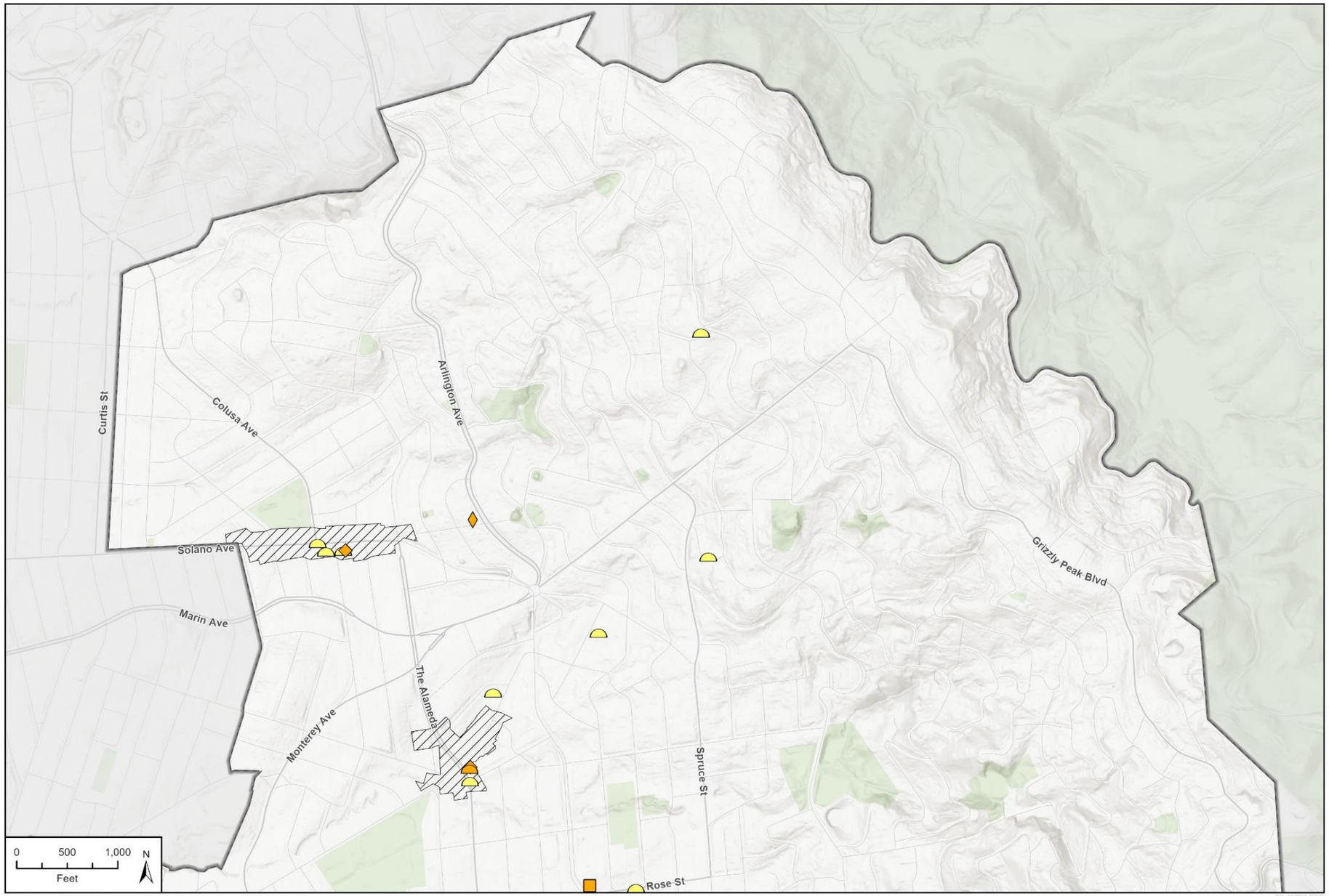
- Refine high priority sites further, based on site specific information including contaminated matrices (e.g., soil, soil vapor, groundwater), contaminant type(s), and contaminant depth.
- Coordinate with oversight agencies by registering for database notifications for high priority sites.
- Consider mitigation measures (e.g., utility trench dams) for capital improvements projects adjacent to or near high priority sites to reduce the potential of preferential groundwater and soil vapor pathways.
- Reanalyze projected groundwater rise and contaminated site on a 5-year review cycle to capture:
    - The evolving data and tools for predicting SLR and GWR

  - New contaminated sites or updates to inventoried contaminated sites
  - Changes in contaminant classification and knowledge.
- Advocate for proactive planning and risk communication with interested parties (the City, residents, environmental oversight agencies) for high priority sites.

Attachment 1

Figures

Figure 1a Contaminated Sites Rankings - Current Conditions Northeast Berkeley



Berkeley City Limits
Environmental Management Area (EMA)

Groundwater Depth (Current)

Marine Inundation (MHHW Sea Level)
Water Table at Surface (Emergent)
Water Table Between 0-1m Depth (Very Shallow)
Water Table Between 1-2m Depth (Shallow)

Site Category

Cleanup Program Sites
DTSC Cleanup Sites
DTSC Hazardous Waste Sites
LUST Cleanup Sites
Land Disposal Site
Non-Case Information Sites
Permitted USTs
Single-Walled UST Sites

Site Priority

High Priority Sites
Medium Priority Sites
Low Priority Sites

Notes

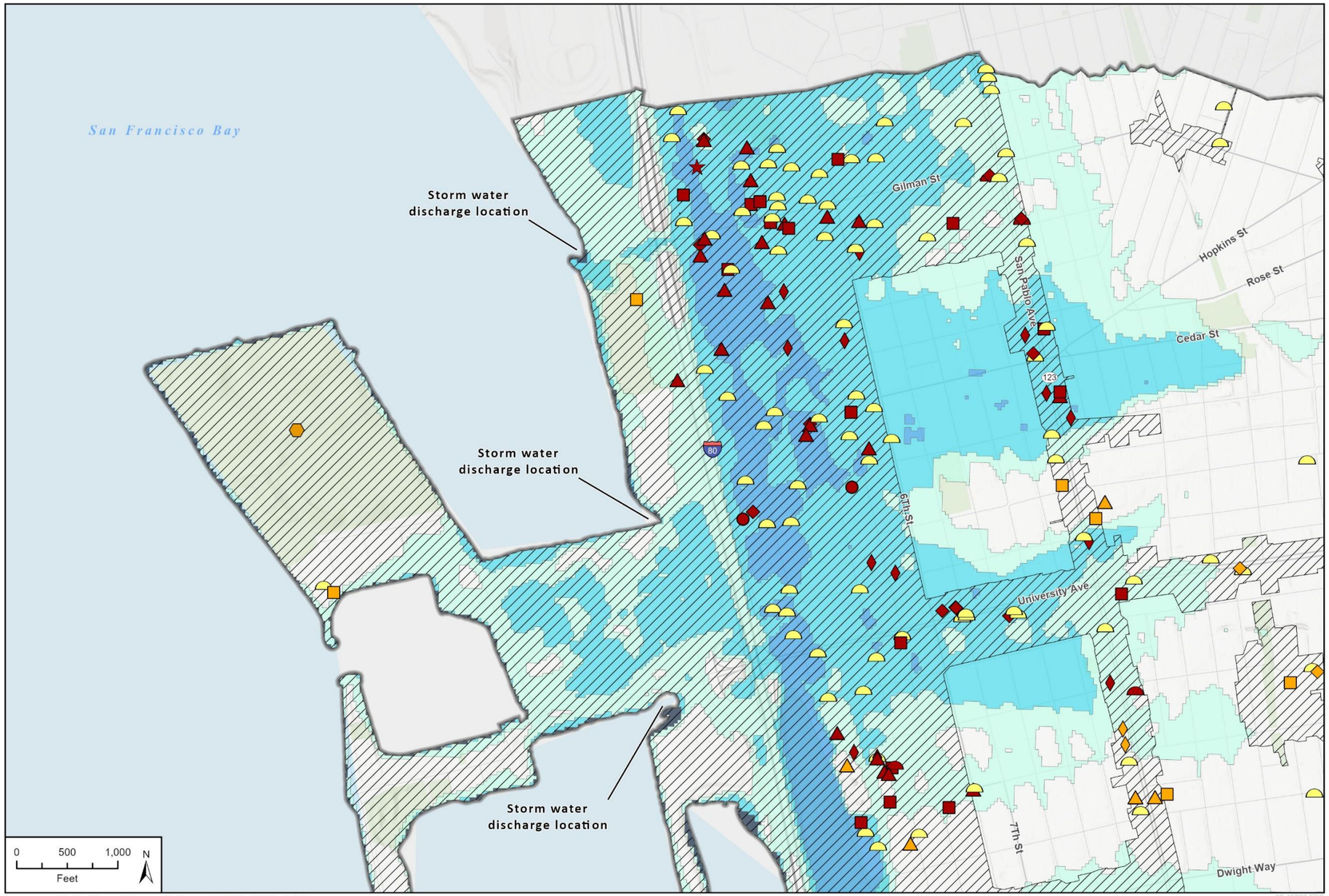
High Priority Sites: Groundwater depth is <2 m
Medium Priority Sites: Groundwater depth >2 m
Low Priority Sites: Closed LUST Cleanup Sites



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23-15392 EES
Fig 1 Berkeley Priority Sites Current

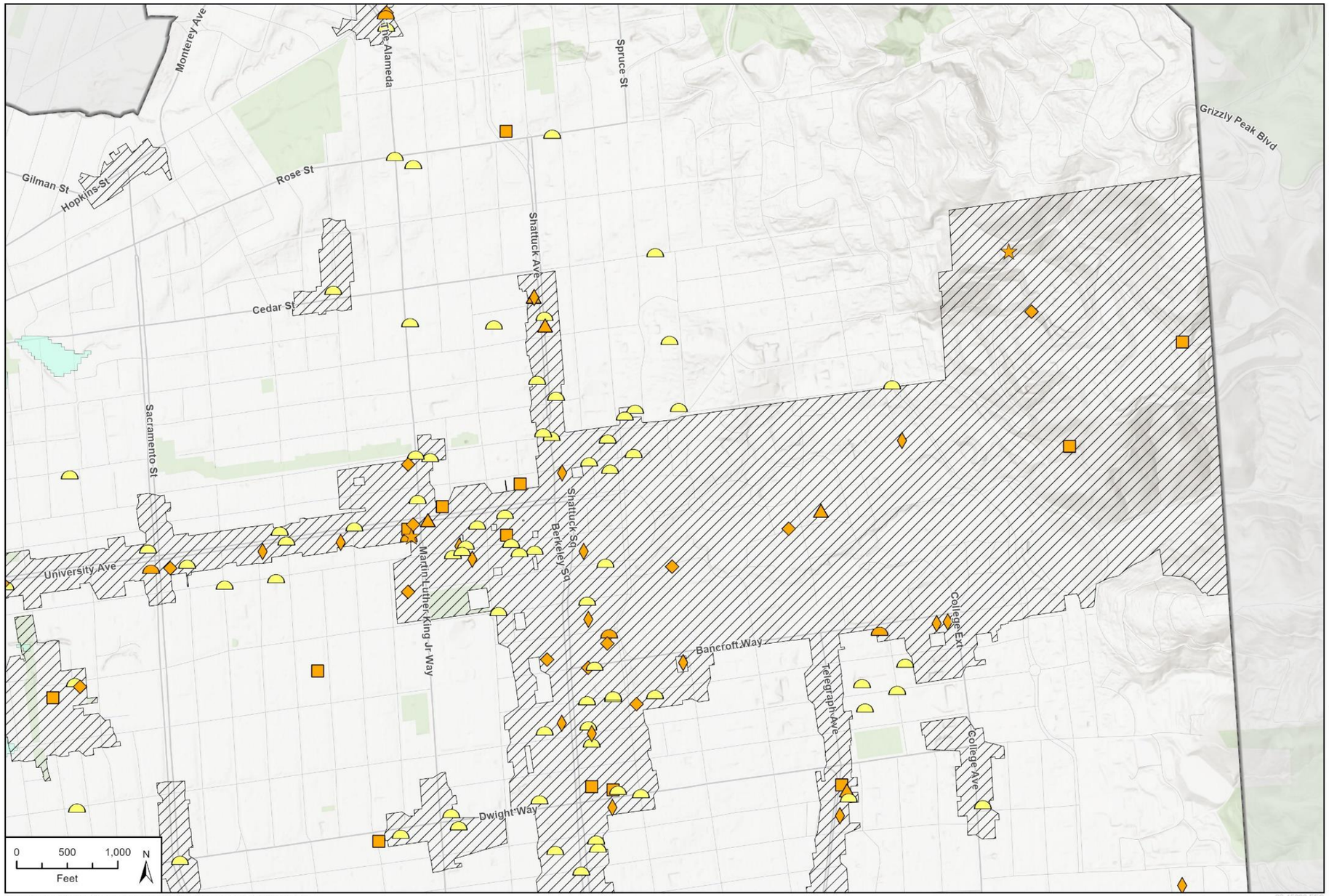
Figure 1b Contaminated Sites Rankings - Current Conditions West Berkeley



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23-15392 EBS
Fig 1 Berkeley Priority Sites Current

Figure 1c Contaminated Sites Rankings - Current Conditions East Berkeley



Berkeley City Limits
Environmental Management Area (EMA)

Groundwater Depth (Current)

- Marine Inundation (MHHW Sea Level)
- Water Table at Surface (Emergent)
- Water Table Between 0-1m Depth (Very Shallow)
- Water Table Between 1-2m Depth (Shallow)

Site Category

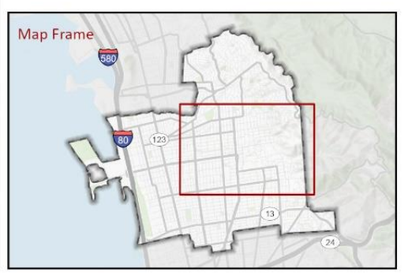
- Cleanup Program Sites
- DTSC Cleanup Sites
- DTSC Hazardous Waste Sites
- LUST Cleanup Sites
- Land Disposal Site
- Non-Case Information Sites
- Permitted USTs
- Single-Walled UST Sites

Site Priority

- High Priority Sites
- Medium Priority Sites
- Low Priority Sites

Notes

High Priority Sites: Groundwater depth is <2 m
Medium Priority Sites: Groundwater depth >2 m
Low Priority Sites: Closed LUST Cleanup Sites



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23-15392 EES
Fig 1 Berkeley Priority Sites Current

Figure 1d Contaminated Sites Rankings - Current Conditions Southwest Berkeley

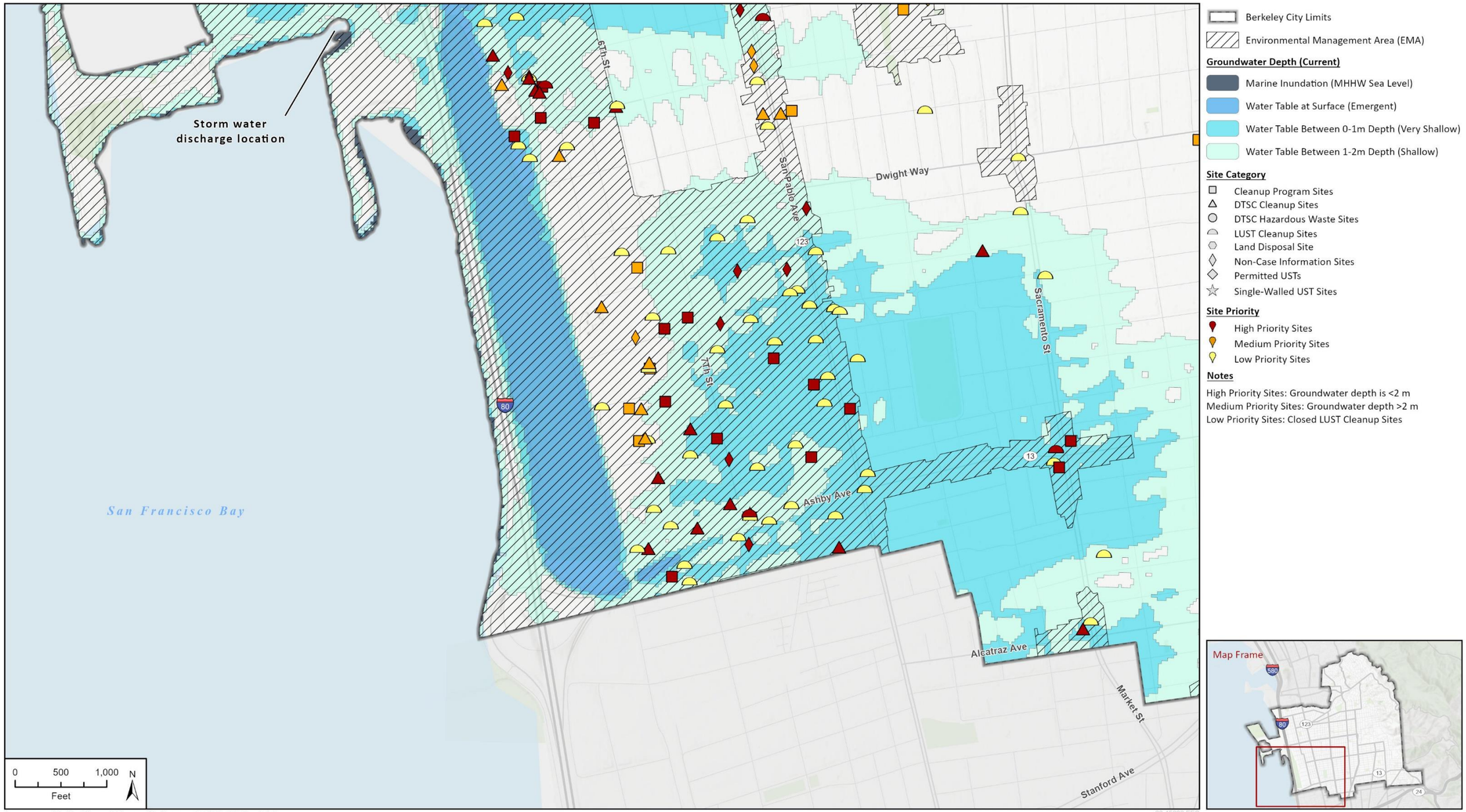
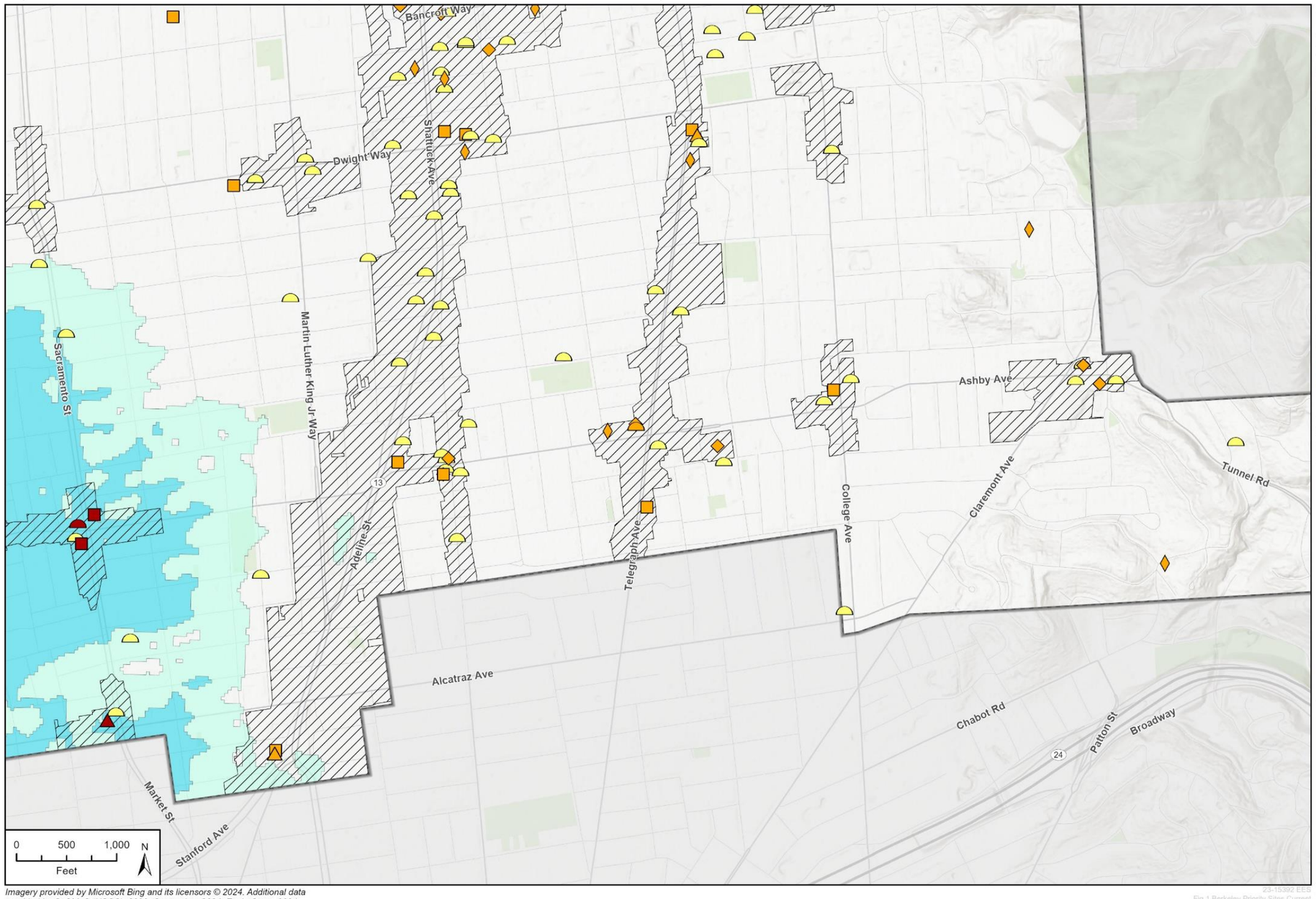


Figure 1e Contaminated Sites Rankings - Current Conditions Southeast Berkeley



Berkeley City Limits
Environmental Management Area (EMA)

Groundwater Depth (Current)

- Marine Inundation (MHHW Sea Level)
- Water Table at Surface (Emergent)
- Water Table Between 0-1m Depth (Very Shallow)
- Water Table Between 1-2m Depth (Shallow)

Site Category

- Cleanup Program Sites
- DTSC Cleanup Sites
- DTSC Hazardous Waste Sites
- LUST Cleanup Sites
- Land Disposal Site
- Non-Case Information Sites
- Permitted USTs
- Single-Walled UST Sites

Site Priority

- High Priority Sites
- Medium Priority Sites
- Low Priority Sites

Notes

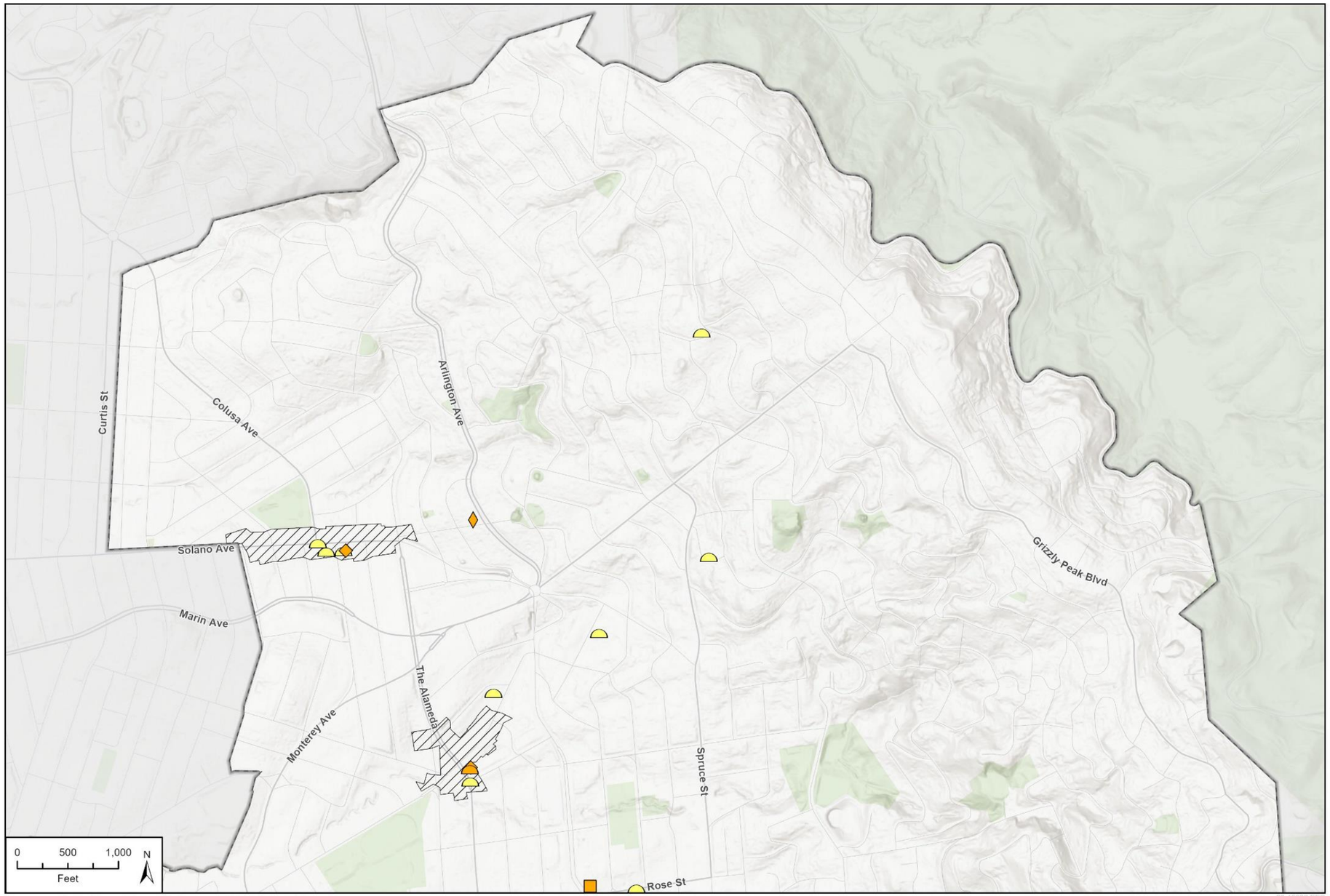
High Priority Sites: Groundwater depth is <2 m
Medium Priority Sites: Groundwater depth >2 m
Low Priority Sites: Closed LUST Cleanup Sites



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23-15302 EEG
Fig 1 Berkeley Priority Sites Current

Figure 2a Contaminated Sites Rankings - 0.8 feet (25 cm) SLR Scenario Northeast Berkeley



Berkeley City Limits
Environmental Management Area (EMA)

Groundwater Depth (0.25m)

Marine Inundation (MHHW Sea Level)
Water Table at Surface (Emergent)
Water Table Between 0-1m Depth (Very Shallow)
Water Table Between 1-2m Depth (Shallow)

Site Category

Cleanup Program Sites
DTSC Cleanup Sites
DTSC Hazardous Waste Sites
LUST Cleanup Sites
Land Disposal Site
Non-Case Information Sites
Permitted USTs
Single-Walled UST Sites

Site Priority

High Priority Sites
Medium Priority Sites
Low Priority Sites

Notes

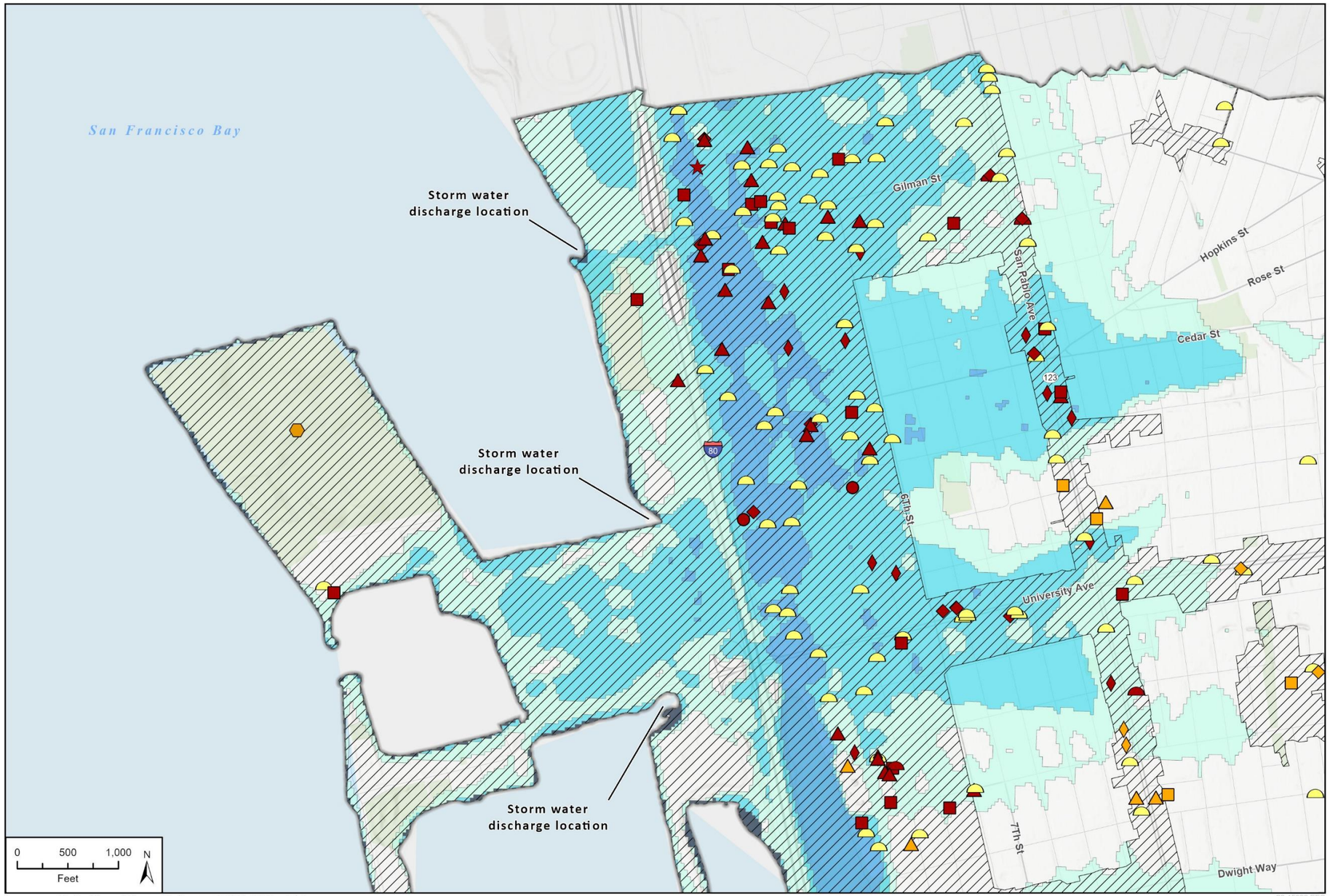
High Priority Sites: Groundwater depth is <2 m
Medium Priority Sites: Groundwater depth >2 m
Low Priority Sites: Closed LUST Cleanup Sites



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23-15392 EBS
Fig 2 Berkeley Priority Sites 0.25m

Figure 2b Contaminated Sites Rankings - 0.8 feet (25 cm) SLR Scenario West Berkeley



Berkeley City Limits
Environmental Management Area (EMA)

Groundwater Depth (0.25m)

- Marine Inundation (MHHW Sea Level)
- Water Table at Surface (Emergent)
- Water Table Between 0-1m Depth (Very Shallow)
- Water Table Between 1-2m Depth (Shallow)

Site Category

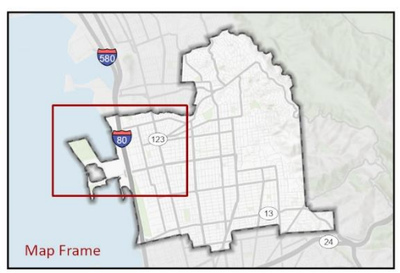
- Cleanup Program Sites
- DTSC Cleanup Sites
- DTSC Hazardous Waste Sites
- LUST Cleanup Sites
- Land Disposal Site
- Non-Case Information Sites
- Permitted USTs
- Single-Walled UST Sites

Site Priority

- High Priority Sites
- Medium Priority Sites
- Low Priority Sites

Notes

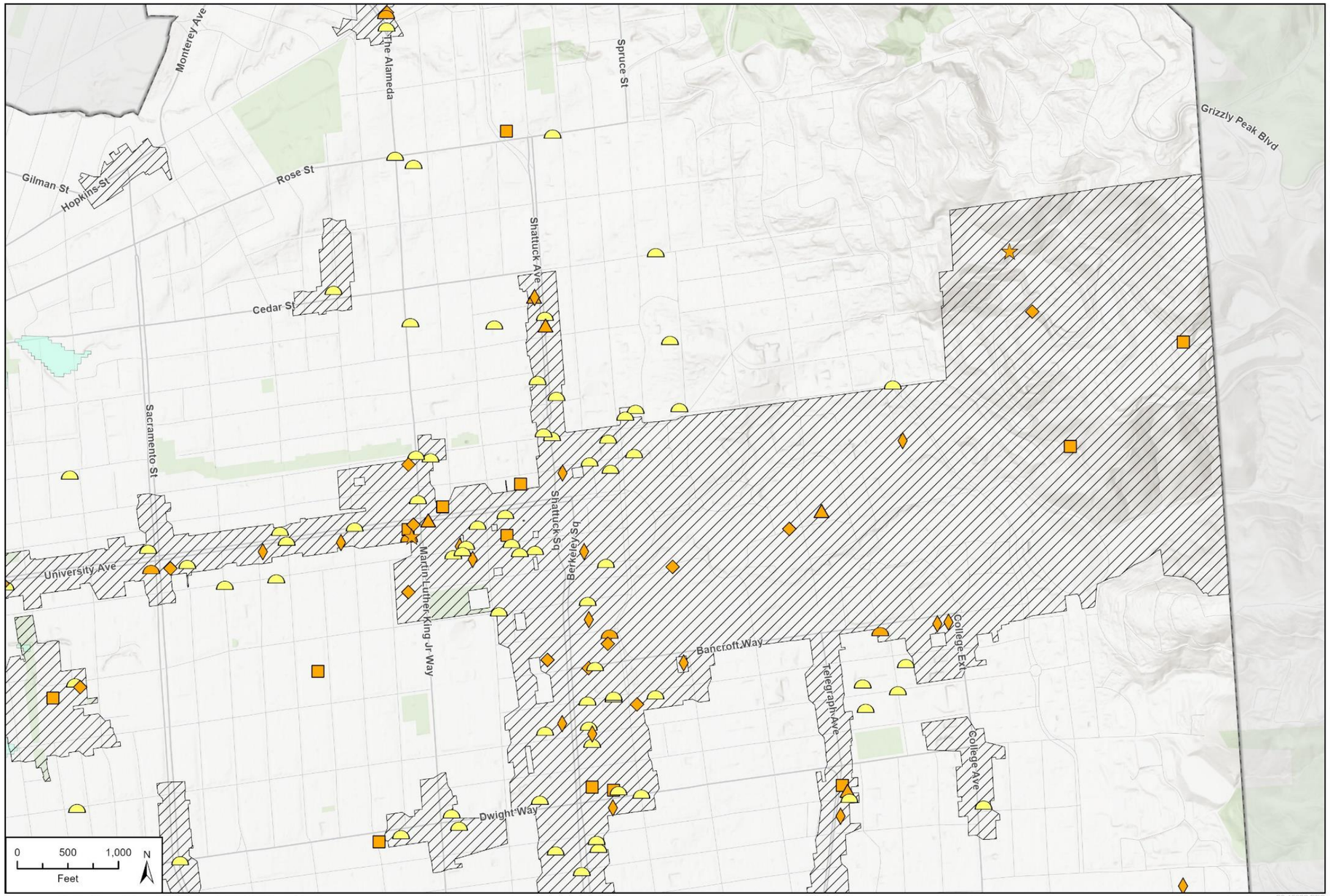
High Priority Sites: Groundwater depth is <2 m
Medium Priority Sites: Groundwater depth >2 m
Low Priority Sites: Closed LUST Cleanup Sites



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23-15392 EBS
Fig 2 Berkeley Priority Sites 0.25m

Figure 2c Contaminated Sites Rankings - 0.8 feet (25 cm) SLR Scenario East Berkeley



Berkeley City Limits
Environmental Management Area (EMA)

Groundwater Depth (0.25m)

- Marine Inundation (MHHW Sea Level)
- Water Table at Surface (Emergent)
- Water Table Between 0-1m Depth (Very Shallow)
- Water Table Between 1-2m Depth (Shallow)

Site Category

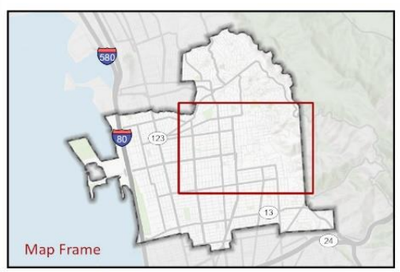
- Cleanup Program Sites
- DTSC Cleanup Sites
- DTSC Hazardous Waste Sites
- LUST Cleanup Sites
- Land Disposal Site
- Non-Case Information Sites
- Permitted USTs
- Single-Walled UST Sites

Site Priority

- High Priority Sites
- Medium Priority Sites
- Low Priority Sites

Notes

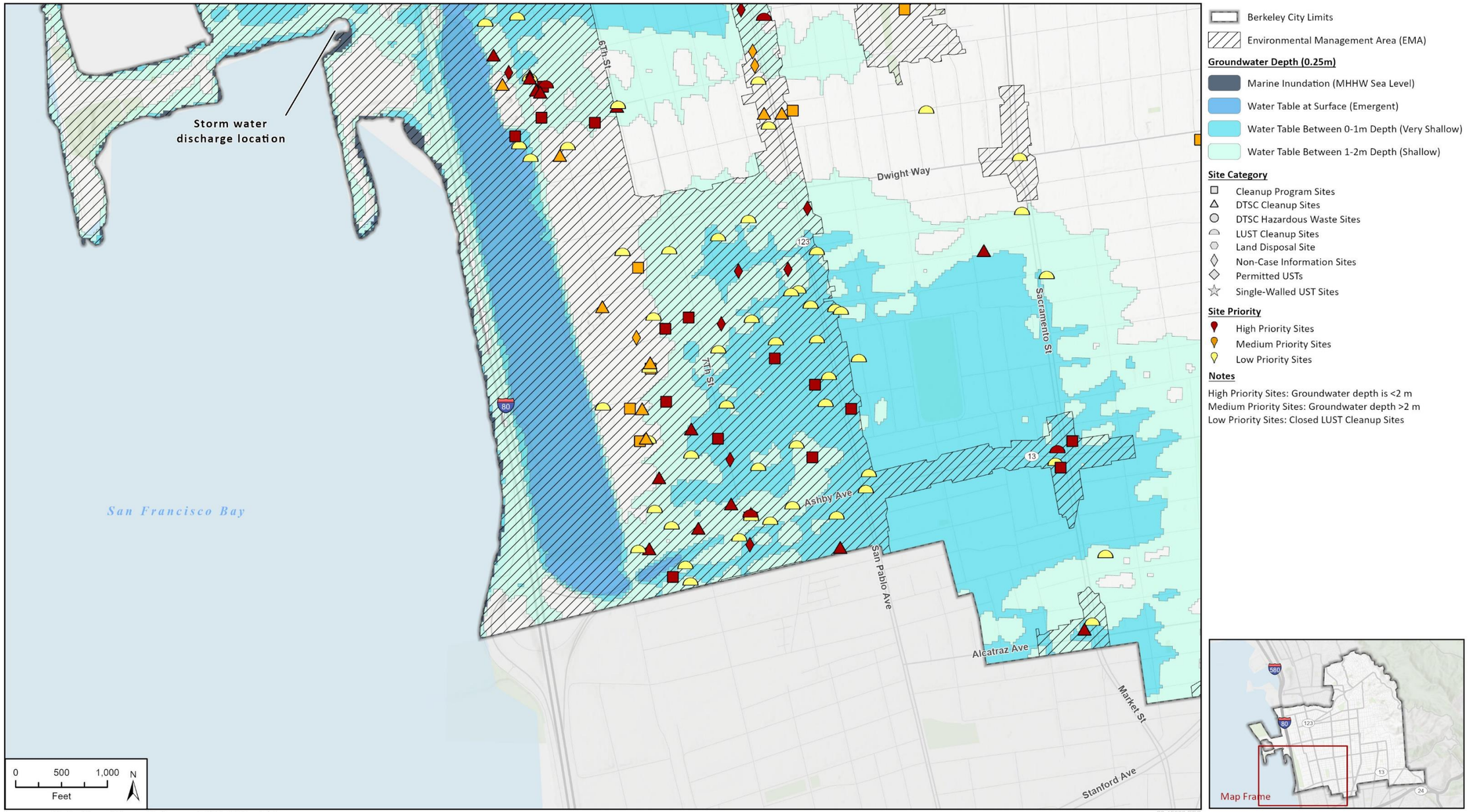
High Priority Sites: Groundwater depth is <2 m
Medium Priority Sites: Groundwater depth >2 m
Low Priority Sites: Closed LUST Cleanup Sites



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23-15302 EES
Fig 2 Berkeley Priority Sites 0.25m

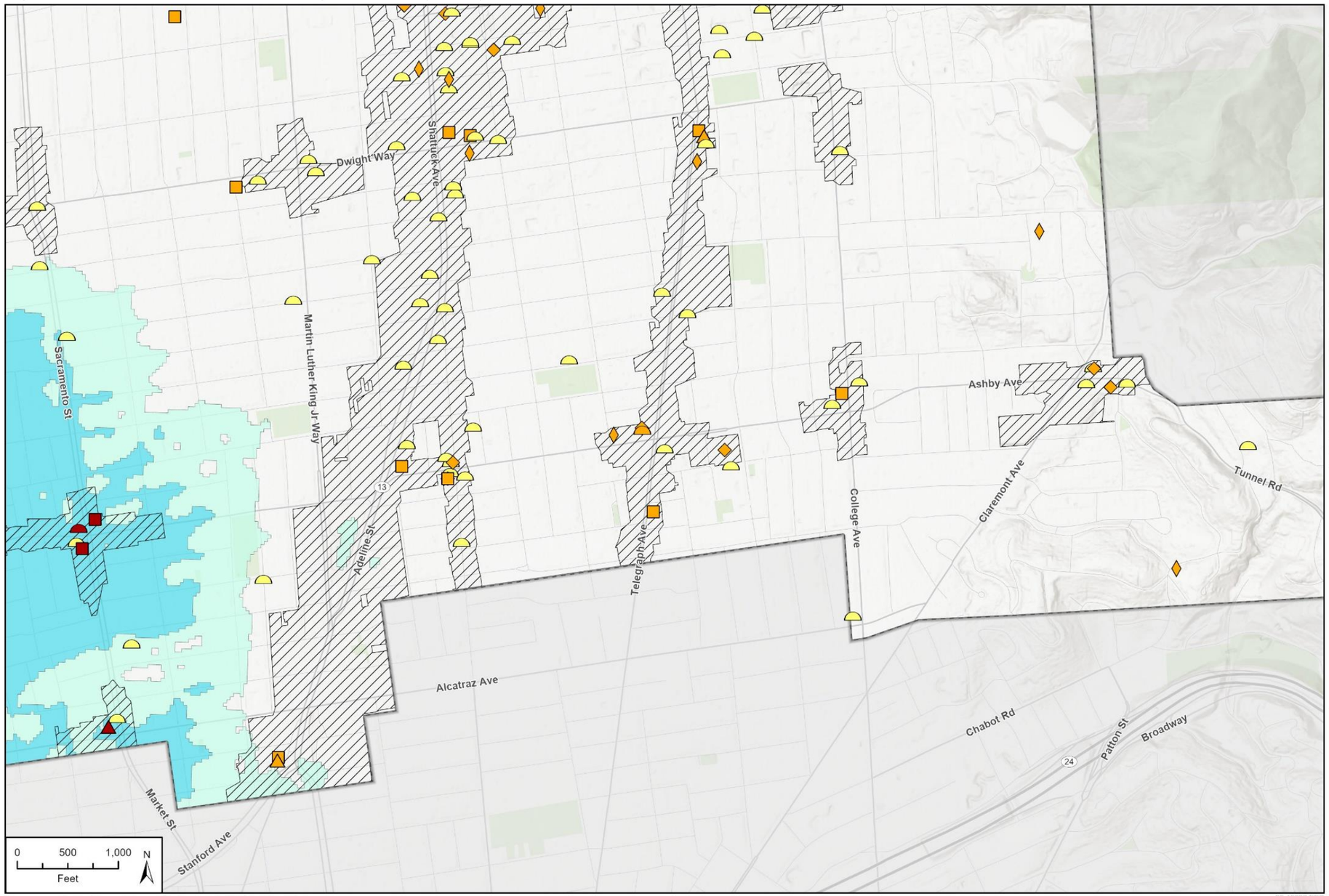
Figure 2d Contaminated Sites Rankings - 0.8 feet (25 cm) SLR Scenario Southwest Berkeley



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23-15392 EES
Fig 2 Berkeley Priority Sites 0.25m

Figure 2e Contaminated Sites Rankings - 0.8 feet (25 cm) SLR Scenario Southeast Berkeley



Berkeley City Limits
Environmental Management Area (EMA)

Groundwater Depth (0.25m)

Marine Inundation (MHHW Sea Level)
Water Table at Surface (Emergent)
Water Table Between 0-1m Depth (Very Shallow)
Water Table Between 1-2m Depth (Shallow)

Site Category

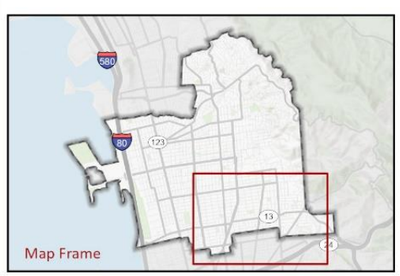
Cleanup Program Sites
DTSC Cleanup Sites
DTSC Hazardous Waste Sites
LUST Cleanup Sites
Land Disposal Site
Non-Case Information Sites
Permitted USTs
Single-Walled UST Sites

Site Priority

High Priority Sites
Medium Priority Sites
Low Priority Sites

Notes

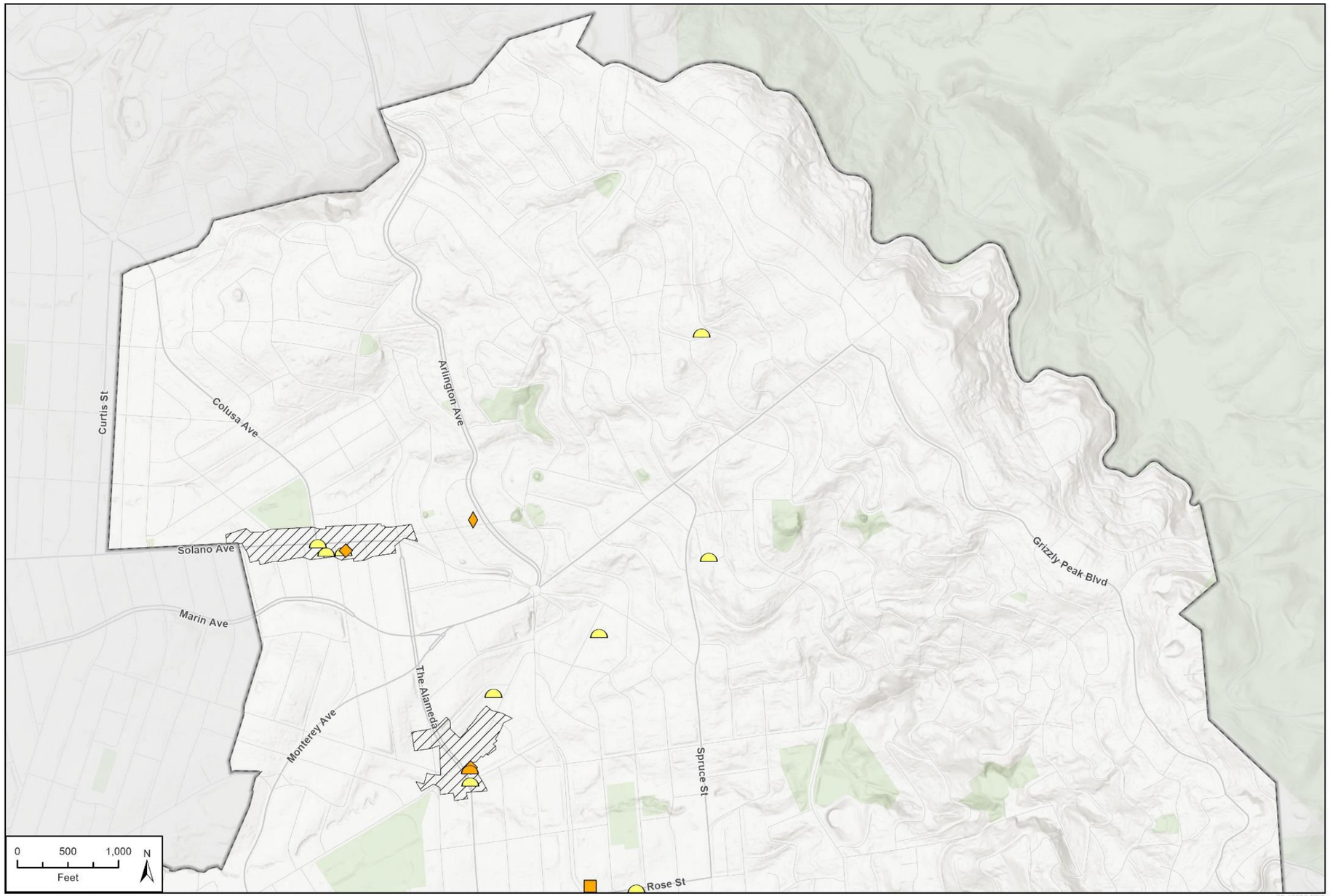
High Priority Sites: Groundwater depth is <2 m
Medium Priority Sites: Groundwater depth >2 m
Low Priority Sites: Closed LUST Cleanup Sites



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23-15392 EES
Fig 2 Berkeley Priority Sites 0.25m

Figure 3a Contaminated Sites Rankings - 2.5 feet (75 cm) SLR Scenario Northeast Berkeley



Berkeley City Limits
Environmental Management Area (EMA)

Groundwater Depth (0.75m)
- Marine Inundation (MHHW Sea Level)
- Water Table at Surface (Emergent)
- Water Table Between 0-1m Depth (Very Shallow)
- Water Table Between 1-2m Depth (Shallow)

Site Category
- Cleanup Program Sites
- DTSC Cleanup Sites
- DTSC Hazardous Waste Sites
- LUST Cleanup Sites
- Land Disposal Site
- Non-Case Information Sites
- Permitted USTs
- Single-Walled UST Sites

Site Priority
- High Priority Sites
- Medium Priority Sites
- Low Priority Sites

Notes

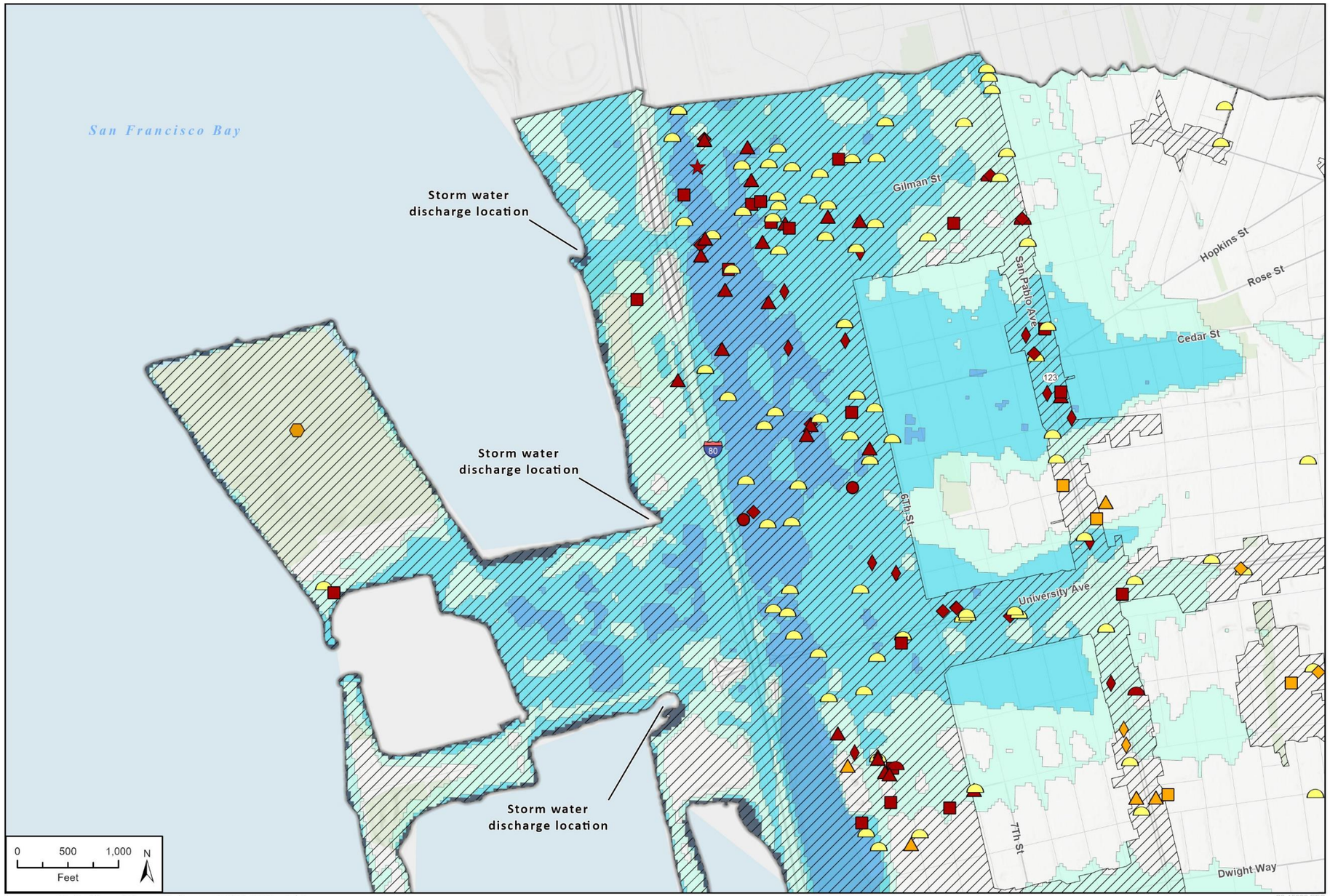
High Priority Sites: Groundwater depth is <2 m
Medium Priority Sites: Groundwater depth >2 m
Low Priority Sites: Closed LUST Cleanup Sites



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23-15392 EBS
Fig 3 Berkeley Priority Sites 0.75m

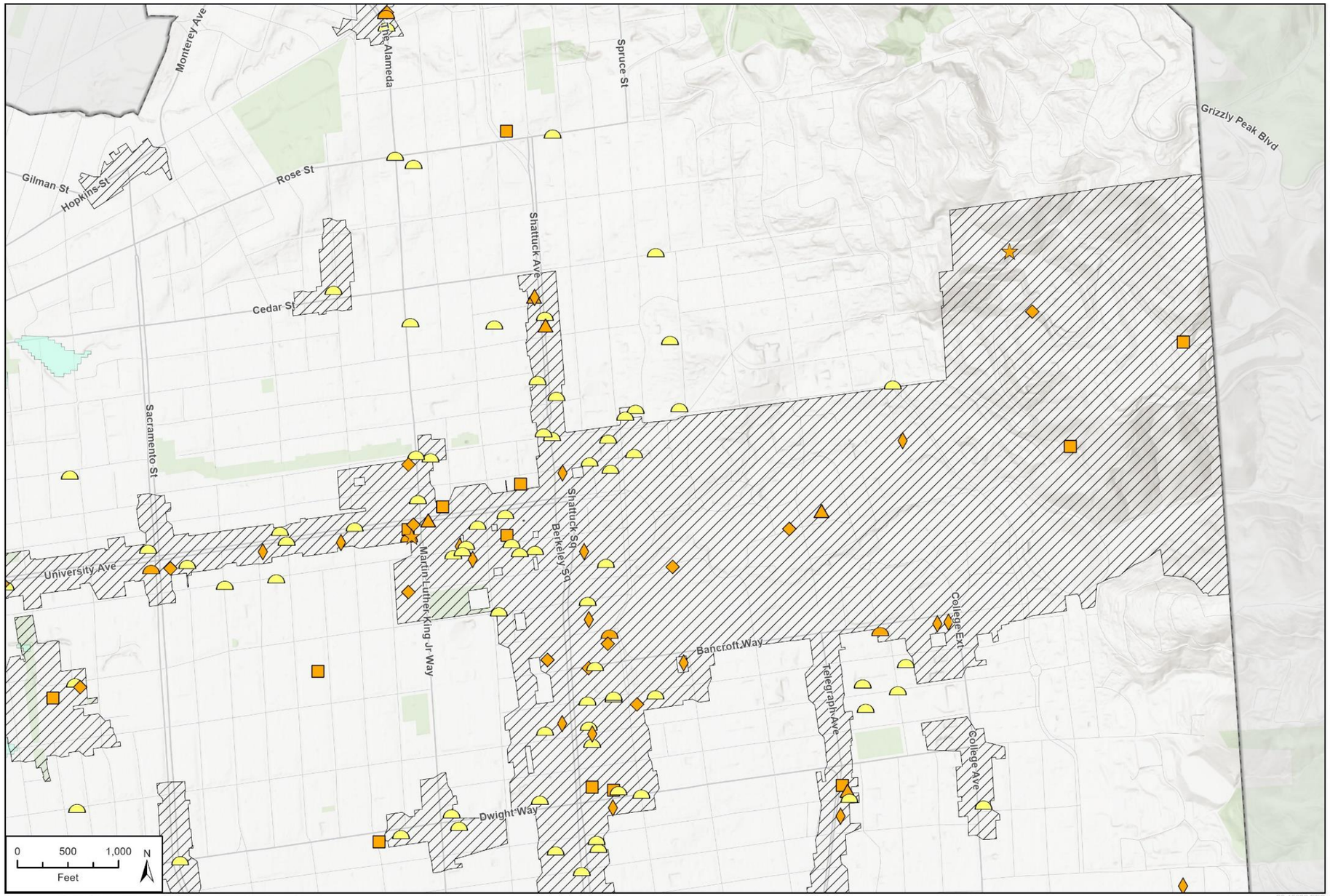
Figure 3b Contaminated Sites Rankings - 2.5 feet (75 cm) SLR Scenario West Berkeley



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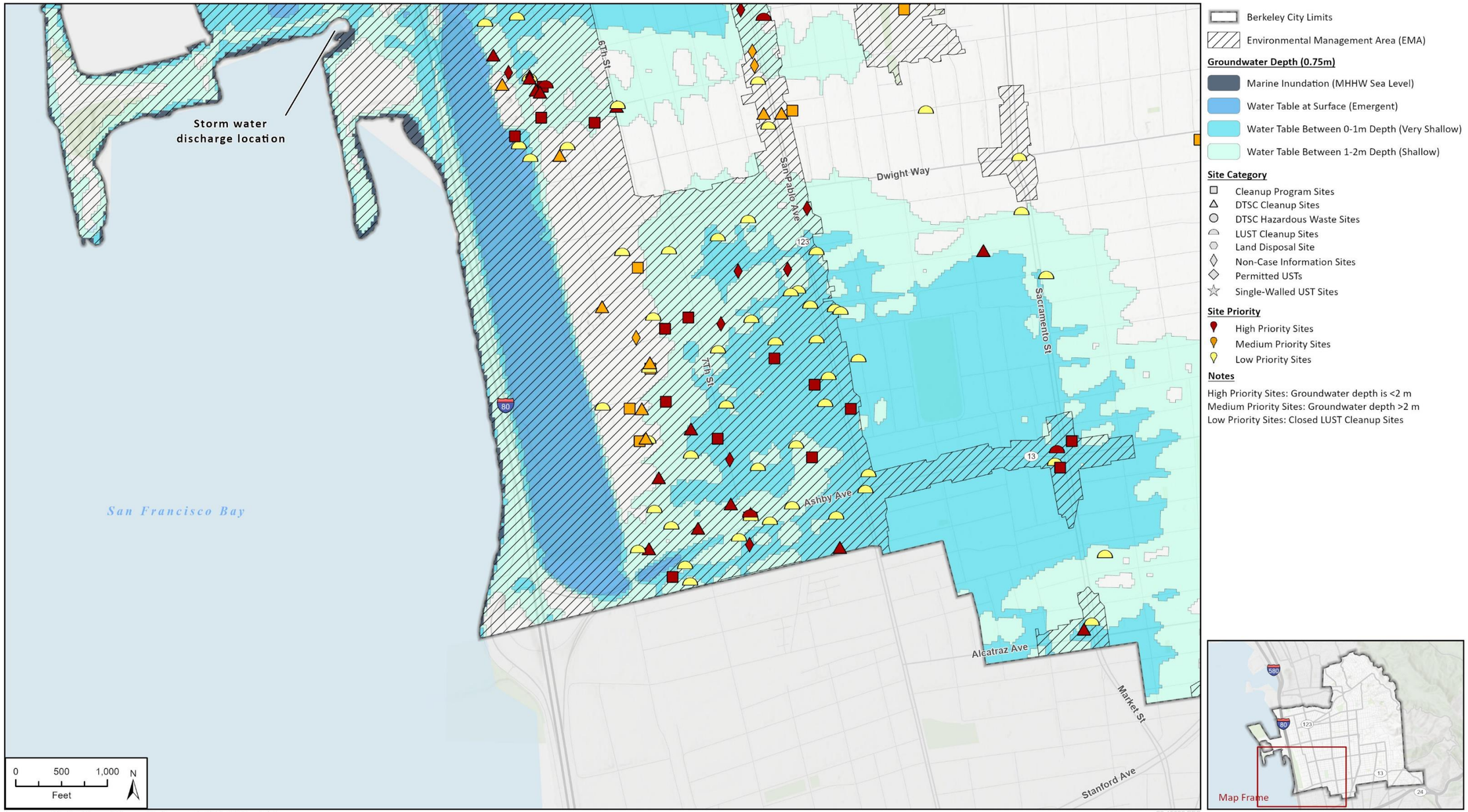
23-15392 EES
Fig 3 Berkeley Priority Sites 0.75m

Figure 3c Contaminated Sites Rankings - 2.5 feet (75 cm) SLR Scenario East Berkeley



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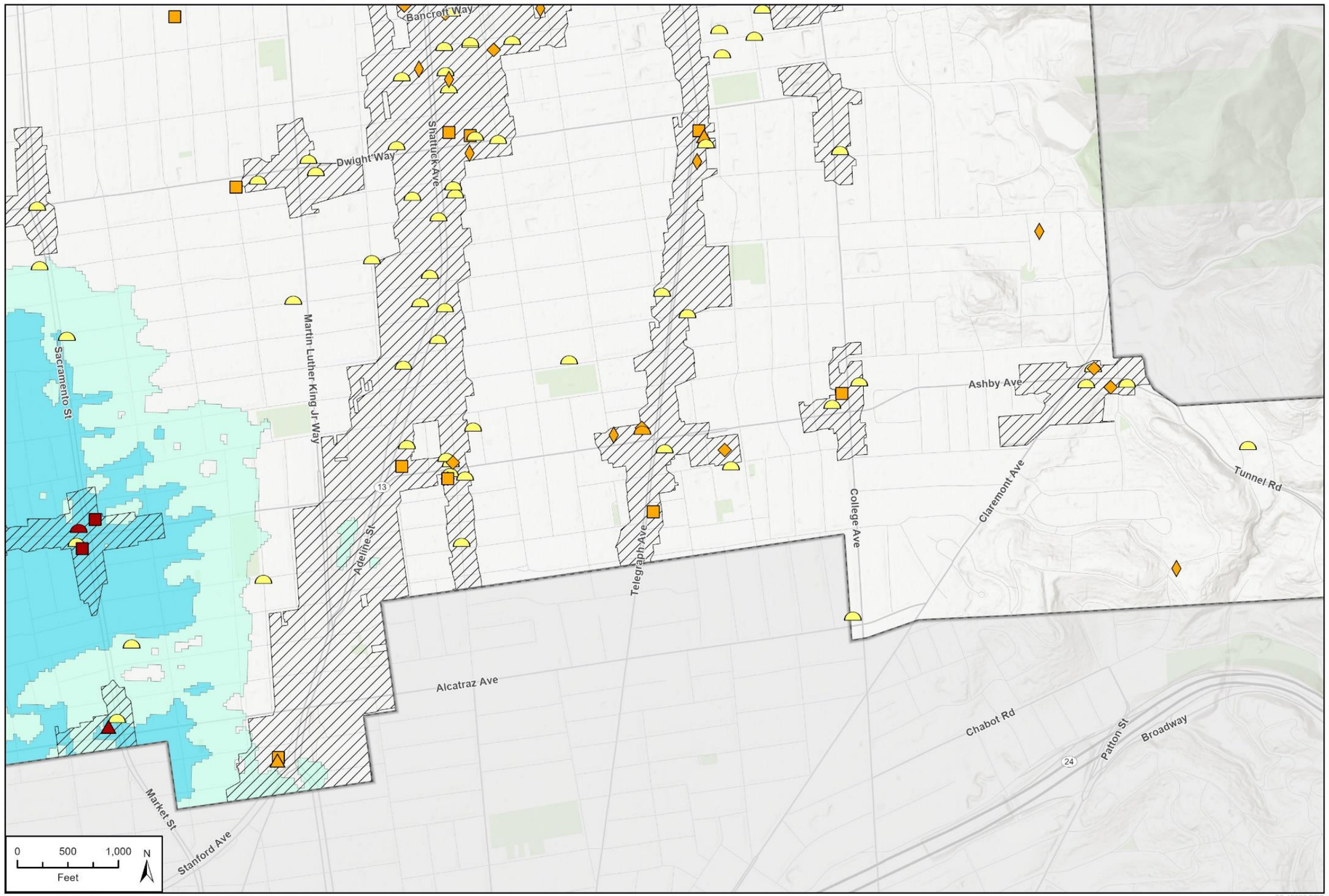
Figure 3d Contaminated Sites Rankings - 2.5 feet (75 cm) SLR Scenario Southwest Berkeley



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23-15392 EES
Fig 3 Berkeley Priority Sites 0.75m

Figure 3e Contaminated Sites Rankings - 2.5 feet (75 cm) SLR Scenario Southeast Berkeley



Berkeley City Limits
Environmental Management Area (EMA)

Groundwater Depth (0.75m)

- Marine Inundation (MHHW Sea Level)
- Water Table at Surface (Emergent)
- Water Table Between 0-1m Depth (Very Shallow)
- Water Table Between 1-2m Depth (Shallow)

Site Category

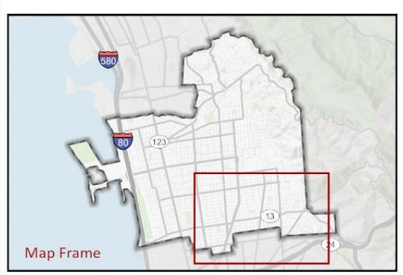
- Cleanup Program Sites
- DTSC Cleanup Sites
- DTSC Hazardous Waste Sites
- LUST Cleanup Sites
- Land Disposal Site
- Non-Case Information Sites
- Permitted USTs
- Single-Walled UST Sites

Site Priority

- High Priority Sites
- Medium Priority Sites
- Low Priority Sites

Notes

High Priority Sites: Groundwater depth is <2 m
Medium Priority Sites: Groundwater depth >2 m
Low Priority Sites: Closed LUST Cleanup Sites



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23-15392 EES
Fig 3 Berkeley Priority Sites 0.75m

Attachment 2

Table 1

Table 1. Contaminated Sites Information and Rankings

No	Site Name	Site Category	Site Type	Status	Address	City	Latitude	Longitude	Projected Groundwater Depth from CoSMoS			Site Ranking		
									Current Conditions	0.8 feet (25 cm) SLR Scenario	2.5 feet (75 cm) SLR Scenario	Current Conditions	0.8 feet (25 cm) SLR Scenario	2.5 feet (75 cm) SLR Scenario
1	1 RENTAL	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1501 EASTSHORE HWY	BERKELEY	37.874038	-122.304942	0 m; emergent	0 m; emergent	0 m; emergent	Low Priority	Low Priority	Low Priority
2	10TH AND PARKER STREETS	Non-Case Information Sites	NON-CASE INFORMATION	INFORMATIONAL ITEM / REVIEW COMPLETE	1050 PARKER STREET	BERKELEY	37.8587	-122.28968	1-2 m; shallow	1-2 m; shallow	1-2 m; shallow	High Priority	High Priority	High Priority
3	1255 EASTSHORE HIGHWAY (FORMER HAWKINS TRAFFIC SAFETY SUPPLY)	Cleanup Program Sites	CLEANUP PROGRAM SITE	OPEN - ELIGIBLE FOR CLOSURE	1255 EASTSHORE HIGHWAY	BERKELEY	37.87948	-122.30658	0-1 m; very shallow	0-1 m; very shallow	0 m; emergent	High Priority	High Priority	High Priority
4	1333 & 1335 SIXTH STREET	Non-Case Information Sites	NON-CASE INFORMATION	PENDING REVIEW	1333 & 1335 SIXTH STREET	BERKELEY	37.87801	-122.30051	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	High Priority	High Priority	High Priority
5	1600 ADDISON STREET	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1600 ADDISON ST	BERKELEY	37.8696994	-122.2796561	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
6	1627 SAN PABLO	DTSC Cleanup Sites	VOLUNTARY AGREEMENT	ACTIVE	1625 - 1627 SAN PABLO AVENUE	BERKELEY	37.87424	-122.29355	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	High Priority	High Priority	High Priority
7	1655 FIFTH STREET LLC	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1655 FIFTH STREET/801 VIRGINIA STREET	BERKELEY	37.87238	-122.30004	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	Low Priority	Low Priority	Low Priority
8	1776, 1782 AND 1790 UNIVERSITY AVENUE	Non-Case Information Sites	NON-CASE INFORMATION	INFORMATIONAL ITEM / REVIEW COMPLETE	1790 UNIVERSITY AVENUE	BERKELEY	37.87092	-122.27571	>5 m; deep	>5 m; deep	>5 m; deep	Medium Priority	Medium Priority	Medium Priority
9	1835 SAN PABLO AVE	Cleanup Program Sites	CLEANUP PROGRAM SITE	OPEN - SITE ASSESSMENT	1835 SAN PABLO AVENUE	BERKELEY	37.87090761	-122.292239	2-5 m; moderate	2-5 m; moderate	2-5 m; moderate	Medium Priority	Medium Priority	Medium Priority
10	1950 MLK, LLC	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1950 MARTIN LUTHER KING JR. WAY	BERKELEY	37.872122	-122.273102	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
11	2001 ASHBY REDEVELOPMENT	Cleanup Program Sites	CLEANUP PROGRAM SITE	OPEN - SITE ASSESSMENT	2001 ASHBY AVENUE	BERKELEY	37.85532	-122.26835	>5 m; deep	>5 m; deep	>5 m; deep	Medium Priority	Medium Priority	Medium Priority
12	2009 TO 2015 ADDISON STREET	Cleanup Program Sites	CLEANUP PROGRAM SITE	OPEN - INACTIVE	2009 ADDISON STREET	BERKELEY	37.8712	-122.27003	>5 m; deep	>5 m; deep	>5 m; deep	Medium Priority	Medium Priority	Medium Priority
13	2100 MILVIA STREET	Non-Case Information Sites	NON-CASE INFORMATION	PENDING REVIEW	2100 MILVIA STREET	BERKELEY	37.87053	-122.27119	>5 m; deep	>5 m; deep	>5 m; deep	Medium Priority	Medium Priority	Medium Priority
14	2107 DWIGHT (AKA "THE DWIGHT")	Cleanup Program Sites	CLEANUP PROGRAM SITE	COMPLETED - CASE CLOSED	2107 DWIGHT WAY	BERKELEY	37.86441218	-122.2669512	>5 m; deep	>5 m; deep	>5 m; deep	Medium Priority	Medium Priority	Medium Priority
15	2127 - 2159 DWIGHT WAY	Cleanup Program Sites	CLEANUP PROGRAM SITE	OPEN - REMEDIATION	2127 - 2159 DWIGHT WAY	BERKELEY	37.86434	-122.26622	>5 m; deep	>5 m; deep	>5 m; deep	Medium Priority	Medium Priority	Medium Priority
16	2246 SAN PABLO AVENUE	Non-Case Information Sites	NON-CASE INFORMATION	INFORMATIONAL ITEM / REVIEW COMPLETE	2246 SAN PABLO AVENUE	BERKELEY	37.86478	-122.29108	2-5 m; moderate	2-5 m; moderate	2-5 m; moderate	Medium Priority	Medium Priority	Medium Priority
17	2300 AND 2306 ELLSWORTH STREET	Non-Case Information Sites	NON-CASE INFORMATION	INFORMATIONAL ITEM / REVIEW COMPLETE	2300 AND 2306 ELLSWORTH STREET	BERKELEY	37.86783	-122.2639	>5 m; deep	>5 m; deep	>5 m; deep	Medium Priority	Medium Priority	Medium Priority
18	2300 COLLEGE AVENUE	Non-Case Information Sites	NON-CASE INFORMATION	INFORMATIONAL ITEM / REVIEW COMPLETE	2300 COLLEGE AVENUE	BERKELEY	37.86907	-122.25486	>5 m; deep	>5 m; deep	>5 m; deep	Medium Priority	Medium Priority	Medium Priority
19	2370 SHATTUCK AVENUE	Non-Case Information Sites	NON-CASE INFORMATION	INFORMATIONAL ITEM / REVIEW COMPLETE	2370 SHATTUCK AVENUE	BERKELEY	37.86612	-122.26802	>5 m; deep	>5 m; deep	>5 m; deep	Medium Priority	Medium Priority	Medium Priority
20	2371 SAN PABLO AVENUE	DTSC Cleanup Sites	VOLUNTARY AGREEMENT	ACTIVE	2371 SAN PABLO AVENUE	BERKELEY	37.863399	-122.29003	2-5 m; moderate	2-5 m; moderate	2-5 m; moderate	Medium Priority	Medium Priority	Medium Priority
21	2587 TELEGRAPH AVENUE	Non-Case Information Sites	NON-CASE INFORMATION	PENDING REVIEW	2587 TELEGRAPH AVENUE	BERKELEY	37.86375	-122.25843	>5 m; deep	>5 m; deep	>5 m; deep	Medium Priority	Medium Priority	Medium Priority
22	2601 SAN PABLO AVENUE LLC	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	2601 SAN PABLO AVENUE	BERKELEY	37.8592683	-122.2886015	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	Low Priority	Low Priority	Low Priority
23	2601-2605 SAN PABLO AVENUE	Non-Case Information Sites	NON-CASE INFORMATION	INFORMATIONAL ITEM / REVIEW COMPLETE	26 SAN PABLO AVENUE	BERKELEY	37.8702761	-122.292454	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	High Priority	High Priority	High Priority
24	2660 AND 2680 BANCROFT WAY	Non-Case Information Sites	NON-CASE INFORMATION	INFORMATIONAL ITEM / REVIEW COMPLETE	2660 BANCROFT WAY	BERKELEY	37.86902	-122.25524	>5 m; deep	>5 m; deep	>5 m; deep	Medium Priority	Medium Priority	Medium Priority
25	2711 CLAREMONT BLVD.	Non-Case Information Sites	NON-CASE INFORMATION	INFORMATIONAL ITEM / REVIEW COMPLETE	2711 CLAREMONT	BERKELEY	37.862029	-122.246662	>5 m; deep	>5 m; deep	>5 m; deep	Medium Priority	Medium Priority	Medium Priority
26	740 EUCLID AVE. RESIDENCE	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	740 EUCLID	BERKELEY	37.8972369	-122.266855	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
27	742 GRAYSON STREET PROPERTY	Cleanup Program Sites	CLEANUP PROGRAM SITE	OPEN - ASSESSMENT & INTERIM REMEDIAL ACTION - LAND USE RESTRICTIONS	742 GRAYSON STREET	BERKELEY	37.85444	-122.29555	2-5 m; moderate	2-5 m; moderate	2-5 m; moderate	Medium Priority	Medium Priority	Medium Priority
28	76 STATION 2218	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1830 SOLANO AVENUE	BERKELEY	37.89112493	-122.2789813	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
29	950 PARKER	Non-Case Information Sites	NON-CASE INFORMATION	INFORMATIONAL ITEM / REVIEW COMPLETE	950 PARKER STREET	BERKELEY	37.85862	-122.29155	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	High Priority	High Priority	High Priority

Table 1. Contaminated Sites Information and Rankings

No	Site Name	Site Category	Site Type	Status	Address	City	Latitude	Longitude	Projected Groundwater Depth from CoSMoS			Site Ranking		
									Current Conditions	0.8 feet (25 cm) SLR Scenario	2.5 feet (75 cm) SLR Scenario	Current Conditions	0.8 feet (25 cm) SLR Scenario	2.5 feet (75 cm) SLR Scenario
30	AAMCO TRANSMISSION	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1177 SAN PABLO AVE	BERKELEY	37.883073	-122.296291	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	Low Priority	Low Priority	Low Priority
31	AAQA MEATS ALLSTAR STEAKS	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1411 SAN PABLO AVE	BERKELEY	37.878375	-122.294779	1-2 m; shallow	1-2 m; shallow	1-2 m; shallow	Low Priority	Low Priority	Low Priority
32	AC PAPER	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1321 7TH ST	BERKELEY	37.8788095	-122.3000129	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	Low Priority	Low Priority	Low Priority
33	ADDISON STREET PROPERTY	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	2040 ADDISON ST	BERKELEY	37.870806	-122.269062	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
34	ADMIRAL MOVING SYSTEMS	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	830 CEDAR ST	BERKELEY	37.873807	-122.299909	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	Low Priority	Low Priority	Low Priority
35	AH THOMPSON	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	695 CEDAR	BERKELEY	37.873647	-122.303313	0 m; emergent	0 m; emergent	0 m; emergent	Low Priority	Low Priority	Low Priority
36	ALAMEDA COUNTY COMPUTER RESOURCE CENTER	DTSC Cleanup Sites	INSPECTION	NO ACTION	620 PAGE STREET	BERKELEY	37.8766395	-122.30362	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	High Priority	High Priority	High Priority
37	ALCAN INGOT & POWDERS	Permitted USTs		PROTECTIVE FILER	1069 SECOND STREET	BERKELEY	37.881008	-122.30592	1-2 m; shallow	1-2 m; shallow	1-2 m; shallow	High Priority	High Priority	High Priority
38	ALCAN INGOT & POWDERS	DTSC Cleanup Sites	CORRECTIVE ACTION	NO FURTHER ACTION	1069 SECOND STREET	BERKELEY	37.881008	-122.30592	1-2 m; shallow	1-2 m; shallow	1-2 m; shallow	High Priority	High Priority	High Priority
39	ALTA BATES HOSPITAL	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	3001 COLBY STREET	BERKELEY	37.855504	-122.257073	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
40	ALTA BATES SUMMIT MEDICAL CENTER-ALTA BATES CAMPUS	Permitted USTs			2450 ASHBY AVE	BERKELEY	37.85593	-122.2573	>5 m; deep	>5 m; deep	>5 m; deep	Medium Priority	Medium Priority	Medium Priority
41	AMERICAN RED CROSS	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	2116 ALLSTON WY	BERKELEY	37.869448	-122.267227	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
42	APARTMENT BUILDING	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1846 SPRUCE ST	BERKELEY	37.8746859	-122.265709	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
43	APRO DISTRIBUTION 2204	Single-Walled UST Sites	SINGLE-WALLED UST	USTS PERMANENTLY CLOSED - REPORT PENDING	901 ASHBY AVE	BERKELEY	37.85135179	-122.2909015	1-2 m; shallow	1-2 m; shallow	1-2 m; shallow	High Priority	High Priority	High Priority
44	APRO DISTRIBUTION 2204	Permitted USTs			901 ASHBY AVE	BERKELEY	37.85135	-122.2909	1-2 m; shallow	1-2 m; shallow	1-2 m; shallow	High Priority	High Priority	High Priority
45	AQUATIC PARK SCIENCE CENTER	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	80 BOLIVAR DR.	BERKELEY	37.86189492	-122.2994828	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	Low Priority	Low Priority	Low Priority
46	AQUATIC PARK SCIENCE CENTER	DTSC Cleanup Sites	VOLUNTARY AGREEMENT	NO FURTHER ACTION	2222 3RD STREET	BERKELEY	37.8649732	-122.30096	1-2 m; shallow	1-2 m; shallow	1-2 m; shallow	High Priority	High Priority	High Priority
47	ARCO # 00414	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	3000 SHATTUCK AVE	BERKELEY	37.85517764	-122.2666875	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
48	ARLINGTON RESIDENCE	Non-Case Information Sites	NON-CASE INFORMATION	INFORMATIONAL ITEM / REVIEW COMPLETE	892 ARLINGTON AVENUE	BERKELEY	37.89205	-122.27456	>5 m; deep	>5 m; deep	>5 m; deep	Medium Priority	Medium Priority	Medium Priority
49	ASPHALT PRODUCT OIL CORP	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1001 ASHBY AVE	BERKELEY	37.8516385	-122.2893427	1-2 m; shallow	1-2 m; shallow	1-2 m; shallow	Low Priority	Low Priority	Low Priority
50	AT&T CALIFORNIA - Q2002	Permitted USTs			2116 BANCROFT WAY	BERKELEY	37.86764	-122.26715	>5 m; deep	>5 m; deep	>5 m; deep	Medium Priority	Medium Priority	Medium Priority
51	ATLAS WELDING SUPPLY	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1224 6TH ST	BERKELEY	37.88014	-122.301936	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	Low Priority	Low Priority	Low Priority
52	AUTOMOTIVE UNLIMITED	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	2020 ADDISON ST	BERKELEY	37.870738	-122.26958	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
53	AVIS RENT A CAR	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1900 OXFORD ST	BERKELEY	37.873864	-122.266631	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
54	BAY EXPORT SERVICES	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	717 POTTER ST	BERKELEY	37.85145	-122.294537	1-2 m; shallow	1-2 m; shallow	1-2 m; shallow	Low Priority	Low Priority	Low Priority
55	BAYER FACILITY (FORMER MILES LABS CUTTER)	Cleanup Program Sites	CLEANUP PROGRAM SITE	OPEN - SITE ASSESSMENT	2550 7TH STREET	BERKELEY	37.85866402	-122.2953413	2-5 m; moderate	2-5 m; moderate	2-5 m; moderate	Medium Priority	Medium Priority	Medium Priority
56	BAYER HEALTHCARE	Non-Case Information Sites	NON-CASE INFORMATION	INFORMATIONAL ITEM / REVIEW COMPLETE	790 CARLETON STREET	BERKELEY	37.85656673	-122.2953554	2-5 m; moderate	2-5 m; moderate	2-5 m; moderate	Medium Priority	Medium Priority	Medium Priority
57	BAYER, FORMER MILES/CUTTER/BERKELEY UNIFIED SCHOOL DISTRICT	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	800 DWIGHT WAY	BERKELEY	37.85913115	-122.2959421	2-5 m; moderate	2-5 m; moderate	2-5 m; moderate	Low Priority	Low Priority	Low Priority
58	BEKINS VAN STORAGE	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	2721 SHATTUCK AVE	BERKELEY	37.8596534	-122.2669727	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
59	BERKELEY ADULT MENTAL HEALTH CLINIC	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	2640 MARTIN LUTHER KING JR. WAY	BERKELEY	37.85977608	-122.2721717	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
60	BERKELEY ASPHALT & READY MIX	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	699 VIRGINA ST	BERKELEY	37.8716704	-122.3024765	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	Low Priority	Low Priority	Low Priority

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									Current Conditions	0.8 feet (25 cm) SLR Scenario	2.5 feet (75 cm) SLR Scenario	Current Conditions	0.8 feet (25 cm) SLR Scenario	2.5 feet (75 cm) SLR Scenario
61	BERKELEY AUTO REPAIR	DTSC Cleanup Sites	STATE RESPONSE OR NPL	CERTIFIED	2378/2366 SAN PABLO AVENUE	BERKELEY	37.8633839	-122.2907	2-5 m; moderate	2-5 m; moderate	2-5 m; moderate	Medium Priority	Medium Priority	Medium Priority
62	BERKELEY BUSINESS CENTER (SCP)	Cleanup Program Sites	CLEANUP PROGRAM SITE	OPEN - SITE ASSESSMENT	2900 SAN PABLO AVENUE	BERKELEY	37.85308673	-122.2886205	1-2 m; shallow	1-2 m; shallow	1-2 m; shallow	High Priority	High Priority	High Priority
63	BERKELEY BUSINESS CENTER (UST)	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	2900 SAN PABLO AVE	BERKELEY	37.85346252	-122.2892308	1-2 m; shallow	1-2 m; shallow	1-2 m; shallow	Low Priority	Low Priority	Low Priority
64	BERKELEY CHEVRON	Permitted USTs			2996 TELEGRAPH AVE	BERKELEY	37.85649	-122.26015	>5 m; deep	>5 m; deep	>5 m; deep	Medium Priority	Medium Priority	Medium Priority
65	BERKELEY CITY OF	Cleanup Program Sites	CLEANUP PROGRAM SITE	OPEN - ELIGIBLE FOR CLOSURE	1326 ALLSTON WAY	BERKELEY	37.86655184	-122.2854675	2-5 m; moderate	2-5 m; moderate	2-5 m; moderate	Medium Priority	Medium Priority	Medium Priority
66	BERKELEY CITY OF CORP YARD	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1326 ALLSTON WY	BERKELEY	37.8669731	-122.2847237	2-5 m; moderate	2-5 m; moderate	2-5 m; moderate	Low Priority	Low Priority	Low Priority
67	BERKELEY COMMONS	Non-Case Information Sites	NON-CASE INFORMATION	PENDING REVIEW	2222 3RD STREET	BERKELEY	37.86443	-122.30037	1-2 m; shallow	1-2 m; shallow	1-2 m; shallow	High Priority	High Priority	High Priority
68	BERKELEY DOWNTOWN HOTEL	Non-Case Information Sites	NON-CASE INFORMATION	INFORMATIONAL ITEM / REVIEW COMPLETE	2129 SHATTUCK AVE	BERKELEY	37.8708	-122.26738	>5 m; deep	>5 m; deep	>5 m; deep	Medium Priority	Medium Priority	Medium Priority
69	BERKELEY FIRE STATION #5	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	2680 SHATTUCK AVE	BERKELEY	37.86055	-122.267515	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
70	BERKELEY FORMER OIL REFINING FACILITIES - BERKELEY WAREHOUSE	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1920 2ND ST	BERKELEY	37.86759517	-122.3025249	0 m; emergent	0 m; emergent	0 m; emergent	Low Priority	Low Priority	Low Priority
71	BERKELEY FORMER OIL REFINING FACILITIES - DECANION IMPORT TILE	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	611 HEARST AVE	BERKELEY	37.8683019	-122.3032441	0 m; emergent	0 m; emergent	0 m; emergent	Low Priority	Low Priority	Low Priority
72	BERKELEY FORMER OIL REFINING FACILITIES - IMPORT TILE SITE	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1822 2ND ST	BERKELEY	37.8688307	-122.3026942	0 m; emergent	0 m; emergent	0 m; emergent	Low Priority	Low Priority	Low Priority
73	BERKELEY FORMER OIL REFINING FACILITIES - LI LIQUIDATION	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	620 HEARST AVE	BERKELEY	37.868209	-122.302758	0 m; emergent	0 m; emergent	0 m; emergent	Low Priority	Low Priority	Low Priority
74	BERKELEY GAS & SMOG	Permitted USTs			3000 SHATTUCK AVE	BERKELEY	37.85501	-122.26677	>5 m; deep	>5 m; deep	>5 m; deep	Medium Priority	Medium Priority	Medium Priority
75	BERKELEY GLASS	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	2011 ADDISON ST	BERKELEY	37.8709801	-122.2698686	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
76	BERKELEY HONDA	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	2600 SHATTUCK	BERKELEY	37.862114	-122.267254	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
77	BERKELEY HOUSING AUTHORITY	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1400 MARTIN LUTHER KING	BERKELEY	37.881429	-122.2741062	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
78	BERKELEY HOUSING AUTHORITY	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1400 MARTIN LUTHER KING	BERKELEY	37.881219	-122.273469	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
79	BERKELEY HUMANE SOCIETY	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	2700 9TH ST	BERKELEY	37.857201	-122.291015	1-2 m; shallow	1-2 m; shallow	1-2 m; shallow	Low Priority	Low Priority	Low Priority
80	BERKELEY HYDRAULIC SERVICE	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	2734 SAN PABLO AVE	BERKELEY	37.856628	-122.288536	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	Low Priority	Low Priority	Low Priority
81	BERKELEY INDUSTRIAL COMPLEX	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	729 HEINZ ST	BERKELEY	37.853527	-122.29482	2-5 m; moderate	2-5 m; moderate	2-5 m; moderate	Low Priority	Low Priority	Low Priority
82	BERKELEY INDUSTRIAL COMPLEX	Cleanup Program Sites	CLEANUP PROGRAM SITE	OPEN - SITE ASSESSMENT	729 HEINZ AVE	BERKELEY	37.85347003	-122.2951467	2-5 m; moderate	2-5 m; moderate	2-5 m; moderate	Medium Priority	Medium Priority	Medium Priority
83	BERKELEY INDUSTRIAL COURT	DTSC Cleanup Sites	STATE RESPONSE OR NPL	REFER: RWQCB	729 HEINZ AVENUE	BERKELEY	37.8535872	-122.29492	2-5 m; moderate	2-5 m; moderate	2-5 m; moderate	Medium Priority	Medium Priority	Medium Priority
84	BERKELEY LANDFILL (CESAR CHAVEZ PARK)	Land Disposal Site	LAND DISPOSAL SITE	OPEN - VERIFICATION MONITORING	11 SPINNAKER WAY	BERKELEY	37.87288864	-122.3196747	>5 m; deep	>5 m; deep	>5 m; deep	Medium Priority	Medium Priority	Medium Priority
85	BERKELEY LINCOLN MERCURY	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	2352 SHATTUCK AVE	BERKELEY	37.866744	-122.267167	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
86	BERKELEY MARINE CENTER	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1 SPINNAKER WY	BERKELEY	37.868688	-122.31865	2-5 m; moderate	2-5 m; moderate	1-2 m; shallow	Low Priority	Low Priority	Low Priority
87	BERKELEY MARINE CENTER	Cleanup Program Sites	CLEANUP PROGRAM SITE	OPEN - SITE ASSESSMENT	1 SPINNAKER WAY	BERKELEY	37.8685	-122.3183	2-5 m; moderate	1-2 m; shallow	1-2 m; shallow	Medium Priority	High Priority	High Priority
88	BERKELEY PROPERTIES	DTSC Cleanup Sites	VOLUNTARY AGREEMENT	ACTIVE	2332 4TH STREET, 700 AND 710 BANCROFT WAY	BERKELEY	37.8620066	-122.29838	2-5 m; moderate	2-5 m; moderate	2-5 m; moderate	Medium Priority	Medium Priority	Medium Priority
89	BERKELEY PUMP	DTSC Cleanup Sites	EVALUATION	NO FURTHER ACTION	829 BANCROFT WAY	BERKELEY	37.86351	-122.29626	1-2 m; shallow	1-2 m; shallow	1-2 m; shallow	High Priority	High Priority	High Priority

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90	BERKELEY PUMP STATION	Non-Case Information Sites	NON-CASE INFORMATION	INFORMATIONAL ITEM / REVIEW COMPLETE	1834 4TH ST	BERKELEY	37.869594	-122.299897	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	High Priority	High Priority	High Priority
91	BERKELEY REDEVELOPMENT AGENCY SITE	DTSC Cleanup Sites	VOLUNTARY AGREEMENT	CERTIFIED	1631 FIFTH STREET	BERKELEY	37.8727236	-122.30006	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	High Priority	High Priority	High Priority
92	BERKELEY ROSEVILLE INC	Permitted USTs			950 UNIVERSITY AVE	BERKELEY	37.86822	-122.29514	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	High Priority	High Priority	High Priority
93	BERKELEY SANTA FE TRACKBED TO PARK	DTSC Cleanup Sites	VOLUNTARY AGREEMENT	ACTIVE	BLAKE TO WARD ALONG ACTON STREET	BERKELEY	37.8594	-122.2823	1-2 m; shallow	1-2 m; shallow	1-2 m; shallow	High Priority	High Priority	High Priority
94	BERKELEY TOUCHLESS	LUST Cleanup Sites	LUST CLEANUP SITE	OPEN - REMEDIATION	2176 KITTREDGE STREET	BERKELEY	37.86857136	-122.2664541	>5 m; deep	>5 m; deep	>5 m; deep	Medium Priority	Medium Priority	Medium Priority
95	BERKELEY TOUCHLESS CARWASH	Permitted USTs			2176 KITTREDGE ST	BERKELEY	37.86831	-122.26651	>5 m; deep	>5 m; deep	>5 m; deep	Medium Priority	Medium Priority	Medium Priority
96	BERKELEY TRANSFER STATION	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1101 2ND ST	BERKELEY	37.8817749	-122.3068217	0 m; emergent	0 m; emergent	0 m; emergent	Low Priority	Low Priority	Low Priority
97	BERKELEY UNIFIED SCHOOL DISTRICT TRANSPORTATION FACILITY	DTSC Cleanup Sites	EVALUATION	REFER: LOCAL AGENCY	1325 SIXTH STREET	BERKELEY	37.87889	-122.30055	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	High Priority	High Priority	High Priority
98	BERKELEY VILLAGE	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1663 SHATTUCK AVE	BERKELEY	37.8771628	-122.2688744	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
99	BERKELEY WAREHOUSE DRAYAGE	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	636 UNIVERSITY AVE	BERKELEY	37.8671129	-122.3016746	0 m; emergent	0 m; emergent	0 m; emergent	Low Priority	Low Priority	Low Priority
100	BERKELEY YAMAHA	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	735 GILMAN	BERKELEY	37.879238	-122.303338	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	Low Priority	Low Priority	Low Priority
101	BERKELEY YMCA	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	2001 ALLSTON ST	BERKELEY	37.869122	-122.270257	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
102	BERKLAND CLEANERS	Cleanup Program Sites	CLEANUP PROGRAM SITE	OPEN - SITE ASSESSMENT	2979 SACRAMENTO STREET	BERKELEY	37.85372	-122.27882	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	High Priority	High Priority	High Priority
103	BERTINO FAMILY	Non-Case Information Sites	NON-CASE INFORMATION	INFORMATIONAL ITEM / REVIEW COMPLETE	160 THE UPLANDS	BERKELEY	37.85294	-122.24175	>5 m; deep	>5 m; deep	>5 m; deep	Medium Priority	Medium Priority	Medium Priority
104	BLOCK PROPERTY	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	651 ADDISON ST	BERKELEY	37.8659152	-122.3012901	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	Low Priority	Low Priority	Low Priority
105	BRIDGE HOUSING CORPORATION	Cleanup Program Sites	CLEANUP PROGRAM SITE	COMPLETED - CASE CLOSED	2012 BERKELEY WAY	BERKELEY	37.8725998	-122.2695998	>5 m; deep	>5 m; deep	>5 m; deep	Medium Priority	Medium Priority	Medium Priority
106	BRIDGEWAY SERVICE	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	3009 ASHBY AVE	BERKELEY	37.858353	-122.244734	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
107	BRIDGEWAY SERVICE INC.	Permitted USTs			3009 ASHBY AVE	BERKELEY	37.85833	-122.2447	>5 m; deep	>5 m; deep	>5 m; deep	Medium Priority	Medium Priority	Medium Priority
108	BUDGET RENT A CAR	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	600 GILMAN ST	BERKELEY	37.878416	-122.305581	0 m; emergent	0 m; emergent	0 m; emergent	Low Priority	Low Priority	Low Priority
109	BUDGET RENT A CAR SYSTEM, INC.	Permitted USTs			600 GILMAN ST	BERKELEY	37.87813	-122.30598	0-1 m; very shallow	0 m; emergent	0 m; emergent	High Priority	High Priority	High Priority
110	CA DHS LABRATORY FACILITY	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	2151 BERKELEY WY	BERKELEY	37.8732348	-122.2672518	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
111	CA SCHOOL PROF PSYCHOLOGY	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1900 ADDISON ST	BERKELEY	37.870646	-122.271857	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
112	CAL CLEANERS	Cleanup Program Sites	CLEANUP PROGRAM SITE	OPEN - INACTIVE	2531 TELEGRAPH AVENUE	BERKELEY	37.86458704	-122.2583901	>5 m; deep	>5 m; deep	>5 m; deep	Medium Priority	Medium Priority	Medium Priority
113	CAL/ INK	Non-Case Information Sites	NON-CASE INFORMATION	INFORMATIONAL ITEM / REVIEW COMPLETE	1404 4TH ST	BERKELEY	37.87691	-122.30308	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	High Priority	High Priority	High Priority
114	CALDWELL ROLAND ROOFING	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1635 4TH ST	BERKELEY	37.873034	-122.300734	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	Low Priority	Low Priority	Low Priority
115	CALIF UNIVERSITY, LAWRENCE BERKELEY LAB	DTSC Cleanup Sites	TIERED PERMIT	REFER: RCRA	1 CYCLOTRON ROAD/ MS75B-101	BERKELEY	37.8715926	-122.27274	>5 m; deep	>5 m; deep	>5 m; deep	Medium Priority	Medium Priority	Medium Priority
116	CALIFORNIA CUNOCAR	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	2020 STUART ST	BERKELEY	37.858068	-122.268362	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
117	CAMELIA STREET PROPERTIES (FORMER PERC-SERV, INC.)	Cleanup Program Sites	CLEANUP PROGRAM SITE	OPEN - REMEDIATION	1001 CAMELIA STREET	BERKELEY	37.87885058	-122.2973263	1-2 m; shallow	1-2 m; shallow	1-2 m; shallow	High Priority	High Priority	High Priority
118	CAMP ASHBY	DTSC Cleanup Sites	FUDS	NO FURTHER ACTION		BERKELEY	37.8516666	-122.29166	1-2 m; shallow	1-2 m; shallow	1-2 m; shallow	High Priority	High Priority	High Priority
119	CAMPUS MINIMART	Permitted USTs			2200 DURANT AVE	BERKELEY	37.86668	-122.26547	>5 m; deep	>5 m; deep	>5 m; deep	Medium Priority	Medium Priority	Medium Priority
120	CARDUCCI PROPERTY	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	2271 CEDAR ST	BERKELEY	37.8789484	-122.2651219	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
121	CARLETON BUSINESS CENTER	Cleanup Program Sites	CLEANUP PROGRAM SITE	COMPLETED - CASE CLOSED	2700 7TH ST	BERKELEY	37.85565	-122.2948	2-5 m; moderate	2-5 m; moderate	2-5 m; moderate	Medium Priority	Medium Priority	Medium Priority

Table 1. Contaminated Sites Information and Rankings

No	Site Name	Site Category	Site Type	Status	Address	City	Latitude	Longitude	Projected Groundwater Depth from CoSMoS			Site Ranking		
									Current Conditions	0.8 feet (25 cm) SLR Scenario	2.5 feet (75 cm) SLR Scenario	Current Conditions	0.8 feet (25 cm) SLR Scenario	2.5 feet (75 cm) SLR Scenario
122	CARLETON BUSINESS CENTER	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	2703 7TH AVE	BERKELEY	37.856266	-122.292252	1-2 m; shallow	1-2 m; shallow	1-2 m; shallow	Low Priority	Low Priority	Low Priority
123	CARLETON BUSINESS CENTER	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	2700 7TH ST	BERKELEY	37.855649	-122.294839	2-5 m; moderate	2-5 m; moderate	2-5 m; moderate	Low Priority	Low Priority	Low Priority
124	CARLETON STREET CONVERSION	Non-Case Information Sites	NON-CASE INFORMATION	PENDING REVIEW	928 CARLETON STREET	BERKELEY	37.85703	-122.29216	1-2 m; shallow	1-2 m; shallow	1-2 m; shallow	High Priority	High Priority	High Priority
125	CASE ENGINEERS	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	801 CEDAR ST	BERKELEY	37.874138	-122.300524	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	Low Priority	Low Priority	Low Priority
126	CHASE PROPERTY	Cleanup Program Sites	CLEANUP PROGRAM SITE	COMPLETED - CASE CLOSED	2366 78 SAN PABLO AVE	BERKELEY	37.863457	-122.289615	2-5 m; moderate	2-5 m; moderate	2-5 m; moderate	Medium Priority	Medium Priority	Medium Priority
127	CHEVRON	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	2401 SHATTUCK AVE	BERKELEY	37.865599	-122.266981	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
128	CHEVRON	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	3250 SACRAMENTO ST	BERKELEY	37.8483255	-122.2779383	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	Low Priority	Low Priority	Low Priority
129	CHEVRON	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	2995 SAN PABLO AVE	BERKELEY	37.852649	-122.286477	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	Low Priority	Low Priority	Low Priority
130	CHEVRON	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	2500 MARTIN LUTHER KING	BERKELEY	37.863281	-122.271484	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
131	CHEVRON	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	2199 BERKELEY WY	BERKELEY	37.873484	-122.265732	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
132	CHEVRON	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1500 UNIVERSITY AVE	BERKELEY	37.870246	-122.280957	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
133	CHEVRON	LUST Cleanup Sites	LUST CLEANUP SITE	OPEN - REMEDIATION	1300 SAN PABLO AVE	BERKELEY	37.8801257	-122.296134	1-2 m; shallow	1-2 m; shallow	1-2 m; shallow	High Priority	High Priority	High Priority
134	CHEVRON	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1285 EASTSHORE HWY	BERKELEY	37.878759	-122.306549	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	Low Priority	Low Priority	Low Priority
135	CHEVRON	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1101 UNIVERSITY AVE	BERKELEY	37.869259	-122.290894	1-2 m; shallow	1-2 m; shallow	1-2 m; shallow	Low Priority	Low Priority	Low Priority
136	CHEVRON #9-0289	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	3048 ASHBY AVE	BERKELEY	37.85795	-122.243562	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
137	CHEVRON SERVICE STATION	LUST Cleanup Sites	LUST CLEANUP SITE	OPEN - SITE ASSESSMENT	2996 TELEGRAPH AVE	BERKELEY	37.85642484	-122.2601321	>5 m; deep	>5 m; deep	>5 m; deep	Medium Priority	Medium Priority	Medium Priority
138	CHEVRON STATION 9-1229	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1820 SOLANO AVENUE	BERKELEY	37.8911	-122.279571	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
139	CHRIS'S PAYLESS PLUMBING	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1207 TENTH STREET	BERKELEY	37.881597	-122.297042	1-2 m; shallow	1-2 m; shallow	1-2 m; shallow	Low Priority	Low Priority	Low Priority
140	CHRONICLE DEPOT	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	2817 7TH ST	BERKELEY	37.85462	-122.291902	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	Low Priority	Low Priority	Low Priority
141	CITY OF BERKELEY - CORPORATION YARD	Permitted USTs			1326 ALLSTON WAY	BERKELEY	37.866861	-122.284544	2-5 m; moderate	2-5 m; moderate	2-5 m; moderate	Medium Priority	Medium Priority	Medium Priority
142	CITY OF BERKELEY CENTRAL LIBRARY	Permitted USTs			2031 BANCROFT WAY	BERKELEY	37.8678409	-122.2685623	>5 m; deep	>5 m; deep	>5 m; deep	Medium Priority	Medium Priority	Medium Priority
143	CITY OF BERKELEY TRANSFER STATION	Single-Walled UST Sites	SINGLE-WALLED UST	SWT-NO PLAN RETURNED	1201 SECOND STREET	BERKELEY	37.88025093	-122.306132	0 m; emergent	0 m; emergent	0 m; emergent	High Priority	High Priority	High Priority
144	CITY OF BERKELEY- PUBLIC SAFETY BUILDING	Permitted USTs			2100 MARTIN LUTHER KING JR. WAY	BERKELEY	37.86961	-122.27337	>5 m; deep	>5 m; deep	>5 m; deep	Medium Priority	Medium Priority	Medium Priority
145	CLAREMONT CHEVRON STATION #0289	Permitted USTs			3048 ASHBY AVE	BERKELEY	37.85783	-122.24412	>5 m; deep	>5 m; deep	>5 m; deep	Medium Priority	Medium Priority	Medium Priority
146	CLAREMONT CONTINENTAL GARAGE	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	2935 CLAREMONT AVE	BERKELEY	37.857914	-122.244957	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
147	CLEAR-COM	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	945 CAMELIA ST	BERKELEY	37.878468	-122.298198	1-2 m; shallow	1-2 m; shallow	1-2 m; shallow	Low Priority	Low Priority	Low Priority
148	CM SERVICE STATION	LUST Cleanup Sites	LUST CLEANUP SITE	OPEN - SITE ASSESSMENT	1441 ASHBY AVE	BERKELEY	37.85346807	-122.2793744	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	High Priority	High Priority	High Priority
149	COBURN CONSTRUCTION	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1006 PARDEE ST	BERKELEY	37.856541	-122.290089	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	Low Priority	Low Priority	Low Priority
150	COLGATE-PALMOLIVE	DTSC Cleanup Sites	EVALUATION	CERTIFIED	2700 7TH STREET	BERKELEY	37.8558495	-122.29482	2-5 m; moderate	2-5 m; moderate	2-5 m; moderate	Medium Priority	Medium Priority	Medium Priority
151	COLLEGE CLEANERS	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	2942 COLLEGE AVE	BERKELEY	37.857848	-122.252734	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
152	COLLEGE CLEANERS (FORMER)	Cleanup Program Sites	CLEANUP PROGRAM SITE	OPEN - SITE ASSESSMENT	2942 COLLEGE AVENUE	BERKELEY	37.85752534	-122.2533229	>5 m; deep	>5 m; deep	>5 m; deep	Medium Priority	Medium Priority	Medium Priority

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No	Site Name	Site Category	Site Type	Status	Address	City	Latitude	Longitude	Projected Groundwater Depth from CoSMoS			Site Ranking		
									Current Conditions	0.8 feet (25 cm) SLR Scenario	2.5 feet (75 cm) SLR Scenario	Current Conditions	0.8 feet (25 cm) SLR Scenario	2.5 feet (75 cm) SLR Scenario
153	COMMERCIAL PROPERTY	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	2201 DWIGHT WAY	BERKELEY	37.864248	-122.265261	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
154	CONSOLIDATED FREIGHTWAYS	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	2515 9TH ST	BERKELEY	37.860187	-122.291208	1-2 m; shallow	1-2 m; shallow	1-2 m; shallow	Low Priority	Low Priority	Low Priority
155	COOPER HAWKINS	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	2701 SAN PABLO AVE	BERKELEY	37.857569	-122.287868	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	Low Priority	Low Priority	Low Priority
156	CORE BERKELEY BANCROFT, LLC	LUST Cleanup Sites	LUST CLEANUP SITE	OPEN - SITE ASSESSMENT	2590 BANCROFT WAY	BERKELEY	37.86878	-122.25719	>5 m; deep	>5 m; deep	>5 m; deep	Medium Priority	Medium Priority	Medium Priority
157	COSHELL LAUNDRY	Non-Case Information Sites	NON-CASE INFORMATION	INFORMATIONAL ITEM / REVIEW COMPLETE	1634 SAN PABLO AVE	BERKELEY	37.874282	-122.294012	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	High Priority	High Priority	High Priority
158	COURTAULDS AEROSPACE INC	Permitted USTs		CLOSED	1608 FOURTH ST	BERKELEY	37.873328	-122.30209	0 m; emergent	0 m; emergent	0 m; emergent	High Priority	High Priority	High Priority
159	COURTAULDS AEROSPACE INC	DTSC Cleanup Sites	CORRECTIVE ACTION	REFER: RWQCB	1608 FOURTH ST	BERKELEY	37.873328	-122.30209	0 m; emergent	0 m; emergent	0 m; emergent	High Priority	High Priority	High Priority
160	CSM PROPERTIES	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1890 ARCH ST	BERKELEY	37.874753	-122.264212	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
161	DAIR PROPERTY AKA SOUTHSIDE LOFTS	Cleanup Program Sites	CLEANUP PROGRAM SITE	OPEN - INACTIVE	3075 TELEGRAPH AVENUE	BERKELEY	37.854215	-122.259704	>5 m; deep	>5 m; deep	>5 m; deep	Medium Priority	Medium Priority	Medium Priority
162	DAVLIN COATINGS	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	700 ALLSTON WY	BERKELEY	37.864306	-122.299569	1-2 m; shallow	1-2 m; shallow	1-2 m; shallow	Low Priority	Low Priority	Low Priority
163	DAVLIN PAINT COMPANY	Non-Case Information Sites	NON-CASE INFORMATION	INFORMATIONAL ITEM / REVIEW COMPLETE	700 ALLSTON WY	BERKELEY	37.864306	-122.299569	1-2 m; shallow	1-2 m; shallow	1-2 m; shallow	High Priority	High Priority	High Priority
164	DAVLIN PAINT COMPANY	DTSC Cleanup Sites	EVALUATION	NO ACTION REQUIRED	700 ALLSTON WAY	BERKELEY	37.8643053	-122.29957	1-2 m; shallow	1-2 m; shallow	1-2 m; shallow	High Priority	High Priority	High Priority
165	DELTAN DIVERSIFIED INC.-CHEVRON STATION #91745	Permitted USTs			1300 SAN PABLO AVE	BERKELEY	37.88017	-122.2961	1-2 m; shallow	1-2 m; shallow	1-2 m; shallow	High Priority	High Priority	High Priority
166	DESOTO	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1608 4TH ST	BERKELEY	37.873495	-122.3017911	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	Low Priority	Low Priority	Low Priority
167	DIESEL FUEL TANK AREA FORMER	Cleanup Program Sites	CLEANUP PROGRAM SITE	COMPLETED - CASE CLOSED	722 FOLGER AVE	BERKELEY	37.8494237	-122.2938051	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	High Priority	High Priority	High Priority
168	DINWIDDIE CONSTRUCTION COMPANY	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1201 8TH ST	BERKELEY	37.8815721	-122.2997331	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	Low Priority	Low Priority	Low Priority
169	DON AUTO CLINIC	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	2555 COLLEGE AVE	BERKELEY	37.864123	-122.253543	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
170	DON REINHARDS INC	Non-Case Information Sites	NON-CASE INFORMATION	INFORMATIONAL ITEM / REVIEW COMPLETE	1917 ADDISON ST	BERKELEY	37.870877	-122.271641	>5 m; deep	>5 m; deep	>5 m; deep	Medium Priority	Medium Priority	Medium Priority
171	DON'S TIRE SERVICE, INC. (FORMERLY FRANK'S TIRE SERVICE)	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	820 GILMAN ST	BERKELEY	37.8792863	-122.3016403	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	Low Priority	Low Priority	Low Priority
172	DOVE CHEMICAL	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	707 PARK	BERKELEY	37.880322	-122.304619	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	Low Priority	Low Priority	Low Priority
173	DOVER SALES	DTSC Cleanup Sites	STATE RESPONSE OR NPL	CERTIFIED	707 PARK WAY	BERKELEY	37.8799459	-122.30429	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	High Priority	High Priority	High Priority
174	DURKEE WAREHAM	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	700 HEINZ ST	BERKELEY	37.8531	-122.2932	1-2 m; shallow	1-2 m; shallow	1-2 m; shallow	Low Priority	Low Priority	Low Priority
175	EASTSHORE PARK - REMAINDER	Cleanup Program Sites	CLEANUP PROGRAM SITE	OPEN - REMEDIATION	BERKELEY, ALBANY, AND RICHMOND	BERKELEY	37.87661489	-122.3081195	2-5 m; moderate	1-2 m; shallow	1-2 m; shallow	Medium Priority	High Priority	High Priority
176	ELECTRO-COATINGS OF CA	Cleanup Program Sites	CLEANUP PROGRAM SITE	OPEN - VERIFICATION MONITORING	893 CARLETON ST	BERKELEY	37.8572	-122.2934	1-2 m; shallow	1-2 m; shallow	1-2 m; shallow	High Priority	High Priority	High Priority
177	ELEMENTS PETROLEUM, INC.	Permitted USTs			833 UNIVERSITY AVE	BERKELEY	37.86832	-122.29744	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	High Priority	High Priority	High Priority
178	EMERALD PACKAGING	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	2821 10TH ST	BERKELEY	37.855535	-122.28806	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	Low Priority	Low Priority	Low Priority
179	EMERALD PACKAGING	Cleanup Program Sites	CLEANUP PROGRAM SITE	COMPLETED - CASE CLOSED	2821 10TH ST	BERKELEY	37.855262	-122.288578	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	High Priority	High Priority	High Priority
180	ENGINEERING SCIENCE	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	600 BANCROFT WAY	BERKELEY	37.862268	-122.299921	0 m; emergent	0 m; emergent	0 m; emergent	Low Priority	Low Priority	Low Priority
181	ENGINEERING SCIENCE INC	Cleanup Program Sites	CLEANUP PROGRAM SITE	OPEN - INACTIVE	600 BANCROFT WAY	BERKELEY	37.86253	-122.30008	0 m; emergent	0 m; emergent	0 m; emergent	High Priority	High Priority	High Priority
182	ENTERPRISE CAR RENTAL	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	3001 SHATTUCK AVE	BERKELEY	37.8550899	-122.266174	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
183	EPWORTH CHURCH	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1953 HOPKINS ST	BERKELEY	37.887353	-122.27375	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
184	ERNIE VAN AND STORAGE	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1650 6TH ST	BERKELEY	37.8729781	-122.299287	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	Low Priority	Low Priority	Low Priority

Table 1. Contaminated Sites Information and Rankings

No	Site Name	Site Category	Site Type	Status	Address	City	Latitude	Longitude	Projected Groundwater Depth from CoSMoS			Site Ranking		
									Current Conditions	0.8 feet (25 cm) SLR Scenario	2.5 feet (75 cm) SLR Scenario	Current Conditions	0.8 feet (25 cm) SLR Scenario	2.5 feet (75 cm) SLR Scenario
185	EUROPEAN MOTORS	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	2396 SAN PABLO AVE	BERKELEY	37.862997	-122.290511	2-5 m; moderate	2-5 m; moderate	2-5 m; moderate	Low Priority	Low Priority	Low Priority
186	EYCHNER	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1120 2ND ST	BERKELEY	37.881036	-122.307019	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	Low Priority	Low Priority	Low Priority
187	EZ SERVE	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1849 SHATTUCK AVE	BERKELEY	37.873905	-122.268552	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
188	FEREYDOON'S GARAGE	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	2598 SACRAMENTO ST	BERKELEY	37.860583	-122.280885	2-5 m; moderate	2-5 m; moderate	2-5 m; moderate	Low Priority	Low Priority	Low Priority
189	FERREIRA PLUMBING	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1724 SAN PABLO AVE	BERKELEY	37.872508	-122.293646	2-5 m; moderate	2-5 m; moderate	2-5 m; moderate	Low Priority	Low Priority	Low Priority
190	FIRESTONE	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1974 UNIVERSITY AVE	BERKELEY	37.87146	-122.271044	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
191	FLINT INK CORP.	DTSC Cleanup Sites	TIERED PERMIT	INACTIVE - NEEDS EVALUATION	750 GILMAN STREET	BERKELEY	37.8787829	-122.3031	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	High Priority	High Priority	High Priority
192	FLINT INK CORPORATION	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1350 FOURTH STREET	BERKELEY	37.878033	-122.303294	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	Low Priority	Low Priority	Low Priority
193	FLINT INK CORPORATION	Cleanup Program Sites	CLEANUP PROGRAM SITE	OPEN - ELIGIBLE FOR CLOSURE - LAND USE RESTRICTIONS	750 GILMAN STREET	BERKELEY	37.87863082	-122.3029516	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	High Priority	High Priority	High Priority
194	FOLGER MURPHY PROPERTY	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1020 MURRAY ST	BERKELEY	37.851362	-122.287667	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	Low Priority	Low Priority	Low Priority
195	FOREIGN AUTO CENTER	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1197 SAN PABLO AVE	BERKELEY	37.8825069	-122.296107	1-2 m; shallow	1-2 m; shallow	1-2 m; shallow	Low Priority	Low Priority	Low Priority
196	FORMER BERKELEY GAS STATION	Non-Case Information Sites	NON-CASE INFORMATION	INFORMATIONAL ITEM / REVIEW COMPLETE	2198 SAN PABLO AVENUE	BERKELEY	37.86645	-122.29164	1-2 m; shallow	1-2 m; shallow	1-2 m; shallow	High Priority	High Priority	High Priority
197	FORMER CAL CLEANERS	DTSC Cleanup Sites	EVALUATION	REFER: 1248 LOCAL AGENCY	2529-2533 TELEGRAPH AVENUE	BERKELEY	37.8644698	-122.25821	>5 m; deep	>5 m; deep	>5 m; deep	Medium Priority	Medium Priority	Medium Priority
198	FORMER CALIFORNIA THEATRE	Non-Case Information Sites	NON-CASE INFORMATION	PENDING REVIEW	2115 KITTREDGE STREET	BERKELEY	37.86895554	-122.2671748	>5 m; deep	>5 m; deep	>5 m; deep	Medium Priority	Medium Priority	Medium Priority
199	FORMER CENTER FOR INDEPENDENT LIVING	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	2539 TELEGRAPH AVE	BERKELEY	37.86424	-122.25814	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
200	FORMER CHEVRON	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1797 SHATTUCK AVE	BERKELEY	37.87499736	-122.2684282	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
201	FORMER CHEVRON	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1900 SAN PABLO AVENUE	BERKELEY	37.870412	-122.292637	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	Low Priority	Low Priority	Low Priority
202	FORMER CO-OP GAS STATION	LUST Cleanup Sites	LUST CLEANUP SITE	OPEN - VERIFICATION MONITORING	1484 - 1498 UNIVERSITY AVENUE	BERKELEY	37.87009	-122.28219	>5 m; deep	>5 m; deep	>5 m; deep	Medium Priority	Medium Priority	Medium Priority
203	FORMER EXXON 7-0200	LUST Cleanup Sites	LUST CLEANUP SITE	OPEN - ELIGIBLE FOR CLOSURE	1894 UNIVERSITY AVE	BERKELEY	37.87108219	-122.2733786	>5 m; deep	>5 m; deep	>5 m; deep	Medium Priority	Medium Priority	Medium Priority
204	FORMER EXXON 7-8465	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	2300 SAN PABLO AVE	BERKELEY	37.864336	-122.290937	2-5 m; moderate	2-5 m; moderate	2-5 m; moderate	Low Priority	Low Priority	Low Priority
205	FORMER GAS STATION	Non-Case Information Sites	NON-CASE INFORMATION	INFORMATIONAL ITEM / REVIEW COMPLETE	2527 SAN PABLO AVE.	BERKELEY	37.86054	-122.28899	1-2 m; shallow	1-2 m; shallow	1-2 m; shallow	High Priority	High Priority	High Priority
206	FORMER HOLLAND SERVICE GARAGE	LUST Cleanup Sites	LUST CLEANUP SITE	OPEN - SITE ASSESSMENT	2201 SAN PABLO AVENUE	BERKELEY	37.86625	-122.29077	1-2 m; shallow	1-2 m; shallow	1-2 m; shallow	High Priority	High Priority	High Priority
207	FORMER MCNEVIN CADILLAC	Non-Case Information Sites	NON-CASE INFORMATION	INFORMATIONAL ITEM / REVIEW COMPLETE	1500 SAN PABLO AVE	BERKELEY	37.87585	-122.29478	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	High Priority	High Priority	High Priority
208	FORMER MOBIL OIL	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	2489 MARTIN LUTHER KING JR. WAY	BERKELEY	37.863612	-122.271747	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
209	FORMER MONSEN'S PLATING & SILVERSMITHS	Cleanup Program Sites	CLEANUP PROGRAM SITE	OPEN - SITE ASSESSMENT	3370 ADELINE STREET	BERKELEY	37.84735	-122.27239	2-5 m; moderate	2-5 m; moderate	2-5 m; moderate	Medium Priority	Medium Priority	Medium Priority
210	FORMER NORGE LAUNDRY AND DRY CLEANING VILLAGE	Cleanup Program Sites	CLEANUP PROGRAM SITE	OPEN - INACTIVE	2089-2091 ROSE STREET	BERKELEY	37.88216963	-122.2703126	>5 m; deep	>5 m; deep	>5 m; deep	Medium Priority	Medium Priority	Medium Priority
211	FORMER PACIFIC STEEL CASTING COMPANY - BERKELEY PROPERTIES, LLC	Cleanup Program Sites	CLEANUP PROGRAM SITE	OPEN - INACTIVE	1314 2ND ST, 1320 2ND ST, 1421 2ND ST, 1310 3RD ST, 1305 EASTSHORE HWY, 1401 EASTSHORE HWY, 1420 EASTSHORE HWY, 648 PAGE ST, 690 GILMAN ST	BERKELEY	37.877482	-122.305009	0 m; emergent	0 m; emergent	0 m; emergent	High Priority	High Priority	High Priority

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No	Site Name	Site Category	Site Type	Status	Address	City	Latitude	Longitude	Projected Groundwater Depth from CoSMoS			Site Ranking		
									Current Conditions	0.8 feet (25 cm) SLR Scenario	2.5 feet (75 cm) SLR Scenario	Current Conditions	0.8 feet (25 cm) SLR Scenario	2.5 feet (75 cm) SLR Scenario
212	FORMER SERVICE STATION	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1801 SOLANO AVENUE	BERKELEY	37.891324	-122.279862	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
213	FORMER SHELL	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	2996 SHATTUCK AVE	BERKELEY	37.85544448	-122.2666743	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
214	FORMER SHELL SERVICE STATION	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	2747 ADELINE ST	BERKELEY	37.858789	-122.26719	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
215	FORMER SHELL SERVICE STATION	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1580 SAN PABLO AVE	BERKELEY	37.87526305	-122.2944208	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	Low Priority	Low Priority	Low Priority
216	FORMER VICTOR LAUNDRY LLC	Cleanup Program Sites	CLEANUP PROGRAM SITE	OPEN - INACTIVE	1625 SAN PABLO AVENUE	BERKELEY	37.87433	-122.29355	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	High Priority	High Priority	High Priority
217	FRANK AUTO	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1245 UNIVERSITY AVE	BERKELEY	37.869869	-122.288278	2-5 m; moderate	2-5 m; moderate	2-5 m; moderate	Low Priority	Low Priority	Low Priority
218	FUKUNAGA PROPERTY	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	2227 OREGON ST	BERKELEY	37.858298	-122.262687	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
219	FVA/DELICOR	Cleanup Program Sites	CLEANUP PROGRAM SITE	COMPLETED - CASE CLOSED	705 BANCROFT WAY	BERKELEY	37.8631	-122.2991	1-2 m; shallow	1-2 m; shallow	1-2 m; shallow	High Priority	High Priority	High Priority
220	GANNET OUTDOOR	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1695 EASTSHORE HWY	BERKELEY	37.87177	-122.304266	0 m; emergent	0 m; emergent	0 m; emergent	Low Priority	Low Priority	Low Priority
221	GARY STEEL COMPANY	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	2560 7TH ST	BERKELEY	37.85920547	-122.2941797	1-2 m; shallow	1-2 m; shallow	1-2 m; shallow	Low Priority	Low Priority	Low Priority
222	GENERAL TRANSMISSIONS	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1187 SAN PABLO AVE	BERKELEY	37.882834	-122.296214	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	Low Priority	Low Priority	Low Priority
223	GERMANY BEST INC	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1931-1935 ADDISON ST	BERKELEY	37.870907	-122.271421	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
224	GILMAN IMPORTS REPAIR	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1320 GILMAN ST	BERKELEY	37.881187	-122.288226	2-5 m; moderate	2-5 m; moderate	2-5 m; moderate	Low Priority	Low Priority	Low Priority
225	GLM REAL ESTATE SERVICES	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	2029 CHANNING WY	BERKELEY	37.865904	-122.268601	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
226	GOSS ROSS DOYLE TRUST	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	2140 DURANT AVE	BERKELEY	37.866844	-122.266278	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
227	GREEN CHEMICAL COMPANY	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	801 GILMAN ST	BERKELEY	37.879435	-122.302322	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	Low Priority	Low Priority	Low Priority
228	GREEN VALLEY PLANT RENTAL	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1475 EASTSHORE HWY	BERKELEY	37.8747597	-122.3057358	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	Low Priority	Low Priority	Low Priority
229	GRING PEST CONTROL	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	741 FOLGER AVE	BERKELEY	37.84979	-122.293339	1-2 m; shallow	1-2 m; shallow	1-2 m; shallow	Low Priority	Low Priority	Low Priority
230	HADJIAN PROPERTY	Cleanup Program Sites	CLEANUP PROGRAM SITE	OPEN - SITE ASSESSMENT	1840/1894 UNIVERSITY AVENUE	BERKELEY	37.87130977	-122.2734218	>5 m; deep	>5 m; deep	>5 m; deep	Medium Priority	Medium Priority	Medium Priority
231	HARRISON STREET PLAYING FIELDS	DTSC Cleanup Sites	VOLUNTARY AGREEMENT	REFER: RWQCB	FOURTH AND HARRISON STREETS	BERKELEY	37.8808333	-122.30444	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	High Priority	High Priority	High Priority
232	HEINZ/GRAYSON PLUME	DTSC Cleanup Sites	STATE RESPONSE OR NPL	REFER: RWQCB	7TH STREET AND GRAYSON STREET	BERKELEY	37.8538894	-122.29322	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	High Priority	High Priority	High Priority
233	HENRY CHIN'S AUTO CARE	Non-Case Information Sites	NON-CASE INFORMATION	PENDING REVIEW	2132 DWIGHT WAY	BERKELEY	37.86386	-122.26623	>5 m; deep	>5 m; deep	>5 m; deep	Medium Priority	Medium Priority	Medium Priority
234	HENRY'S SERVICE	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1321 GILMAN ST	BERKELEY	37.882185	-122.288123	2-5 m; moderate	2-5 m; moderate	2-5 m; moderate	Low Priority	Low Priority	Low Priority
235	HERRICK HOSPITAL ALTA BATES	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	2001 DWIGHT WY	BERKELEY	37.864029	-122.268734	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
236	HOLETT MACHINE WORKS	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	746 FOLGER AVENUE	BERKELEY	37.849298	-122.293136	1-2 m; shallow	1-2 m; shallow	1-2 m; shallow	Low Priority	Low Priority	Low Priority
237	HOTEL DURANT	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	2600 DURANT AVE	BERKELEY	37.867925	-122.256292	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
238	HUB PAINT CENTER	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	2917 ADELINE ST	BERKELEY	37.8559119	-122.268188	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
239	INTER MOUNTAIN TRADING CORP	Non-Case Information Sites	NON-CASE INFORMATION	INFORMATIONAL ITEM / REVIEW COMPLETE	1451 5TH ST	BERKELEY	37.875607	-122.300963	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	High Priority	High Priority	High Priority
240	JACKSON PROPERTY	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	2131 DURANT AVE	BERKELEY	37.8668897	-122.2662753	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
241	JANCO CHEMICAL CORP	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1235 FIFTH STREET	BERKELEY	37.880301	-122.3029	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	Low Priority	Low Priority	Low Priority

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242	JETTON CONSTRUCTION	Non-Case Information Sites	NON-CASE INFORMATION	INFORMATIONAL ITEM / REVIEW COMPLETE	1117 VIRGINIA STREET	BERKELEY	37.87363	-122.29316	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	High Priority	High Priority	High Priority
243	JIFFY LUBE #889	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	960 UNIVERSITY AVE	BERKELEY	37.868277	-122.294838	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	Low Priority	Low Priority	Low Priority
244	JIM DOTEN HONDA	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	2000 5TH ST	BERKELEY	37.8676292	-122.2987907	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	Low Priority	Low Priority	Low Priority
245	JWP MECHANICAL	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	999 ANTHONY ST	BERKELEY	37.852771	-122.29066	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	Low Priority	Low Priority	Low Priority
246	K & S MANAGEMENT	DTSC Cleanup Sites	STATE RESPONSE OR NPL	CERTIFIED	1138 DELAWARE ST	BERKELEY	37.8713888	-122.29194	2-5 m; moderate	2-5 m; moderate	2-5 m; moderate	Medium Priority	Medium Priority	Medium Priority
247	KAHN SCRAPYARD	Non-Case Information Sites	NON-CASE INFORMATION	INFORMATIONAL ITEM / REVIEW COMPLETE	803 HEARST AVE	BERKELEY	37.86932264	-122.2990707	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	High Priority	High Priority	High Priority
248	KAISER BIOMEDICAL FACILITY	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1795 2ND ST	BERKELEY	37.8706699	-122.302677	0 m; emergent	0 m; emergent	0 m; emergent	Low Priority	Low Priority	Low Priority
249	KAISER PERMANENTE BERKELEY REGIONAL LAB - 1705	DTSC Hazardous Waste Sites	LOWER TIER	CLOSED	1705 EASTSHORE HWY	BERKELEY	37.870702	-122.30432	0-1 m; very shallow	0 m; emergent	0 m; emergent	High Priority	High Priority	High Priority
250	KAISER REGIONAL LABORATORY	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1725 EASTSHORE HWY	BERKELEY	37.8706	-122.3035	0 m; emergent	0 m; emergent	0 m; emergent	Low Priority	Low Priority	Low Priority
251	KALMAR PROPERTY	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	2034 BLAKE ST	BERKELEY	37.862662	-122.268161	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
252	KAPLAN PROPERTY	Non-Case Information Sites	NON-CASE INFORMATION	INFORMATIONAL ITEM / REVIEW COMPLETE	2234 SAN PABLO AVE	BERKELEY	37.865206	-122.291173	2-5 m; moderate	2-5 m; moderate	2-5 m; moderate	Medium Priority	Medium Priority	Medium Priority
253	KAYO OIL	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1900 MARTIN LUTHER KING	BERKELEY	37.873265	-122.2727	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
254	KRENZ LIMITED	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	750 POTTER ST	BERKELEY	37.850967	-122.2938889	1-2 m; shallow	1-2 m; shallow	1-2 m; shallow	Low Priority	Low Priority	Low Priority
255	LAWRENCE BERKELEY LAB - FACILITY WIDE	Cleanup Program Sites	CLEANUP PROGRAM SITE	OPEN - REMEDIATION	1 CYCLOTRON RD	BERKELEY	37.8739	-122.2508	>5 m; deep	>5 m; deep	>5 m; deep	Medium Priority	Medium Priority	Medium Priority
256	LAWRENCE BERKELEY NATIONAL LABORATORY	Single-Walled UST Sites	SINGLE-WALLED UST	SAFE SUCTION PIPING VERIFIED BY CUPA	1 CYCLOTRON RD	BERKELEY	37.879162	-122.253006	>5 m; deep	>5 m; deep	>5 m; deep	Medium Priority	Medium Priority	Medium Priority
257	LAWRENCE BERKELEY NATIONAL LABORATORY	Permitted USTs			1 CYCLOTRON RD	BERKELEY	37.87754	-122.25219	>5 m; deep	>5 m; deep	>5 m; deep	Medium Priority	Medium Priority	Medium Priority
258	LBL BUILDING 50	Cleanup Program Sites	CLEANUP PROGRAM SITE	COMPLETED - CASE CLOSED	1 CYCLOTRON RD	BERKELEY	37.8767916	-122.2470012	>5 m; deep	>5 m; deep	>5 m; deep	Medium Priority	Medium Priority	Medium Priority
259	LBL BUILDING 62	Cleanup Program Sites	CLEANUP PROGRAM SITE	COMPLETED - CASE CLOSED	1 CYCLOTRON RD	BERKELEY	37.8767916	-122.2470012	>5 m; deep	>5 m; deep	>5 m; deep	Medium Priority	Medium Priority	Medium Priority
260	LBL BUILDING 69	Cleanup Program Sites	CLEANUP PROGRAM SITE	COMPLETED - CASE CLOSED	1 CYCLOTRON RD	BERKELEY	37.8739	-122.2508	>5 m; deep	>5 m; deep	>5 m; deep	Medium Priority	Medium Priority	Medium Priority
261	LBL BUILDING 74	Cleanup Program Sites	CLEANUP PROGRAM SITE	OPEN - REMEDIATION	1 CYCLOTRON RD	BERKELEY	37.8739	-122.2508	>5 m; deep	>5 m; deep	>5 m; deep	Medium Priority	Medium Priority	Medium Priority
262	LBL BUILDING 76	Cleanup Program Sites	CLEANUP PROGRAM SITE	COMPLETED - CASE CLOSED	1 CYCLOTRON RD	BERKELEY	37.8739	-122.2508	>5 m; deep	>5 m; deep	>5 m; deep	Medium Priority	Medium Priority	Medium Priority
263	LBL BUILDING 7E	Cleanup Program Sites	CLEANUP PROGRAM SITE	OPEN - REMEDIATION	1 CYCLOTRON RD	BERKELEY	37.8739	-122.2508	>5 m; deep	>5 m; deep	>5 m; deep	Medium Priority	Medium Priority	Medium Priority
264	LIFELONG MEDICAL CARE	DTSC Cleanup Sites	CALMORTGAGE	NO ACTION REQUIRED	3250 SACRAMENTO STREET	BERKELEY	37.8481181	-122.27823	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	High Priority	High Priority	High Priority
265	LINOLEUM SALES	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1706 SAN PABLO AVE	BERKELEY	37.87317918	-122.2938001	1-2 m; shallow	1-2 m; shallow	1-2 m; shallow	Low Priority	Low Priority	Low Priority
266	LONESTAR INDUSTRIES	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	808 GILMAN ST	BERKELEY	37.8784319	-122.301706	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	Low Priority	Low Priority	Low Priority
267	LONGFELLOW MIDDLE SCHOOL	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1500 DERBY ST	BERKELEY	37.85868	-122.279906	1-2 m; shallow	1-2 m; shallow	1-2 m; shallow	Low Priority	Low Priority	Low Priority
268	MACAULAY FOUNDRY	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	811 CARLETON	BERKELEY	37.857211	-122.294725	2-5 m; moderate	2-5 m; moderate	2-5 m; moderate	Low Priority	Low Priority	Low Priority
269	MACAULAY FOUNDRY INC	Cleanup Program Sites	CLEANUP PROGRAM SITE	COMPLETED - CASE CLOSED	811 CARELTON ST	BERKELEY	37.85685066	-122.2942686	1-2 m; shallow	1-2 m; shallow	1-2 m; shallow	High Priority	High Priority	High Priority
270	MACBETH HARDWARE COMPANY	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	930 ASHBY AVE	BERKELEY	37.851164	-122.290168	1-2 m; shallow	1-2 m; shallow	1-2 m; shallow	Low Priority	Low Priority	Low Priority
271	MALCOM X SCHOOL	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1734 PRINCE ST	BERKELEY	37.85218	-122.273016	2-5 m; moderate	2-5 m; moderate	2-5 m; moderate	Low Priority	Low Priority	Low Priority
272	MANASSE-BLOCK TANNING COMPANY	Cleanup Program Sites	CLEANUP PROGRAM SITE	OPEN - INACTIVE	1300 4TH ST	BERKELEY	37.87878	-122.30358	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	High Priority	High Priority	High Priority

Table 1. Contaminated Sites Information and Rankings

No	Site Name	Site Category	Site Type	Status	Address	City	Latitude	Longitude	Projected Groundwater Depth from CoSMoS			Site Ranking		
									Current Conditions	0.8 feet (25 cm) SLR Scenario	2.5 feet (75 cm) SLR Scenario	Current Conditions	0.8 feet (25 cm) SLR Scenario	2.5 feet (75 cm) SLR Scenario
273	MARCHANT CORPORATION SITE	DTSC Cleanup Sites	VOLUNTARY AGREEMENT	ACTIVE	6701 SAN PABLO AVENUE	BERKELEY	37.8504292	-122.28751	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	High Priority	High Priority	High Priority
274	MARIPOSA PROPERTY	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1028 MARIPOSA	BERKELEY	37.889032	-122.270174	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
275	MAXWELL CAMERON PROPERTY	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1336 CHANNING WY	BERKELEY	37.8635657	-122.2845711	2-5 m; moderate	2-5 m; moderate	2-5 m; moderate	Low Priority	Low Priority	Low Priority
276	MCKEVITT VOLVO	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	2700 SHATTUCK AVE	BERKELEY	37.859781	-122.267824	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
277	MEADOWS PROPERTY	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1440 ASHBY AVE	BERKELEY	37.85308999	-122.2794411	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	Low Priority	Low Priority	Low Priority
278	MERCHANT PROPERTY	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	18 ALVARADO RD	BERKELEY	37.856316	-122.239378	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
279	MEYER SOUND	Cleanup Program Sites	CLEANUP PROGRAM SITE	OPEN - INACTIVE	2835 SAN PABLO AVE	BERKELEY	37.85456037	-122.2871923	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	High Priority	High Priority	High Priority
280	MEYER SOUND	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	2832 SAN PABLO AVE	BERKELEY	37.8547269	-122.288163	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	Low Priority	Low Priority	Low Priority
281	MIKE AUTO SERVICE	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1699 UNIVERSITY AVE	BERKELEY	37.871191	-122.277804	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
282	MOBIL	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1299 SAN PABLO AVE	BERKELEY	37.880801	-122.295553	1-2 m; shallow	1-2 m; shallow	1-2 m; shallow	Low Priority	Low Priority	Low Priority
283	MONSEN PLTG & SILVERSMITHS	DTSC Cleanup Sites	TIERED PERMIT	INACTIVE - NEEDS EVALUATION	3370 ADELINE STREET	BERKELEY	37.847292	-122.27242	2-5 m; moderate	2-5 m; moderate	2-5 m; moderate	Medium Priority	Medium Priority	Medium Priority
284	MOORE PROPERTY	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	3155 SACRAMENTO ST	BERKELEY	37.850358	-122.277487	1-2 m; shallow	1-2 m; shallow	1-2 m; shallow	Low Priority	Low Priority	Low Priority
285	MOTOR CITY AUTOMOTIVE	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	3058 SHATTUCK AVE	BERKELEY	37.8532851	-122.2662518	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
286	MUSSEN PROPERTY	Non-Case Information Sites	NON-CASE INFORMATION	INFORMATIONAL ITEM / REVIEW COMPLETE	1450 4TH ST	BERKELEY	37.875377	-122.302905	0 m; emergent	0 m; emergent	0 m; emergent	High Priority	High Priority	High Priority
287	NATIONAL STARCH & CHEM COMPANY	Cleanup Program Sites	CLEANUP PROGRAM SITE	OPEN - SITE ASSESSMENT	742 AND 800 GRAYSON ST	BERKELEY	37.85466568	-122.2941836	1-2 m; shallow	1-2 m; shallow	1-2 m; shallow	High Priority	High Priority	High Priority
288	NATIONAL STARCH AND CHEMICAL COMPANY	DTSC Cleanup Sites	STATE RESPONSE OR NPL	REFER: RWQCB	742 AND 800 GRAYSON AVENUE	BERKELEY	37.8544669	-122.29509	2-5 m; moderate	2-5 m; moderate	2-5 m; moderate	Medium Priority	Medium Priority	Medium Priority
289	NEWBERRY STATION	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	2929 SHATTUCK AVE	BERKELEY	37.856424	-122.265931	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
290	NIRP BERKELEY	DTSC Cleanup Sites	FUDS	NO FURTHER ACTION		BERKELEY	37.8502777	-122.29472	1-2 m; shallow	1-2 m; shallow	1-2 m; shallow	High Priority	High Priority	High Priority
291	NOMURA BROS INC	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	2720 SAN PABLO AVE	BERKELEY	37.857496	-122.287652	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	Low Priority	Low Priority	Low Priority
292	NUMBER 1 GAS	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1900 MARTIN LUTHER KING JR. WAY	BERKELEY	37.873326	-122.273197	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
293	NUMBER ONE GAS	Permitted USTs			1900 MARTIN LUTHER KING JR WAY	BERKELEY	37.87307	-122.27345	>5 m; deep	>5 m; deep	>5 m; deep	Medium Priority	Medium Priority	Medium Priority
294	O.H. OLSEN	Cleanup Program Sites	CLEANUP PROGRAM SITE	OPEN - REMEDIATION	2220 FOURTH STREET	BERKELEY	37.86403	-122.29906	1-2 m; shallow	1-2 m; shallow	1-2 m; shallow	High Priority	High Priority	High Priority
295	OLIVER COMPANY	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1035 CARLETON ST	BERKELEY	37.8581069	-122.289271	1-2 m; shallow	1-2 m; shallow	1-2 m; shallow	Low Priority	Low Priority	Low Priority
296	OSCARS CAFE	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1890 SHATTUCK AVE	BERKELEY	37.8739984	-122.2688447	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
297	PACIFIC BELL	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	2116 BANCROFT WY	BERKELEY	37.8676853	-122.2669311	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
298	PACIFIC COAST CHEMICALS CO.	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	2424 FOURTH STREET	BERKELEY	37.8688788	-122.3002756	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	Low Priority	Low Priority	Low Priority
299	PACIFIC STEEL CASTING	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	650 CEDAR ST	BERKELEY	37.87327	-122.3036758	0 m; emergent	0 m; emergent	0 m; emergent	Low Priority	Low Priority	Low Priority
300	PACIFIC STEEL CASTING	DTSC Cleanup Sites	VOLUNTARY AGREEMENT	ACTIVE	1316/1333/1420/1421 2ND STREET, 648 PAGE STREET	BERKELEY	37.87787	-122.30596	0 m; emergent	0 m; emergent	0 m; emergent	High Priority	High Priority	High Priority
301	PACIFIC STEEL PLANT #2	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1333 2ND ST	BERKELEY	37.8774919	-122.304895	0 m; emergent	0 m; emergent	0 m; emergent	Low Priority	Low Priority	Low Priority
302	PAHLMEYER FAMILY TRUST	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	2700 SAN PABLO AVE	BERKELEY	37.85766	-122.288803	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	Low Priority	Low Priority	Low Priority
303	PE-BERKELEY, INC.	Permitted USTs			1 FRANK SCHLESSINGER WAY	BERKELEY	37.87043	-122.26434	>5 m; deep	>5 m; deep	>5 m; deep	Medium Priority	Medium Priority	Medium Priority

Table 1. Contaminated Sites Information and Rankings

No	Site Name	Site Category	Site Type	Status	Address	City	Latitude	Longitude	Projected Groundwater Depth from CoSMoS			Site Ranking		
									Current Conditions	0.8 feet (25 cm) SLR Scenario	2.5 feet (75 cm) SLR Scenario	Current Conditions	0.8 feet (25 cm) SLR Scenario	2.5 feet (75 cm) SLR Scenario
304	PEERLESS ELECTRIC	DTSC Cleanup Sites	VOLUNTARY AGREEMENT	INACTIVE - ACTION REQUIRED	2220 4TH STREET	BERKELEY	37.8639473	-122.29932	1-2 m; shallow	1-2 m; shallow	1-2 m; shallow	High Priority	High Priority	High Priority
305	PEERLESS LIGHTING	LUST Cleanup Sites	LUST CLEANUP SITE	OPEN - REMEDIATION	2220 FOURTH STREET	BERKELEY	37.86410205	-122.2989595	1-2 m; shallow	1-2 m; shallow	1-2 m; shallow	High Priority	High Priority	High Priority
306	PG&E 7TH STREET CONSTRUCTION SITE	Non-Case Information Sites	NON-CASE INFORMATION	INFORMATIONAL ITEM / REVIEW COMPLETE	2891 7TH STREET	BERKELEY	37.85297	-122.29173	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	High Priority	High Priority	High Priority
307	PG&E POLE 4279	Non-Case Information Sites	NON-CASE INFORMATION	PENDING REVIEW	2301 ASHBY	BERKELEY	37.85628	-122.26111	>5 m; deep	>5 m; deep	>5 m; deep	Medium Priority	Medium Priority	Medium Priority
308	PODLESAK PROPERTY	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1241 6TH ST	BERKELEY	37.880557	-122.300848	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	Low Priority	Low Priority	Low Priority
309	PQ CORP	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	801 GRAYSON ST	BERKELEY	37.8544902	-122.2965712	2-5 m; moderate	2-5 m; moderate	2-5 m; moderate	Low Priority	Low Priority	Low Priority
310	PRC-DESOTO INTERNATIONAL	Cleanup Program Sites	CLEANUP PROGRAM SITE	COMPLETED - CASE CLOSED	1608 4TH ST	BERKELEY	37.873666	-122.300693	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	High Priority	High Priority	High Priority
311	PRIVATE RESIDENCE	Cleanup Program Sites	CLEANUP PROGRAM SITE	COMPLETED - CASE CLOSED	PRIVATE RESIDENCE	BERKELEY	37.867415	-122.276416	>5 m; deep	>5 m; deep	>5 m; deep	Medium Priority	Medium Priority	Medium Priority
312	PRIVATE RESIDENCE	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	PRIVATE RESIDENCE	BERKELEY	37.891155	-122.266464	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
313	PROEN PRODUCTS COMPANY	Cleanup Program Sites	CLEANUP PROGRAM SITE	COMPLETED - CASE CLOSED	2777 9TH ST	BERKELEY	37.85602587	-122.290116	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	High Priority	High Priority	High Priority
314	PROPEL FUELS, INC. (202018)	Permitted USTs			849 UNIVERSITY AVE STE B	BERKELEY	37.86842	-122.296989	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	High Priority	High Priority	High Priority
315	R STRONG HANDBLOWN ARTGLASS	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1235 4TH ST	BERKELEY	37.879495	-122.30338	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	Low Priority	Low Priority	Low Priority
316	READ INVESTMENTS BERKELEY LLC SITE (FORMER JIM DOTEN HONDA SITE)	Cleanup Program Sites	CLEANUP PROGRAM SITE	COMPLETED - CASE CLOSED	2001 4TH STREET	BERKELEY	37.86743	-122.29884	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	High Priority	High Priority	High Priority
317	REGAL	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1801 UNIVERSITY AVE	BERKELEY	37.8713461	-122.2752524	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
318	RIPSTEEN PROPERTY	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	3170 COLLEGE AVE	BERKELEY	37.851483	-122.252803	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
319	RVEECO INC	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1335 6TH ST	BERKELEY	37.87812343	-122.3006468	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	Low Priority	Low Priority	Low Priority
320	SAFETY-KLEEN CORP	DTSC Hazardous Waste Sites	RCRA	CLOSED	1717 FOURTH ST	BERKELEY	37.871629	-122.30061	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	High Priority	High Priority	High Priority
321	SALES BUILDING	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1310 SAN PABLO AVE	BERKELEY	37.8801212	-122.2957817	1-2 m; shallow	1-2 m; shallow	1-2 m; shallow	Low Priority	Low Priority	Low Priority
322	SAN PABLO MINI-MART	Permitted USTs			1580 SAN PABLO AVE	BERKELEY	37.87536	-122.29449	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	High Priority	High Priority	High Priority
323	SBC FACILITY	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1206 FIFTH STREET	BERKELEY	37.880376	-122.303697	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	Low Priority	Low Priority	Low Priority
324	SHATTUCK, LLC	Non-Case Information Sites	NON-CASE INFORMATION	INFORMATIONAL ITEM / REVIEW COMPLETE	1951 SHATTUCK AVENUE	BERKELEY	37.87292	-122.26817	>5 m; deep	>5 m; deep	>5 m; deep	Medium Priority	Medium Priority	Medium Priority
325	SHELL	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1752 SHATTUCK AVE	BERKELEY	37.875419	-122.269082	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
326	SHELL	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	2200 DURANT AVE	BERKELEY	37.866946	-122.264843	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
327	SHELL BRANDED SERVICE STATION	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1200 ASHBY AVENUE	BERKELEY	37.852166	-122.286583	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	Low Priority	Low Priority	Low Priority
328	SHELL STATION	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1250 UNIVERSITY AVENUE	BERKELEY	37.86956985	-122.2871635	2-5 m; moderate	2-5 m; moderate	2-5 m; moderate	Low Priority	Low Priority	Low Priority
329	SHIELD HEALTHCARE	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	2567 SHATTUCK AVE	BERKELEY	37.862751	-122.266697	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
330	SIERRA DESIGNS LILY WONG	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	2039 4TH ST	BERKELEY	37.8670325	-122.2996624	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	Low Priority	Low Priority	Low Priority
331	SOUTHERN PACIFIC	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	UNKNOWN DELAWARE & VIRGINIA	BERKELEY	37.872612	-122.285038	2-5 m; moderate	2-5 m; moderate	2-5 m; moderate	Low Priority	Low Priority	Low Priority
332	SOUTHSIDE PLAZA	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	2399 SHATTUCK AVE	BERKELEY	37.8660629	-122.267108	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
333	SOUTHWICK CHRYSLER PLYMOUTH	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	2900 SHATTUCK AVE	BERKELEY	37.855587	-122.266832	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
334	STAN ANDERSON SERVICE	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1745 CEDAR ST	BERKELEY	37.87776	-122.276129	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority

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									Current Conditions	0.8 feet (25 cm) SLR Scenario	2.5 feet (75 cm) SLR Scenario	Current Conditions	0.8 feet (25 cm) SLR Scenario	2.5 feet (75 cm) SLR Scenario
335	STANLEY HALL	Non-Case Information Sites	NON-CASE INFORMATION	INFORMATIONAL ITEM / REVIEW COMPLETE	317 UNIVERSITY HALL, #1150	BERKELEY	37.87397263	-122.256546	>5 m; deep	>5 m; deep	>5 m; deep	Medium Priority	Medium Priority	Medium Priority
336	STEAD BUILDING	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1960 ADDISON ST	BERKELEY	37.8707352	-122.2715451	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
337	STUDIO COMPLEX	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1025 CARLETON ST	BERKELEY	37.85802	-122.289542	1-2 m; shallow	1-2 m; shallow	1-2 m; shallow	Low Priority	Low Priority	Low Priority
338	SUPER 7	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	950 UNIVERSITY AVE	BERKELEY	37.868366	-122.294981	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	Low Priority	Low Priority	Low Priority
339	SUPER 7	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	901 ASHBY AVE	BERKELEY	37.85127024	-122.2908944	1-2 m; shallow	1-2 m; shallow	1-2 m; shallow	Low Priority	Low Priority	Low Priority
340	SVENSSON AUTOMOTIVE	Cleanup Program Sites	CLEANUP PROGRAM SITE	OPEN - SITE ASSESSMENT	1740 SAN PABLO AVE	BERKELEY	37.87179	-122.29341	2-5 m; moderate	2-5 m; moderate	2-5 m; moderate	Medium Priority	Medium Priority	Medium Priority
341	TAKARA SAKE	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	708 ADDISON ST	BERKELEY	37.8661225	-122.3000878	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	Low Priority	Low Priority	Low Priority
342	TANNERY THE	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1300 4TH ST	BERKELEY	37.8789106	-122.3035225	0 m; emergent	0 m; emergent	0 m; emergent	Low Priority	Low Priority	Low Priority
343	TEMESCAL BUSINESS CENTER	Cleanup Program Sites	CLEANUP PROGRAM SITE	OPEN - SITE ASSESSMENT	2850 7TH ST	BERKELEY	37.85358943	-122.2921996	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	High Priority	High Priority	High Priority
344	TEMESCAL BUSINESS CENTER	DTSC Cleanup Sites	STATE RESPONSE OR NPL	REFER: RWQCB	2850 7TH STREET	BERKELEY	37.853889	-122.29322	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	High Priority	High Priority	High Priority
345	TERMINAL MANUFACTURING, LLC	Cleanup Program Sites	CLEANUP PROGRAM SITE	OPEN - VERIFICATION MONITORING	707 GILMAN ST	BERKELEY	37.87926	-122.30426	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	High Priority	High Priority	High Priority
346	TERMINAL MANUFACTURING, LLC	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	707 GILMAN ST	BERKELEY	37.87906533	-122.3045518	0 m; emergent	0 m; emergent	0 m; emergent	Low Priority	Low Priority	Low Priority
347	TEXACO	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	833 UNIVERSITY AVE	BERKELEY	37.868146	-122.296758	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	Low Priority	Low Priority	Low Priority
348	TEXACO	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1899 OXFORD ST	BERKELEY	37.874496	-122.266059	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
349	TEXACO	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	840 ASHBY AVE	BERKELEY	37.850648	-122.291325	1-2 m; shallow	1-2 m; shallow	1-2 m; shallow	Low Priority	Low Priority	Low Priority
350	TIME OIL COMPANY	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	2748 SAN PABLO AVE	BERKELEY	37.856084	-122.286943	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	Low Priority	Low Priority	Low Priority
351	TOLTEC PROPERTY	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	2148 CENTER ST	BERKELEY	37.870489	-122.2666254	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
352	TONY & JOHN'S FOREIGN CARS	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	2730 TELEGRAPH AVE	BERKELEY	37.860183	-122.259546	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
353	TOSCO - FACILITY #0852	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	3001 TELEGRAPH AVE	BERKELEY	37.85593123	-122.2593571	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
354	TOSCO - FACILITY #1700	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1499 UNIVERSITY AVE	BERKELEY	37.8706379	-122.2823096	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
355	TOSCO - FACILITY #3185	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	849 UNIVERSITY AVE	BERKELEY	37.868194	-122.296598	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	Low Priority	Low Priority	Low Priority
356	TOWER CLEANERS	Cleanup Program Sites	CLEANUP PROGRAM SITE	OPEN - ASSESSMENT & INTERIM REMEDIAL ACTION	1110 UNIVERSITY AVENUE	BERKELEY	37.86887415	-122.2913074	1-2 m; shallow	1-2 m; shallow	1-2 m; shallow	High Priority	High Priority	High Priority
357	TOYOTA FLYNN TRUST	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	2555 SHATTUCK AVE	BERKELEY	37.862965	-122.266766	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
358	TOYOTA OF BERKELEY	Non-Case Information Sites	NON-CASE INFORMATION	INFORMATIONAL ITEM / REVIEW COMPLETE	2400 SHATTUCK AVE	BERKELEY	37.865854	-122.266984	>5 m; deep	>5 m; deep	>5 m; deep	Medium Priority	Medium Priority	Medium Priority
359	TPMG REGIONAL LABORATORY (KAISER)	Permitted USTs			1725 EASTSHORE HWY	BERKELEY	37.87091	-122.30399	0 m; emergent	0 m; emergent	0 m; emergent	High Priority	High Priority	High Priority
360	TRANSAMERICA DEVAUAL	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	829 BANCROFT WAY	BERKELEY	37.8635299	-122.2962185	1-2 m; shallow	1-2 m; shallow	1-2 m; shallow	Low Priority	Low Priority	Low Priority
361	TRIANGLE COATINGS	DTSC Cleanup Sites	VOLUNTARY AGREEMENT	REFER: LOCAL AGENCY	2222 THIRD STREET	BERKELEY	37.8640996	-122.3006	2-5 m; moderate	2-5 m; moderate	2-5 m; moderate	Medium Priority	Medium Priority	Medium Priority
362	TROUT PLUMBING	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	812 PAGE ST	BERKELEY	37.876074	-122.300995	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	Low Priority	Low Priority	Low Priority
363	TRUST SECURITY MANAGEMENT	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	2321 4TH ST	BERKELEY	37.862268	-122.298088	2-5 m; moderate	2-5 m; moderate	2-5 m; moderate	Low Priority	Low Priority	Low Priority
364	TUNE UP MASTERS	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1698 UNIVERSITY STREET	BERKELEY	37.870929	-122.277571	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority

Table 1. Contaminated Sites Information and Rankings

No	Site Name	Site Category	Site Type	Status	Address	City	Latitude	Longitude	Projected Groundwater Depth from CoSMoS			Site Ranking		
									Current Conditions	0.8 feet (25 cm) SLR Scenario	2.5 feet (75 cm) SLR Scenario	Current Conditions	0.8 feet (25 cm) SLR Scenario	2.5 feet (75 cm) SLR Scenario
365	TUTTLE GALVANIZING	Cleanup Program Sites	CLEANUP PROGRAM SITE	COMPLETED - CASE CLOSED	725 GILMAN ST	BERKELEY	37.87934	-122.303953	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	High Priority	High Priority	High Priority
366	U-HAUL #710-52	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	2100 SAN PABLO AVENUE	BERKELEY	37.867948	-122.291843	1-2 m; shallow	1-2 m; shallow	1-2 m; shallow	Low Priority	Low Priority	Low Priority
367	U.C. BERKELEY ANNA HEAD HOUSING PROJECT	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	2536 CHANNING WAY	BERKELEY	37.86668897	-122.2576404	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
368	U.S. SMOG AND GAS	Cleanup Program Sites	CLEANUP PROGRAM SITE	COMPLETED - CASE CLOSED	3000 SHATTUCK AVENUE	BERKELEY	37.85501	-122.266767	>5 m; deep	>5 m; deep	>5 m; deep	Medium Priority	Medium Priority	Medium Priority
369	UC BERKELEY	Non-Case Information Sites	NON-CASE INFORMATION	INFORMATIONAL ITEM / REVIEW COMPLETE	UNKNOWN MURRY ST & FOLGER ST & 7TH ST	BERKELEY	37.850434	-122.290921	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	High Priority	High Priority	High Priority
370	UC BERKELEY	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	2515 CHANNING WY	BERKELEY	37.867349	-122.257759	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
371	UC BERKELEY	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	UNKNOWN JEFFERSON & ADDISON	BERKELEY	37.8699	-122.2779	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
372	UC BERKELEY	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	777 HARRISON STREET	BERKELEY	37.8808	-122.3034	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	Low Priority	Low Priority	Low Priority
373	UC BERKELEY	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1750 ARCH ST	BERKELEY	37.876573	-122.264576	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
374	UC BERKELEY - DINING FACILITY	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	2401 BOWDITCH STREET	BERKELEY	37.867183	-122.256548	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
375	UC BERKELEY - MAIN CAMPUS	Permitted USTs			200 CALIFORNIA HALL	BERKELEY	37.87152	-122.26037	>5 m; deep	>5 m; deep	>5 m; deep	Medium Priority	Medium Priority	Medium Priority
376	UC BERKELEY CORP YARD	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	2000 MILVIA ST	BERKELEY	37.871765	-122.2701	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
377	UC BERKELEY HEARST MINING BLDG	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	UNKNOWN HEARST STREET	BERKELEY	37.87547851	-122.2569209	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
378	UC BERKELEY PHYSICAL PLANT	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	2000 CARLETON ST	BERKELEY	37.8609189	-122.2695059	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
379	UC BERKELEY SITE GARAGE	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1952 OXFORD ST	BERKELEY	37.873047	-122.266528	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
380	UC GAS&FOOD	Permitted USTs			1894 UNIVERSITY AVE	BERKELEY	37.87144	-122.27324	>5 m; deep	>5 m; deep	>5 m; deep	Medium Priority	Medium Priority	Medium Priority
381	UNITED #5616	Permitted USTs			1830 SOLANO AVE	BERKELEY	37.89115	-122.2789	>5 m; deep	>5 m; deep	>5 m; deep	Medium Priority	Medium Priority	Medium Priority
382	UNITED PACIFIC # 2204AD	LUST Cleanup Sites	LUST CLEANUP SITE	OPEN - ASSESSMENT & INTERIM REMEDIAL ACTION	901 ASHBY AVE	BERKELEY	37.85137	-122.29092	1-2 m; shallow	1-2 m; shallow	1-2 m; shallow	High Priority	High Priority	High Priority
383	UNIVERSITY ASSOCIATES	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	901 21 UNIVERSITY AVE	BERKELEY	37.8682717	-122.2966308	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	Low Priority	Low Priority	Low Priority
384	UNIVERSITY CHEVRON #90877	Permitted USTs			1500 UNIVERSITY AVE	BERKELEY	37.87013	-122.28153	>5 m; deep	>5 m; deep	>5 m; deep	Medium Priority	Medium Priority	Medium Priority
385	UNIVERSITY LAUNDROMAT	Non-Case Information Sites	NON-CASE INFORMATION	PENDING REVIEW	1652 UNIVERSITY AVENUE	BERKELEY	37.87063	-122.27838	>5 m; deep	>5 m; deep	>5 m; deep	Medium Priority	Medium Priority	Medium Priority
386	UNIVERSITY OF CALIFORNIA, BERKELEY - MAIN CAMPUS	DTSC Cleanup Sites	TIERED PERMIT	INACTIVE - NEEDS EVALUATION	317 UNIVERSITY HALL, MC 1150	BERKELEY	37.87205	-122.25928	>5 m; deep	>5 m; deep	>5 m; deep	Medium Priority	Medium Priority	Medium Priority
387	UNIVERSITY SHELL #100	Permitted USTs			1250 UNIVERSITY AVE	BERKELEY	37.86963	-122.28727	2-5 m; moderate	2-5 m; moderate	2-5 m; moderate	Medium Priority	Medium Priority	Medium Priority
388	UNIVERSITY VALERO # 7200	Single-Walled UST Sites	SINGLE-WALLED UST	SWT-NO PLAN RETURNED	1894 UNIVERSITY AVE	BERKELEY	37.87111862	-122.2732878	>5 m; deep	>5 m; deep	>5 m; deep	Medium Priority	Medium Priority	Medium Priority
389	UNIVERSITY VALERO-BERKELEY	Permitted USTs			849 UNIVERSITY AVE	BERKELEY	37.86841	-122.29697	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	High Priority	High Priority	High Priority
390	UNKNOWN	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1149 THE ALAMEDA _ MARTIN LUTHER KING	BERKELEY	37.884934	-122.2744847	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
391	UNKNOWN	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1649 MARTIN LUTHER KING	BERKELEY	37.876922	-122.273476	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
392	UNKNOWN	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	2167-2183 DWIGHT WY	BERKELEY	37.864327	-122.26605	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
393	UNOCAL	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	2101 ROSE ST	BERKELEY	37.882114	-122.268728	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
394	UNOCAL	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	2501 SACRAMENTO ST	BERKELEY	37.8622005	-122.2810075	2-5 m; moderate	2-5 m; moderate	2-5 m; moderate	Low Priority	Low Priority	Low Priority
395	URBAN DESIGNS	Cleanup Program Sites	CLEANUP PROGRAM SITE	COMPLETED - CASE CLOSED	1800 DWIGHT WY	BERKELEY	37.86281816	-122.2742105	2-5 m; moderate	2-5 m; moderate	2-5 m; moderate	Medium Priority	Medium Priority	Medium Priority
396	URBAN DESIGNS	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1800 -1812 DWIGHT WAY	BERKELEY	37.86302224	-122.273464	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
397	UTILITY BODY COMPANY	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	901 GILMAN ST	BERKELEY	37.880592	-122.300011	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	Low Priority	Low Priority	Low Priority

Table 1. Contaminated Sites Information and Rankings

No	Site Name	Site Category	Site Type	Status	Address	City	Latitude	Longitude	Projected Groundwater Depth from CoSMoS			Site Ranking		
									Current Conditions	0.8 feet (25 cm) SLR Scenario	2.5 feet (75 cm) SLR Scenario	Current Conditions	0.8 feet (25 cm) SLR Scenario	2.5 feet (75 cm) SLR Scenario
398	VACANT BUILDING/ FREDS MARKET	Cleanup Program Sites	CLEANUP PROGRAM SITE	COMPLETED - CASE CLOSED	1929 UNIVERSITY AVENUE	BERKELEY	37.871943	-122.27225	>5 m; deep	>5 m; deep	>5 m; deep	Medium Priority	Medium Priority	Medium Priority
399	VERIFLO	Cleanup Program Sites	CLEANUP PROGRAM SITE	OPEN - VERIFICATION MONITORING	800 BANCROFT WAY	BERKELEY	37.86298095	-122.2970779	1-2 m; shallow	1-2 m; shallow	1-2 m; shallow	High Priority	High Priority	High Priority
400	VIRGINIA CLEANERS	DTSC Cleanup Sites	VOLUNTARY AGREEMENT	ACTIVE	1650 SHATTUCK AVENUE	BERKELEY	37.877718	-122.26926	>5 m; deep	>5 m; deep	>5 m; deep	Medium Priority	Medium Priority	Medium Priority
401	VIRGINIA CLEANERS	Non-Case Information Sites	NON-CASE INFORMATION	INFORMATIONAL ITEM / REVIEW COMPLETE	1650 SHATTUCK AVENUE	BERKELEY	37.87767	-122.26924	>5 m; deep	>5 m; deep	>5 m; deep	Medium Priority	Medium Priority	Medium Priority
402	VIRGINIA CLEANERS	DTSC Cleanup Sites	STATE RESPONSE OR NPL	NO FURTHER ACTION	1667 SHATTUCK AVENUE	BERKELEY	37.8769423	-122.26885	>5 m; deep	>5 m; deep	>5 m; deep	Medium Priority	Medium Priority	Medium Priority
403	WALKER ESTATE	Cleanup Program Sites	CLEANUP PROGRAM SITE	OPEN - VERIFICATION MONITORING	1507 SAN PABLO AVENUE	BERKELEY	37.876031	-122.294134	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	High Priority	High Priority	High Priority
404	WAREHAM PROPERTIES	DTSC Cleanup Sites	STATE RESPONSE OR NPL	CERTIFIED	700 HEINZ AVENUE	BERKELEY	37.8524104	-122.2944	1-2 m; shallow	1-2 m; shallow	1-2 m; shallow	High Priority	High Priority	High Priority
405	WEATHERFORD BMW (FORMER NAVAL INDUSTRIAL RESERVE PLANT BERKELEY)	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	735 ASHBY AVENUE	BERKELEY	37.85024241	-122.2951298	1-2 m; shallow	1-2 m; shallow	1-2 m; shallow	Low Priority	Low Priority	Low Priority
406	WEST COAST PROPERTY MANAGEMENT	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	2547 8TH ST	BERKELEY	37.859627	-122.29234	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	Low Priority	Low Priority	Low Priority
407	WHITTIER SCHOOL	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1645 MILVIA ST	BERKELEY	37.876903	-122.2706	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
408	WILLARD SCHOOL	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	2425 STUART ST	BERKELEY	37.8596141	-122.2586631	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
409	WILLIAM BYRON RUMFORD SR PLAZA	Cleanup Program Sites	CLEANUP PROGRAM SITE	COMPLETED - CASE CLOSED	3000 SACRAMENTO ST	BERKELEY	37.85292051	-122.2792437	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	High Priority	High Priority	High Priority
410	WRE/COLORTECH	Cleanup Program Sites	CLEANUP PROGRAM SITE	OPEN - VERIFICATION MONITORING	1225 6TH STREET	BERKELEY	37.88053	-122.30131	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	High Priority	High Priority	High Priority
411	WRIGHT'S AUTOMOTIVE	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	2629 ASHBY AVE	BERKELEY	37.857224	-122.253643	>5 m; deep	>5 m; deep	>5 m; deep	Low Priority	Low Priority	Low Priority
412	XTRA OIL CO - SHATTUCK DBA CHEVRON	Permitted USTs			2996 SHATTUCK AVE	BERKELEY	37.85545	-122.2666	>5 m; deep	>5 m; deep	>5 m; deep	Medium Priority	Medium Priority	Medium Priority
413	XTRA OIL CO.- THE ALAMEDA DBA CHEVRON	Permitted USTs			1201 THE ALAMEDA	BERKELEY	37.88533	-122.27448	>5 m; deep	>5 m; deep	>5 m; deep	Medium Priority	Medium Priority	Medium Priority
414	XTRA OIL COMPANY	LUST Cleanup Sites	LUST CLEANUP SITE	OPEN - SITE ASSESSMENT	1201 THE ALAMEDA	BERKELEY	37.88527108	-122.2745088	>5 m; deep	>5 m; deep	>5 m; deep	Medium Priority	Medium Priority	Medium Priority
415	XTRA OIL COMPANY	LUST Cleanup Sites	LUST CLEANUP SITE	OPEN - SITE ASSESSMENT	1399 SAN PABLO AVE	BERKELEY	37.87896782	-122.2949681	1-2 m; shallow	1-2 m; shallow	1-2 m; shallow	High Priority	High Priority	High Priority
416	XTRA OIL COMPANY DBA CHEVRON	Permitted USTs			1399 SAN PABLO AVE	BERKELEY	37.87901	-122.29498	1-2 m; shallow	1-2 m; shallow	1-2 m; shallow	High Priority	High Priority	High Priority
417	ZAITLIAN PROPERTY	LUST Cleanup Sites	LUST CLEANUP SITE	COMPLETED - CASE CLOSED	1507 SAN PABLO AVE	BERKELEY	37.87610562	-122.2940454	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	Low Priority	Low Priority	Low Priority
418	ALAMEDA COUNTY COMPUTER RESOURCE CENTER	DTSC Cleanup Sites	INSPECTION	NO ACTION	620 PAGE STREET	BERKELEY	37.87534891	-122.3051806	0 m; emergent	0 m; emergent	0 m; emergent	High Priority	High Priority	High Priority
419	BERKELEY FORGE DEVELOPMENT PROJECT	DTSC Cleanup Sites	VOLUNTARY CLEANUP	ACTIVE	EASTSHORE HIGHWAY/GILMAN ST/3RD ST/PAGE ST, 631-643 CAMELIA ST.	BERKELEY	37.87695168	-122.305113	0 m; emergent	0 m; emergent	0 m; emergent	High Priority	High Priority	High Priority
420	CALTRANS WEST FRONTAGE RD BERKELEY	DTSC Cleanup Sites	HISTORICAL	REFER: OTHER AGENCY	W. OF HWY 80 APPROX. VIRGINIA TO GILMAN	BERKELEY	37.87447569	-122.3066691	1-2 m; shallow	1-2 m; shallow	1-2 m; shallow	High Priority	High Priority	High Priority
421	DESOTO INCORPORATED	DTSC Cleanup Sites	HISTORICAL	REFER: RWQCB	1608 4TH STREET	BERKELEY	37.87305556	-122.3022222	0 m; emergent	0 m; emergent	0 m; emergent	High Priority	High Priority	High Priority
422	FRANK'S TIRE SERVICE	DTSC Cleanup Sites	HISTORICAL	REFER: OTHER AGENCY	820 GILMAN STREET	BERKELEY	37.8789915	-122.3016417	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	High Priority	High Priority	High Priority
423	KRENZ INC	DTSC Cleanup Sites	HISTORICAL	REFER: OTHER AGENCY	ASHBY AT 6TH STREET	BERKELEY	37.85092004	-122.2928822	1-2 m; shallow	1-2 m; shallow	1-2 m; shallow	High Priority	High Priority	High Priority
424	MANASSE - BLOCK TANNING COMPANY	DTSC Cleanup Sites	HISTORICAL	REFER: OTHER AGENCY	1300 4TH STREET	BERKELEY	37.878272	-122.303864	0-1 m; very shallow	0-1 m; very shallow	0-1 m; very shallow	High Priority	High Priority	High Priority
425	MILES INC CUTTER BIOLOGICAL FACILITY #38	DTSC Cleanup Sites	HISTORICAL	REFER: OTHER AGENCY	4TH AND PARKER STREETS	BERKELEY	37.8575	-122.2966667	2-5 m; moderate	2-5 m; moderate	2-5 m; moderate	Medium Priority	Medium Priority	Medium Priority

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No	Site Name	Site Category	Site Type	Status	Address	City	Latitude	Longitude	Projected Groundwater Depth from CoSMoS			Site Ranking		
									Current Conditions	0.8 feet (25 cm) SLR Scenario	2.5 feet (75 cm) SLR Scenario	Current Conditions	0.8 feet (25 cm) SLR Scenario	2.5 feet (75 cm) SLR Scenario
426	SOLID WASTE MANAGEMENT CENTER	DTSC Cleanup Sites	HISTORICAL	REFER: OTHER AGENCY	2ND AND GILMAN STREETS	BERKELEY	37.87833333	-122.3058333	0 m; emergent	0 m; emergent	0 m; emergent	High Priority	High Priority	High Priority
427	TERMINEX-PEERLESS	DTSC Cleanup Sites	HISTORICAL	REFER: OTHER AGENCY	2240 4TH STREET	BERKELEY	37.863889	-122.299167	1-2 m; shallow	1-2 m; shallow	1-2 m; shallow	High Priority	High Priority	High Priority

Notes:
cm - centimeter
CoSMoS - Coastal Storm Modeling System
DTSC - Department of Toxic Substances Control
LUST - leaking underground storage tank
m - meter
SLR - sea level rise
UST - underground storage tank

Appendix C

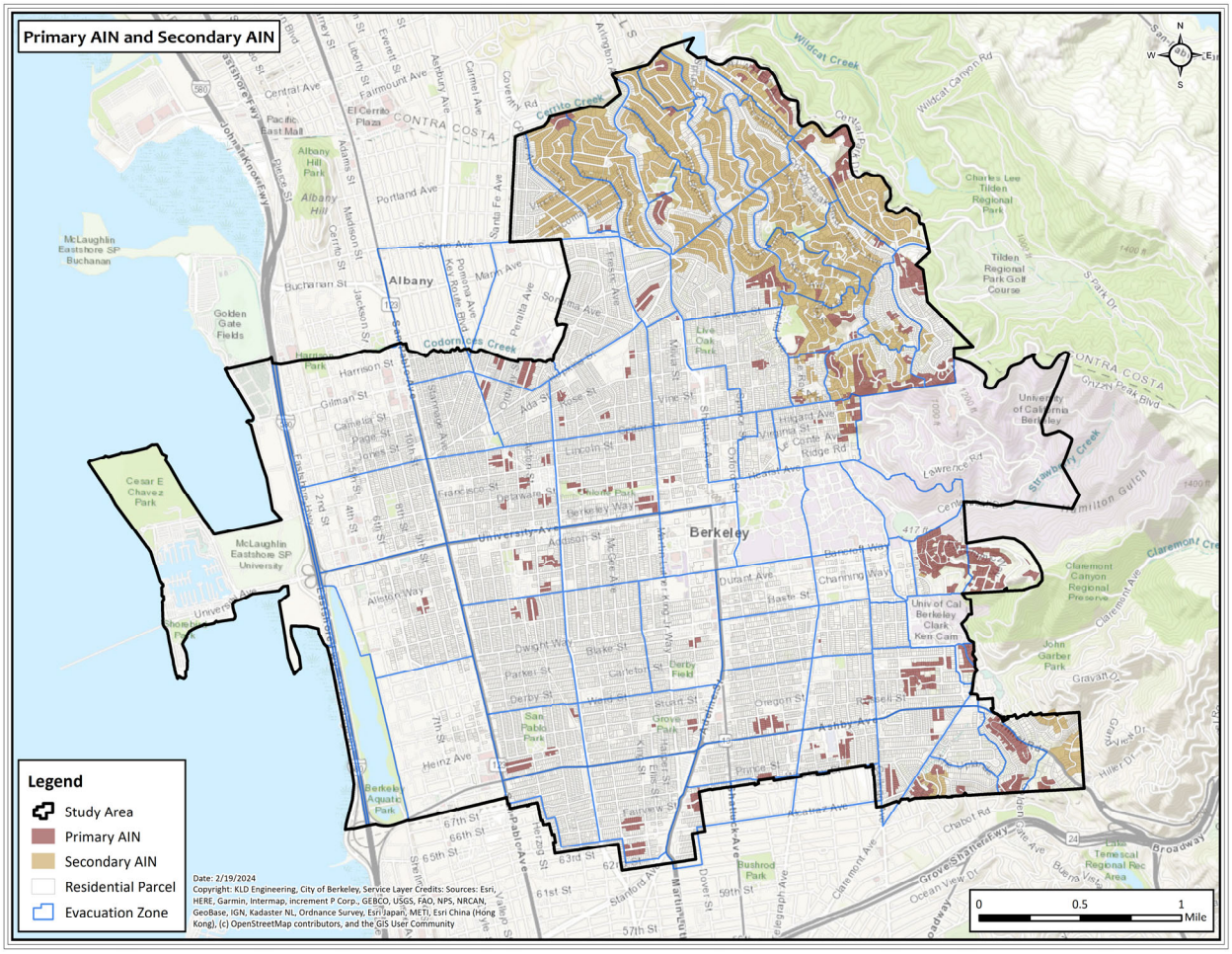
Access Impaired Neighborhood Analysis

KLD ENGINEERING, P.C.

City of Berkeley, California

Access Impaired Neighborhood Analysis

Senate Bill 99 Requirement



Work performed for the City of Berkeley, by:

KLD Engineering, P.C.
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Islandia, NY 11749
email: rcohen@kldcompanies.com

Introduction

Number five (5) of item G of Section 1 of Section 65302 of Senate Bill 99 stipulates that a safety element for the protection of the community "shall be reviewed and updated to identify residential developments in any hazard area identified in the safety element that do not have at least two emergency evacuation routes."

The City of Berkeley, California has contracted KLD Engineering, P.C. to help identify residential developments, or neighborhoods, that are in a hazard area with limited means of egress. These neighborhoods may experience more challenges evacuating and should be given special consideration when planning for emergencies that require evacuation. This memo describes the data, assumptions, analysis and results of these Access Impaired Neighborhoods (AIN) within the City of Berkeley.

Data Sources

- The latest parcel data from the city Open Data portal[1] was used as the base data for the AIN analysis.
- Fire Hazard Severity Zones (FHSZ) data obtained from the City of Berkeley. FHSZ are scored based on factors that influence fire likelihood and fire behavior. Fire Zones 2 and 3 were considered at-risk in this study.
- Federal Emergency Management Agency's (FEMA) 500-year flood zones[2]. This data identifies areas that have a 0.2% chance of flooding in any given year.
- California Department of Conservation tsunami zones[3]. This dataset includes all populated areas that are at risk of tsunamis.
- California Department of Conservation[3] earthquake zones and the United States Geological Survey (USGS) Hayward Fault Scenario[4]. This dataset includes areas that are at risk for seismic hazards which includes:
    - deep-seated landslide susceptibility based on estimates of rock strength and steepness of slopes,
    - liquefaction,
    - surface fault rupture,
    - and ground shaking.
- The street centerline data was provided by the city and was used to identify dead ends, narrow roads, and winding roads. In addition, the dead-end data provided by the city and those obtained from the road survey were also considered in this analysis.

[1] https://data.cityofberkeley.info/City-Government/Parcels/bhxd-e6up
[2] https://hazards-fema.maps.arcgis.com/apps/webappviewer/index.html?id=8b0adb51996444d4879338b5529aa9cd
[3] https://maps.conservation.ca.gov/cgs/#datalist
[4] https://earthquake.usgs.gov/education/shakingsimulations/hayward/M7.0.php#

Assumptions

An additional consideration of risk is the distance of a neighborhood from safety resources, like fire stations. To analyze this risk, the following assumptions must be made:

- A threshold of 5 minutes for urban and suburban areas is assumed to be the maximum drive time from a fire station[5]. A 5-minute service area for each fire station was generated using ArcGIS Network Analyst extension. The service area for this analysis represents an area that can be driven by a fire truck from the fire station within a defined period of travel time.
- The maximum dimensions for fire trucks within the city are 11.25 feet high, 60 feet long and 9.25 feet wide[6].

For the analysis on pavement width (narrow roadways), the following assumptions were made:

- Parking stalls are 8 feet wide. Using the city's curb data for parking information, pavement width was reduced by 8 feet to account for roadways with street parking (or 16 feet if parking is permitted on both sides of the road).
- A minimum of 10 feet is necessary for large vehicles (delivery trucks, buses, etc.) to evacuate.

Analysis

To identify the hazardous areas within the city that meet the SB 99 criteria, the residential parcel layer was overlaid, in ArcGIS, with the hazard area layers for wildfire, flooding, earthquake, tsunami, liquefaction, and landslide. Figure 1. Hazards affecting the City of Berkeley shows all the different hazard areas that can affect the city that were considered in this study.

In addition, residential parcels outside of the service areas of fire stations are considered vulnerable in this analysis. As such, an additional analysis was performed to assess the serviceability of the neighborhoods within the city based on their distances from fire stations. Figure 2. Fire Station Service Area shows an overview of the service areas of all the fire stations within the city. Although this analysis is not designed to address responder ingress, it is presumed that if responders cannot quickly access an area, then that area is at a higher risk in an emergency.

It should be noted that the entire city falls within at least one hazard area. For this reason, the entire city was considered *at-risk* and was included in this analysis. Although every hazard is not included in this analysis, inclusion of additional hazards would not affect the outcome as the entire city was analyzed for one way in/out to meet the SB 99 requirement.

Next, ESRI's ArcGIS was used to identify all the dead-end roadways within the street network. These dead-end roadways were supplemented with the dead-end roadways provided by the city and those identified during the road survey. The dead ends in this analysis include natural dead ends (e.g., cul-de-sacs, etc.) and man-made barriers (e.g., bollards, gates, traffic calming islands, etc.). Each dead end was verified using aerial imagery. Residential parcels that are within any

[5] Based on the city's recent Standards of Coverage assessment.
[6] This represents the largest truck (ladder truck) that the city owns. The height does not include antenna.

hazard area, as well as are located outside of the fire station 5-minute service area and are located along dead-end roadways are considered as the AIN. Those areas are shown in Figure 3. Primary Access Impaired Neighborhoods. Since all of these neighborhoods are within a hazard zone and have only one evacuation route available, these are Berkeley's AIN as defined using SB99 criteria.

Once the primary AIN were identified, they were inspected for man-made barriers (e.g., bollards, gates, traffic calming islands, etc.) that could be lifted in an emergency to provide additional evacuation routes out of the neighborhood. These AIN were flagged as having emergency exits since they could have multiple ways out in an emergency if the man-made barrier was removed (or vehicles with high clearance could traverse the barrier in the case of the traffic calming bollards). Figure 4. Primary Access Impaired Neighborhoods with Removeable/Traversable Barriers highlights the primary AIN that have more than one way in/out if a barrier was removed, or a vehicle is high enough to clear a low-profile bollard. These AIN are flagged in Table 1. Access Impaired Neighborhoods as having a "potential emergency exit".

In addition to the risk factors considered above, narrow and/or winding roadways were also considered. These roadways pose their own risks and can significantly impede evacuation. For this reason, a second level of analysis was completed for those neighborhoods that have more than one evacuation route, but one or more of those routes is narrow and/or winding leaving one *viable* evacuation route. These *secondary* neighborhoods are not considered single lane egress AIN but are within a hazard risk area and only have one *viable* way out. As such, they are identified as *Secondary AIN*. These are additional neighborhoods to those that meet the SB99 criteria.

The city centerline dataset was utilized to determine which roadways were narrow (with a travel lane of less than 10 feet wide[7]). Those roadways which meet or exceed 10 feet wide[8] were not considered in the analysis. To identify the winding roads, the curvature of the roadway was calculated based on its geometry. Each roadway segment within the city's centerline data is made up of vertices defined by longitude and latitude. Three sequential vertices along a roadway segment were utilized to create a triangle. The distances of the sides of the triangle (x, y, and z) were computed based on the longitude and latitude of the three sequential vertices. The radius of the circumscribed circle[9], or circumcircle radius, was then computed using Equation 1. This circumcircle radius corresponds to the curvature of the roadway at the middle of the three sequential vertices and is assigned to that vertex, or point. A larger radius corresponds to a straighter segment; a smaller radius corresponds to a more curved segment. This process is repeated for every three sequential vertices along the roadway centerline. The curvature of the roadway segment between vertices is computed as the average of the circumcircle radii of the

[7] Based on discussions with staff from the City's Public Works and Fire Departments, a viable evacuation travel lane width of 10 feet was chosen to account for larger vehicles (8 feet wide) and sideview mirrors. It is assumed that even larger vehicles (10 feet wide) are operated by professional drivers with a higher degree of skill to reduce or eliminate driver error.
[8] Pavement width was utilized (with modifications made for side street parking). Eight feet of parking was removed from the pavement width for single side street parking and 16 feet was removed for street parking on both sides of the road. Eight feet was used since the typical width for a standard parking space is 8 feet. Although a width of 7.5 feet has been used to provide a balance among users, eight feet was used as vehicles are not always parked well, may not be parked in contact with the face of the curb or vegetation, and throughout the day, large vehicles may be parked on the side of the street. Overhanging vegetation was not accounted for.
[9] Circle that passes through all three vertices of a triangle.

two vertices that it connects. This methodology is illustrated in Figure 5. Curvature Radius Example.

Equation 1

$$r = \frac{xyz}{\sqrt{(x+y+z)(y+z-x)(z+x-y)(x+y-z)}}$$

Using a minimum radius of 81 feet[10], roadway segments with tight turns (radii less than 81 feet) are flagged for review. Figure 6. Narrow and Winding Roads displays all of the roadways that were considered narrow and/or winding. The narrow roadways are color coded by tiers. Red roadways are considered severely constrained (6 feet or less wide), yellow roadways are considered moderately constrained (7 to 8 feet wide) and green roadways are considered constrained (9 to 10 feet wide).

A secondary analysis was then conducted on the residential parcels that have more than one way out but have exit paths along narrow and/or winding roadways (that are shown in Figure 6. Narrow and Winding Roads). If a residential parcel has access to multiple exits, but only one *viable* exit, it was flagged as a Secondary AIN. Since all parts of the city are considered to be within a hazard area, all the neighborhoods that were flagged were included as Secondary AINs. Figure 7. Secondary Access Impaired Neighborhoods shows the Secondary AINs. The primary and secondary AIN are shown together in Figure 8. Primary and Secondary Access Impaired Neighborhoods and are also listed in Table 1. Access Impaired Neighborhoods by priority, evacuation zone (Zonehaven), and street name. Table 1. Access Impaired Neighborhoods also provides the number of parcels that are within each AIN.

Results and Recommendations

In total, there are 141 primary AIN (1,461 residential parcels) and 195 secondary AIN (3,687 residential parcels) within the City of Berkeley.

Evacuation Zones E013 and E058 (Panoramic Way neighborhood) have the most AIN parcels. This entire neighborhood has only one access point to the nearest evacuation route (at a stop-controlled intersection at Panoramic Way and Prospect St/Canyon Rd). There are some removable or traversable barriers, but these additional exits will not expedite the evacuation of these neighborhoods since they are located so far up the mountain and do not provide additional access points to Prospect St/Canyon Rd. This neighborhood is within Fire Zones 2 and 3 and is at risk of landslides. The neighborhood also is at risk of violent ground shaking. Most of this neighborhood is also outside of a 5-minute drive from the nearest fire station. Many of the roadways within this area are less than 10 feet across and do not have side street parking.

[10] Table 3-7 of the 2018 AASHTO Policy on Geometric Design of Highways and Streets indicates the minimum radii for a curve with a design speed of 20mph is 81 feet. Based on the data collected during the road survey, the speed travelled on these curves was 20mph or less.

The vast majority of secondary AIN are in Berkeley Hills and Thousand Oaks due to the narrow and winding roadways in this area, as shown in Figure 7. Secondary Access Impaired Neighborhoods. Berkeley Hills and this part of Thousand Oaks are at risk of violent ground shaking. They are within Fire Zone 2 but are within a 5-minute drive of the nearest fire station. Parts of these areas are also at risk of landslides.

Depending on the hazard, these neighborhoods may require early notification to have sufficient time to evacuate before their safety is at risk. It is recommended that plans be put into place to ensure 100% notification of these areas and to notify these areas of an emergency even before they may be at risk.

Table 1. Access Impaired Neighborhoods

Priority	Evacuation Zone	Neighborhood	Potential Emergency Exit?	Number of Parcels
Primary	**ALB-E006**	Acton St	No	29
	ALB-E006	Tevlin St	No	14
	BER-E002	Vincente Ave	No	2
	BER-E003	San Mateo Rd	No	1
	BER-E004	Florida Ave	No	6
	BER-E005	Vermont Ave	No	11
	BER-E007	My Way	No	8
		Rochdale Way	No	5
		Vistamont Ave	No	20
		Woodmont Ct	No	5
	BER-E010	San Mateo Rd	No	26
	BER-E011	Station Pl	No	5
		Vincente Ave	No	12
	BER-E013	Dwight Pl	No	11
		Dwight Way	No	27
		Panoramic Place	No	2
		Panoramic Place	Yes	2
		Panoramic Way	No	21
		Panoramic Way	Yes	5
	BER-E014	Carleton St	No	2
	BER-E016	Martin Ave	No	4
		Middlefield Rd	No	6
		Overlook Rd	No	10
		The Spiral	No	8
		Woodhaven Rd	No	11
		Woodmont Ave	No	1
	BER-E017	Stoddard Way	No	6
	BER-E018	Private Dr Off of Keith Ave	No	3
	BER-E019	Corona Ct	No	17
		Crystal Way	No	7
		High Ct	No	27
		Laurel St	No	6
		Oak St	No	1
	BER-E021	Napa Ave	Yes	26
	BER-E025	Northside Ave	No	13
	BER-E026	Berryman St	No	3
		Buena Ave	No	6
		Grant St	No	4
		Miramonte Ct	No	9

Priority	Evacuation Zone	Neighborhood	Potential Emergency Exit?	Number of Parcels
		North St	No	7
	BER-E027	Eunice St	No	1
	BER-E028	Private Drive Off of Arch St	No	4
		Spring Way	No	10
	BER-E029	Codornices Rd	No	8
		El Portal Ct	No	5
		Northgate Ave	No	14
		Ross St	No	3
	BER-E030	Columbia Cir	No	8
		Private Dr Off of Fairlawn Dr	No	5
	BER-E031	Ajax Pl	No	11
		Grizzly Peak Blvd	No	3
		Hill Rd	No	16
		Olympus Ave	No	6
		Private Driveway Off of Summit Rd	No	4
		Summit Rd	No	21
	BER-E032	Buena Vista Way	No	25
		Campus Dr	No	22
		Cedar St	No	1
		Harvard Cir	No	5
		Maybeck Twin Dr	No	19
		Olympus Ave	No	8
		Parnassus Ct	No	12
	BER-E033	Greenwood Commons	No	4
		Hill Ct	No	10
		Ross St	No	2
	BER-E036	Francisco St	No	14
		Lincoln St	No	15
		Short St	No	24
		Virginia Gardens	No	13
		West St	No	2
	BER-E037	Berkeley Way	Yes	17
		California St	No	5
		Delaware St	No	9
		Grant St	No	8
		Grant St	Yes	10
		Mc Gee Ave	No	5
	BER-E038	Bonita Ave	Yes	5
	BER-E040	Cedar St	No	2
		Higard Ave	No	9

Priority	Evacuation Zone	Neighborhood	Potential Emergency Exit?	Number of Parcels
		La Vereda Rd	No	7
		Le Conte Ave	No	6
		Leroy Ave	No	4
		Virginia St	No	3
	BER-E046	Acroft Court	No	11
		Action Circle	No	20
		Noth Valley St	No	14
		West St	No	4
	BER-E047	8Th St	No	10
	BER-E051	Poe St	No	5
		Valley St	No	30
	BER-E053	Milvia St	Yes	5
	BER-E058	Arden Rd	No	14
		Canyon Rd	No	8
		Dwight Way	No	2
		Fernwald Rd	No	6
		Hillside Ct	No	7
		Mosswood Ln	No	3
		Mosswood Rd	No	14
		Panoramic Place	No	3
		Panoramic Way	No	63
		Private Drive Off of Panoramic Way	No	4
	BER-E062	Burnett St	Yes	36
		Russell St	No	10
		Sojourner Truth Way	No	3
	BER-E063	Grant St	No	2
		Russell St	Yes	10
	BER-E064	Deakin St	Yes	15
		Ellsworth St	Yes	6
		Fulton St	Yes	16
	BER-E065	Russell St	No	6
	BER-E066	Garber St	No	4
		Tanglewood Rd	Yes	5
	BER-E067	Bateman St	No	16
		Colby St	No	3
		Dana St	Yes	5
		Regent St	No	10
		Webster St	No	6
	BER-E068	Woolsey St	Yes	11
	BER-E069	Fairview St	No	21

Priority	Evacuation Zone	Neighborhood	Potential Emergency Exit?	Number of Parcels
	BER-E070	63Rd St	Yes	24
		Harmon St	Yes	19
	BER-E072	Elmwood Ct	No	10
		Lewiston Ave	Yes	27
		Webster St	No	6
	BER-E073	Avalon Ave	No	12
		Claremont Blvd	Yes	10
		Garber St	No	28
		Kelsey St	Yes	14
		Palm Ct	No	6
		Stuart St	Yes	8
	BER-E078	El Camino Real	No	15
		Hillcrest Rd	No	6
		Oak Ridge Rd	No	31
		Private Drive Off of The Uplands	No	7
	OKL-E004	Tanglewood Rd	Yes	7
	OKL-E017	Eton Ct	No	6
		Mystic Ct	No	6
	OKL-E018	Brookside Ave	No	15
		Hillcrest Ct	No	8
		Roslyn Ct	No	7
	OKL-E019	Roble Ct	No	7
Total Primary AIN		**141**	**Total Primary AIN Parcels**	**1,461**
Secondary	**BER-E001**	Capistrano Ave	N/A	42
		Colusa Ave		2
		Vincente Ave		22
		San Lorenzo Ave		25
		Tacoma Ave		34
		Ensenada Ave		15
		Miramar Ave		1
		Solano Ave		1
	BER-E002	Arlington Ave		5
		Capistrano Ave		6
		Contra Costa Ave		70
		Mendocino Ave		35
		San Antonio Ave		29
		San Fernando Ave		16
		San Juan Ave		22
		San Ramon Ave		31
		Santa Clara Ave		24

Priority	Evacuation Zone	Neighborhood	Potential Emergency Exit?	Number of Parcels
		The Alameda		45
		Thousand Oaks Blvd		31
		Vallejo St		7
		Yosemite Rd		60
	BER-E003	Arlington Ave		3
		Avis Rd		10
		San Antonio Ave		22
		San Diego Rd		10
		San Luis Rd		21
		Somerset Pl		1
		Southampton Ave		29
	BER-E004	Arlington Ave		2
		Boynton Ave		54
		Florida Ave		8
		Montrose Rd		5
		Northampton Ave		27
		San Luis Rd		32
		Santa Barbara Rd		73
		Southampton Ave		7
		Spruce St		5
		Vermont Ave		1
	BER-E005	Colorado Ave		9
		Kentucky Ave		40
		Maryland Ave		15
		Michigan Ave		42
		Spruce St		2
		Vassar Ave		23
		Vermont Ave		40
		Rugby Ave		3
	BER-E006	Acacia Ave		3
		Alta Rd		7
		Cragmont Ave		36
		Creston Rd		1
		Euclid Ave		1
		Grizzly Peak Blvd		1
		Rosemont Ave		1
		Spruce St		2
		Vassar Ave		25
	BER-E007	Rochdale Way		1
		Rosemont Ave		6
		Sunset Ln		3

Priority	Evacuation Zone	Neighborhood	Potential Emergency Exit?	Number of Parcels
		Vistamont Ave		21
		Woodmont Ave		51
	BER-E008	Bonnie Ln		22
		Creston Rd		52
		Grizzly Peak Blvd		3
		Hilldale Ave		58
		Keeler Ave		46
		Marin Ave		6
		Poplar St		10
		Rosemont Ave		1
		Sunset Ln		1
	BER-E009	Acacia Ave		7
		Alamo Ave		24
		Cragmont Ave		79
		Euclid Ave		1
		Halkin Ln		6
		Marin Ave		1
		Poplar St		10
		Regal Rd		18
		Rock Ln		25
		Spruce St		4
	BER-E010	Indian Rock Ave		4
		Marin Ave		17
		Montrose Rd		8
		Oxford St		32
		San Diego Rd		16
		San Luis Rd		27
		San Mateo Rd		1
		Santa Barbara Rd		37
		Shattuck Ave		17
		Spruce St		1
	BER-E011	Capistrano Ave		31
		Colusa Ave		3
		Menlo Pl		26
		San Miguel Ave		12
		Santa Rosa Ave		47
		The Alameda		45
		Thousand Oaks Blvd		19
		Vincente Ave		67
		Visalia Ave		18
		San Lorenzo Ave		25

Priority	Evacuation Zone	Neighborhood	Potential Emergency Exit?	Number of Parcels
		San Pedro Ave		30
		Tacoma Ave		32
	BER-E015	Creston Rd		58
		Forest Ln		29
		Grizzly Peak Blvd		5
		Hilldale Ave		36
		Keeler Ave		37
		Latham Ln		2
		Marin Ave		7
		Miller Ave		30
		Poppy Ln		15
		Regal Rd		26
		Sunset Ln		2
	BER-E016	Hillview Rd		19
		Latham Ln		2
		Middlefield Rd		25
		Muir Way		1
		Overlook Rd		31
		Park Gate		1
		Park Hills Rd		53
		Shasta Rd		4
		Sunset Ln		3
		The Crescent		18
		The Crossways		2
		The Shortcut		1
		Wildcat Canyon Rd		4
		Woodhaven Rd		19
		Woodside Rd		27
	BER-E017	Creston Rd		21
		Grizzly Peak Blvd		7
		Keeler Ave		32
		Latham Ln		5
		Miller Ave		47
		Muir Way		3
		Private Drive Off of Whitaker Ave		3
		Shasta Rd		11
		Sterline Ave		52
		Sterling Ave		3
		Stevenson Ave		8
		Twain Ave		5

Priority	Evacuation Zone	Neighborhood	Potential Emergency Exit?	Number of Parcels
		Whitaker Ave		7
	BER-E018	Bret Harte Rd		19
		Cragmont Ave		70
		Euclid Ave		22
		Keeler Ave		21
		Keith Ave		64
		Shasta Rd		8
		Tamalpais Rd		2
	BER-E019	Cragmont Ave		56
		Euclid Ave		37
		Keith Ave		47
		Marin Ave		6
		Regal Rd		15
		Santa Barbara Rd		14
		Spruce St		3
	BER-E020	Del Norte St		17
		Marin Ave		8
		Oxford St		44
		San Benito Rd		23
		Santa Barbara Rd		2
		Shattuck Ave		30
		Spruce St		3
	BER-E029	Campus Dr		6
		Euclid Ave		10
		Le Roy Ave		6
		Northgate Ave		14
		Rose St		2
		Shasta Rd		53
		Tamalpais Rd		43
	BER-E030	Campus Dr		27
		Queens Rd		21
		Shasta Rd		7
	BER-E031	Avenida Dr		17
		Hill Rd		1
	BER-E032	Buena Vista Way		39
		Campus Dr		1
		Cedar St		1
		Del Mar Ave		14
		La Vereda Rd		12
		Olympus Ave		26
		Parnassus Rd		19

Priority	Evacuation Zone	Neighborhood	Potential Emergency Exit?	Number of Parcels
		Queens Rd		1
	BER-E033	Buena Vista Way		14
		Greenwood Terrace		3
		Le Roy Ave		24
	BER-E040	Hilgard Ave		2
		La Vereda Rd		10
		Le Loma Ave		2
		Virginia St		4
	BER-E058	Hillside Ave		3
	BER-E067	Bateman St		3
	OKL-E008	Alvarado Rd		14
	OKL-E009	Alvarado Rd		5
	OKL-E010	Vicente Rd		22
	OKL-E015	Vicente Rd		3
	OKL-E018	Hillcrest Rd		31
Total Secondary AIN		**195**	**Total Secondary AIN Parcels**	**3,687**

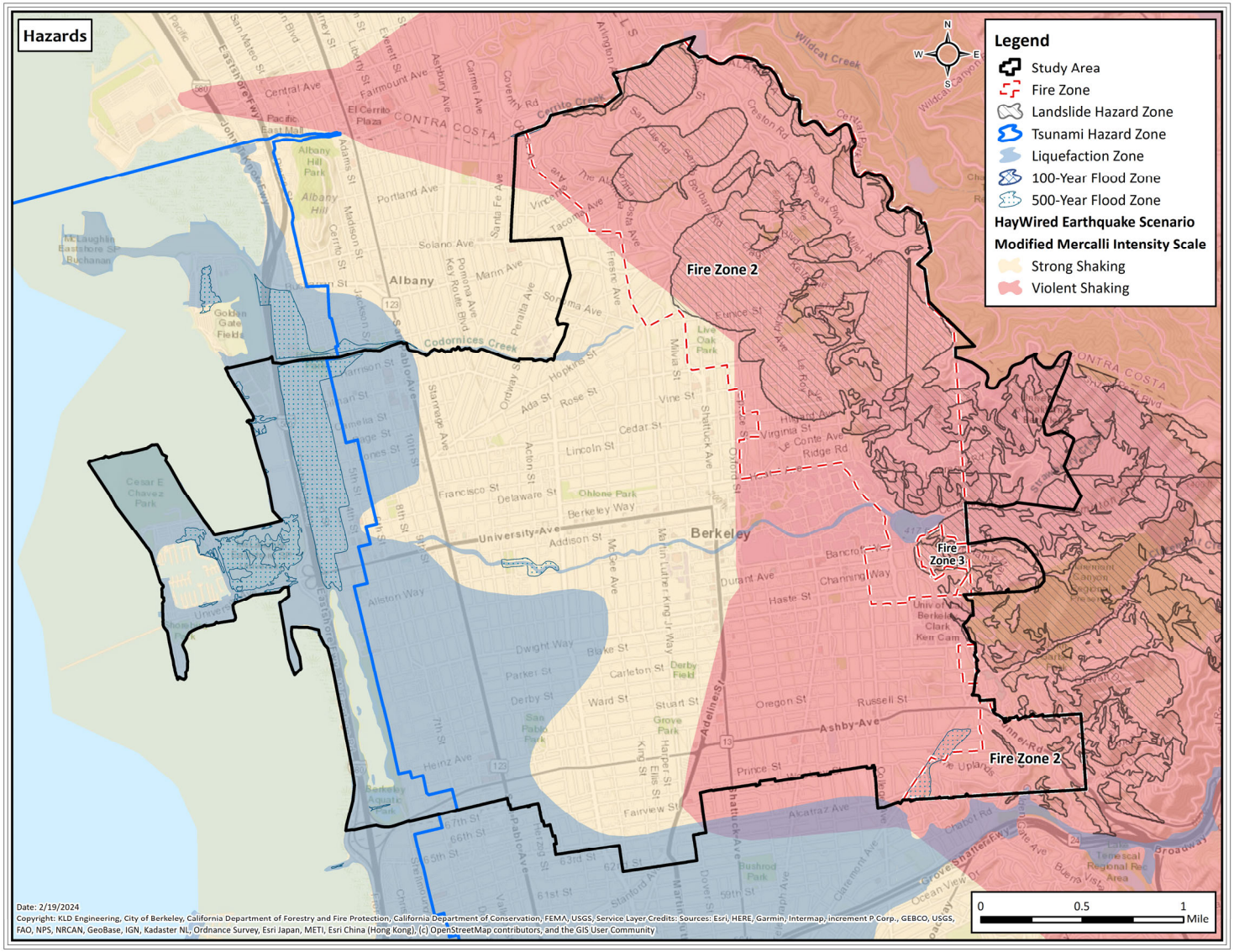


Figure 1. Hazards affecting the City of Berkeley

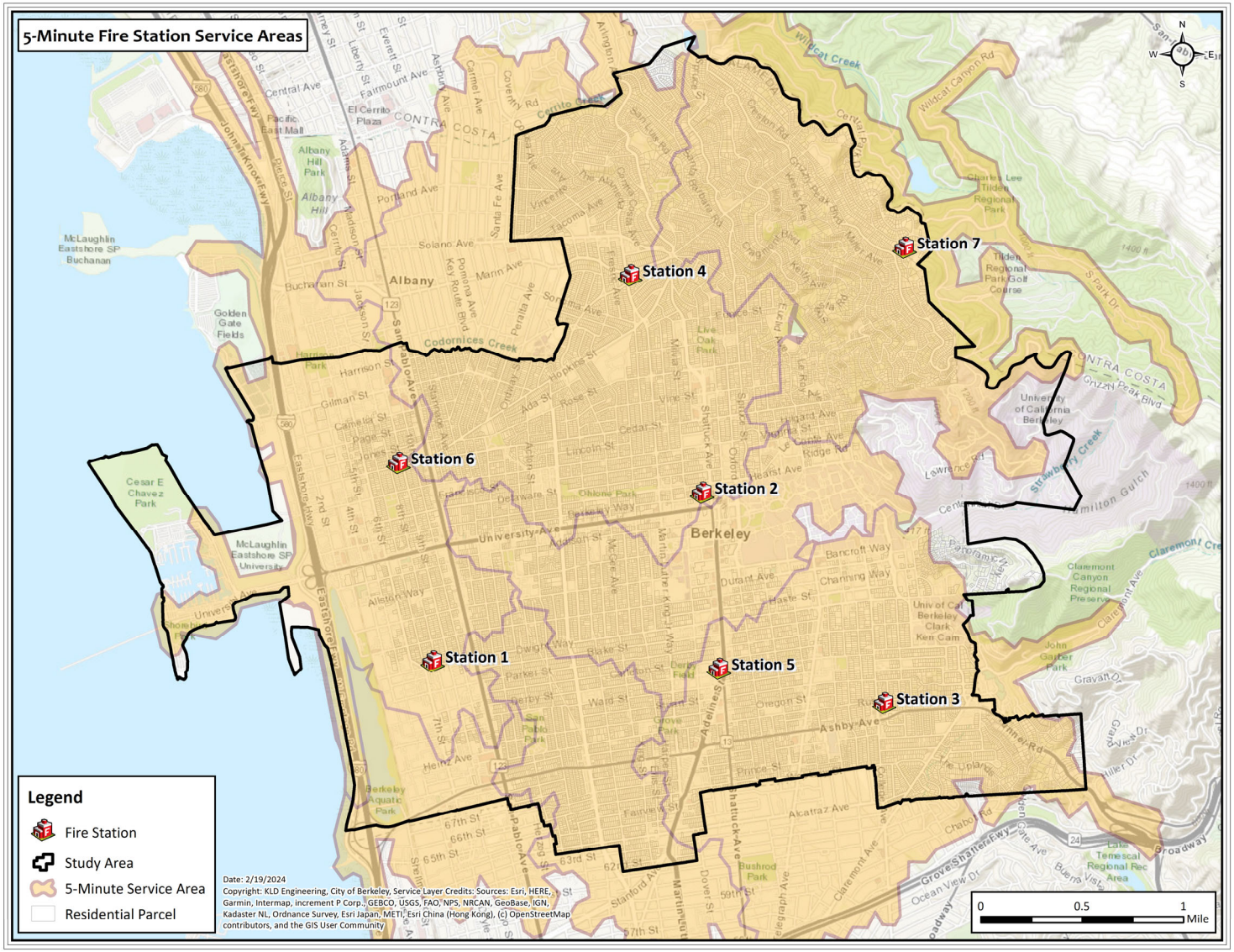
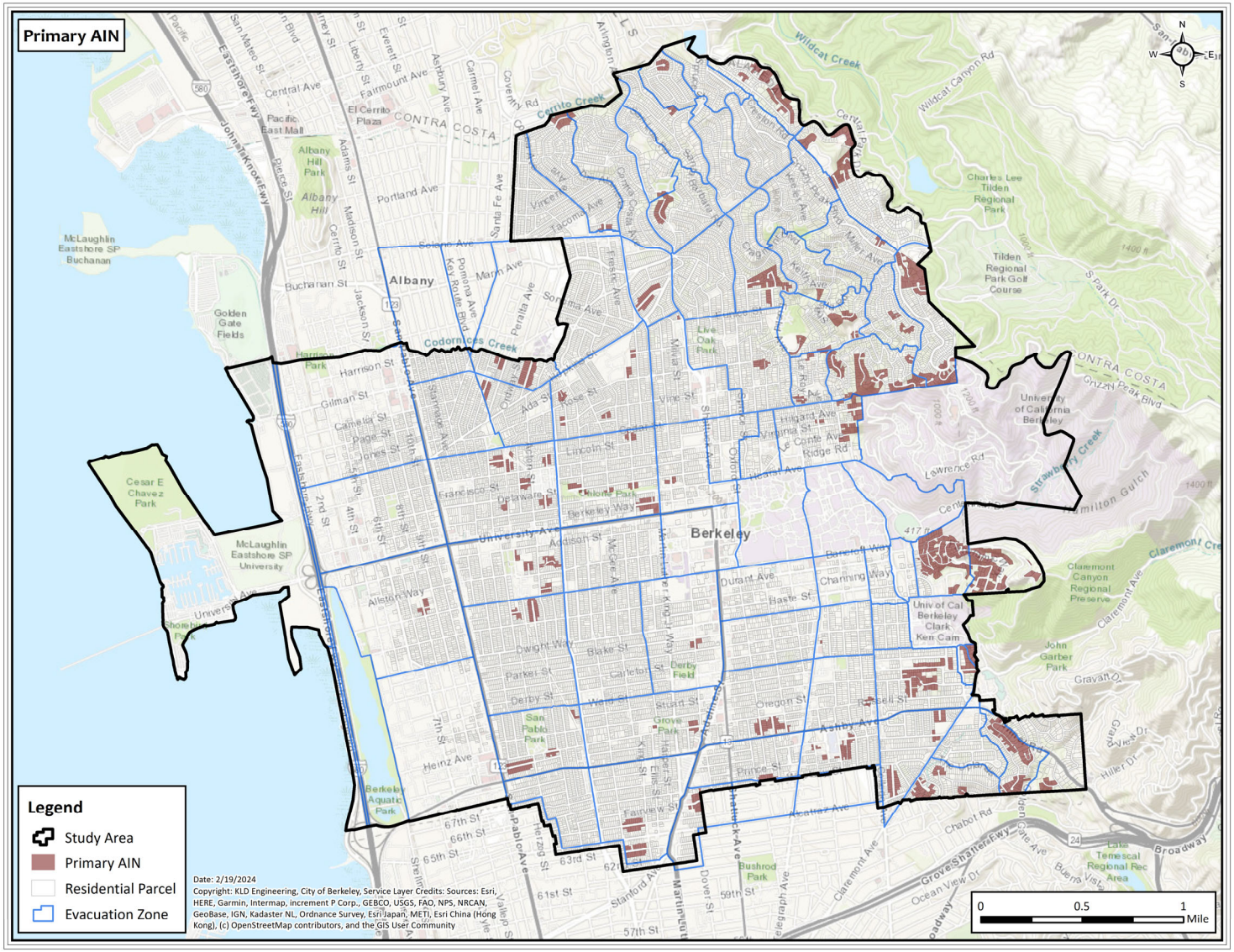


Figure 2. Fire Station Service Area


Primary AIN
Legend
Study Area
Primary AIN
Residential Parcel
Evacuation Zone
Date: 2/19/2024
Copyright: KLD Engineering, City of Berkeley, Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community
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Mile
Albany
Berkeley
CONTRA COSTA
Wildcat Creek
Cerrito Creek
Codornices Creek
Strawberry Creek
Hamilton Gulch
Tilden Regional Park Golf Course
Charles Lee Tilden Regional Park
University of California Berkeley
Claremont Canyon Regional Preserve
John Garber Park
Lake Temescal Regional Rec Area
Bushrod Park
Live Oak Park
Harrison Park
San Pablo Park
Grove Park
Berkeley Aquatic Park
Cesar E Chavez Park
McLaughlin Eastshore SP University
McLaughlin Eastshore SP Buchanan
Golden Gate Fields
Albany Hill Park
Pacific East Mall
El Cerrito Plaza
Derby Field
Univ of Cal Berkeley Clark Kerr Cam
Eastshore Fwy
Johnson Knowland Fwy
Grove Shafter Fwy
Ashby Ave
University Ave
Central Ave
Portland Ave
Bucharan St
Harrison St
Gilman St
Francisco St
Lincoln St
Virginia St
Hearst Ave
Durant Ave
Channing Way
Haste St
Dwight Way
Parker St
Derby St
Stuart St
Oregon St
Prince St
Heinz Ave
Alston Way
Addison St
Berkeley Way
Ridge Rd
Lawrence Rd
Chabot Rd
Broadway
Claremont Ave
Fairmount Ave
Ashbury Ave
Carmel Ave
Santa Fe Ave
Solano Ave
Marin Ave
Pomona Ave
Peralta Ave
Adams St
Madison St
Cerrito St
Jackson St
Sacramento St
Shattuck Ave
Oxford St
Milvia St
Vine St
Rose St
Ada St
Camelia St
Page St
Jones St
Delaware St
Addison St
McGee Ave
Martin Luther King Jr Way
Sacramento St
Adeline St
Telegraph Ave
Hillegard Ave
Le Conte Ave
Keith Ave
Miller Ave
Vincente Ave
Tacoma Ave
Fresno Ave
Schoma Ave
Key Route Blvd
Ordway St
Yosemite Rd
Arlington Ave
Spruce St
Grizzly Peak Blvd
S Park Dr
Hiller Dr
Gravatt Dr
Buena Vista Ave
Ocean View Dr
Stanford Ave
Dover St
Martin Luther King Jr Way
Fairview St
Ellis St
Aileen St
Harper St
Colusa Ave
Indian Rock Ave
Arch St
Posen Ave
Rose St
Virginia St
Berkeley Way
Addison St
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Dwight Way
Parker St
Derby St
Stuart St
Oregon St
Prince St
Ashby Ave
Heinz Ave
Alston Way

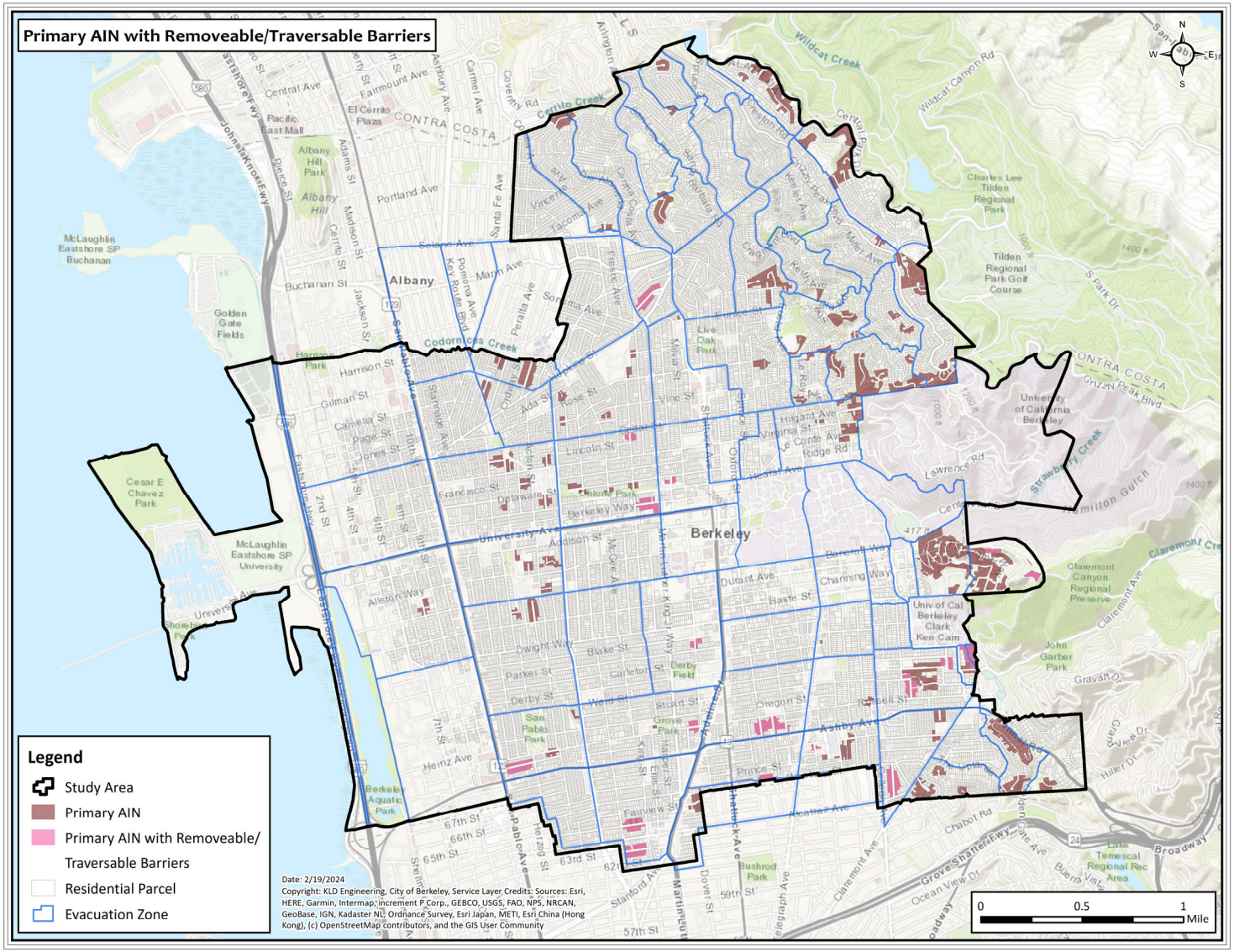
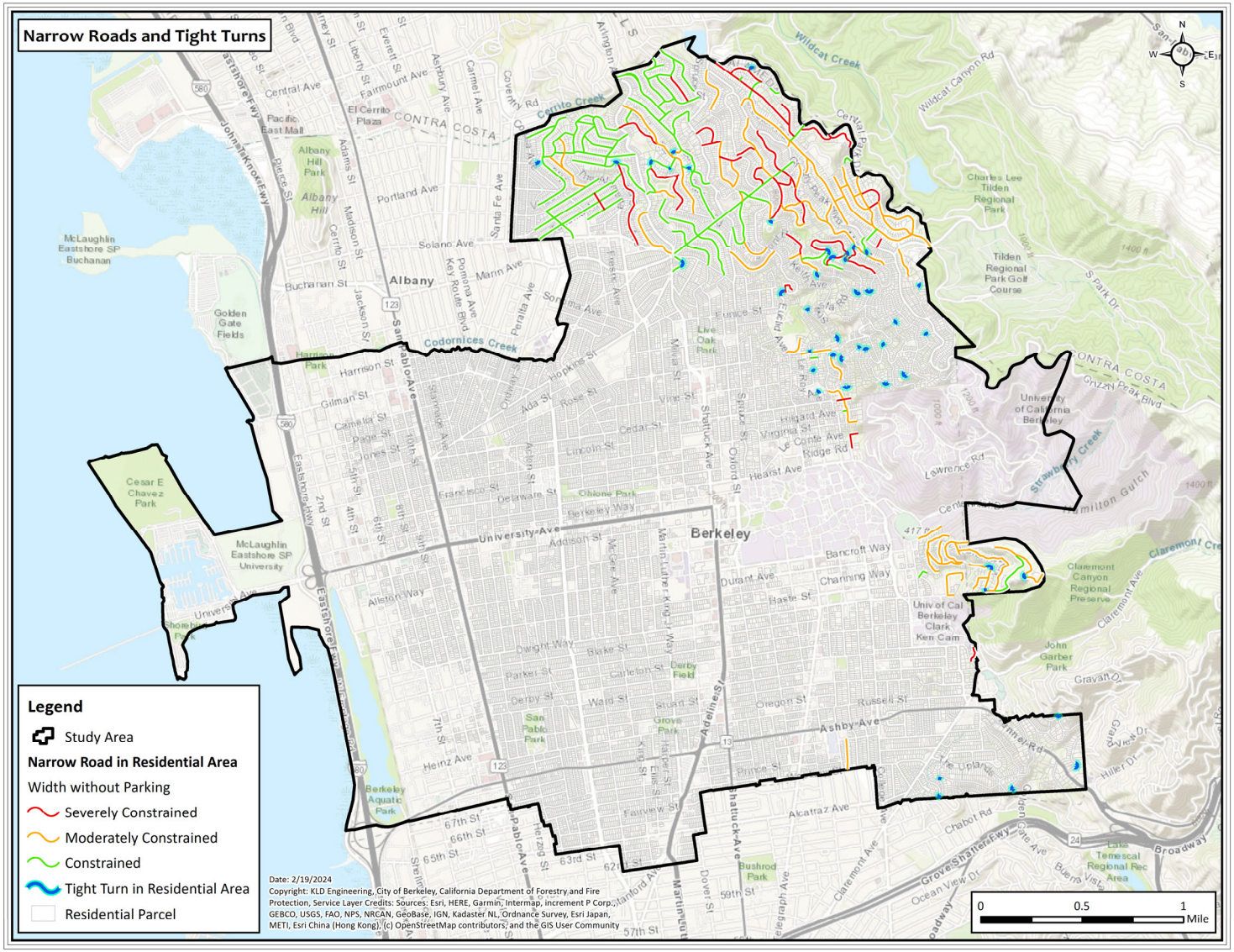

Primary AIN with Removeable/Traversable Barriers
Legend
Study Area
Primary AIN
Primary AIN with Removeable/ Traversable Barriers
Residential Parcel
Evacuation Zone
Date: 2/19/2024
Copyright: KLD Engineering, City of Berkeley, Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community
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Mile
Albany
Berkeley
CONTRA COSTA
Wildcat Creek
Codornices Creek
Strawberry Creek
Cesar E Chavez Park
McLaughlin Eastshore SP University
McLaughlin Eastshore SP Buchanan
Golden Gate Fields
Albany Hill Park
Harrison Park
San Pablo Park
Berkeley Aquatic Park
Live Oak Park
Grove Park
Derby Field
Bushrod Park
John Garber Park
Claremont Canyon Regional Preserve
Charles Lee Tilden Regional Park
Tilden Regional Park Golf Course
Lake Temescal Regional Rec Area
University of California Berkeley
Univ of Cal Berkeley Clark Kerr Cam
Eastshore Fwy
Johnson Knowland Fwy
Grove Shafter Fwy
Central Ave
Fairmount Ave
Portland Ave
Solano Ave
Marin Ave
Gilman St
Harrison St
Bancroft Way
Durant Ave
Haste St
Dwight Way
Ashby Ave
University Ave
Addison St
Lincoln St
Francisco St
Delaware St
Berkeley Way
Channing Way
Parker St
Derby St
Oregon St
Prince St
Heinz Ave
Alcatraz Ave
Chabot Rd
Ridge Rd
Lawrence Rd
Hilgard Ave
Le Conte Ave
Virginia St
Vine St
Rose St
Ada St
Hearst Ave
Cedar St
Gayley Rd
Arlington Ave
Cordonices Creek
Hamilton Gulch
Claremont Ave
Broadway
Stanford Ave
Martin Luther King Jr Way
Shattuck Ave
Telegraph Ave
Ocean View Dr
Buena Vista Ave
S Park Dr
Grizzly Peak Blvd
Wildcat Canyon Rd
Central Park Rd
Keith Ave
Miller Ave
Vincente Ave
Tacoma Ave
Santa Fe Ave
Peralta Ave
Pomona Ave
Key Route Blvd
Adams St
Madison St
Cerrito St
Jackson St
Pierce St
Buchanan St
Pacific East Mall
El Cerrito Plaza
Carmel Ave
Ashbury Ave
Covington Rd
Cerrito Creek
Arlington Blvd
Hillcrest Rd
Grizzly Peak Blvd
Euclid Ave
Spruce St
Panoramic Way
Piedmont Ave
Dana St
Bowditch St
College Ave
Fulton St
Dana St
Milvia St
Shattuck Ave
Oxford St
Walnut St
Martin Luther King Jr Way
Sacramento St
McGee Ave
Alston Way
Addison St
Durant Ave
Haste St
Dwight Way
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Parker St
Derby St
Carleton St
Stuart St
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Ellis St
Fairview St
Hearst Ave
Oregon St
Ashby Ave
Prince St
Alcatraz Ave
Chabot Rd
Claremont Ave
Broadway
Grove Shafter Fwy
Ocean View Dr
Buena Vista Ave
Lake Temescal Regional Rec Area
Hiller Dr
Grizzly Peak Blvd
S Park Dr



Figure 5. Curvature Radius Example


Narrow Roads and Tight Turns
Legend
Study Area
Narrow Road in Residential Area
Width without Parking
Severely Constrained
Moderately Constrained
Constrained
Tight Turn in Residential Area
Residential Parcel
Date: 2/19/2024
Copyright: KLD Engineering, City of Berkeley, California Department of Forestry and Fire Protection, Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community
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Mile
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Codornices Creek
Strawberry Creek
Claremont Creek
Hamilton Gulch
Charles Lee Tilden Regional Park
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Channing Way
Durant Ave
Haste St
Dwight Way
Ashby Ave
Alcatraz Ave
Hearst Ave
Lawrence Rd
Ridge Rd
Le Conte Ave
Virginia St
Cedar St
Lincoln St
Rose St
Ada St
Hopkins St
Gilman St
Camelia St
Page St
Jones St
Allston Way
Heinz Ave
Russell St
Oregon St
Prince St
Fairview St
Ward St
Parker St
Blake St
Carleton St
Derby St
Stuart St
Grizzly Peak Blvd
Wildcat Canyon Rd
Central Park Dr
S Park Dr
Keith Ave
Arlington Ave
Santa Fe Ave
Colusa Ave
Key Route Blvd
Pomona Ave
Peralta Ave
Monterey Ave
Ordway St
Spruce St
Oxford St
Shattuck Ave
Martin Luther King Jr Way
Adeline St
Sacramento St
Acton St
Delaware St
Francisco St
Addison St
Milvia St
Fresno Ave
Euclid Ave
Grizzly Peak Blvd
Claremont Ave
Broadway
Grove-Shafter Fwy
Eastshore Fwy
Johnson Knowland Fwy
Pierce St
Adams St
Madison St
Cerrito St
Jackson St
Sacramento St
Peralta Ave
Santa Fe Ave
Colusa Ave
Key Route Blvd
Pomona Ave
Marin Ave
Solano Ave
Portland Ave
Adams St
Fairmount Ave
Everett St
Liberty St
Ashbury Ave
Carmel Ave
Central Ave
Pacific East Mall
Albany Hill Park
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Cerrito St
Madison St
Jackson St
Buchanan St
Harrison St
Gilman St
Camelia St
Page St
Jones St
2nd St
4th St
6th St
8th St
9th St
10th St
Eastshore Hwy
Alcatraz Ave
Chabot Rd
Ocean View Dr
Buena Vista Ave
Hiller Dr
Claremont Ave
Dover St
Martin Luther King Jr Way
Shattuck Ave
Adeline St
Telegraph Ave
Sacramento St
Acton St
Delaware St
Francisco St
Chilone Park
Berkeley Way
Addison St
Milvia St
Fresno Ave
Euclid Ave
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Eastshore Fwy
Johnson Knowland Fwy
Pierce St
Adams St
Madison St
Cerrito

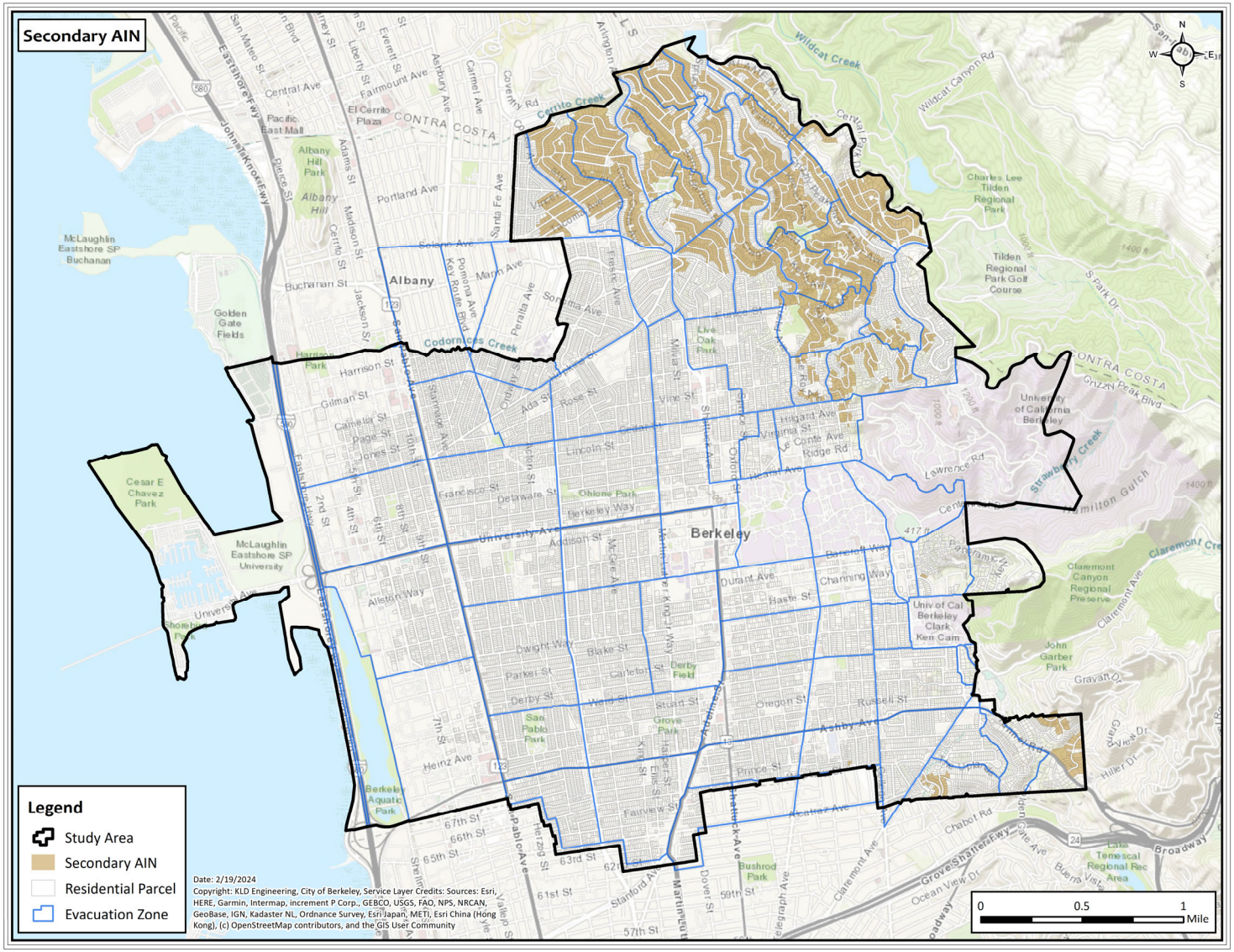


Figure 7. Secondary Access Impaired Neighborhoods

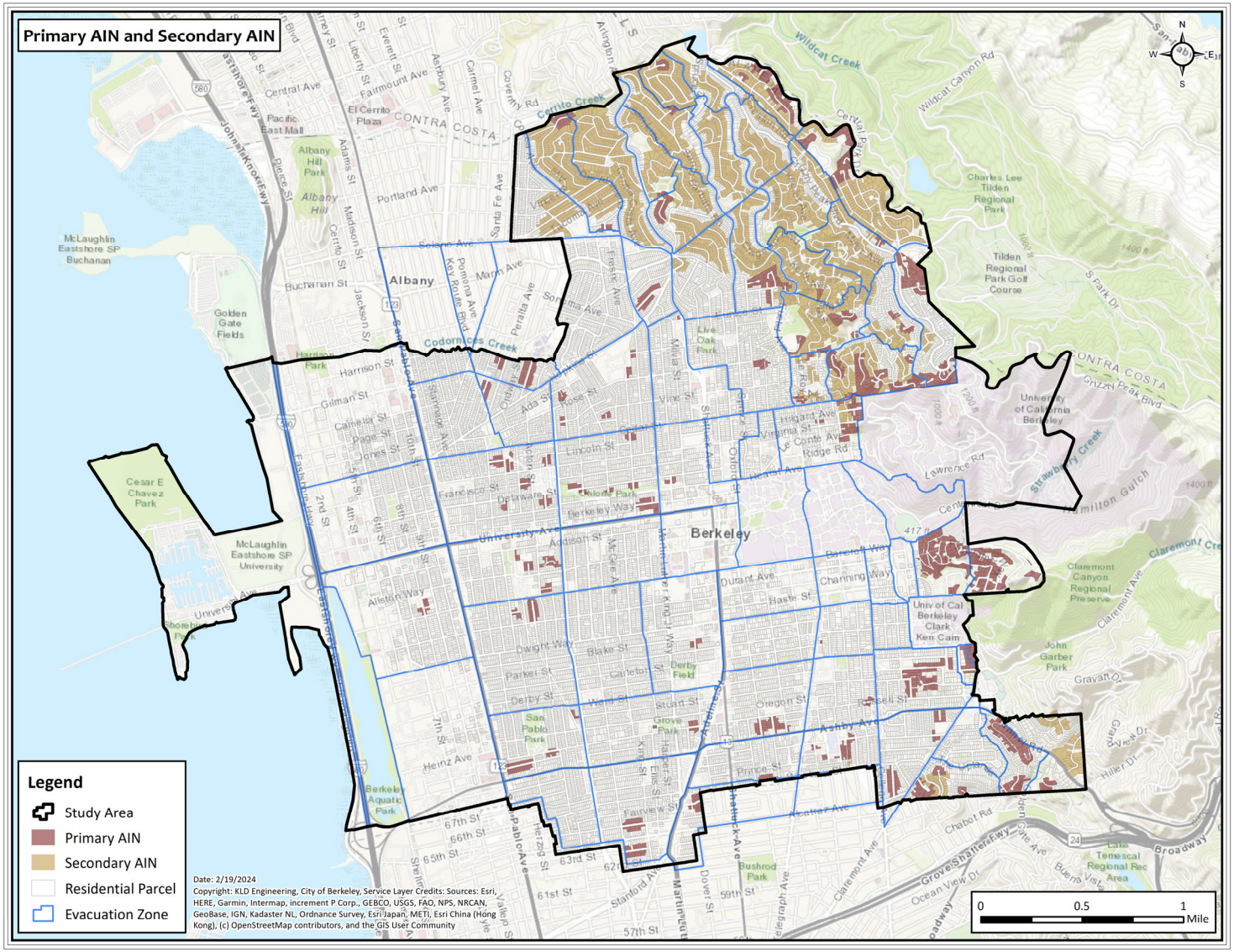


Figure 8. Primary and Secondary Access Impaired Neighborhoods

Appendix D

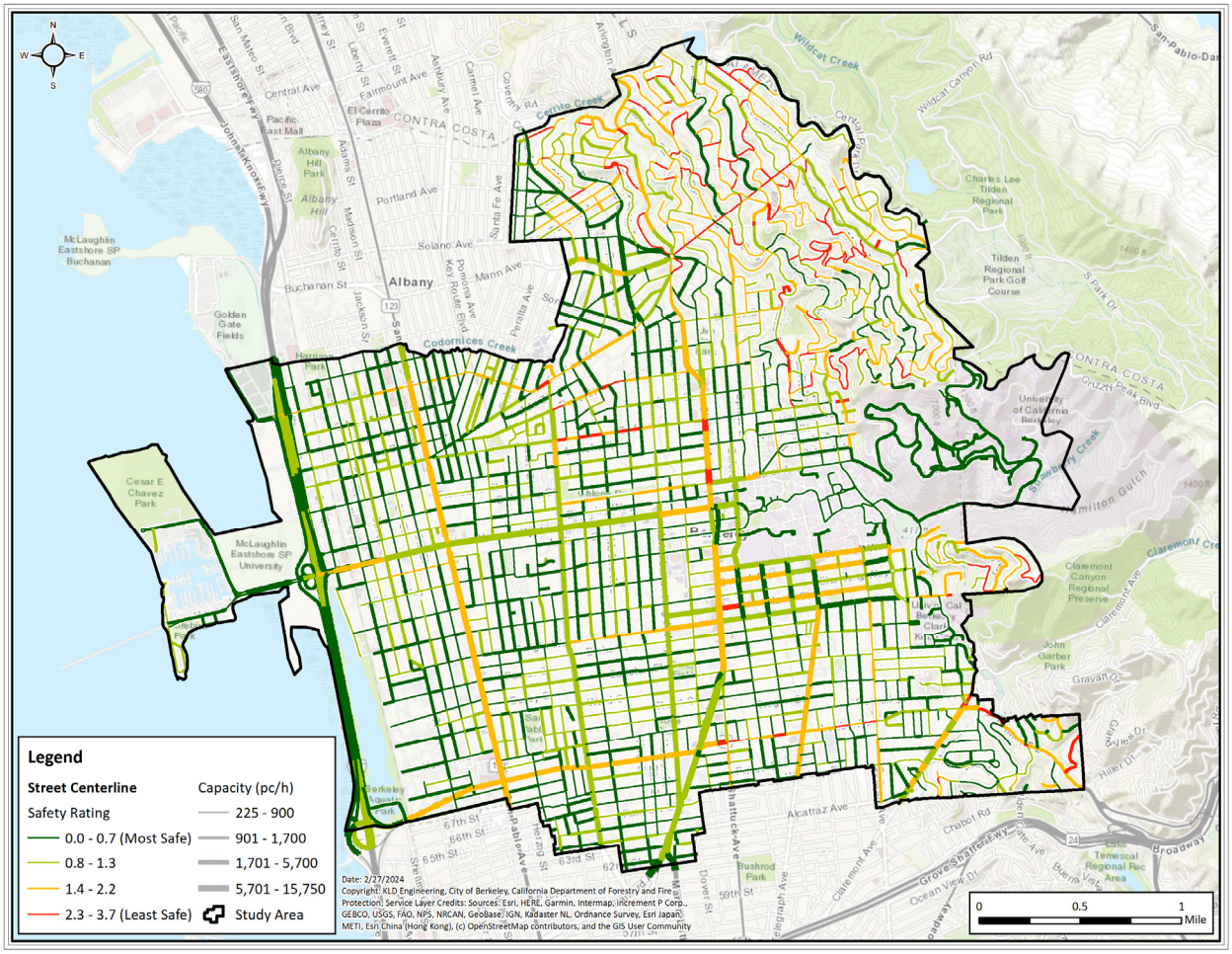
Evacuation Route Safety, Capacity, and Viability Analysis

KLD ENGINEERING, P.C.

City of Berkeley, California

Evacuation Route Safety, Capacity, and Viability Analysis

Assembly Bill 747 Requirement



Work performed for the City of Berkeley, by:

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Introduction

Section 65302.15 of Assembly Bill (AB) 747, dated October 9, 2019, states that the safety element, as described in subdivision (g) of Section 65302, shall "identify evacuation routes and their capacity, safety, and viability under a range of emergency scenarios".

The City of Berkeley has contracted KLD Engineering, P.C. to analyze the capacity, safety, and viability of the evacuation routes within the city limits. The results of the analysis will help the City of Berkeley identify which evacuation routes are safest, have the largest capacity, and are the most viable under a variety of circumstances, as well as identify which evacuation routes may underserve the evacuating population. This report describes the data, assumptions, analysis, and results of the safety, capacity, and viability of the roadways within the City of Berkeley.

Data Sources

- The city street centerline dataset was provided by the city and is used as the basis for this analysis.
- The following datasets were utilized to analyze the safety of each evacuation route:
    - Crash data from the City of Berkeley Vision Zero high collision corridors within the city.
    - The street centerline data was provided by the city and was used to identify dead ends, narrow roads, and winding roads. In addition, the dead-end data provided by the city and those obtained from the road survey were also considered in this analysis.
    - The Pavement Conditions Index (PCI) was utilized to determine pavement quality on the roadways within the city. This data was provided by the city. Roadways with missing PCI data were supplemented with aerial imagery using data from neighboring roadways with similar characteristics/pavement conditions.
    - The International Roughness Index[1] (IRI) data from the Federal Highway Administration[2] (FHWA) was used to determine pavement quality on I-80.
    - National bridge and tunnel inventory from the Bureau of Transportation Statistics (BTS). The inventory includes information on bridge/ tunnel location, structure condition, year of construction, average daily traffic, etc.
    - Federal Emergency Management Agency's (FEMA) 100-year and 500-year flood zones[3]. The 100-year and 500-year flood zones identify areas that have a 1% and 0.2% chance of flooding, respectively, in any given year.

[1] https://www.fhwa.dot.gov/policyinformation/pubs/hf/pl11028/chapter7.cfm#:~:text=The%20International%20Roughness%20Index%20(IRI,or%20very%20good%20ride%20quality
[2] https://geodata.bts.gov/datasets/highway-performance-monitoring-system-hpms-2020/about
[3] https://www.fema.gov/flood-maps

- California Department of Conservation[4] earthquake zones and the United States Geological Survey (USGS) HayWired Scenario[5]. This dataset includes areas that are at risk for seismic hazards which include the following risks:
  - deep-seated landslide susceptibility based on estimates of rock strength and steepness of slopes,
  - liquefaction,
  - surface fault rupture,
  - and ground shaking.
- California Department of Conservation tsunami zones[4]. This dataset includes all populated areas that are at risk of tsunamis.
- Fire Hazard Severity Zones (FHSZ) data obtained from the City of Berkeley. FHSZ are scored based on factors that influence fire likelihood and fire behavior. Fire Zones 2 and 3 were considered at-risk in this study.

- The following datasets were utilized to analyze the viability of each evacuation route:
  - Number and location of electric charging stations were obtained via PlugShare as referenced on the City's Electric Mobility website[6].
  - Google Places was utilized to determine the number and location of gas stations throughout the city.
  - Freeway ramps only exist within the city along I-80. The ramp locations are included in the street centerline data provided by the city.
- The following datasets were utilized to estimate the demand that would utilize each evacuation route:
  - The latest census tract data from the U.S. Census Bureau.
  - The permanent resident population is based on the 2020 U.S. Census population from the Census Bureau website extrapolated to April 2023 using annual growth rates that are computed from the 2022 Census population estimates.
  - Data from the U.S. Census Longitudinal Employer-Household Dynamics (LEHD) from the OnTheMap Census analysis tool is used to estimate the number of employees commuting into the city.
  - Data for Almeda County from the Highway Performance Monitoring System[7] (HMPS) 2020 was utilized to estimate the volumes on I-80 within the city limits.
  - Total enrollment at UC Berkeley from 2019 to 2020[8] was utilized to estimate the number of student vehicles that would evacuate from the campus.
- The following datasets were utilized to analyze the demographics[9] of the neighborhoods surrounding each evacuation route:

[4] https://maps.conservation.ca.gov/cgs/#datalist
[5] https://earthquake.usgs.gov/education/shakingsimulations/hayward/M7.0.php#
[6] https://berkeleyca.gov/city-services/getting-around/electric-mobility
[7] https://geodata.bts.gov/datasets/highway-performance-monitoring-system-hpms-2020/about
[8] https://opa.berkeley.edu/campus-data/common-data-set
[9] The population demographics along each evacuation route can predict additional risks to people living along the route. For example, people living along evacuation routes in areas with higher rates of poverty may be at a higher risk than people living along evacuation routes in areas with lower rates of poverty due to the resources that are available to higher income people.

- ESRI's ACS poverty status variables by census tract[10]. This dataset estimates the percentage of population with income lower than the federal poverty level at census tract level. The data is provided by the U.S. Census Bureau's ACS 2017-2021 5-year estimates.
- ESRI's American Community Survey (ACS) vehicle availability variables by census tract[11]. This dataset shows the percentage of households without vehicles at census tract level. The data is provided by the U.S. Census Bureau's ACS 2017 – 2021 5-year estimates of household size by number of vehicles available.
- California Department of Transportation housing and transportation affordability index[12]. This dataset measures the percentage of income devoted to housing and transportation for the regional typical household at the census tract level.
- ESRI's ACS disability by type variables by census tract[13]. This dataset shows the percentage of the population with a disability at census tract level. The data is provided by the U.S. Census Bureau's ACS 2017-2021 5-year estimates of six different types of disability[14].

Assumptions

- Jenks Method of Natural Breaks[15] is used to develop the scaling factors, where applicable.
- Link centroids (midpoint) are used when applying factors of safety, demographics, and viability.
- For the analysis on pavement width (narrow roadways), the following assumptions were made:
  - Parking stalls are 8 feet wide. Using the city's curb data for parking information, pavement width was reduced by 8 feet to account for roadways with street parking (or 16 feet if parking is permitted on both sides of the road).
  - A minimum of 10 feet is necessary for large vehicles (delivery trucks, buses, etc.) to evacuate.
- For the viability analysis, the connectivity score is based on the following assumptions:
  - The centroid (geometric center) of each Census block group was utilized as the representative trip origin.
  - Shortest path chosen from each centroid to each exit leaving the city along a major evacuation route. (Some examples of exits leaving the city along a major

[10] https://www.arcgis.com/home/item.html?id=0e468b75bca545ee8dc4b039cbb5aff6
[11] https://www.arcgis.com/home/item.html?id=9a9e43ec1603446880c50d4ed1df2207
[12] https://caltrans-gis.dot.ca.gov/arcgis/rest/services/CHhqcore/Economic_Opportunity/FeatureServer/0
[13] https://livingatlas-dcdev.opendata.arcgis.com/maps/esri::acs-disability-by-type-variables-boundaries/about
[14] The following disabilities are included: hearing, vision, cognitive, ambulatory, self-care, and independent living difficulties.
[15] The Natural Breaks (Jenks) identify class breaks as groups with similar values and maximize differences between classes. https://pro.arcgis.com/en/pro-app/latest/help/mapping/layer-properties/data-classification-methods.htm

evacuation route are I-80 eastbound at exit 13A/Buchanan Street and I-80 westbound at the junction with SR 13/Ashby Avenue.)

- For the viability analysis, the following assumptions were utilized to estimate the vehicular demand on a link:
  - The 2020 Census data, extrapolated to 2023, and 2020 employee estimates from OnTheMap, as well as 5-year ACS aggregate number of vehicles by block group, are used to determine the number of vehicles that are likely to use a given roadway segment.
  - Tourist vehicles are not included.
  - Employee and commuting student vehicle occupancies are assumed to be 1 employee per vehicle.
  - Public transit was not considered.
  - It was assumed that on campus students are included in the census data.
  - It was conservatively assumed that off campus students live within the City of Berkeley.
  - No reduction in commuters is considered for remote work and learning.

Analysis

Safety

There are several considerations when determining how safe a roadway is. For example, crash history can be a good indication of how well a roadway was designed. If an intersection is prone to side-impact collisions, it could be an indication of poor sight distance and, therefore, an unsafe roadway. Narrow and/or winding roadways were also considered a safety risk. These roadways can significantly impede evacuation since drivers often need to slow down to safely traverse these sections of roadway.

The safety factors were utilized to determine the overall safety of the evacuation routes within the city. Table 1 shows the safety factors, their associated scaling system (using Jenk's Law of Natural Breaks where appropriate), the weight applied (if any), and the description of each factor that was utilized in this study. Scales that ranged beyond 1 were normalized to fall between 0 and 1. **The higher the safety rating, the more unsafe a roadway segment is.** An overall safety rating was computed by summing each safety factor (multiplied by its weight, if applicable).

Figure 1 through Figure 6 show the various factors that were applied for the safety analysis and the results that were obtained.

Hazards

In addition to the roadway characteristics, roadways can be more or less unsafe than other roadways under different circumstances. For example, in rainy weather, a roadway that is in an area with a high landslide probability is likely to be more unsafe than a roadway in an area with low landslide probability. It should be noted that even if a route is exposed to one or more hazards, it may still need to be used to evacuate areas of the city. As such, the hazard factors are presented separately from the safety factors and were excluded in the overall safety rating.

Table 1 also presents the hazard factors, their associated scaling system (using Jenk's Law of Natural Breaks where appropriate), the weight applied (if any), and the description of each factor that was utilized in this study. Figure 7 through Figure 11 show the various factors that were applied for the hazard analysis and the results that were obtained.

Capacity

The ability of the road network to service vehicle demand is a major factor in determining how rapidly an evacuation can be completed. The capacity of a road is defined as the maximum hourly rate at which persons or vehicles can reasonably be expected to traverse a point or uniform section of a lane of roadway during a given time period under prevailing roadway, traffic and control conditions, as stated in the 2022 Highway Capacity Manual (HCM). This section discusses how the capacity of the roadway network was estimated.

For the purposes of this analysis, capacity is estimated along sections of roadway, rather than at intersections or ramp junctions. The capacity of roadway sections[16] is a function of roadway geometrics (e.g. number of lanes, grade, etc.), traffic composition (e.g., percent heavy trucks and buses in the traffic stream) and, of course, motorist behavior. The source material for the capacity estimates presented herein is contained in:

> 2022 Highway Capacity Manual (HCM)
> Transportation Research Board
> National Research Council
> Washington, D.C.

The evacuation route system in the city consists primarily of three categories of roads:

- Two-Lane roads: Local, State
- Multilane Highways/Roadways (at-grade)
- Freeways

Each of these classifications will be discussed. The roadway classifications, and resulting estimated capacities, are based on field observations, including number of lanes, collected during the road survey which was conducted in May 2023.

[16] This analysis is based on computed capacity alone and does not consider the time-varying demand impact on actual capacity.

Two-Lane Roads

Ref: HCM Chapter 15

Two lane roads (one lane in each direction) comprise the majority of roadways within the city. The per-lane capacity of a two-lane roadway is based on its speed. The speeds[17] and corresponding estimated roadway capacities for two lane roads are provided in Table 2. These estimates are essentially independent of the directional distribution of traffic volume. The HCM procedures then estimate LOS and Average Travel Speed.

Based on the field survey, aerial imagery, and on expected traffic operations associated with evacuation scenarios:

- Most sections of two-lane roads within the study area are classified as "Class I", with "level terrain"; some are "rolling terrain".
- "Class II" highways/roadways are mostly those within urban and suburban centers.

Multilane Roadways

Ref: HCM Chapter 12

Exhibit 12-8 of the HCM presents a set of curves that indicate a per-lane capacity ranging from approximately 1,900 to 2,300 pc/h, for free-speeds of 45 to 70 mph, respectively. Based on observation and estimation, the multilane roadways within the city service traffic with free-speeds in this range. Once again, for purposes of this analysis on multilane roadways, the actual time-varying speeds, the demand and capacity relationship, and the impact of control at intersections are ignored due to their dynamic nature. A conservative estimate of per-lane capacity of 1,900 pc/h is adopted for this study for multilane roadways within the city.

Freeways

Ref: HCM Chapters 10, 12, 13, 14

Chapter 12 of the HCM presents procedures for estimating capacity and LOS for "Basic Freeway Segments". Exhibit 12-37 of the HCM presents capacity vs. free speed estimates, which are provided below.

Free Speed (mph):	55	60	65	70+
Per-Lane Capacity (pc/h):	2,250	2,300	2,350	2,400

The inputs to the estimation of capacity are roadway geometrics and free-speeds. A conservative estimate of per-lane capacity of 2,250 pc/h is adopted for this study for freeways.

[17] Free flow speeds and number of lanes, as driven during the road survey in May 2023, were utilized to compute capacity. The impact of traffic control devices on free flow speeds is considered for two lane roadways within the City.

Chapter 13 of the HCM presents procedures for estimating capacity, speed, density and LOS for freeway weaving sections. Chapter 14 of the HCM presents procedures for estimating capacities of ramps and of "merge" areas. There are three significant factors to the determination of capacity of a ramp-freeway junction: The capacity of the freeway immediately downstream of an on-ramp or immediately upstream of an off-ramp; the capacity of the ramp roadway; and the maximum flow rate entering the ramp influence area. In most cases, the freeway capacity is the controlling factor. Values of this merge area capacity are presented in Exhibit 14-10 of the HCM and depend on the number of freeway lanes and on the freeway free speed. Ramp capacity is presented in Exhibit 14-12 and is a function of the ramp's free flow speed. Concepts in these chapters are utilized to estimate the capacity of freeway ramps within the city.

Viability

Viability is defined as the ability to function adequately. It is also defined as the ability to succeed or be sustained. As such, the viability of an evacuation route can be defined in several different ways. The following scores have been developed for this study to assess the viability of the roadways within the city. Table 3 presents each of the viability scores, their scales, and their descriptions.

Connectivity score: How well does a roadway connect you to an area of refuge or nearby city? Roadways that directly connect evacuees to places of safety are more *connected* and are considered more viable than roadways that do not. To determine how well connected each roadway is, ArcGIS's network analyst was utilized to find the shortest path from each trip origin (Census block centroid) to each trip destination (city exit along a major evacuation route). Once each route was computed from each origin (O) to each destination (D), the routes were spatially joined with each roadway link to determine the total number of origin-destination paths that traversed each segment. Roadway segments with more paths are more connected, and more viable, than roadway segments with less paths.

Accessibility score: How accessible is a roadway to evacuees? A freeway usually has a very high capacity and great connectivity, but if the ramps that give access to the freeway are 10 miles apart, it may not be the most viable evacuation route. For this reason, the number of connections, or intersections/ramp junctions, was considered in the accessibility score. To determine the number of connections or intersections for each route, the number of other links (roadway segments) that are connected to each link was computed. Nodes were created at the intersections of links. A spatial join was done to count the number of links that connect each node. Finally, a spatial join was conducted to assign the total number of connected links from connected nodes to their corresponding links. In addition, aerial imagery was used to verify the link and node connection. For ramps, if a roadway is a ramp or has a ramp connection, it was assigned a value of 5 for appropriate weight in the accessibility score. The accessibility score is the sum of the number of ramps and the number of connected links. The more intersections/connections/ramps a roadway has, the higher the accessibility score and the more viable the roadway is considered.

Service score: Does the roadway have the necessary commodities or services to sustain evacuees, like gas stations and/or electric charging stations? Roadways that have these types of commodities facilitate evacuation and, therefore, are more viable evacuation routes than roadways that do not have these types of commodities.

ArcGIS's network analyst was utilized to determine how far a roadway was from a service (gas or charging) station. For example, a roadway with a gas station score of 2 and a charging station score of 4 is a 2 minute drive from the nearest gas station and a 4 minute drive from the nearest charging station. The service rating is the sum of these two values.

Congestion score: A good way to measure the viability of an evacuation route is to determine if the population demand (residents, employees, students, and pass through traffic) that is expected to utilize the route will exceed the estimated capacity. For example, can the route service the demand in an evacuation, or will it operate below capacity and have bottlenecks and operational constraints?

The best way to answer these questions is with a traffic simulation model that uses algorithms to simulate real traffic behavior under a variety of circumstances. Currently, the City of Berkeley is conducting an evacuation time estimate (ETE) study to compute how long it would take to evacuate the city under different temporal and spatial conditions. This study utilizes a traffic simulation model. As part of this work effort, the congestion during evacuation conditions along each evacuation route can be assessed. This project is still ongoing, and as a result, the results of the project cannot be utilized to assess the congestion score, or viability, of the evacuation routes within the city at this time.

In the meantime, the evacuating vehicular demand can be estimated based on trip origins and this demand can be compared to the capacity[18] of the roadway segments within the vicinity of each origin.

The evacuating vehicular demand for each route was computed from Census data (population data extrapolated to 2023 and employment data from LEHD) in the proximity of the route. Resident and employee datapoints (converted to vehicles using assumed occupancies) within a quarter mile buffer of the roadway segment were assigned to each roadway segment as the vehicular demand to be serviced. In addition, pass through traffic along I-80 was estimated from annual average daily traffic counts collected by the US Department of Transportation along I-80.

This demand can fluctuate depending on the time of year, day of week, and time of day. For this reason, a minimum and maximum demand was estimated using scenario percentages for varying temporal conditions. For example, employees within the city peak between 9am and 5pm on weekdays and only about 10% of employees may be present on weekends and in the evening. It should be noted that the minimum demand represents when UC Berkeley is not in session; the maximum demand represents when UC Berkeley is in session.

[18] As computed in the *Capacity* section of this report.

Since vehicles will load onto the roadway network over time, rather than all at once, the mobilization distribution[19] was computed from an online demographic survey of residents and employees/commuting students within the City of Berkeley. Figure 12 shows the mobilization curve that was utilized. The maximum demand (volume) was computed for each roadway segment based on the highest hourly mobilization percentage (57% for residents [between 45 minutes and 1 hour and 45 minutes after the order to evacuate] and 100% for employees and commuting students [in the first hour]).

The volume was then divided by the total roadway capacity to compute the volume-to-capacity (v/c) ratio for each roadway segment. The v/c ratio was utilized as the congestion score for the maximum and minimum demand, the higher the congestion score, the lower the viability.

Vulnerability

Although not specifically a roadway safety, capacity or viability consideration, the demographics of the neighborhoods that surround the roadway could be indicative of areas that are more vulnerable and may face challenges when evacuating. For example, areas with less vehicle availability are likely to require public transit and may face more challenges than those areas with enough vehicles to sufficiently evacuate the household in a personal vehicle. These factors were considered separately from the safety, capacity or viability factors but were included in this analysis for a complete picture. The vulnerability factors and their scaling system (using Jenk's Law of Natural Breaks where appropriate), the weight applied (if any), and their description are included in Table 4. **The higher the vulnerability rating, the greater vulnerability of the population living along a roadway segment.** An overall vulnerability rating was computed by summing each factor (multiplied by its weight, if applicable).

through show the various factors that were applied for the vulnerability analysis and the results that were obtained.

Results

Appendix A provides a summary (sorted by street name[20]) of the average[21] overall safety rating, capacity, viability score and vulnerability rating by roadway name. Each of the various components and factors that were utilized to compute the safety, capacity, and viability of each roadway segment, as well as the overall safety, capacity, and viability scores of each roadway segment, were provided to the City in electronic format.

While the safety, capacity, viability, and vulnerability varies somewhat within individual street segments on a particular roadway, the following evacuation routes have the highest capacity, are relatively safe, and are the most viable across the entire length of the roadway, see Figure 17:

- University Ave

[19] The notification distribution was assumed over a 30-minute period due to the presence of wireless emergency alerts within the city and based on survey responses.
[20] The City's naming conventions within the centerline dataset were adopted with minimal changes.
[21] Each value shown is the average of all roadway segments that share that street name.

- Adeline St
- Ashby Ave (SR13)
- Cedar St
- Interstate 80 (I-80)
- San Pablo Ave (SR 123)
- Sacramento St
- Claremont Ave
- Marin Ave

Safety

Each of the safety risk scores were summed (with specified weights, if necessary) to obtain an overall safety rating for each roadway segment. Those roadway segments that have the highest overall score are the most unsafe roadway segments. Those with lower scores are safer. Figure 18 shows the overall evacuation safety ratings for each of the roadway segments within the city. Jenk's Law of Natural Breaks was used to develop the 4 thresholds of overall safety. Those roadways with the highest safety score (2.3 - 3.7) are shown in red and represent the roadways with the highest exposure to traffic fatalities, narrowest width, tightest turns, steepest slopes, poorest pavement condition and/or are located above or below a bridge or tunnel. The least safe roadways are within the hills and along Panoramic Way. These roadways are extremely narrow, winding, and steep. Many of the roadways within the flats, including San Pablo Ave, have poor or very poor pavement conditions, giving them a higher *unsafe* rating. The safest roadways are Frontage Rd, University Ave, and Adeline St.

Hazards

Each of the hazard risk scores were summed (with specified weights, if necessary) to obtain an overall hazard rating for each roadway segment. Those roadway segments that have the highest overall score have the highest exposure to flooding, landslides, earthquakes, tsunamis, wildfires. Those with lower scores are less exposed. Figure 19 shows the overall hazard ratings for each of the roadway segments within the city. The safest roadways are in central Berkeley between San Pablo Ave and the foothills of the mountains, including Hopkins St, Shattuck Ave, Adeline St, as well as parts of Cedar St, University Ave, and Ashby Ave. Roadways west of San Pablo Ave are exposed to water related hazards like flooding and tsunamis. Roadways in the mountains are exposed to fires, landslides, and more severe ground shaking.

Capacity

Figure 20 shows the capacity of each roadway segment within the City of Berkeley based on the field observations collected in May 2023, including the number of moving lanes on each roadway. I-80 has the highest capacity, followed by multilane major arterials like San Pablo Ave, University Ave, Shattuck Ave/Adeline St, Sacramento St, Telegraph Ave, and Claremont Ave. The vast majority of roadways within the city are single-lane collectors with a free flow speed of 45mph or less and a capacity of approximately 1,700 passenger cars per hour or less. In the hills, free flow speeds are 20 mph or less and capacities are 900 passenger cars per hour or less.

Viability

Figure 21 displays the connectivity score for the roadways within the city. In the figure, thicker roadways provide more origin-destination connections than thinner roadways and are, therefore, more connected. The most connected roadways are Sacramento St, Ashby Ave (SR 13), Martin Luther King Jr Way, Monterey Ave, Piedmont Ave (in Oakland), and Marin Ave. University Ave, Dwight Way and Cedar St are very connected as well.

Figure 22 displays the results of the accessibility score. Most of the roadways between I-80 and San Pablo Ave, South Berkeley, parts of central and north Berkeley, and I-80 are very accessible. Berkeley Hills and the eastern part of the city are not very accessible since they have limited connections to major roadways and very limited connections to the east of the city due to the mountainous terrain. Some of the most accessible roadways are I-80, Marin Ave, Shattuck Ave/Adeline St, and University Ave.

Figure 23 displays the results of the service score. Roadways west of San Pablo Ave, in the vicinity of University Ave, and in the vicinity of Shattuck Ave and Adeline St have the highest scores due to the density of gas and electric charging stations along these roadways.

Figure 24 and Figure 25 display the congestion scores[22] (v/c) for the maximum and minimum estimated effective demand during an evacuation event (respectively) converted to Level-of-Service (LOS), which is a term used to describe the operating conditions of a roadway. The LOS shown in these figures is based on the Highway Capacity Manual (HCM) rounded to the nearest tenth. As shown in these figures, during an evacuation, many of the roadways within the city will operate at LOS F and experience significant congestion. In both cases, the major arterials, like San Pablo Ave (SR 123), Sacramento St, University Ave, Adeline St, Ashby Ave (SR13), and Claremont Ave can better service the evacuating demand than the smaller, local streets within the heart of the city. As such, these roadways are more viable evacuation routes. During the case with minimal demand, and less pass-through traffic on I-80 (at night, for example), I-80 becomes one of the most viable evacuation routes as shown in Figure 25.

Vulnerability

Each of the vulnerability risk scores were summed (with specified weights, if necessary) to obtain an overall vulnerability rating for each roadway segment. Those roadway segments that have the highest overall score are the areas that could potentially have the most difficulty and/or challenges evacuating. Those with lower scores are less likely to have difficulty and/or challenges evacuating. Figure 26 shows the overall vulnerability ratings for each of the roadway segments within the city. Jenk's Law of Natural Breaks was used to develop the 4 thresholds of overall vulnerability. Those roadways with the highest vulnerability score (2.8 – 3.8) are shown in red and represent the roadways that are within areas with the most poverty, the least amount of income spent on transportation, the lowest vehicle availability and the highest population with disabilities.

[22] It should be noted that this methodology treats the evacuation of the city in a vacuum ignoring possible, simultaneous evacuation in areas adjacent to the city.

Table 1. Safety and Hazard Factors

Factor	Scale	Description
Safety Factors		
Collisions	0 - No	The City of Berkeley Vision Zero collisions data was utilized to determine corridors with high collision rates. This data was spatially joined with the roadway segments to identify which roadways had the most, or any, collisions. Roadways with more collisions may be indicative of poor roadway design. Those roadways with high collision rates were assigned a value of 1; those corridors that did not have high collision rates were assigned a value of 0. See Figure 1.
	1 - Yes	
Pavement Width	0 – Not Constrained	The city centerline dataset was utilized to determine which roadways were narrow/constrained (with a travel lane of less than 10 feet wide[23]). Roadways that were considered not constrained (less than 10 feet wide) were assigned a value of 0. Those roadways which are considered constrained (meet or exceed 10 feet wide[24]) were assigned a value of 1. See Figure 2.
	1 – Constrained	
Curvature	0 – greater than or equaled to 81 feet	The curvature of the roadway was calculated based on its geometry. The radius of the circumscribed circle of three sequential points was computed and assigned to the midpoint of those three points. The roadway segment between two points was assigned the average of the two radii of the points in which it connects. A threshold of 81 feet[25] was selected as the minimum radius. See Figure 3.
	1 – less than 81 feet	
Slope	0.0 – 2.3	The slope of the roadway was also considered. Slopes are represented as a percentage (rise/run x 100). Roadways with steep slopes can be more dangerous than roadways with shallow slopes. As such, larger slopes were assigned a higher value than smaller slopes. A weight of 0.33 is applied to this factor to normalize the results between 0 and 1. See Figure 4.
	2.4 – 7.0	
	7.1 – 15.2	
	15.3 – 37.1	

[23] Based on discussions with staff from the City's Public Works and Fire Departments, a viable evacuation travel lane width of 10 feet was chosen to account for larger vehicles (8 feet wide) and sideview mirrors. It is assumed that even larger vehicles (10 feet wide) are operated by professional drivers with a higher degree of skill to reduce or eliminate driver error.
[24] Pavement width was utilized (with modifications made for side street parking). Eight feet of parking was removed from the pavement width for single side street parking and 16 feet was removed for street parking on both sides of the road. Eight feet was used since the typical width for a standard parking space is 8 feet. Although a width of 7.5 feet has been used to provide a balance among users, eight feet was used as vehicles are not always parked well, may not be parked in contact with the face of the curb or vegetation, and throughout the day, large vehicles may be parked on the side of the street. Overhanging vegetation was not accounted for.
[25] Table 3-7 of the 2018 AASHTO Policy on Geometric Design of Highways and Streets indicates the minimum radii for a curve with a design speed of 20mph is 81 feet. Based on the data collected during the road survey, the speed travelled on these curves was 20mph or less.

Factor	Scale	Description
Pavement Quality	0 – Very Good	Roadways with poor pavement quality can be more unsafe than roadways with good pavement quality. As such, the quality of the pavement was also considered in the safety analysis. Pavement quality was rated as unpaved, poor, fair/acceptable, and good. Unpaved and poorly rated roadways were rated higher than fair and good rated roadways. A weight of 0.33 is applied to this factor to normalize the results between 0 and 1. See Figure 5.
	1 - Good	
	2 - Poor	
	3 – Very Poor	
Bridges and Tunnels	0 - No	Bridges and tunnels are at risk of collapsing, making the roadways that traverse under or over them unsafe. The roadway segments that contained a bridge or tunnel were given a factor one 1. The remaining roadway segments were assigned a value of 0. Since all bridges (5) and tunnels (1) within the city are currently rated as 'fair', this factor was given a weight of 0.5. See Figure 6.
	1 - Yes	
Hazard Factors (excluded from overall safety rating)		
FEMA 100-Year and 500-Year Flood Hazard Areas	0 - not within a flood zone	The data depicts the FEMA 100-year and 500-year flood risk zones for Alameda County. The 100-year flood plain is the area with a 1% chance of flooding in any given year, while the 500-year flood plain is the area with a 0.2% chance of flooding in any given year. Roadways within a 100-year flood plain are at a higher risk, and are more unsafe, than roadways within a 500-year flood plain. It should be noted that none of the roadways within the city are within the 100-year flood zone. See Figure 7.
	0.2 - 500-year flood zone	
	1 - 100-year flood zone	
Landslide Hazard Areas	0 – 0.04 – Very low or none	The statewide landslide inventory shows many of the landslides mapped by CGS and others over the past 50 years. The database focuses on deep-seated landslides. Rock strength and slope are combined to create classes of landslide susceptibility. These classes express the generalization that on very low slopes, landslide susceptibility is low even in weak materials, and that landslide susceptibility increases with slope and in weaker rocks. Higher rates of landslide susceptibility include very steep slopes in hard rocks, and moderate to very steep slopes in weak rocks. Roadways with medium or high landslide susceptibility are less safe than roadways with low or very low (or no) landslide susceptibility. See Figure 8.
	0.05 – 0.12 - Low	
	0.13 – 0.22 - Medium	
	0.23 – 0.34 - High	

Factor	Scale	Description
Earthquake Hazard Risk	0.67 - Severe	HAZUS[26] results of an earthquake scenario on the Hayward Fault. These results include impacts due to ground shaking, landslide, and liquefaction. The results are measured in Modified Mercalli Intensity (MMI) which is composed of twelve levels that increase from imperceptible shaking to catastrophic destruction. The MMI rating is divided by 12 to scale the results from 0 to 1. The entire city falls either in severe (8) or violent (9) ground shaking. See Figure 9.
	0.75 - Violent	
Tsunami Hazard Areas	0 - No	The Tsunami hazard areas are developed for all populated areas at risk to tsunamis in California and represent a combination of the maximum considered tsunamis for each area. "No" indicates the roadway is not within a tsunami hazard area. "Yes" indicates the roadway is within a tsunami hazard area. See Figure 10.
	1 - Yes	
Fire Hazard Severity Zone	0 – Zone 1	FHSZ are scored based on factors that influence fire likelihood and fire behavior. Fire Zones 2 and 3 were considered at-risk in this study. Roadways that were not within Zones 2 or 3 are assigned a value of 0. Roadways within Zone 2 are assigned a value of 0.5 and those roadways within Zone 3 are assigned a value of 1. See Figure 11.
	0.5 – Zone 2	
	1 – Zone 3	

Table 2. Capacity for Two Lane Roads

Speed (mph)	Capacity (pc/h)
5	225
10	450
15	675
20	900
25	1,125
30	1,350
35	1,575
40+	1,700

[26] Hazards US software developed by the Federal Emergency Management Agency (FEMA).

Table 3. Viability Scores

Score	Scale	Description
Connectivity	1 - 187	Roadways that directly connect evacuees to places of safety are more connected and are considered more viable than roadways that do not. The scale of this score is based on the number of origin-destination connections that are made.
	188 – 519	
	520 – 1,023	
	1,024+	
Accessibility	0 - 3	The more intersections/connections/ramps a roadway has, the higher the accessibility score and the more viable the roadway is considered. Ramps were assigned a value of 5 for weighting purposes.
	4 - 5	
	6 - 7	
	8 - 11	
Service	2 - 4	Roadways that have gas stations and/or charging stations readily accessible help evacuees maintain their evacuation and, therefore, are more viable evacuation routes than roadways that do not have these types of commodities. The scores represent the sum of the driving time to the nearest gas station and charging station. Roadways that are furthest from a gas or charging station have a higher score and are less viable.
	5 - 8	
	9 - 12	
	13 - 17	
Congestion	LOS A (0 – 0.1)	The congestion score compares the demand (volume) against the capacity to see how the roadways will operate under evacuation conditions. This metric is called the v/c ratio. The Highway Capacity Manual provides an equivalent Level-of-Service (LOS) that ranges from A (free flow conditions) to F (bumper to bumper traffic) based on the characteristics of the roadway. This concept was used to develop general thresholds for the congestion score, rather than Jenk's Law of Natural Breaks.
	LOS B (0.1 – 0.2)	
	LOS C (0.2 – 0.4)	
	LOS D (0.4 – 0.6)	
	LOS E (0.6 – 0.95)	
	LOS F (0.95+)	

Table 4. Vulnerability Factors

Factor	Scale	Description
Poverty	Low (0.6% - 7.9%)	The poverty data estimates the percentage of population with income lower than the federal poverty level at the census tract level. The data is provided by the U.S. Census Bureau's American Community Survey (ACS) 2017-2021 5-year estimates. Areas with high percentages of poverty are more likely to have evacuation challenges and, therefore, have a higher vulnerability rating. See Figure 13.
	Medium (8.0% - 15.3%)	
	High (15.4% - 26.9%)	
	Very High (27.0% - 64.3%)	
Housing and Transportation Income	Low (0.0%)	The H+T income indicator measures the percentage of income devoted to housing plus (+) transportation for the regional typical household at the census tract level. The latest data (as of 2017) for this indicator were collected directly from the Housing and Transportation Costs (H+T) Index webpage. Areas with higher H+T have dedicated a higher percent of their income to housing and transportation and are not likely to have evacuation difficulties. As such, areas with low H+T percentages have a higher vulnerability rating. See Figure 14.
	Medium (0.1% - 45.0%)	
	High (45.1% - 58.0%)	
	Very High (58.1% - 76.0%)	
Vehicle Availability	Low (0.0% - 5.1%)	The data shows the percentage of households with no vehicles at the census tract level. The data is provided by the U.S. Census Bureau's ACS 2017-2021 5-year estimates of household size by number of vehicles available. These individuals are more likely to depend on public transit or need transportation assistance in an evacuation. As such, areas with high percentages of households with no vehicles are assigned a higher vulnerability rating than those with lower percentages. See Figure 15.
	Medium (5.2% - 14.0%)	
	High (14.1% - 25.5%)	
	Very High (25.6% - 71.0%)	
Population with Disabilities	Low (3.8% - 7.8%)	The data shows the percentage of population with a disability at the census tract level. The data is provided by the U.S. Census Bureau's ACS 2017-2021 5-year estimates of six different types of disability (hearing, vision, cognitive, ambulatory, self-care, and independent living difficulties). Individuals with disabilities are more likely to have difficulty evacuating. Areas with higher populations with disabilities are given a higher vulnerability rating. Since this factor has such low scaling, a weight of 2 was applied to this factor. See Figure 16.
	Medium (7.9% - 9.6%)	
	High (9.7% - 14.6%)	
	Very High (14.7% - 18.7%)	

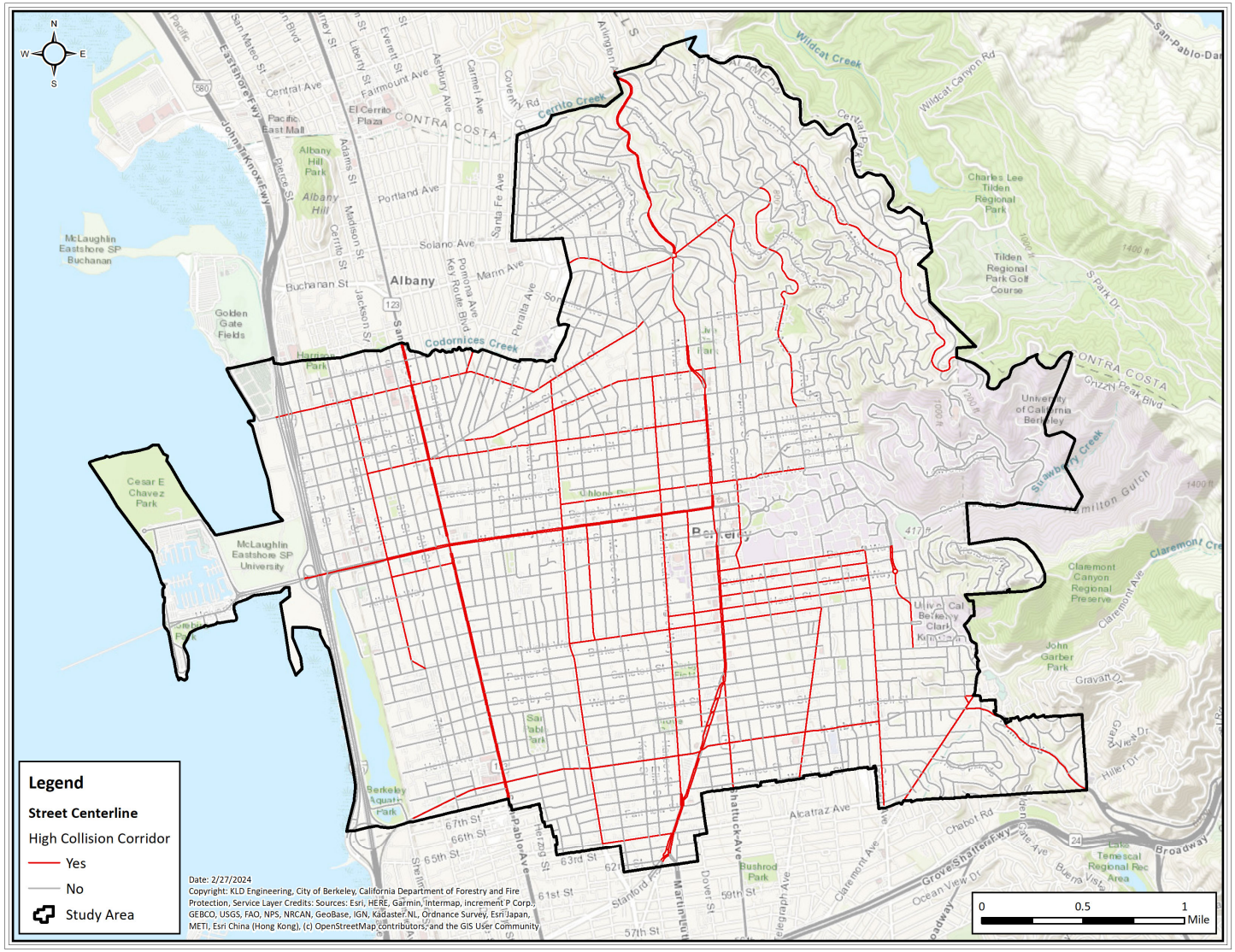


Figure 1. Collision Factor

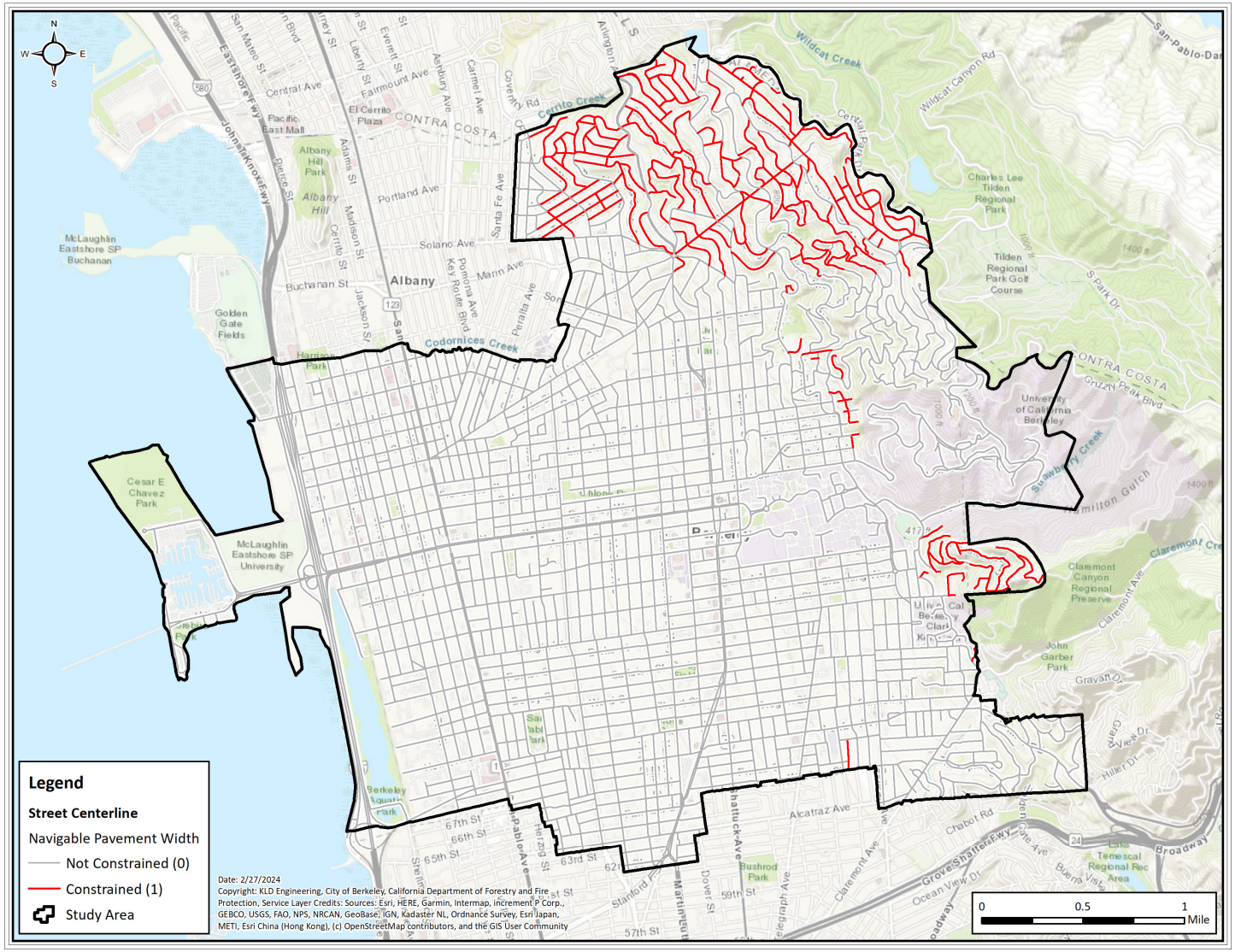


Figure 2. Navigable Pavement Width

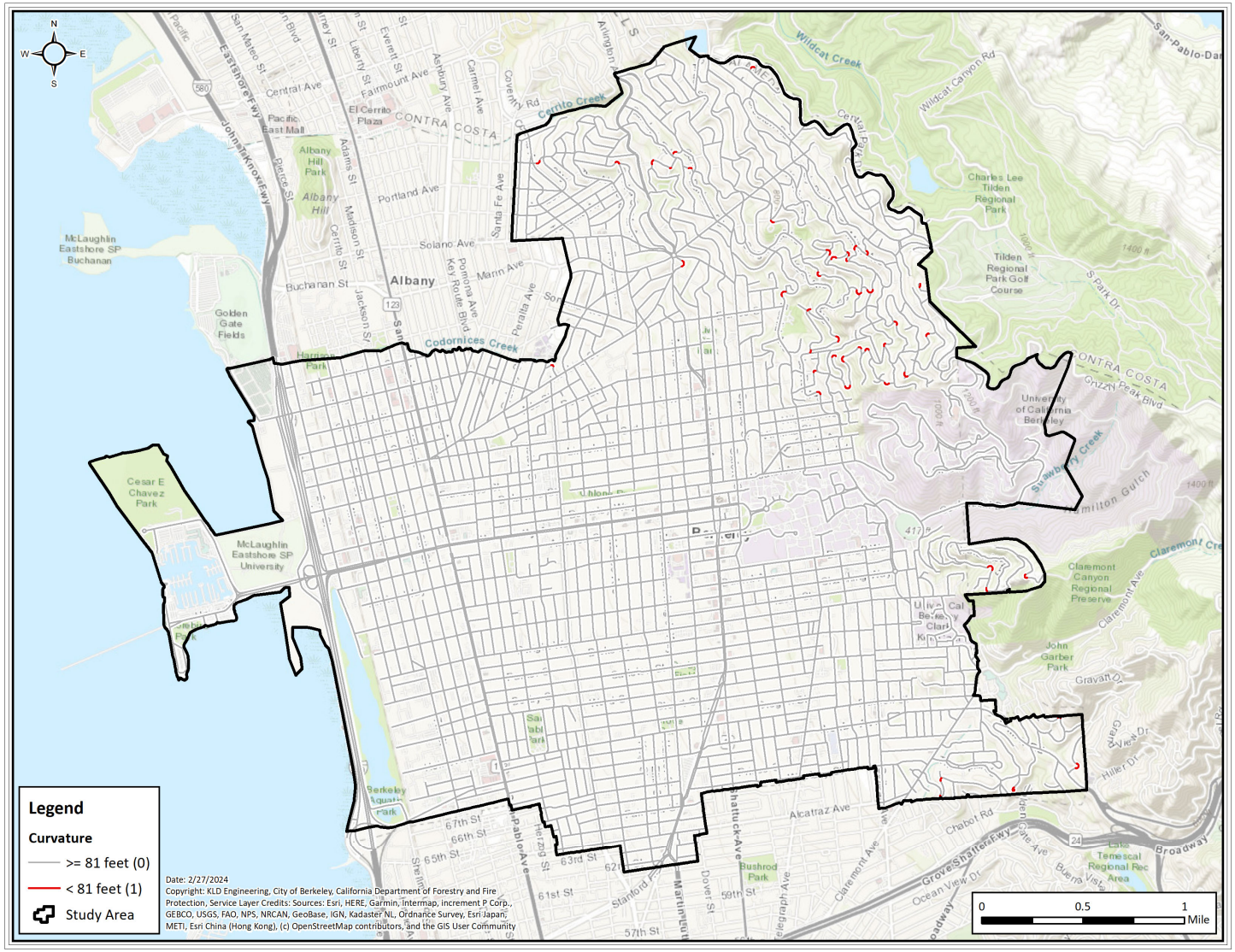


Figure 3. Roadway Curvature

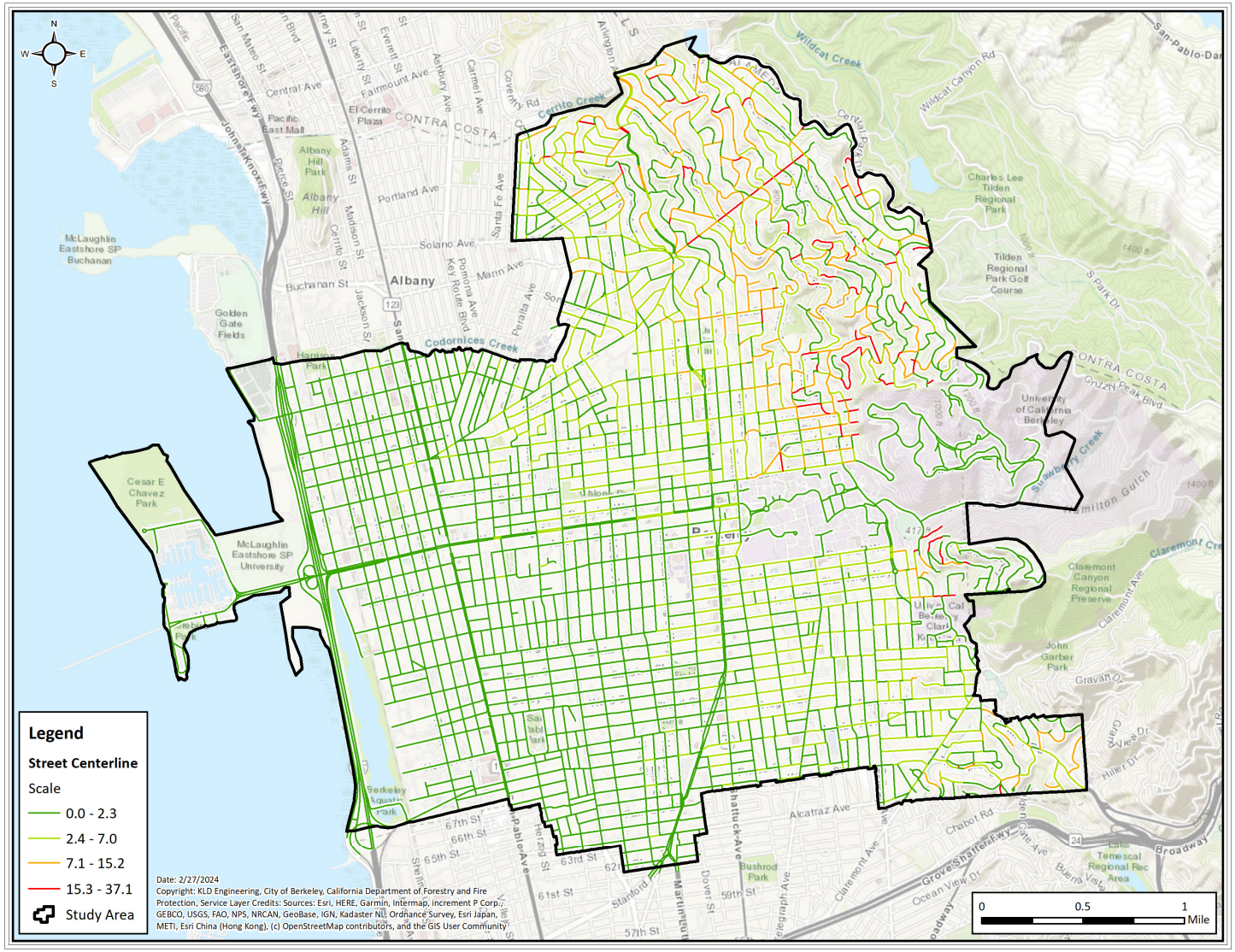


Figure 4. Roadway Slope

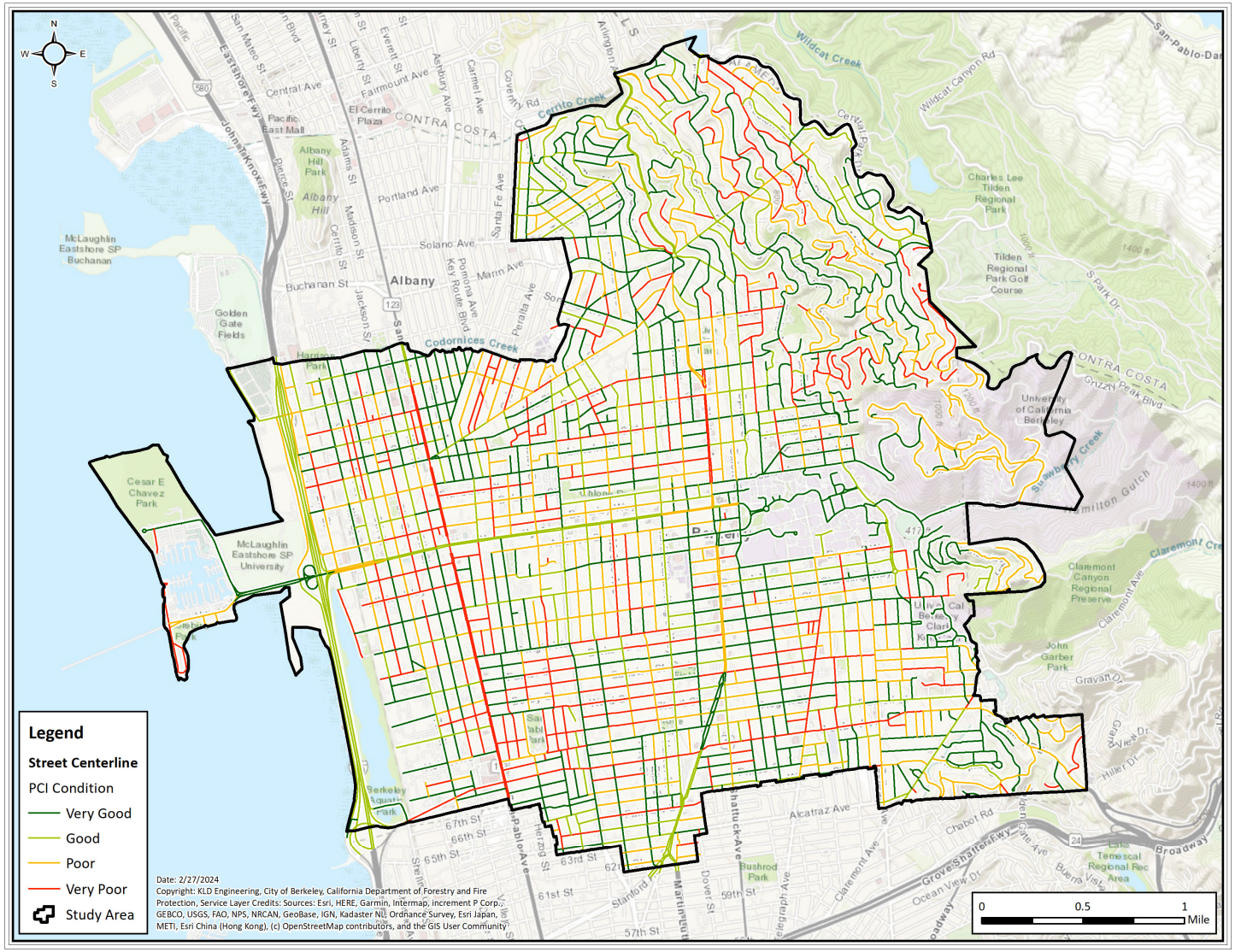


Figure 5. Pavement Condition Index

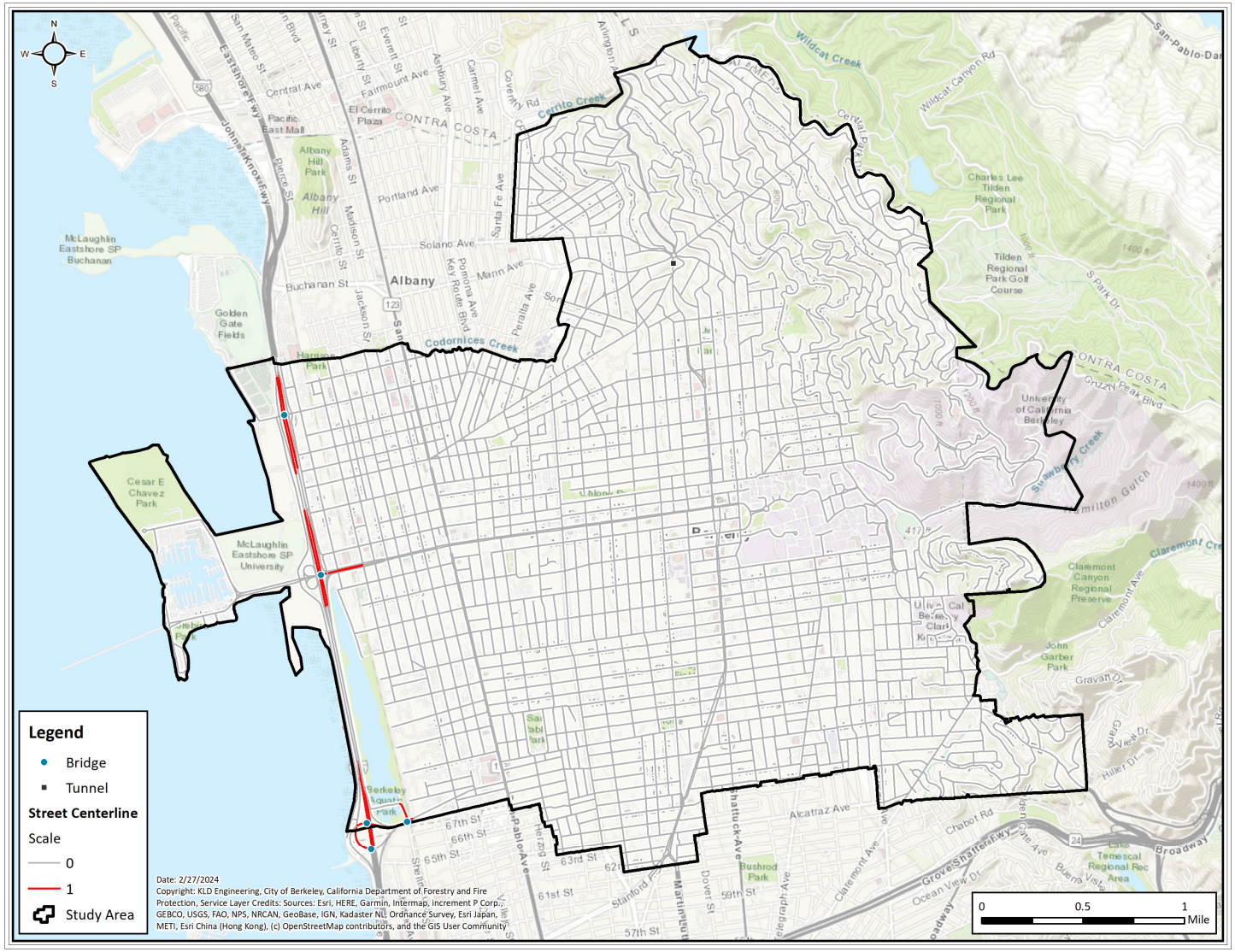


Figure 6. Bridges and Tunnels

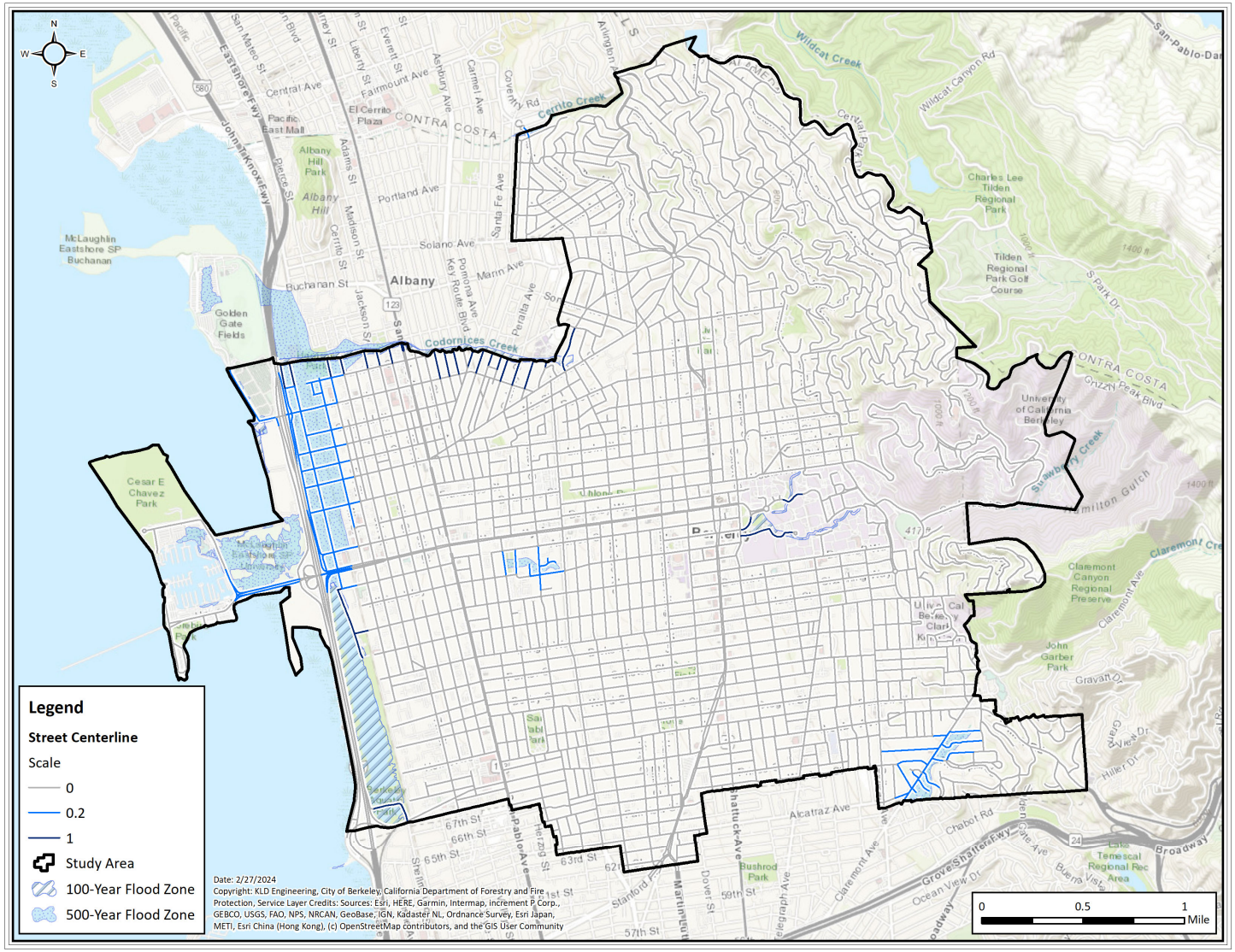


Figure 7. Flood Hazard Areas

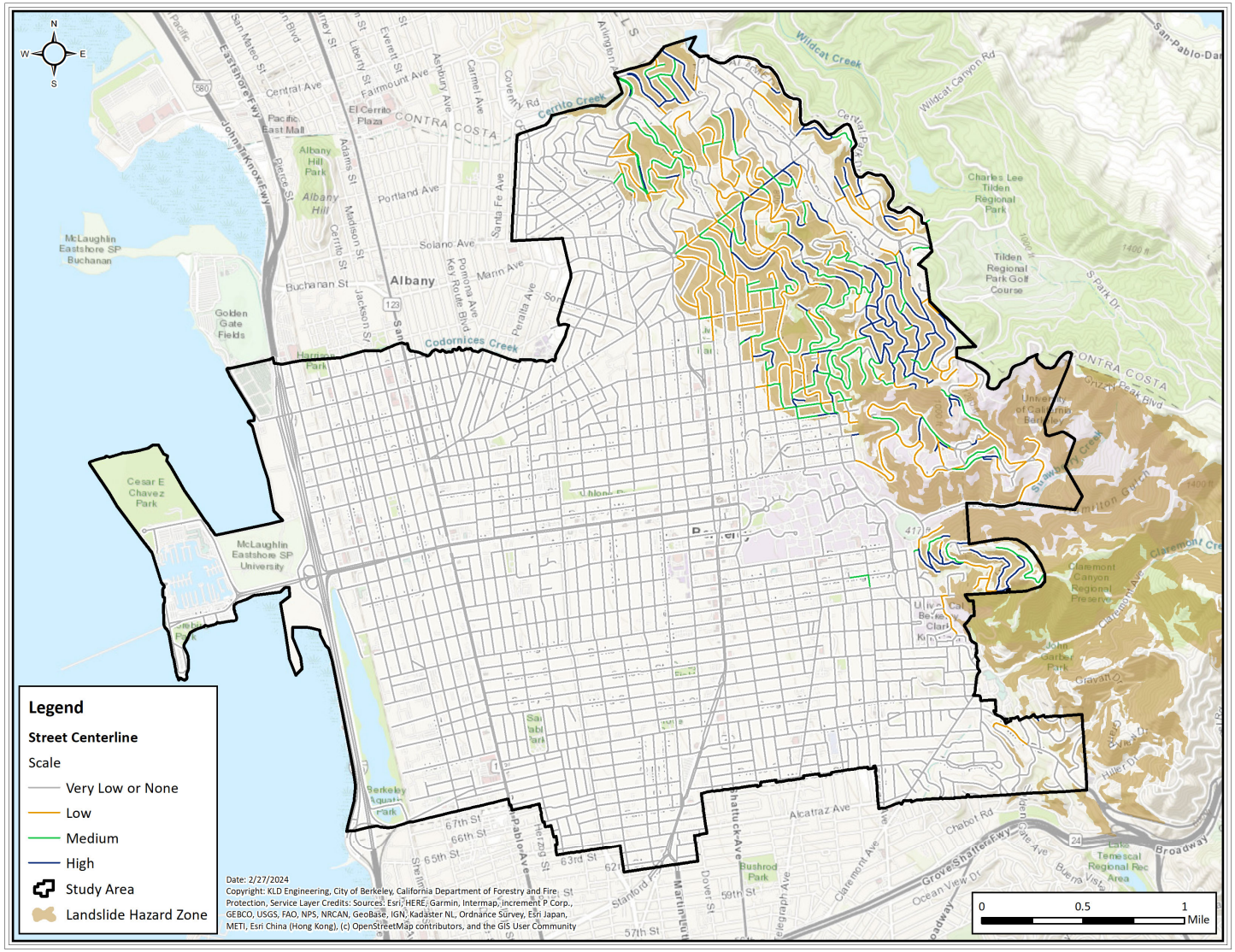


Figure 8. Landslide Hazard Areas

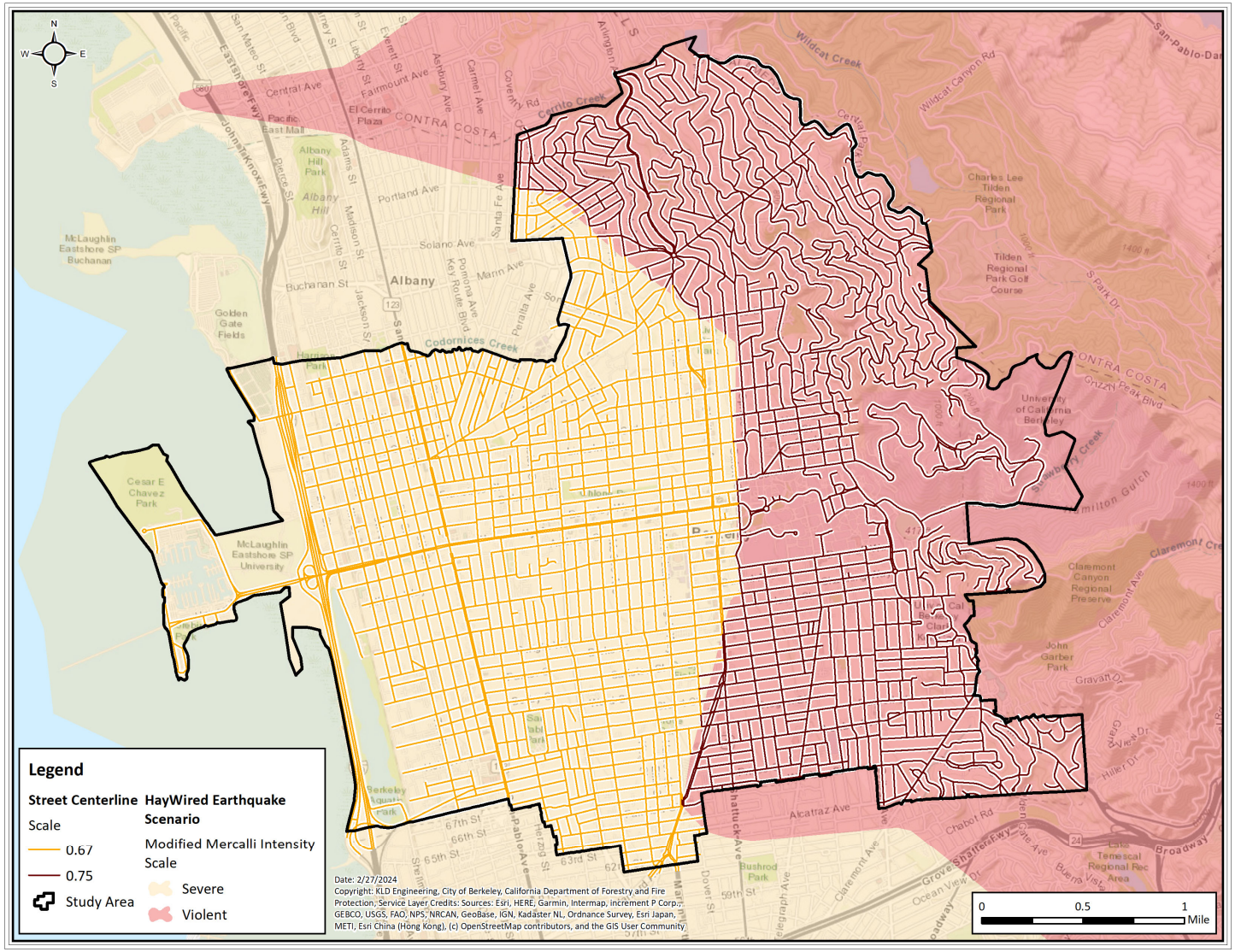


Figure 9. Earthquake ShakeMap

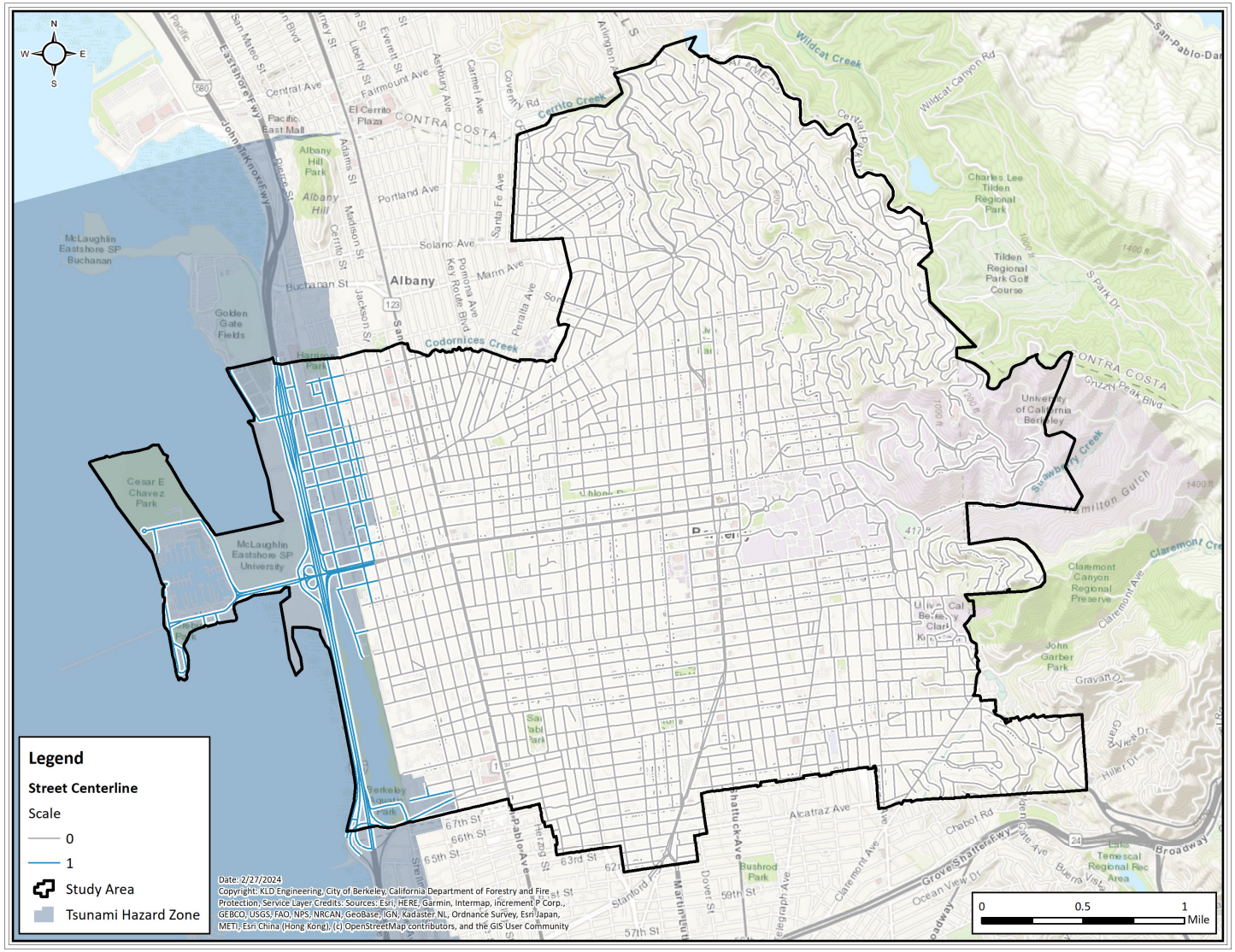


Figure 10. Tsunami Hazard Zone

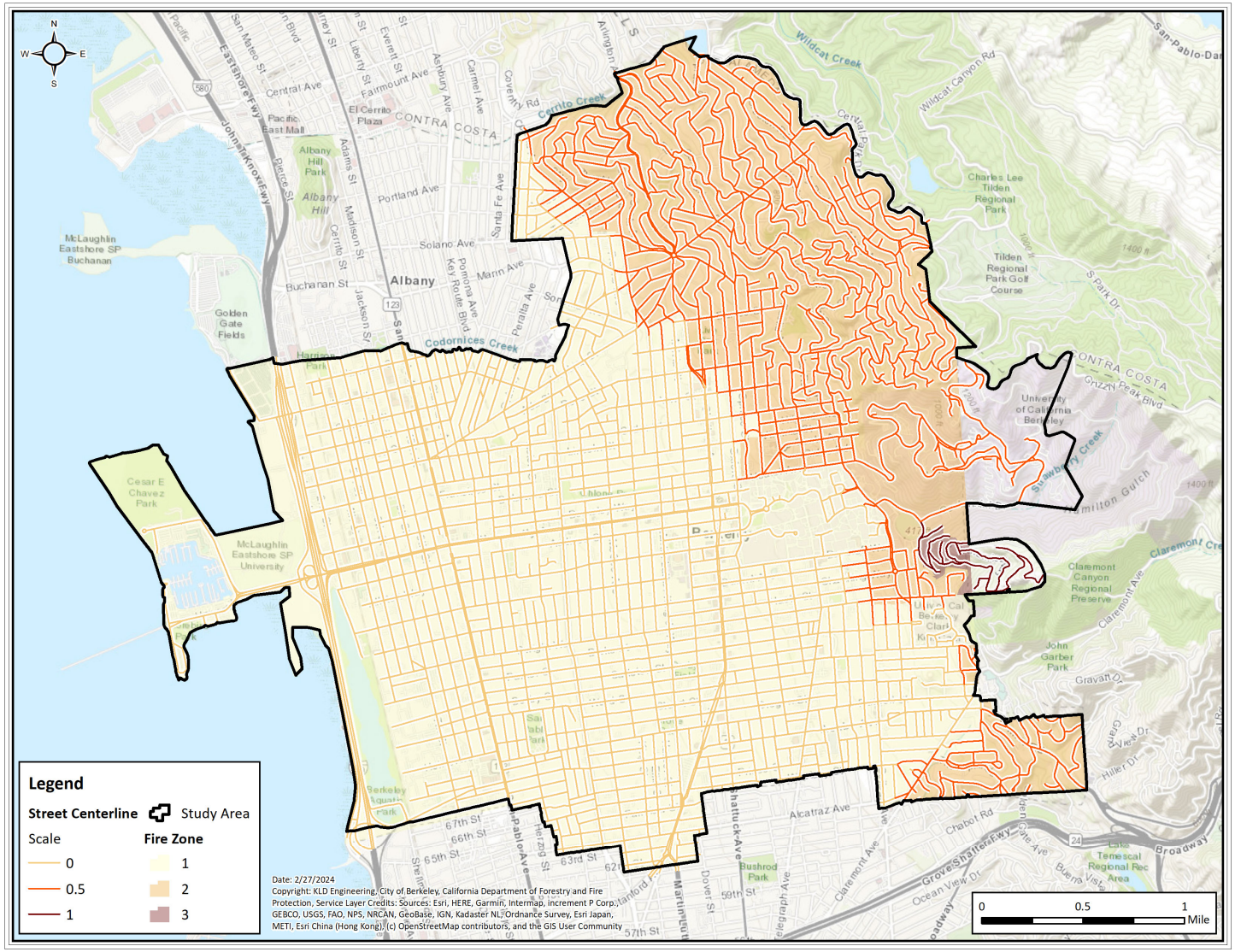


Figure 11. Fire Hazard Severity Zones

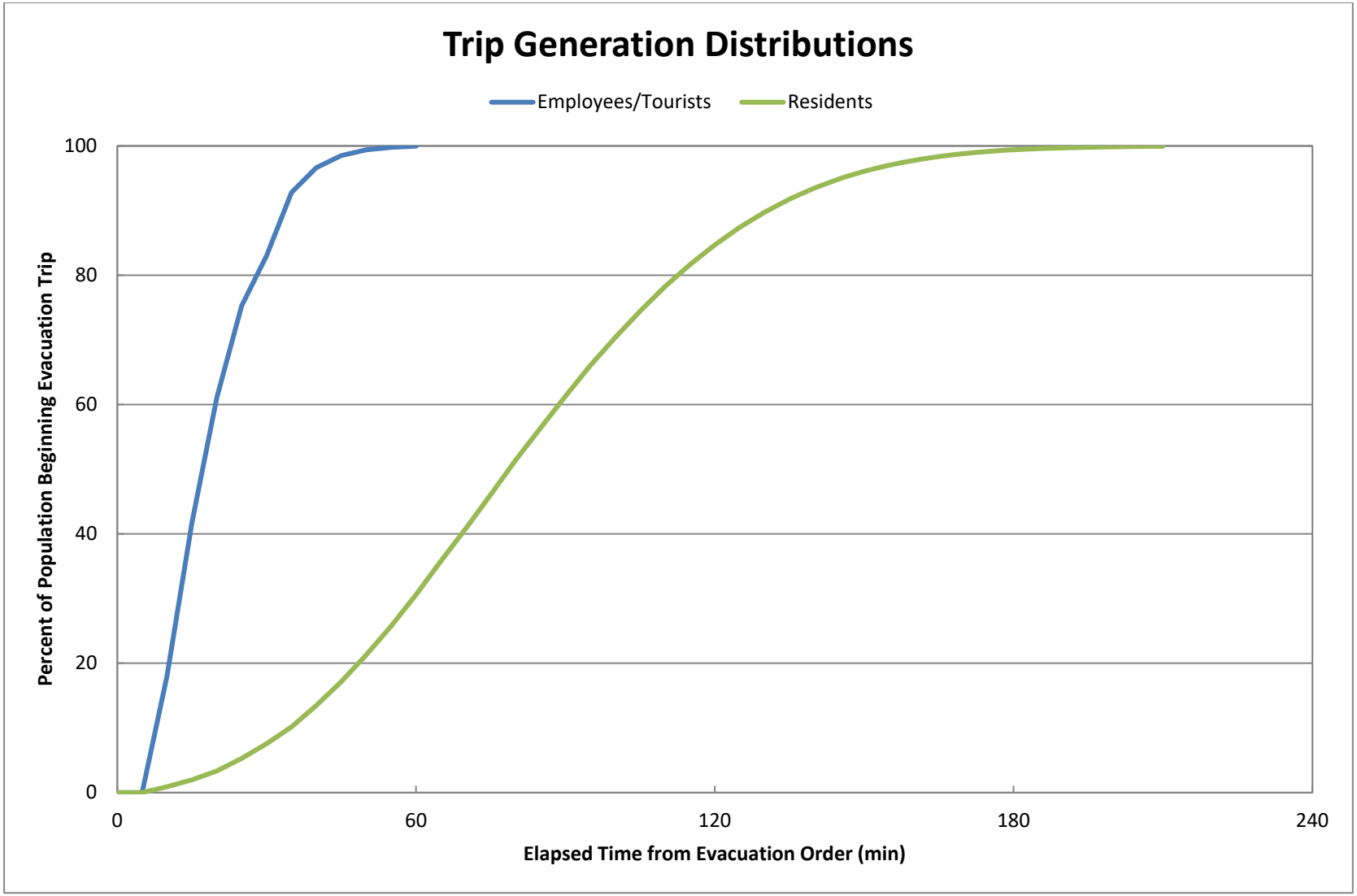


Figure 12. Mobilization Times

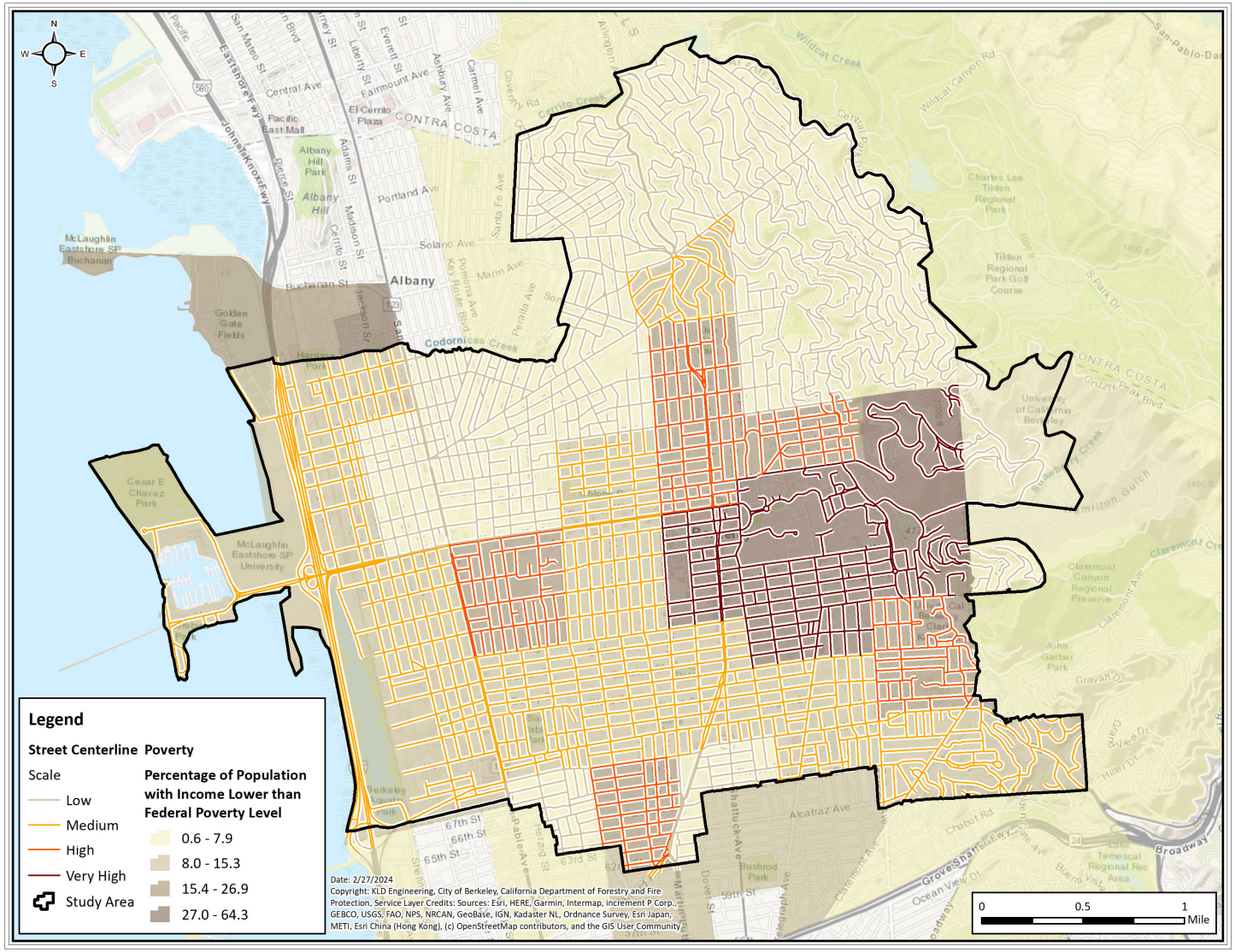


Figure 13. Poverty

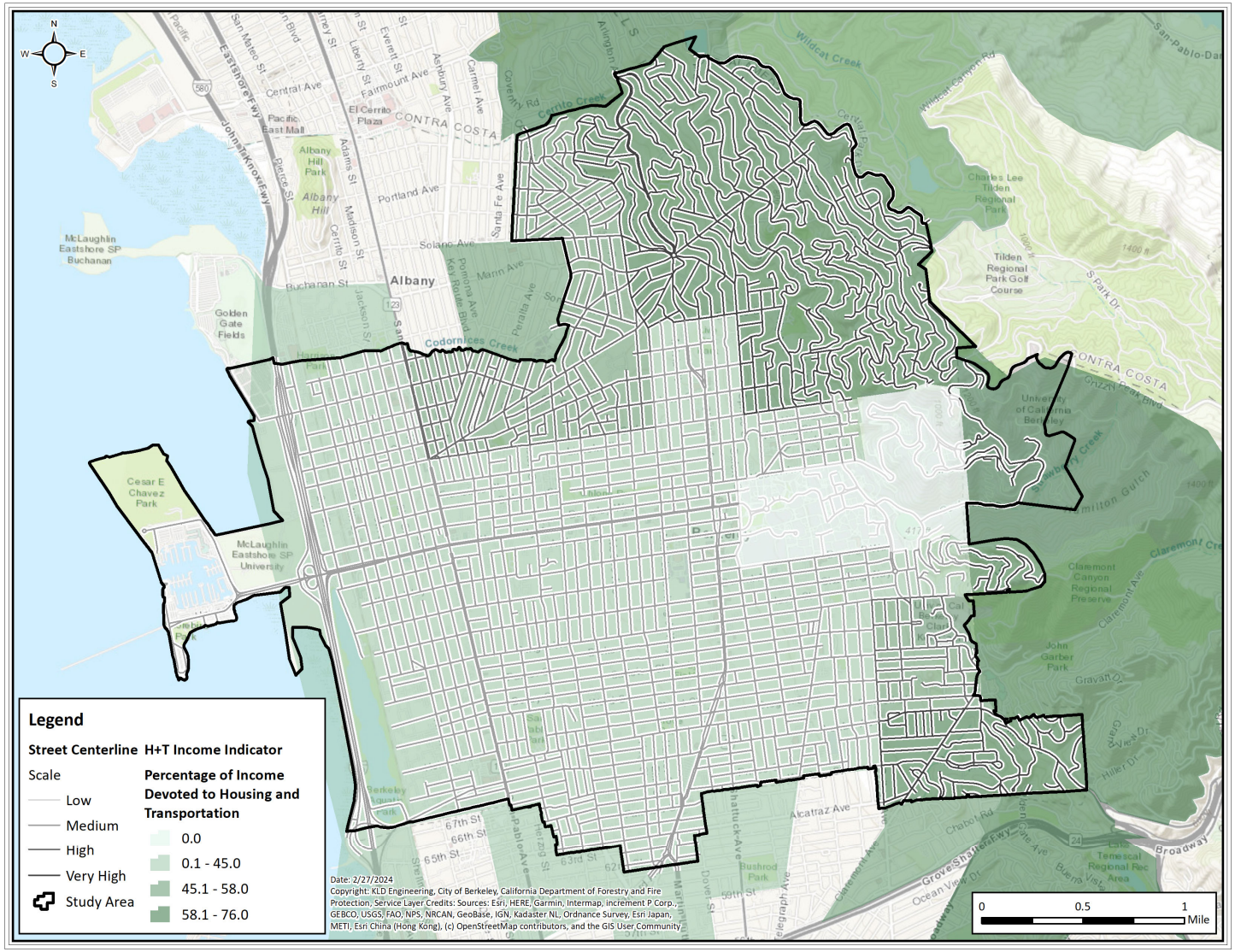


Figure 14. H+T Household Indicator

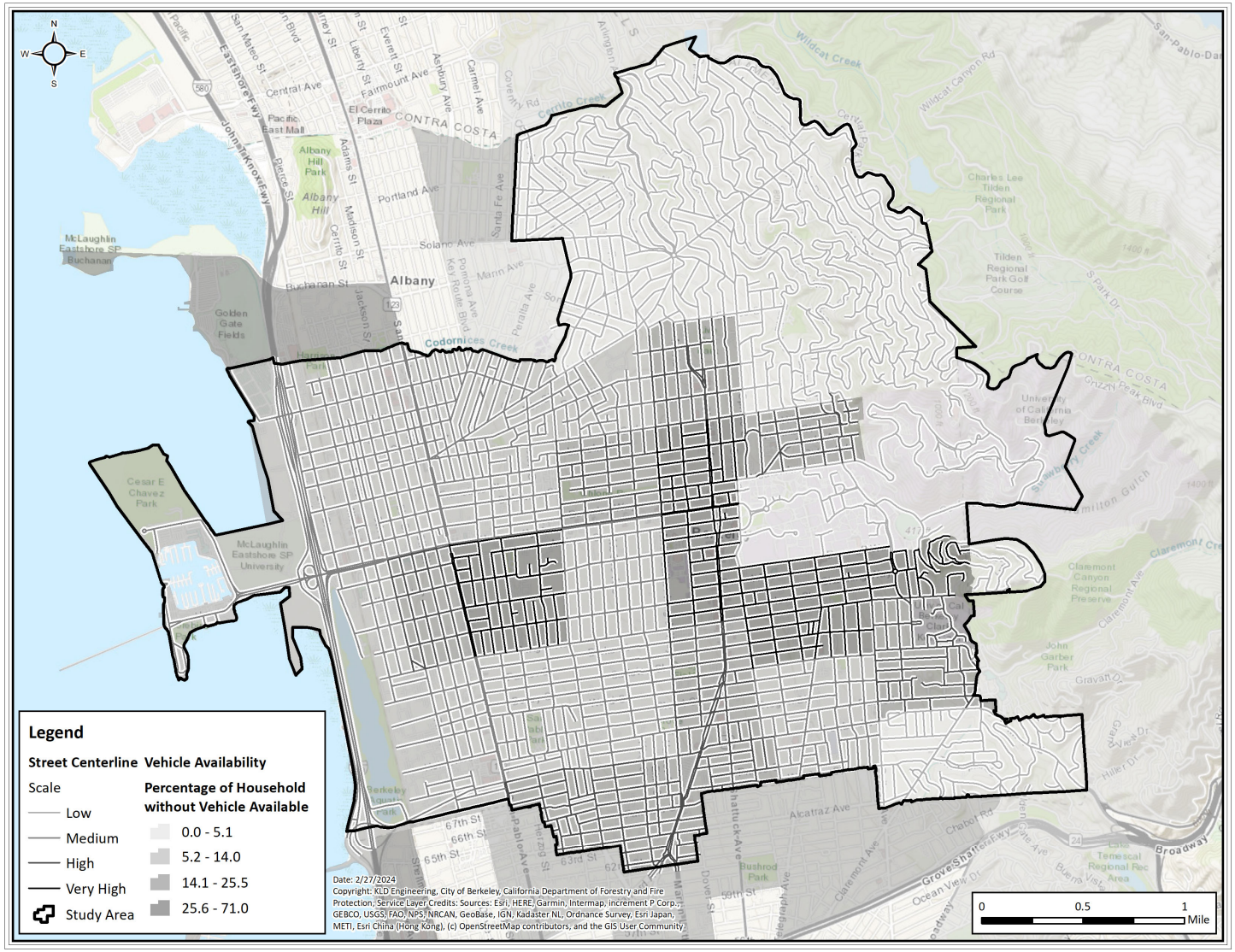


Figure 15. Vehicle Availability

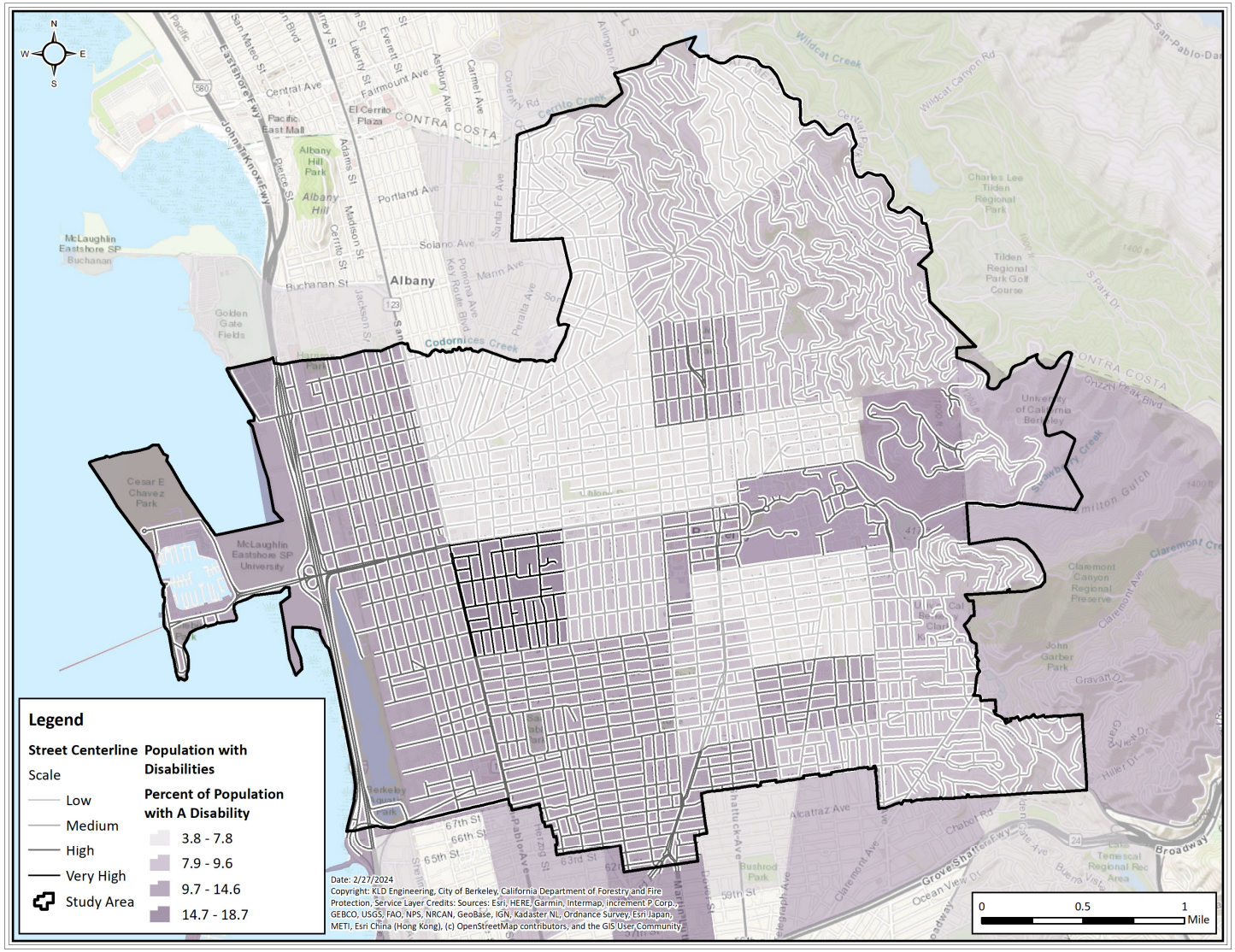


Figure 16. Population with Disabilities

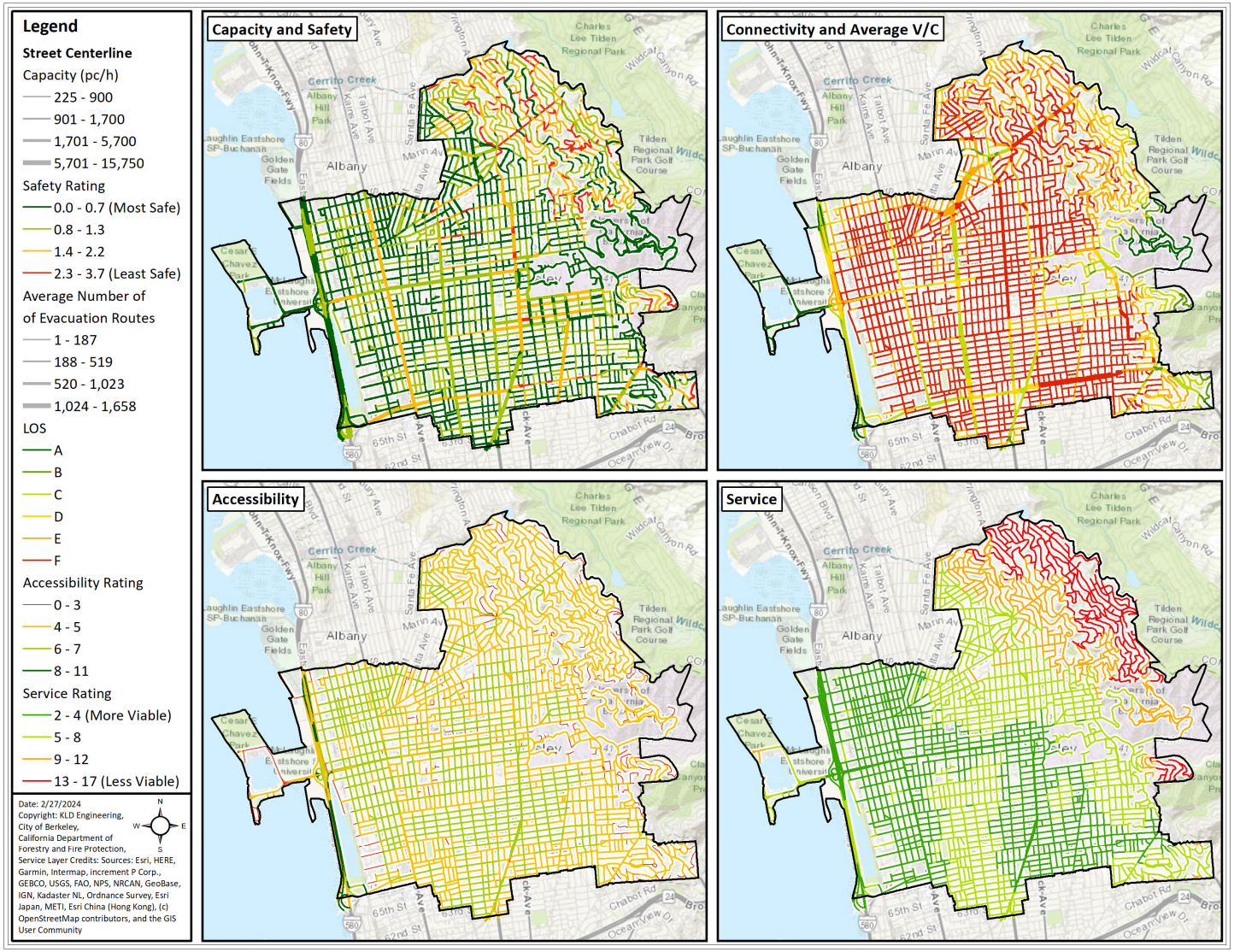


Figure 17. Overview of Capacity, Safety, and Viability

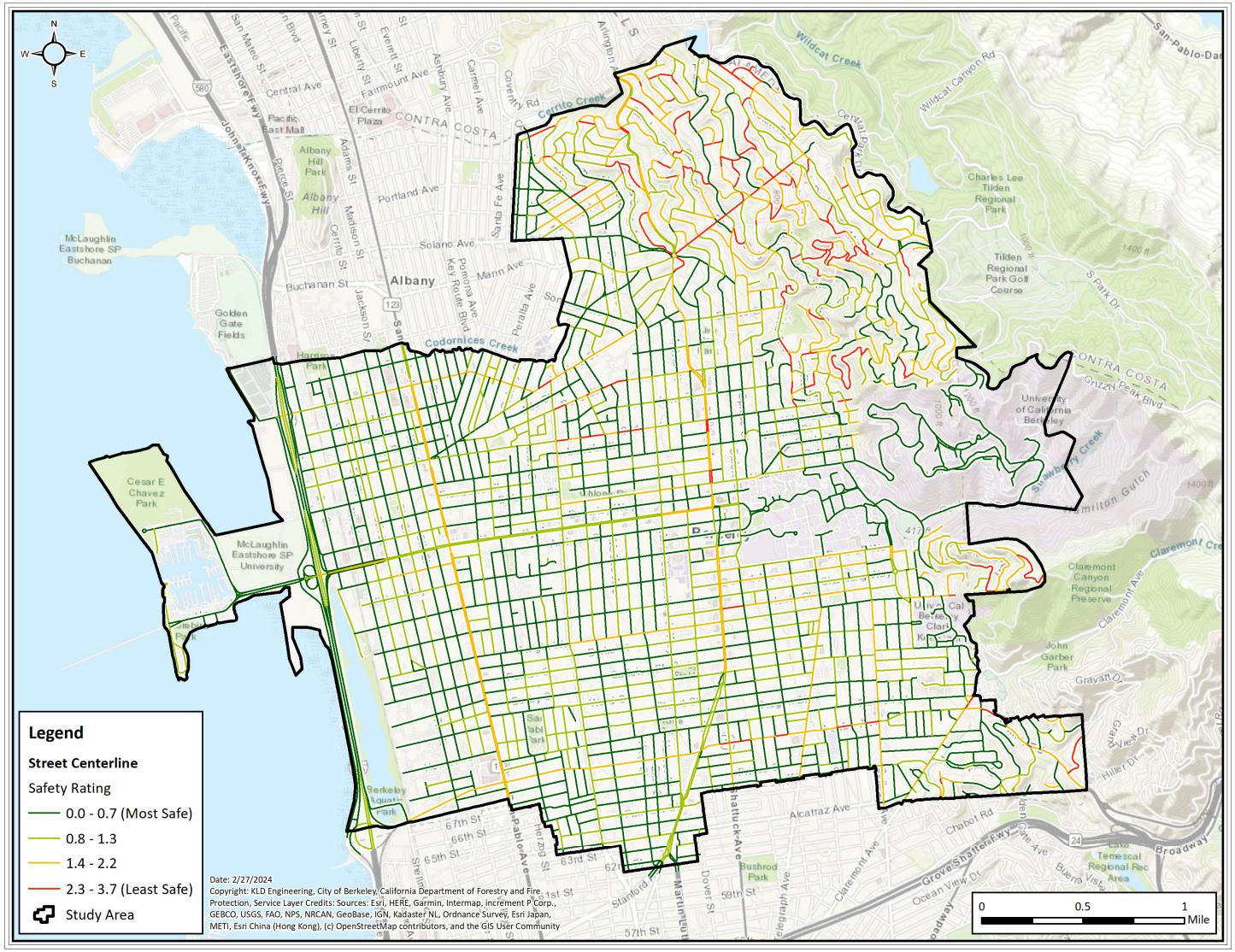


Figure 18. Overall Evacuation Safety Rating

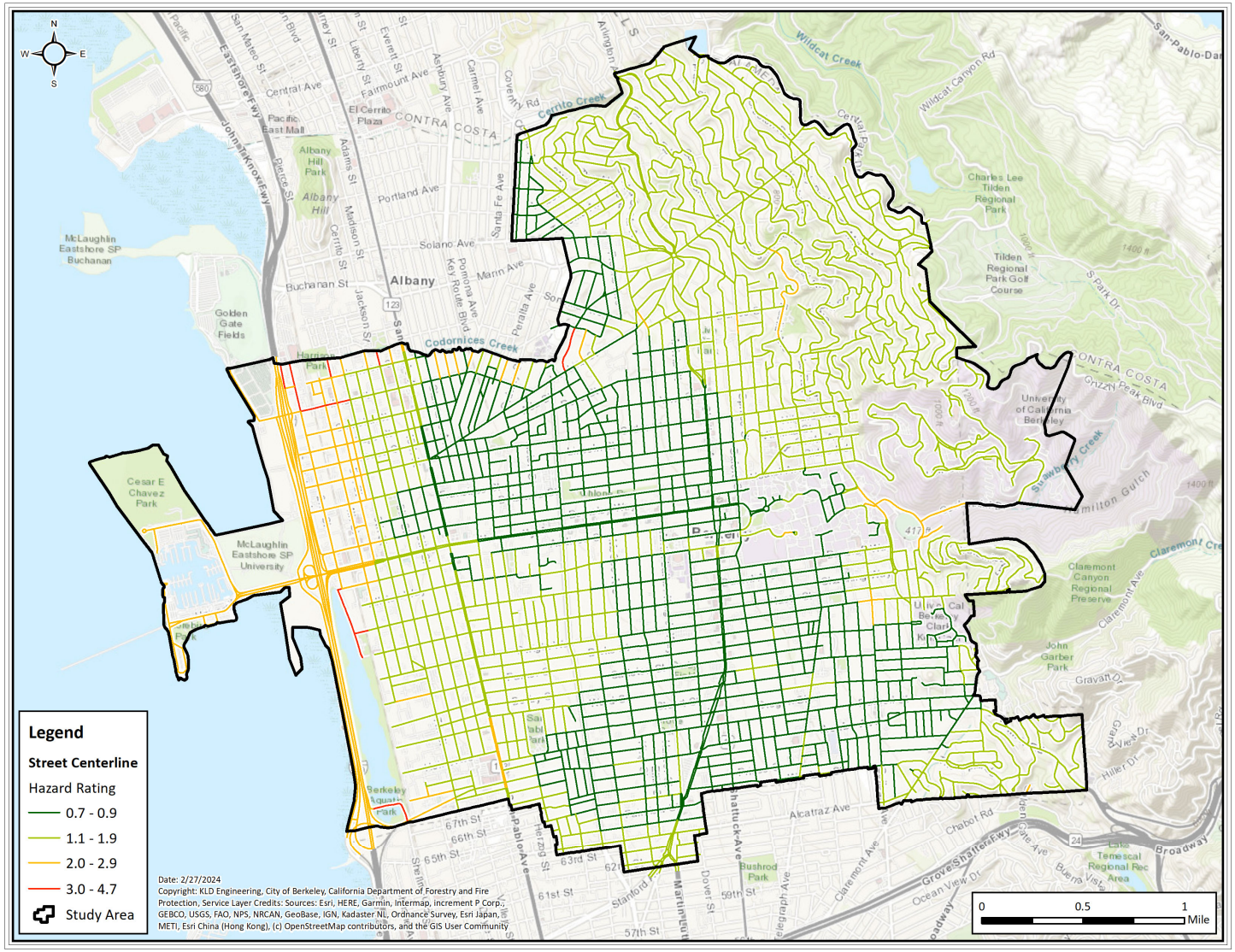


Figure 19. Hazard Rating

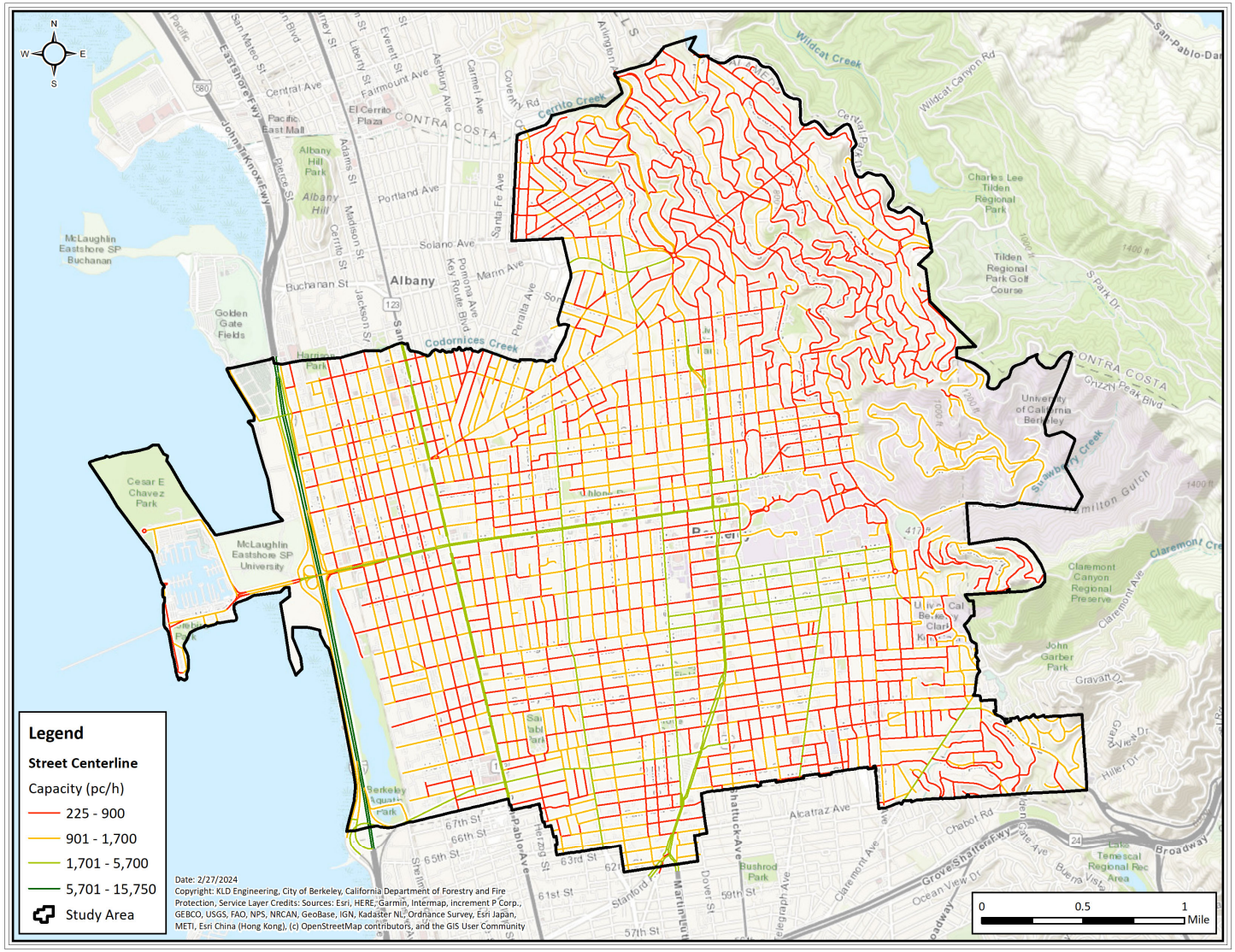


Figure 20. Capacity

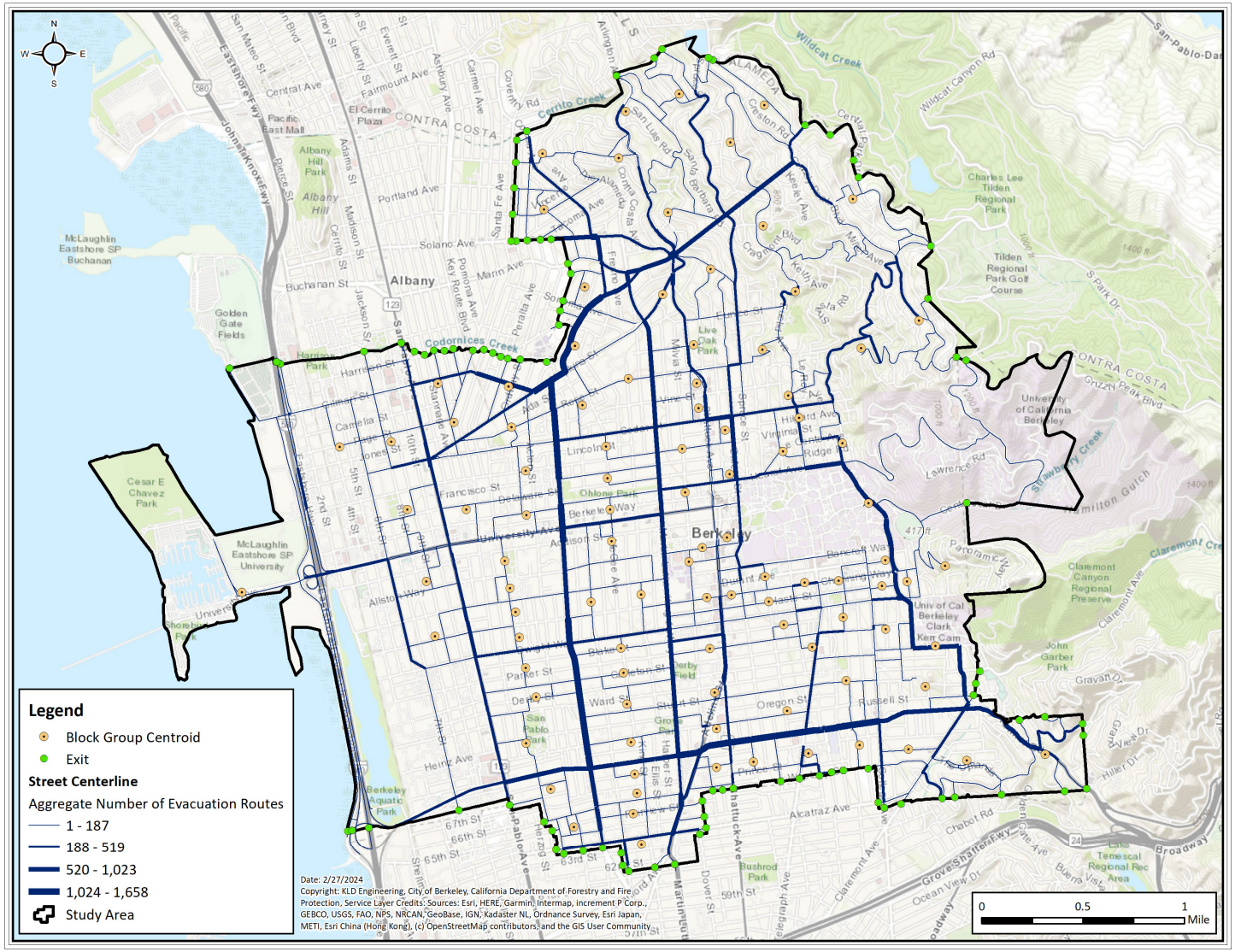


Figure 21. Connectivity

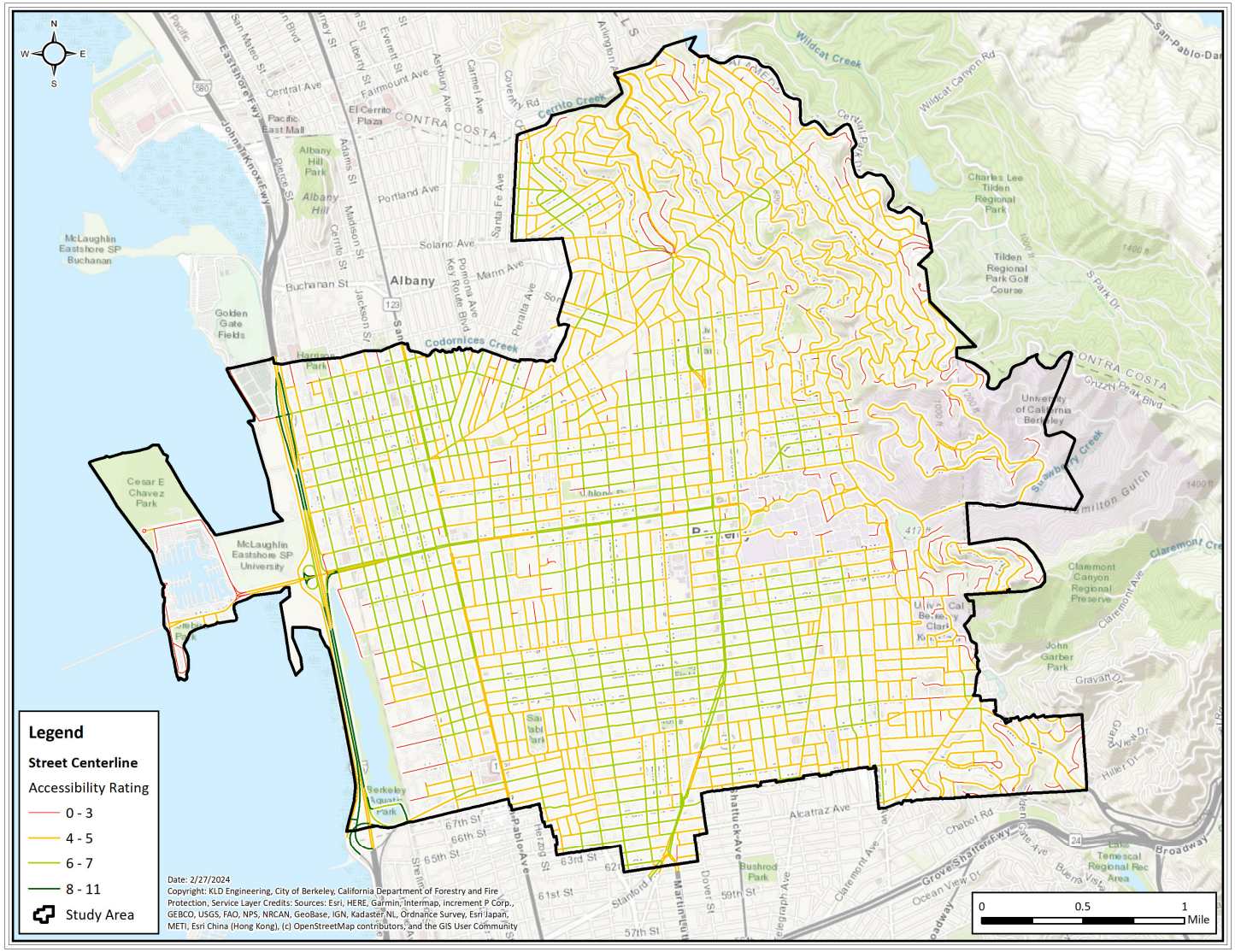


Figure 22. Accessibility Score

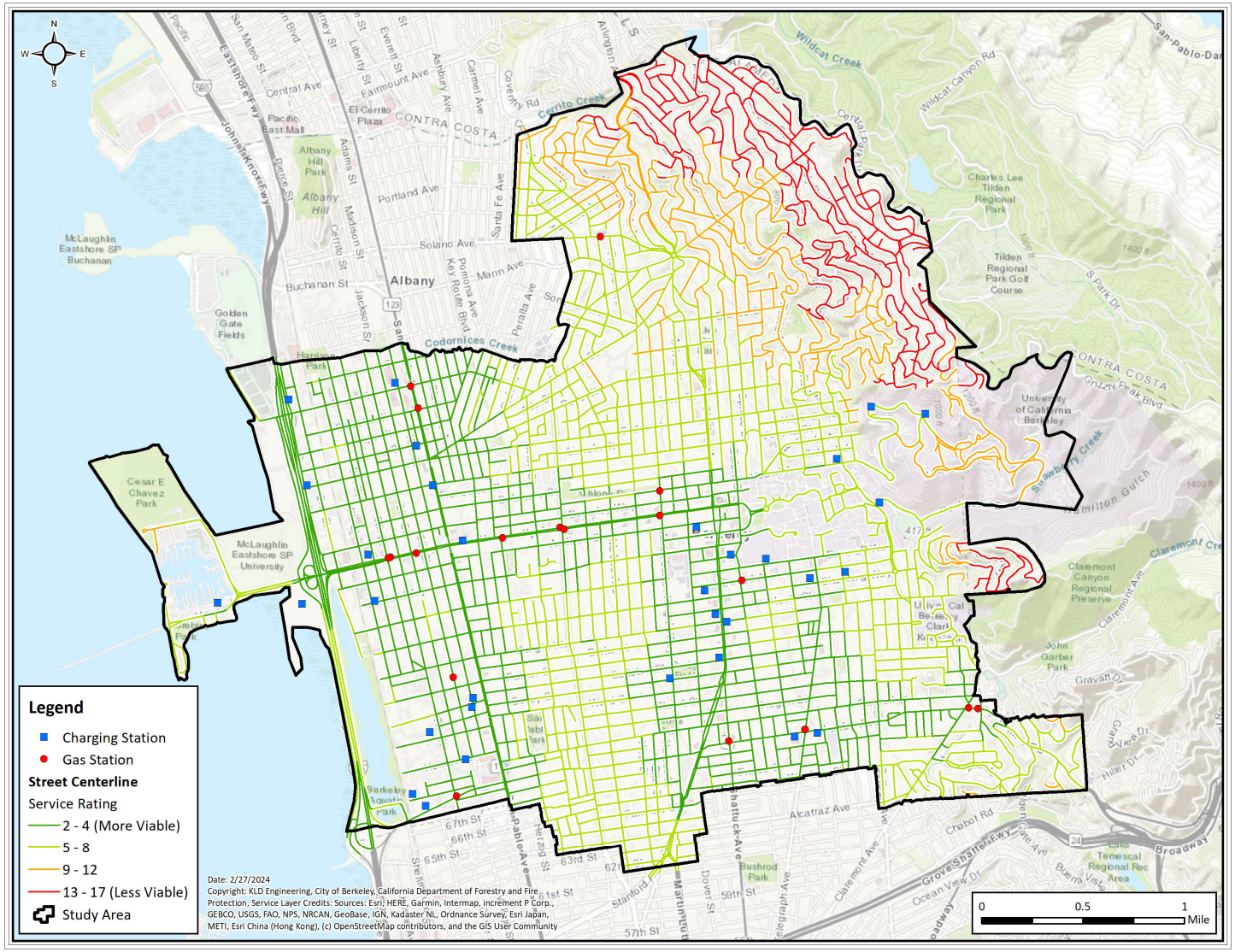


Figure 23. Service Score

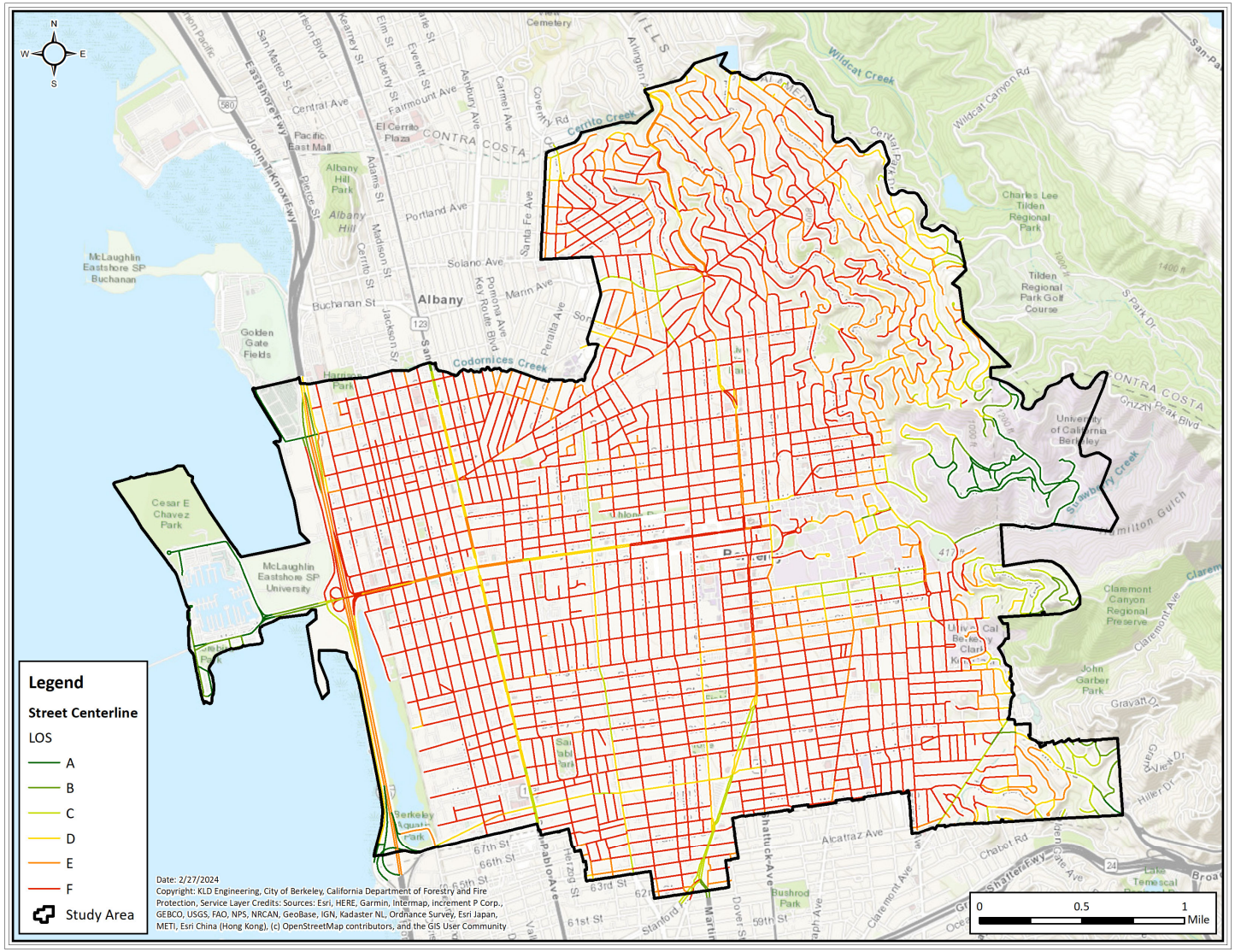
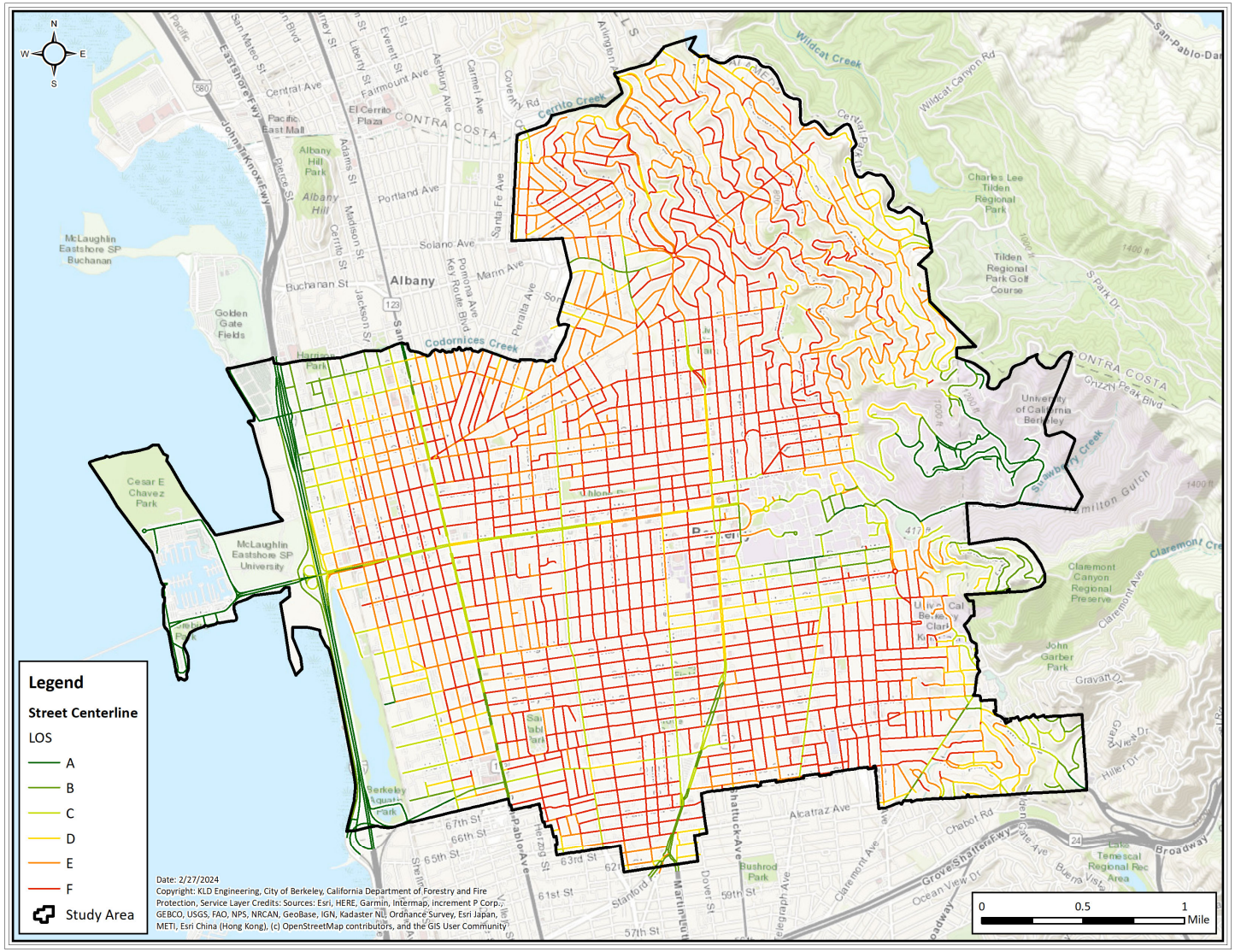


Figure 24. Maximum Demand During an Evacuation Event


Legend
Street Centerline
LOS
A
B
C
D
E
F
Study Area
Date: 2/27/2024
Copyright: KLD Engineering, City of Berkeley, California Department of Forestry and Fire Protection, Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community
0
0.5
1
Mile
Albany
CONTRA COSTA
Wildcat Creek
Cerrito Creek
Codornices Creek
Strawberry Creek
Hamilton Gulch
Cesar E Chavez Park
McLaughlin Eastshore SP
Golden Gate Fields
Berkeley Aquatic Park
Bushrod Park
John Garber Park
Claremont Canyon Regional Preserve
Charles Lee Tilden Regional Park
Tilden Regional Park Golf Course
Lake Temescal Regional Rec Area
University of California Berkeley
Albany Hill Park
Albany Hill
El Cerrito Plaza
Pacific East Mall
Central Ave
Portland Ave
Solano Ave
Marin Ave
Buchanan St
Alcatraz Ave
Ashby Ave
Claremont Ave
Broadway
Grizzly Peak Blvd
Gravatt Dr
Hiller Dr
Chabot Rd
Ocean View Dr
Buena Vista
Stanford
Martin Luther
Dover St
Telegraph Ave
Shattuck Ave
San Pablo Ave
Herzog St
Strawberry Creek
Eastshore Fwy
Johnson Knox Fwy
Grove Shafter Fwy
Key Route Blvd
Pomona Ave
Peralta Ave
Santa Fe Ave
Carmel Ave
Fairmount Ave
Everett St
Liberty St
Adams St
Madison St
Cerrito St
Jackson St
Pierce St
Arlington Ave
Coventry Rd
Wildcat Canyon Rd
Central Park Dr
S Park Dr
Gravatt Dr
Hiller Dr
Claremont Ave
Claremont Cre
Alcatraz Ave
Chabot Rd
Ocean View Dr
Buena Vista
Broadway
Grizzly Peak Blvd

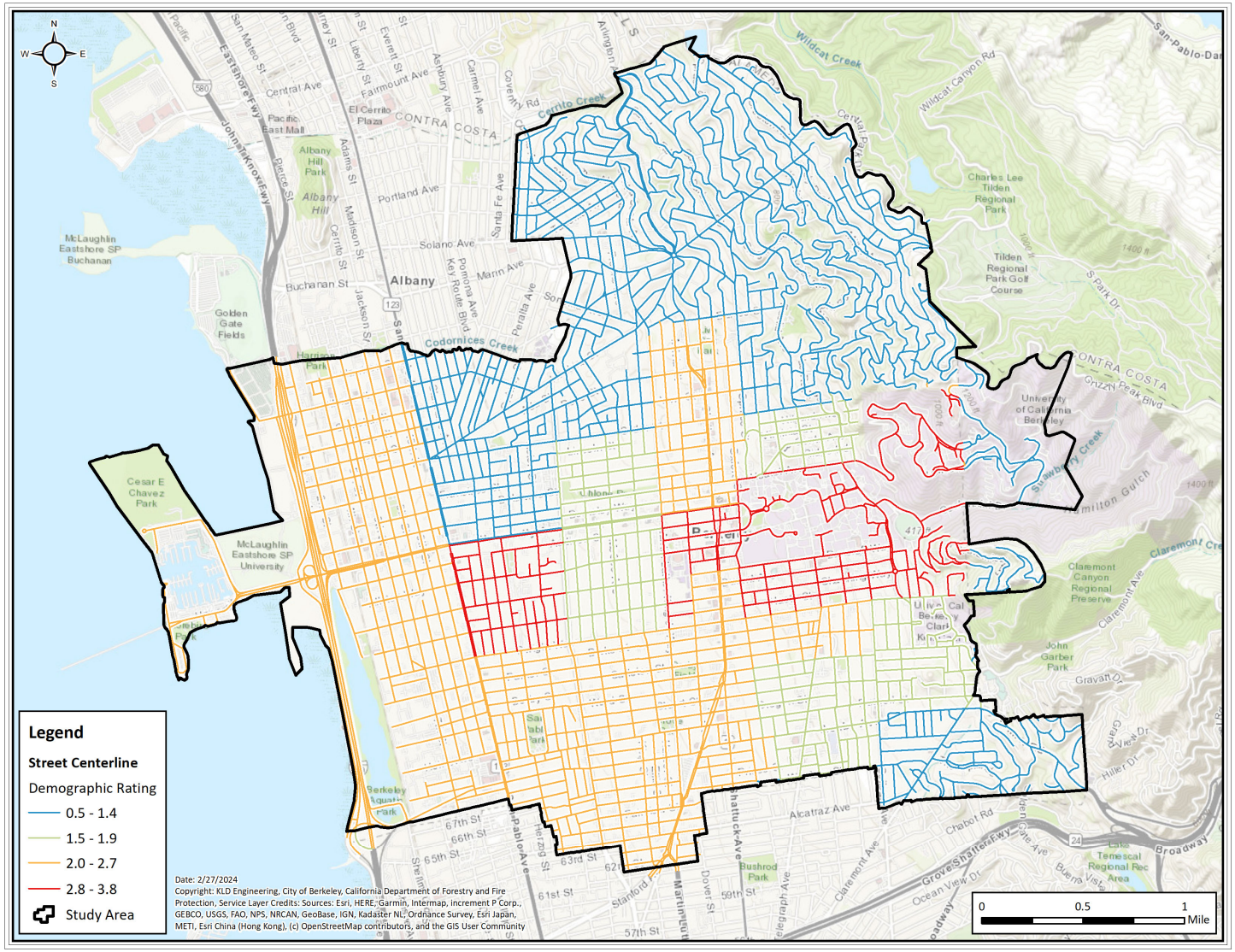


Figure 26. Demographic Vulnerability Rating

Appendix A

Table A-1. Summary of Safety, Capacity, Viability, and Vulnerability Scores

Street Name	Average[21] of								
	Total Capacity (vph)	Safety Score	Hazard Score	Connectivity	Accessibility	Congestion Score (Max)	Congestion Score (Min)	Service Score	Vulnerability Score
	▲ ▼	▲ ▼	▲ ▼	▲ ▼	▲ ▼	▲ ▼	▲ ▼	▲ ▼	▲ ▼
10TH ST	986	0.46	1.57	5.95	5.95	2.24	1.07	2.62	2.11
2ND ST	994	0.64	3.10	5.33	5.33	1.91	0.38	3.75	2.11
4TH ST	1,024	0.18	2.51	5.50	5.50	1.95	0.55	3.40	2.11
5TH ST	936	0.67	2.31	5.37	5.37	2.39	0.72	3.05	2.11
62ND ST	1,163	0.89	1.67	5.17	5.17	0.96	0.56	6.83	2.23
63RD ST	1,215	0.80	1.67	5.00	5.00	1.11	0.69	5.80	2.18
65TH ST	1,125	0.67	1.67	4.00	4.00	0.71	0.56	7.00	2.12
66TH ST	1,050	0.33	1.33	4.17	4.17	1.19	0.99	6.67	2.12
67TH ST	750	0.00	1.33	5.33	5.33	2.11	1.79	6.00	2.12
6TH ST	1,167	0.90	1.73	5.63	5.63	1.84	0.69	3.31	2.13
7TH ST	1,058	0.52	1.63	5.67	5.67	2.25	0.73	2.85	2.11
8TH ST	879	0.68	1.62	5.62	5.62	2.85	1.08	3.00	2.11
9TH ST	881	0.14	1.67	5.50	5.50	2.68	1.09	2.58	2.11
ACACIA AVE	900	2.00	1.25	4.00	4.00	0.92	0.84	15.00	0.89
ACROFT CT	1,125	0.33	0.67	2.00	2.00	1.33	0.92	5.00	3.26
ACTON CIR	1,125	0.78	0.87	2.67	2.67	1.53	1.05	5.00	3.26
ACTON ST	955	0.67	0.98	5.00	5.00	1.61	1.28	5.11	2.08
ADA ST	990	0.40	0.67	5.20	5.20	1.32	0.95	6.20	1.34
ADDISON ST	892	0.86	1.23	5.52	5.52	4.78	1.62	3.03	2.48
ADELINE ST	5,454	1.17	1.14	5.51	5.51	0.32	0.18	3.94	2.10
ALAMO AVE	675	2.00	1.25	4.00	4.00	1.35	1.25	13.00	0.89
ALCATRAZ AVE	1,073	0.51	1.66	5.23	5.23	1.16	0.78	5.92	1.95
ALLSTON WAY	852	0.51	1.25	5.57	5.57	4.04	1.67	3.86	2.53
ALTA RD	675	1.67	1.25	4.00	4.00	0.82	0.77	14.00	0.89
ALVARADO RD	1,125	0.81	1.25	3.86	3.86	0.27	0.24	6.71	1.20
AMADOR AVE	788	0.67	1.25	4.00	4.00	1.41	1.13	8.00	1.27
ANTHONY ST	563	0.83	1.67	5.00	5.00	4.14	0.78	2.00	2.11
ARCADE AVE	900	1.00	1.25	4.00	4.00	0.60	0.56	13.00	1.24
ARCH ST	859	0.97	1.25	4.27	4.27	1.95	1.59	8.00	1.40

Street Name	Average[21] of								
	Total Capacity (vph)	Safety Score	Hazard Score	Connectivity	Accessibility	Congestion Score (Max)	Congestion Score (Min)	Service Score	Vulnerability Score
ARDEN RD	788	1.50	1.75	2.00	2.00	0.55	0.52	11.00	2.82
ARLINGTON AVE	1,133	1.65	1.25	4.36	4.36	0.70	0.63	11.25	1.02
ASHBY AVE	2,477	1.78	0.99	5.11	5.21	1.48	0.67	3.15	1.82
ASHBY PL	1,125	0.33	0.75	4.00	4.00	1.59	1.10	4.00	1.20
ATHERTON ST	1,125	1.00	0.75	4.00	4.00	2.56	1.43	4.00	3.39
ATLAS PL	450	1.00	1.25	4.00	4.00	0.98	0.93	14.00	1.24
AVALON AVE	990	1.20	0.75	3.00	3.00	1.07	0.77	4.60	1.74
AVENIDA DR	750	0.89	1.25	4.67	4.67	0.67	0.65	13.83	1.24
AVIS RD	900	1.33	1.25	4.00	4.00	0.86	0.77	12.00	1.06
BAKER ST	1,013	0.33	1.67	5.25	5.25	1.06	0.87	7.25	2.12
BANCROFT PL	450	1.67	1.75	2.00	2.00	0.25	0.22	17.00	1.14
BANCROFT STEPS WAY	675	1.00	1.25	4.00	4.00	1.30	0.86	7.00	2.82
BANCROFT WAY	1,872	0.78	1.30	5.02	5.02	1.66	0.87	4.44	2.70
BARROWS LN	1,125	0.33	0.75	4.00	4.00	0.95	0.27	5.00	3.30
BATAAN AVE	1,125	1.00	1.67	4.00	4.00	1.60	0.79	3.00	1.98
BATEMAN ST	675	1.00	0.75	4.00	4.00	5.34	1.63	4.00	1.68
BAY ST	1,125	0.50	3.67	3.00	8.00	0.84	0.10	2.00	2.11
BAYTREE LN	450	2.00	1.25	1.00	1.00	0.68	0.63	13.00	1.24
BAYVIEW PL	675	0.67	1.25	4.00	4.00	1.68	1.41	10.00	1.24
BELROSE AVE	1,125	0.00	1.25	5.00	5.00	0.64	0.46	4.00	1.74
BELVEDERE AVE	1,013	0.50	0.67	5.00	5.00	1.60	1.14	4.00	1.37
BENVENUE AVE	956	0.67	0.75	5.50	5.50	3.50	1.66	4.38	2.02
BERKELEY SQ	3,800	0.67	0.67	6.00	6.00	1.58	0.38	3.00	3.31
BERKELEY WAY	916	0.60	0.67	5.36	5.36	6.89	2.09	3.50	1.82
BERRYMAN PATH	900	0.67	1.17	5.00	5.00	1.90	1.29	8.00	2.14
BERRYMAN ST	996	0.48	0.81	5.57	5.57	1.57	1.07	8.43	1.91
BEVERLY PL	1,200	0.56	1.00	5.33	5.33	0.75	0.61	6.67	1.20
BLAKE ST	970	0.85	1.07	5.63	5.63	2.29	1.56	4.25	2.38
BOISE ST	1,125	0.33	1.67	4.00	4.00	1.10	0.92	7.00	2.12
BOLIVAR DR	788	1.00	3.67	2.50	2.50	1.98	0.46	5.50	2.11
BONAR ST	1,050	0.00	1.53	5.67	5.67	1.41	0.99	4.00	3.26

Street Name	Average[21] of								
	Total Capacity (vph)	Safety Score	Hazard Score	Connectivity	Accessibility	Congestion Score (Max)	Congestion Score (Min)	Service Score	Vulnerability Score
	▲ ▼	▲ ▼	▲ ▼	▲ ▼	▲ ▼	▲ ▼	▲ ▼	▲ ▼	▲ ▼
BONITA AVE	950	0.33	0.72	5.00	5.00	6.00	1.99	5.89	2.16
BONNIE LN	675	1.67	1.25	4.00	4.00	1.57	1.41	12.00	0.89
BOWDITCH ST	844	1.00	0.75	5.50	5.50	2.92	1.64	5.00	3.39
BOYNTON AVE	863	1.83	1.25	4.00	4.00	0.61	0.57	14.50	1.06
BREAKWATER DR	1,125	1.00	2.67	2.00	2.00	0.00	0.00	9.00	2.11
BRET HARTE PATH	1,125	3.00	1.25	4.00	4.00	0.67	0.59	14.00	1.10
BRET HARTE RD	788	2.50	1.25	4.00	4.00	1.12	1.01	13.00	1.10
BRIDGE RD	1,125	0.67	1.25	4.00	4.00	0.34	0.29	6.00	1.20
BROOKSIDE AVE	675	0.00	1.45	2.00	2.00	1.41	1.02	6.00	1.20
BROOKSIDE CT	1,125	0.00	0.75	2.00	2.00	1.03	0.77	6.00	1.20
BROOKSIDE DR	1,013	0.00	1.35	4.00	4.00	1.08	0.81	6.00	1.20
BROWNING ST	1,125	0.00	1.67	5.75	5.75	1.46	0.93	4.00	3.26
BUCHANAN ST	1,350	0.33	2.87	2.00	2.00	0.02	0.00	6.00	2.11
BUENA AVE	731	0.33	0.67	4.75	4.75	1.84	1.35	6.75	1.33
BUENA VISTA WAY	731	2.00	1.25	4.50	4.50	1.07	1.00	9.13	1.24
BURNETT ST	900	0.50	1.17	4.75	4.75	1.96	1.41	3.75	2.32
BYRON ST	1,069	0.25	1.17	4.50	4.50	1.99	1.08	3.50	3.26
CAL SAILING LOOP	1,125	0.67	2.67	4.00	4.00	0.11	0.04	5.00	2.11
CALIFORNIA ST	956	0.38	1.00	5.72	5.72	1.79	1.49	5.61	1.94
CAMELIA ST	953	0.65	1.64	5.76	5.76	1.97	0.76	3.00	1.89
CAMPUS DR	900	0.70	1.25	4.18	4.18	0.70	0.66	12.00	1.24
CANYON RD	1,125	2.00	2.75	2.00	2.00	0.61	0.37	8.00	3.30
CAPISTRANO AVE	900	1.72	1.04	5.00	5.00	1.24	0.88	8.17	1.18
CARLETON ST	956	0.75	1.19	5.60	5.60	2.15	1.22	3.85	2.30
CARLOTTA AVE	1,125	0.50	2.17	4.00	4.00	1.16	0.87	8.00	1.27
CARRISON ST	900	0.00	1.00	5.00	5.00	1.88	1.53	4.67	2.12
CATALINA AVE	1,125	0.17	1.25	4.00	4.00	1.04	0.69	8.00	1.20
CATHERINE DR	1,125	1.33	0.67	4.00	4.00	0.94	0.69	6.00	1.35
CEDAR ST	1,082	1.20	1.14	5.23	5.23	1.51	1.05	4.98	1.59
CEDARWOOD LN	1,125	0.67	2.87	4.00	4.00	0.88	0.11	4.00	2.11
CENTENNIAL DR	1,200	0.59	1.36	3.78	3.78	0.08	0.06	11.11	1.86

Street Name	Average[21] of								
	Total Capacity (vph)	Safety Score	Hazard Score	Connectivity	Accessibility	Congestion Score (Max)	Congestion Score (Min)	Service Score	Vulnerability Score
	▲ ▼	▲ ▼	▲ ▼	▲ ▼	▲ ▼	▲ ▼	▲ ▼	▲ ▼	▲ ▼
CENTER ST	844	0.08	0.67	5.75	5.75	9.26	1.99	3.25	3.31
CHABOLYN TER	675	0.00	1.25	3.00	3.00	0.55	0.48	9.00	1.20
CHANNING WAY	940	0.72	1.29	5.54	5.54	2.35	1.43	4.67	2.68
CHAUCER ST	900	1.00	1.67	4.00	4.00	1.41	1.10	4.00	3.26
CHERRY ST	675	0.33	0.75	4.00	4.00	2.63	1.98	4.00	1.74
CHESTNUT ST	928	0.96	0.67	5.50	5.50	1.74	1.23	3.50	1.39
CHILTON WAY	900	1.00	0.75	4.00	4.00	2.43	1.62	4.00	2.68
CLAREMONT AVE	3,429	1.59	1.15	4.33	4.33	0.25	0.18	4.89	1.28
CLAREMONT BLVD	964	0.71	0.82	4.86	4.86	0.76	0.55	4.86	1.74
CLAREMONT CRES	675	0.00	0.75	4.00	4.00	1.18	0.92	3.00	1.20
CODORNICES RD	1,125	1.67	1.25	2.00	2.00	0.84	0.78	9.00	1.10
COLBY ST	731	0.08	0.75	4.50	4.50	5.88	1.65	2.75	1.68
COLLEGE AVE	1,057	1.49	1.10	4.78	4.78	2.16	1.36	5.22	1.93
COLORADO AVE	675	2.17	1.25	4.00	4.00	1.14	1.06	15.00	1.06
COLUMBIA CIR	1,125	0.00	1.25	2.00	2.00	0.50	0.47	14.00	1.24
COLUSA AVE	1,054	0.54	1.01	5.00	5.00	0.95	0.70	7.32	1.19
COMSTOCK CT	1,350	0.00	0.67	4.00	4.00	0.91	0.76	7.00	1.33
CONTRA COSTA AVE	700	1.04	1.25	4.56	4.56	1.26	1.05	8.67	1.06
CORNELL AVE	1,029	0.00	0.95	5.86	5.86	1.51	1.02	2.57	1.35
CORONA CT	675	1.33	1.25	2.00	2.00	1.36	1.19	10.00	1.10
COURT ST	1,125	0.00	0.75	2.00	2.00	0.82	0.70	7.00	1.74
COWPER ST	900	0.00	0.67	4.00	4.00	2.50	1.25	4.00	3.26
CRAGMONT AVE	783	1.30	1.25	4.07	4.07	1.05	0.95	12.59	1.00
CRESCENT DR	900	0.00	0.75	4.50	4.50	2.43	0.79	3.50	3.30
CRESCENT RD	788	0.00	0.75	4.00	4.00	1.86	0.49	4.00	3.30
CRESTON RD	900	1.52	1.25	4.44	4.44	0.80	0.75	13.67	1.01
CROSS CAMPUS RD	1,125	0.00	1.75	4.00	4.00	1.70	0.47	4.00	3.30
CRYSTAL WAY	1,125	2.33	1.25	2.00	2.00	0.61	0.54	10.00	1.10
CURTIS ST	830	0.56	1.10	5.56	5.56	2.42	1.49	3.19	2.08
CUTTER WAY	1,125	0.00	1.67	4.00	4.00	1.90	0.52	4.00	2.11
CYCLOTRON RD	1,125	0.48	1.25	4.00	4.00	0.15	0.14	9.29	3.30

Street Name	Average[21] of								
	Total Capacity (vph)	Safety Score	Hazard Score	Connectivity	Accessibility	Congestion Score (Max)	Congestion Score (Min)	Service Score	Vulnerability Score
	▲ ▼	▲ ▼	▲ ▼	▲ ▼	▲ ▼	▲ ▼	▲ ▼	▲ ▼	▲ ▼
CYPRESS ST	900	0.00	0.67	3.00	3.00	1.47	1.13	7.00	1.33
DANA ST	1,648	0.48	0.89	5.29	5.29	3.32	1.26	3.71	2.47
DEAKIN ST	990	0.00	0.75	5.20	5.20	2.22	1.01	2.80	1.73
DEL MAR AVE	675	2.00	1.25	4.00	4.00	0.90	0.85	11.00	1.24
DEL NORTE ST	975	0.78	1.25	4.00	4.00	0.96	0.84	8.00	1.27
DELAWARE ST	1,017	0.46	0.75	5.13	5.13	3.31	1.50	3.91	1.73
DELMAR AVE	900	2.11	1.25	4.00	4.00	0.67	0.64	11.67	1.24
DERBY ST	870	0.82	0.93	5.10	5.10	2.32	1.63	4.73	1.99
DOHR ST	1,013	0.75	0.92	4.50	4.50	1.77	1.51	6.00	2.27
DOMINGO AVE	900	0.19	1.18	4.29	4.29	0.72	0.57	4.29	1.27
DOVER ST	1,125	1.00	1.67	4.00	4.00	0.89	0.42	5.00	2.05
DOWLING PL	900	0.33	0.75	4.00	4.00	4.87	1.34	2.00	1.68
DURANT AVE	4,573	1.43	0.88	5.50	5.50	1.08	0.45	3.70	3.12
DWIGHT CIR	1,125	1.00	1.67	6.00	6.00	1.90	0.58	3.00	2.31
DWIGHT PL	450	1.33	1.75	2.00	2.00	0.50	0.47	15.00	1.14
DWIGHT WAY	1,724	1.04	1.36	4.55	4.55	1.24	0.84	5.13	2.19
EAST GATE DR	563	0.00	1.25	4.00	4.00	0.62	0.46	6.00	3.30
EASTSHORE HWY	1,254	0.62	2.98	4.14	4.14	0.89	0.14	3.86	2.11
EASTWAY DR	1,125	0.17	0.75	4.00	4.00	0.46	0.37	6.00	1.74
EDITH ST	1,125	0.60	0.67	4.80	4.80	2.13	1.18	6.60	1.46
EDWARDS ST	1,013	0.33	1.67	5.00	5.00	1.58	1.25	5.00	3.26
EL DORADO AVE	900	1.17	1.21	5.00	5.00	1.13	1.00	8.00	1.27
EL PORTAL CT	1,125	2.00	1.25	2.00	2.00	0.52	0.48	10.00	1.24
ELLIS ST	825	0.11	0.83	5.67	5.67	2.56	1.66	5.17	2.27
ELLSWORTH ST	1,664	0.02	0.82	5.71	5.71	2.70	1.39	3.86	2.56
ELMWOOD AVE	1,125	1.00	0.75	4.00	4.00	1.46	1.02	4.00	1.20
ELMWOOD CT	450	0.33	0.75	2.00	2.00	2.23	1.61	3.00	1.20
EMERSON ST	1,050	0.44	0.75	4.67	4.67	2.15	1.11	3.00	2.05
ENCINA PL	675	0.33	1.45	4.00	4.00	1.33	1.04	5.00	1.20
ENSENADA AVE	868	1.05	0.68	5.71	5.71	1.43	0.98	7.57	1.20
EOLA ST	675	1.00	0.67	4.00	4.00	1.53	1.40	6.00	1.65

Street Name	Average[21] of								
	Total Capacity (vph)	Safety Score	Hazard Score	Connectivity	Accessibility	Congestion Score (Max)	Congestion Score (Min)	Service Score	Vulnerability Score
ESHLEMAN DR	1,125	0.33	0.75	2.50	2.50	0.63	0.15	6.00	3.30
ESPLANADE DR	900	0.00	0.75	4.00	4.00	0.41	0.15	7.00	3.30
ESSEX ST	975	0.44	0.75	5.33	5.33	2.13	1.10	3.00	2.05
ETNA ST	1,125	1.00	1.00	5.00	5.00	1.96	1.61	7.50	1.74
ETON AVE	1,125	0.00	1.45	5.00	5.00	1.13	0.82	5.00	1.20
ETON CT	1,125	1.00	1.45	3.00	3.00	0.78	0.55	6.00	1.20
EUCALYPTUS RD	1,013	1.17	1.25	4.00	4.00	0.35	0.31	8.00	1.25
EUCLID AVE	961	1.46	1.44	4.68	4.68	1.05	0.94	10.03	1.17
EUCLID ST	900	1.33	2.25	4.00	4.00	1.09	0.95	9.00	1.10
EUNICE ST	825	1.30	1.18	5.33	5.33	1.41	1.11	8.56	1.19
EVELYN AVE	900	0.00	1.67	5.50	5.50	1.08	0.91	3.00	1.35
FAIRLAWN DR	716	0.36	1.25	4.00	4.00	0.86	0.81	13.45	1.24
FAIRVIEW ST	868	0.90	0.82	5.71	5.71	2.37	1.54	5.86	2.22
FERNWALD RD	1,125	2.00	1.25	2.00	2.00	0.62	0.54	8.00	2.82
FLORENCE ST	900	1.00	0.75	4.00	4.00	5.11	1.53	2.00	1.93
FLORIDA AVE	900	1.83	1.25	3.00	3.00	0.90	0.82	15.00	1.06
FOLGER AVE	1,125	0.11	2.00	2.67	2.67	1.40	0.31	2.33	2.11
FOREST AVE	900	1.00	0.75	5.00	5.00	2.13	1.73	6.00	1.74
FOREST LN	675	2.33	1.25	4.00	4.00	0.97	0.92	13.00	1.10
FOUNTAIN WALK	1,125	1.67	1.25	7.00	7.00	0.82	0.71	8.00	1.27
FRANCISCO ST	1,050	1.17	0.67	5.50	5.50	2.75	1.34	4.83	1.63
FRANKLIN ST	1,181	0.00	0.67	5.50	5.50	1.02	0.83	4.25	1.39
FRESNO AVE	1,275	0.89	0.67	4.67	4.67	0.98	0.75	6.33	1.20
FRONTAGE RD	1,350	0.33	2.67	1.50	1.50	0.51	0.05	4.00	2.11
FULTON ST	1,918	0.07	0.88	5.60	5.60	2.40	1.46	3.33	2.62
GARBER ST	900	1.11	0.92	4.67	4.67	1.54	1.15	5.00	1.74
GAYLEY RD	900	0.33	1.75	4.50	4.50	0.46	0.22	5.83	3.30
GILMAN AVE	1,013	1.67	1.67	6.00	6.00	1.39	0.51	2.00	2.11
GILMAN ST	1,823	1.59	1.85	5.39	6.19	0.86	0.43	3.19	1.77
GLASER RD	1,125	0.00	1.25	3.00	3.00	0.05	0.05	11.00	3.30
GLEN AVE	788	1.33	1.25	4.33	4.33	1.32	1.08	9.00	1.22

Street Name	Average[21] of								
	Total Capacity (vph)	Safety Score	Hazard Score	Connectivity	Accessibility	Congestion Score (Max)	Congestion Score (Min)	Service Score	Vulnerability Score
GLENDALE AVE	975	1.33	1.25	4.00	4.00	0.70	0.66	10.67	1.24
GOLDEN GATE AVE	1,125	0.67	2.25	0.00	0.00	0.26	0.23	8.00	1.20
GRANT ST	832	0.48	0.71	5.57	5.57	4.96	2.14	4.96	1.83
GRAYSON ST	945	0.33	1.67	5.20	5.20	2.57	0.62	2.80	2.11
GREENWOOD TER	600	1.33	1.25	4.00	4.00	1.13	1.04	9.33	1.24
GRIZZLY PEAK BLVD	1,085	1.29	1.25	4.00	4.00	0.57	0.53	13.56	1.11
HALCYON CT	900	0.00	0.75	4.00	4.00	4.73	1.39	2.00	1.68
HALKIN LN	675	2.33	1.25	4.00	4.00	1.25	1.17	12.50	0.89
HARDING CIR	450	2.33	1.25	2.00	2.00	0.81	0.78	14.00	1.24
HARMON ST	900	0.63	1.04	5.50	5.50	1.98	1.36	6.38	2.18
HAROLD WAY	1,125	0.67	1.67	4.00	4.00	6.90	1.64	3.00	3.31
HARPER ST	788	0.25	0.67	5.00	5.00	2.64	1.64	4.25	2.27
HARRISON ST	917	0.15	2.05	5.23	5.23	1.32	0.27	3.15	2.00
HARVARD CIR	675	1.67	1.25	3.00	3.00	0.76	0.73	14.00	1.24
HASKELL ST	900	0.00	1.33	4.67	4.67	1.55	1.28	5.33	2.12
HASTE ST	3,800	1.77	0.83	5.40	5.40	0.81	0.48	4.20	3.17
HAVILAND RD	900	0.00	0.75	3.00	3.00	0.92	0.67	5.00	3.30
HAWTHORNE TER	900	0.53	1.25	3.80	3.80	1.41	1.28	8.20	1.24
HAZEL RD	900	0.00	1.45	4.00	4.00	1.13	0.85	5.00	1.20
HEARST AVE	1,398	1.02	1.17	5.05	5.05	2.92	1.20	3.54	2.17
HEARST MINING CIR	675	0.00	0.75	4.00	4.00	0.57	0.41	7.00	3.30
HEINZ AVE	945	0.27	1.67	4.00	4.00	2.62	0.65	2.60	2.11
HENRY ST	2,463	1.00	0.83	5.33	5.33	1.73	0.92	6.83	2.15
HIGH CT	563	1.33	1.25	4.00	4.00	1.54	1.40	10.50	1.10
HIGHLAND PL	1,125	1.17	1.25	4.00	4.00	0.44	0.42	6.00	1.79
HILGARD AVE	1,093	0.71	1.25	4.57	4.57	1.13	0.99	7.43	1.79
HILGARD WAY	1,125	0.00	0.75	1.00	1.00	1.18	0.54	5.00	3.30
HILL CT	900	0.00	1.25	2.00	2.00	1.47	1.36	7.00	1.24
HILL RD	720	1.60	1.25	3.00	3.00	0.75	0.71	13.80	1.24
HILLCREST CT	450	2.00	1.25	2.00	2.00	1.72	1.40	6.00	1.20
HILLCREST RD	850	1.41	1.27	3.56	3.56	0.68	0.55	7.56	1.20

Street Name	Average[21] of								
	Total Capacity (vph)	Safety Score	Hazard Score	Connectivity	Accessibility	Congestion Score (Max)	Congestion Score (Min)	Service Score	Vulnerability Score
HILLDALE AVE	816	2.25	1.25	4.25	4.25	1.07	0.99	12.88	1.00
HILLEGASS AVE	872	0.21	0.75	5.38	5.38	4.27	1.75	3.63	2.03
HILLSIDE AVE	1,125	0.00	1.25	3.33	3.33	0.86	0.73	7.00	2.82
HILLSIDE CT	1,125	1.67	1.25	2.00	2.00	0.90	0.74	6.00	2.82
HILLVIEW RD	900	1.00	1.25	4.00	4.00	0.40	0.38	14.50	1.10
HOLLY ST	675	0.17	0.67	5.00	5.00	2.08	1.58	5.50	1.33
HOPKINS ST	1,001	1.25	0.86	4.52	4.52	1.28	0.91	5.66	1.29
HOWE ST	900	1.00	0.75	4.00	4.00	5.28	1.63	2.00	1.93
I80 EAST (OFF RAMP) GILMAN HWY	3,400	0.33	2.87	4.00	9.00	0.25	0.04	4.00	2.11
I80 EAST (ON RAMP) ASHBY HWY	1,700	0.33	2.67	2.33	7.33	0.01	0.00	4.67	2.11
I80 EAST (ON RAMP) GILMAN HWY	3,400	0.33	2.87	4.00	9.00	0.15	0.02	4.00	2.11
I80 EAST HWY	11,250	0.65	2.67	4.00	5.25	0.74	0.08	4.13	2.11
I80 W FRONTAGE RD	1,294	0.42	2.69	5.00	5.00	0.58	0.12	4.00	2.11
I80 WEST (OFF RAMP) ASHBY HWY	3,000	0.38	2.67	3.25	8.25	0.00	0.00	4.00	2.07
I80 WEST (OFF RAMP) GILMAN HWY	3,400	0.33	2.67	4.00	9.00	0.12	0.02	4.00	2.11
I80 WEST (ON RAMP) ASHBY HWY	2,700	0.71	2.67	3.00	8.00	0.01	0.00	4.50	2.11
I80 WEST (ON RAMP) GILMAN HWY	3,400	0.33	2.67	4.00	9.00	0.19	0.03	4.00	2.11
I80 WEST HWY	11,925	0.63	2.67	4.00	5.00	0.68	0.07	4.10	2.11
IDAHO ST	900	0.75	1.67	4.50	4.50	0.94	0.75	6.25	2.12
INDIAN ROCK AVE	825	1.33	1.25	4.00	4.00	1.07	0.96	9.83	1.06
JAYNES ST	1,125	0.17	0.67	4.50	4.50	1.03	0.90	6.50	1.33
JEFFERSON AVE	1,170	0.53	1.27	5.60	5.60	1.76	1.49	4.80	1.70
JONES ST	1,029	0.19	2.01	5.71	5.71	1.54	0.70	3.14	1.95
JOSEPHINE ST	1,061	0.33	0.74	5.14	5.14	1.95	1.21	7.14	1.34
JUANITA WAY	675	1.17	0.67	4.00	4.00	1.68	1.34	5.00	1.35
JULIA ST	1,125	0.00	0.67	5.00	5.00	1.80	1.43	5.50	2.26
KAINS AVE	932	0.05	0.81	5.71	5.71	1.70	0.95	2.14	1.35
KEELER AVE	816	1.54	1.25	4.31	4.31	0.90	0.82	13.81	1.09
KEITH AVE	720	0.57	1.25	4.20	4.20	1.08	0.97	12.20	1.10
KELSEY ST	1,125	0.33	0.75	4.00	4.00	1.25	0.94	5.00	1.74
KENTUCKY AVE	750	1.89	1.25	3.33	3.33	0.88	0.81	15.67	1.06

Street Name	Average[21] of								
	Total Capacity (vph)	Safety Score	Hazard Score	Connectivity	Accessibility	Congestion Score (Max)	Congestion Score (Min)	Service Score	Vulnerability Score
KEONCREST DR	900	1.25	0.67	3.50	3.50	1.18	0.91	5.00	1.35
KING ST	859	0.00	1.03	5.45	5.45	2.32	1.59	5.45	2.27
KITTREDGE ST	900	0.89	0.67	4.67	4.67	7.43	2.08	2.33	3.31
LA LOMA AVE	881	0.94	1.25	4.58	4.58	0.92	0.86	7.50	1.61
LA VEREDA RD	1,125	1.67	1.25	4.00	4.00	0.64	0.60	8.50	1.65
LASSEN ST	900	0.67	1.25	4.00	4.00	0.95	0.78	8.00	1.27
LATHAM LN	675	2.00	1.25	4.00	4.00	0.92	0.85	13.00	1.10
LAUREL LN	788	1.83	1.25	5.00	5.00	1.52	1.12	9.00	1.20
LAUREL ST	1,125	1.33	1.25	4.00	4.00	0.72	0.66	10.00	1.10
LE CONTE AVE	900	0.48	1.25	4.89	4.89	1.16	1.00	5.89	1.79
LE ROY AVE	1,125	0.67	1.25	3.00	3.00	0.78	0.71	8.00	1.24
LEROY AVE	750	0.85	1.25	4.56	4.56	1.37	1.24	7.11	1.55
LEWISTON AVE	1,125	0.00	0.75	4.00	4.00	1.06	0.74	6.00	1.20
LINCOLN ST	1,069	0.50	0.67	4.75	4.75	1.35	1.09	5.50	1.62
LINDEN AVE	900	0.67	0.75	4.00	4.00	1.65	1.19	3.00	1.20
LORINA ST	450	0.33	0.75	4.00	4.00	5.14	2.76	3.00	2.10
LOS ANGELES AVE	1,097	0.63	1.25	3.88	3.88	0.95	0.82	8.00	1.19
MABEL ST	813	0.51	1.44	5.38	5.38	1.66	1.32	4.54	2.26
MADERA ST	1,050	0.89	0.67	4.00	4.00	0.77	0.52	6.33	1.20
MAGNOLIA ST	675	0.67	0.75	4.00	4.00	1.91	1.40	3.00	1.20
MARIN AVE	2,033	2.01	1.10	4.88	4.88	0.74	0.66	9.04	1.09
MARINA BLVD	1,238	0.00	2.77	2.25	2.25	0.03	0.02	5.75	2.11
MARIPOSA AVE	1,125	0.17	1.25	4.00	4.00	0.98	0.84	9.00	1.27
MARTIN LUTHER KING JR WAY	3,059	1.17	0.91	5.32	5.32	1.94	0.70	4.43	2.33
MARYLAND AVE	675	2.50	1.25	4.00	4.00	0.85	0.78	16.50	1.06
MATHEWS ST	996	0.57	1.67	5.71	5.71	1.68	0.96	4.00	2.32
MAYBECK TWIN DR	450	3.00	1.25	2.00	2.00	1.55	1.44	8.00	1.24
MC GEE AVE	1,021	0.72	0.71	5.46	5.46	2.90	1.56	5.62	1.77
MC KINLEY AVE	1,069	0.67	0.92	5.50	5.50	5.46	1.82	4.25	1.70
MCMILLIAN RD	1,141	0.67	1.25	4.00	4.00	0.05	0.04	10.07	2.69
MENDOCINO AVE	788	2.50	1.25	3.00	3.00	1.35	1.09	9.00	1.06

Street Name	Average[21] of								
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MENLO PL	788	1.42	1.25	4.00	4.00	0.99	0.90	11.25	1.20
MERCED ST	1,125	1.00	0.67	5.00	5.00	0.88	0.66	7.00	1.20
MICHIGAN AVE	900	1.58	1.25	4.00	4.00	0.96	0.89	15.25	1.06
MIDDLEFIELD RD	844	1.42	1.25	3.25	3.25	0.56	0.52	15.25	1.10
MILLER AVE	798	2.09	1.25	4.36	4.36	0.98	0.89	13.64	1.10
MILLER RD	675	1.67	1.25	4.00	4.00	0.91	0.84	13.00	1.10
MILVIA ST	885	0.80	0.75	5.48	5.48	5.94	2.03	4.77	2.30
MINING CIR	600	0.00	0.75	4.00	4.00	0.56	0.41	6.33	3.30
MIRAMAR AVE	675	0.67	0.67	4.00	4.00	1.40	0.92	7.00	1.20
MIRAMONTE CT	1,125	0.67	0.67	2.00	2.00	0.98	0.71	6.00	1.33
MODOC ST	1,125	0.00	0.67	4.00	4.00	1.07	0.66	6.00	1.20
MONTEREY AVE	1,041	0.29	1.17	5.50	5.50	0.85	0.72	6.88	1.21
MONTROSE RD	788	3.00	1.25	5.00	5.00	1.20	1.06	12.00	1.06
MOSSWOOD RD	990	1.60	1.75	2.00	2.00	0.57	0.37	7.80	2.92
MUIR WAY	900	1.67	1.25	4.00	4.00	0.56	0.51	13.00	1.10
MURRAY ST	900	0.00	1.67	4.00	4.00	2.04	0.65	2.50	2.11
MY WAY	450	1.67	1.25	2.00	2.00	0.92	0.84	17.00	0.89
MYSTIC ST	1,125	0.00	1.45	2.00	2.00	0.63	0.44	6.00	1.20
NAPA AVE	1,125	1.00	1.17	4.00	4.00	1.04	0.88	9.00	1.27
NEILSON ST	844	0.75	0.81	5.13	5.13	1.06	0.90	6.38	1.27
NEWBURY ST	675	0.33	0.75	4.00	4.00	3.28	1.71	3.00	2.10
NOGALES ST	1,125	0.00	1.25	4.00	4.00	0.56	0.45	6.00	1.20
NOGALES ST PATH	1,125	1.00	1.25	4.00	4.00	0.48	0.38	6.00	1.20
NORTH ST	1,125	0.00	0.96	2.00	2.00	0.94	0.86	7.00	1.54
NORTH VALLEY ST	1,125	0.00	1.87	2.00	2.00	1.31	0.85	5.00	3.26
NORTHAMPTON AVE	900	2.67	1.25	4.00	4.00	1.15	1.06	13.00	1.06
NORTHGATE AVE	788	1.00	1.25	3.00	3.00	0.85	0.77	12.00	1.24
NORTHSIDE AVE	1,125	0.78	0.67	3.33	3.33	1.05	0.92	4.67	1.35
OAK KNOLL TER	1,013	1.00	0.75	3.50	3.50	0.75	0.54	6.00	1.74
OAK ST	525	1.78	1.25	4.00	4.00	1.54	1.36	10.33	1.10
OAKRIDGE RD	675	0.33	1.25	2.00	2.00	0.81	0.62	4.67	1.20

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OAKVALE AVE	788	0.00	1.20	4.00	4.00	1.71	1.34	5.00	1.20
OLYMPUS AVE	675	2.00	1.25	3.60	3.60	0.64	0.62	14.40	1.41
ORDWAY ST	1,013	0.67	1.17	5.25	5.25	1.26	0.98	5.00	1.35
OREGON ST	853	0.74	0.90	5.53	5.53	2.66	1.57	4.16	2.20
OTIS ST	675	0.67	0.67	4.00	4.00	3.28	1.74	3.00	2.10
OVERLOOK RD	975	1.56	1.25	3.33	3.33	0.57	0.53	13.67	1.10
OXFORD ST	2,957	0.91	1.01	5.42	5.42	1.33	0.90	5.58	2.44
PAGE ST	1,035	0.38	1.92	5.93	5.93	1.68	0.67	3.20	1.91
PALM CT	1,125	0.67	0.75	2.00	2.00	1.03	0.82	5.00	1.74
PANORAMIC PL	1,125	1.67	1.75	2.00	2.00	0.20	0.19	15.00	2.80
PANORAMIC WAY	888	1.16	1.80	3.68	3.68	0.55	0.39	10.58	2.47
PARDEE ST	788	1.00	1.67	5.50	5.50	2.69	0.69	2.50	2.11
PARK HILLS RD	855	1.30	1.25	4.20	4.20	0.63	0.60	14.20	1.10
PARK ST	750	1.00	1.00	4.00	4.00	2.03	1.70	5.33	2.32
PARK WAY	1,125	0.67	2.87	3.00	3.00	0.97	0.12	3.00	2.11
PARKER ST	931	0.44	1.12	5.59	5.59	2.34	1.50	4.34	2.30
PARKSIDE DR	996	0.05	1.25	3.57	3.57	0.65	0.55	6.71	1.20
PARNASSUS CT	900	0.17	1.25	2.00	2.00	0.50	0.48	12.50	1.24
PARNASSUS RD	750	1.11	1.25	4.00	4.00	0.68	0.66	13.00	1.24
PERALTA AVE	765	0.27	0.89	5.00	5.00	1.35	1.00	7.20	1.23
PIEDMONT AVE	900	0.96	1.09	4.16	4.16	1.47	1.05	5.60	2.50
PIEDMONT CIR	1,013	1.00	1.25	4.00	4.00	1.61	1.34	5.50	2.28
PINE AVE	1,013	0.83	0.75	5.00	5.00	1.17	0.89	3.00	1.47
POE ST	1,125	0.00	1.67	2.00	2.00	0.94	0.62	5.00	3.26
POPLAR ST	750	2.67	1.25	4.00	4.00	1.26	1.11	12.67	0.89
POPPY LN	675	1.78	1.25	4.67	4.67	1.08	0.99	12.67	1.10
PORTLAND AVE	1,013	0.58	0.85	6.25	6.25	0.95	0.73	8.00	1.20
POSEN AVE	1,013	1.08	0.67	4.75	4.75	0.80	0.61	6.25	1.16
POTTER ST	1,181	0.00	2.67	3.50	4.75	1.40	0.22	3.25	2.11
PRINCE ST	817	0.44	0.73	4.95	4.95	3.08	1.51	4.47	1.95
PROSPECT ST	1,050	0.44	1.25	4.00	4.00	1.15	0.88	7.00	2.82

Street Name	Average[21] of								
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	▲ ▼	▲ ▼	▲ ▼	▲ ▼	▲ ▼	▲ ▼	▲ ▼	▲ ▼	▲ ▼
QUAIL AVE	788	1.00	1.25	5.00	5.00	0.91	0.83	12.00	1.24
QUEENS RD	638	1.00	1.25	3.83	3.83	1.05	1.00	12.67	1.24
REGAL RD	900	2.00	1.25	5.00	5.00	1.07	0.97	11.25	1.00
REGENT ST	923	0.70	0.75	5.00	5.00	4.15	1.51	3.60	1.99
RIDGE RD	1,013	0.42	1.25	6.00	6.00	1.11	0.93	5.00	1.79
RIMWAY RD	825	0.00	2.42	4.67	4.67	0.52	0.25	6.33	3.30
ROANOKE RD	900	1.17	1.25	5.00	5.00	0.46	0.42	8.00	1.20
ROBLE CT	1,125	1.67	1.25	2.00	2.00	0.22	0.19	10.00	1.20
ROBLE RD	788	0.33	1.25	3.00	3.00	0.25	0.20	7.50	1.20
ROCHDALE WAY	900	3.00	1.25	2.00	2.00	0.33	0.32	17.00	0.89
ROCK LN	600	2.33	1.25	4.00	4.00	1.54	1.38	12.33	0.89
ROOSEVELT AVE	956	0.75	0.92	5.50	5.50	6.58	2.56	5.50	1.70
ROSE ST	999	1.48	0.85	4.74	4.74	1.55	1.12	6.88	1.48
ROSEMONT AVE	675	2.00	1.25	5.00	5.00	0.76	0.69	16.50	0.89
ROSLYN CT	675	0.00	1.25	2.00	2.00	0.56	0.49	9.00	1.20
RUGBY AVE	900	1.00	1.25	4.00	4.00	0.44	0.39	17.00	1.06
RUSSELL ST	846	0.58	0.78	4.59	4.59	2.85	1.55	3.96	2.08
SACRAMENTO ST	3,595	1.09	0.94	5.32	5.32	0.44	0.36	5.16	1.94
SAN ANTONIO AVE	1,050	2.00	1.25	4.67	4.67	0.78	0.70	13.00	1.06
SAN BENITO RD	675	1.67	1.25	4.00	4.00	1.84	1.63	10.00	1.27
SAN DIEGO RD	855	1.80	1.25	3.60	3.60	0.97	0.87	12.40	1.06
SAN FERNANDO AVE	675	1.50	1.25	4.50	4.50	1.35	1.23	11.50	1.06
SAN JUAN AVE	1,125	1.33	1.25	4.00	4.00	0.85	0.79	12.00	1.06
SAN LORENZO AVE	771	1.29	0.90	5.29	5.29	1.35	0.97	8.29	1.20
SAN LUIS RD	825	1.63	1.25	4.00	4.00	0.91	0.83	13.11	1.06
SAN MATEO RD	750	2.00	1.25	2.00	2.00	1.18	1.02	10.00	1.06
SAN MIGUEL AVE	675	1.33	1.25	4.00	4.00	1.21	1.12	10.00	1.20
SAN PABLO AVE	3,800	1.95	1.60	5.02	5.02	0.44	0.23	2.70	2.15
SAN PEDRO AVE	788	1.33	1.25	4.00	4.00	1.47	1.00	8.00	1.20
SAN RAMON AVE	750	1.56	1.25	4.00	4.00	1.00	0.91	13.67	1.06
SAN ROSA AVE	1,125	1.00	1.25	2.00	2.00	0.76	0.70	10.00	1.20

Street Name	Average[21] of								
	Total Capacity (vph)	Safety Score	Hazard Score	Connectivity	Accessibility	Congestion Score (Max)	Congestion Score (Min)	Service Score	Vulnerability Score
	▲ ▼	▲ ▼	▲ ▼	▲ ▼	▲ ▼	▲ ▼	▲ ▼	▲ ▼	▲ ▼
SANTA BARBARA RD	802	1.50	1.25	4.69	4.69	1.07	0.96	12.38	1.08
SANTA CLARA AVE	900	1.33	1.25	4.00	4.00	0.85	0.77	11.00	1.06
SANTA FE AVE	900	0.33	1.00	5.50	5.50	1.27	1.05	3.17	1.35
SANTA ROSA AVE	900	1.25	1.25	4.50	4.50	1.04	0.95	9.50	1.20
SCENIC AVE	788	1.04	1.25	5.25	5.25	1.98	1.70	7.50	1.51
SEAWALL DR	844	1.00	2.67	2.63	2.63	0.08	0.03	6.63	2.11
SENIOR AVE	900	1.67	1.25	5.00	5.00	0.57	0.55	14.00	1.24
SHASTA RD	844	0.83	1.25	4.06	4.06	0.74	0.68	13.00	1.17
SHATTUCK AVE	3,060	1.47	0.82	5.71	5.71	1.17	0.63	4.12	2.26
SHATTUCK PL	3,800	1.47	0.97	5.40	5.40	0.55	0.36	7.00	2.14
SHATTUCK SQ	3,800	0.00	0.67	5.00	5.00	1.22	0.34	3.00	3.31
SHORT ST	788	0.50	0.67	4.00	4.00	1.42	1.17	4.00	1.39
SIERRA ST	900	0.67	0.67	4.00	4.00	1.15	0.82	7.00	1.20
SMYTH RD	1,125	2.00	1.25	2.00	2.00	0.39	0.35	9.00	2.82
SOJOURNER TRUTH WAY	1,125	0.33	0.67	2.00	2.00	1.25	1.07	6.00	2.32
SOLANO AVE	935	0.28	0.81	5.08	5.08	1.16	0.73	6.54	1.18
SOMERSET PL	1,013	1.00	1.25	2.75	2.75	0.75	0.69	11.25	1.06
SONOMA AVE	868	0.10	0.81	4.71	4.71	1.05	0.93	7.00	1.20
SOULE RD	1,125	0.00	0.75	2.50	2.50	0.75	0.49	5.50	3.30
SOUTH DR	675	0.00	1.25	4.00	4.00	0.90	0.33	6.50	3.30
SOUTH HALL RD	675	0.00	0.75	3.50	3.50	0.70	0.23	6.50	3.30
SOUTH ST	450	0.00	0.75	4.00	4.00	1.72	1.44	6.00	1.74
SOUTHAMPTON AVE	868	1.95	1.25	3.86	3.86	0.81	0.74	12.29	1.06
SOUTHWEST ST	675	0.00	0.75	4.00	4.00	1.68	1.38	6.00	1.74
SPAULDING AVE	1,181	0.67	1.67	5.50	5.50	1.51	1.26	4.50	1.70
SPINNAKER WAY	1,125	0.00	2.67	3.25	3.25	0.00	0.00	8.25	2.11
SPORTS LN	675	0.00	1.00	4.00	4.00	1.09	0.94	7.50	1.74
SPRING WAY	675	0.33	1.25	2.00	2.00	1.74	1.55	10.00	1.24
SPRUCE ST	1,118	0.83	1.31	4.19	4.19	1.01	0.83	10.63	1.09
STANFORD AVE	3,800	0.33	1.67	4.67	4.67	0.23	0.12	7.00	2.23
STANNAGE AVE	1,125	0.05	0.67	5.43	5.43	1.46	0.89	2.43	1.35

Street Name	Average[21] of								
	Total Capacity (vph)	Safety Score	Hazard Score	Connectivity	Accessibility	Congestion Score (Max)	Congestion Score (Min)	Service Score	Vulnerability Score
	▲ ▼	▲ ▼	▲ ▼	▲ ▼	▲ ▼	▲ ▼	▲ ▼	▲ ▼	▲ ▼
STANTON ST	1,050	0.33	0.67	4.00	4.00	1.90	1.65	6.00	2.25
STATION PL	1,125	0.67	1.25	2.00	2.00	0.91	0.61	7.00	1.20
STERLING AVE	725	2.30	1.25	4.00	4.00	1.05	0.94	13.67	1.10
STEVENSON AVE	788	2.83	1.25	4.00	4.00	0.75	0.67	13.00	1.10
STODDARD WAY	1,125	2.67	1.25	2.00	2.00	0.56	0.51	14.00	1.10
STUART ST	875	0.69	0.84	5.33	5.33	2.34	1.49	4.00	2.00
SUMMER ST	675	1.33	1.25	4.00	4.00	1.71	1.41	9.00	1.24
SUMMIT RD	816	1.33	1.25	3.13	3.13	0.48	0.45	13.50	1.19
SUNSET LN	731	1.67	1.25	4.00	4.00	0.71	0.66	13.50	0.97
SUNSET TRAIL	1,125	0.67	1.25	2.00	2.00	0.19	0.16	7.00	1.01
SUTTER ST	1,200	1.78	1.19	5.00	5.00	1.00	0.79	8.00	1.27
SW PL	900	0.00	0.75	4.00	4.00	0.91	0.76	6.00	1.74
TACOMA AVE	900	1.67	1.08	5.50	5.50	1.35	0.92	7.50	1.20
TALBOT AVE	900	0.00	1.33	6.00	6.00	1.61	1.26	3.00	1.35
TAMALPAIS PATH	1,125	2.00	1.25	2.00	2.00	0.52	0.47	15.00	1.10
TAMALPAIS RD	619	2.00	1.25	4.00	4.00	1.10	1.01	12.00	1.14
TANGLEWOOD RD	1,125	0.75	1.25	3.50	3.50	0.48	0.35	5.25	1.74
TELEGRAPH AVE	3,800	1.65	1.10	5.35	5.35	0.83	0.32	2.85	2.30
TERMINAL PL	1,125	1.00	0.67	2.00	2.00	3.39	0.79	3.00	3.31
TEVLIN ST	1,125	1.11	1.00	3.00	3.00	0.79	0.71	4.33	1.35
THE PLAZA DR	731	0.08	1.30	4.00	4.00	0.97	0.82	6.50	1.20
THE UPLANDS PATH	1,125	1.00	1.25	4.00	4.00	0.44	0.40	6.00	1.20
THOUSAND OAKS BLVD	839	1.55	1.11	5.27	5.27	0.88	0.83	9.55	1.16
TOMLEE DR	675	1.33	0.67	4.00	4.00	1.72	1.39	6.00	1.35
TREMONT ST	956	1.00	0.75	5.00	5.00	1.72	0.93	4.25	2.05
TULARE AVE	1,125	0.33	0.67	4.00	4.00	0.80	0.50	6.75	1.20
TUNNEL RD	1,414	2.05	1.25	4.29	4.29	0.29	0.24	5.43	1.20
TWAIN AVE	675	3.67	1.25	4.00	4.00	1.21	1.09	14.00	1.10
TYLER ST	1,125	1.00	0.67	5.00	5.00	2.01	1.61	5.50	2.27
UNIVERSITY AVE	2,814	0.98	1.61	5.08	5.15	1.14	0.39	3.27	2.19
UNIVERSITY DR	844	0.00	0.75	4.00	4.00	0.28	0.15	6.50	3.30

Street Name	Average[21] of								
	Total Capacity (vph)	Safety Score	Hazard Score	Connectivity	Accessibility	Congestion Score (Max)	Congestion Score (Min)	Service Score	Vulnerability Score
	▲ ▼	▲ ▼	▲ ▼	▲ ▼	▲ ▼	▲ ▼	▲ ▼	▲ ▼	▲ ▼
UNNAMED UC BERKELEY PATH	844	0.00	0.75	2.75	2.75	1.19	0.56	5.25	3.30
VALLEJO ST	900	2.67	1.25	4.00	4.00	0.71	0.64	12.00	1.06
VALLEY ST	1,013	0.67	1.67	4.00	4.00	1.31	1.02	5.00	3.26
VASSAR AVE	750	1.44	1.25	3.33	3.33	0.78	0.72	15.67	1.06
VERMONT AVE	765	1.60	1.25	3.20	3.20	0.66	0.60	16.40	1.06
VICENTE RD	1,125	1.67	1.25	2.00	2.00	0.15	0.13	7.00	1.20
VINCENTE AVE	750	1.22	1.14	4.67	4.67	1.26	1.02	9.17	1.17
VINE ST	948	0.93	0.87	5.86	5.86	2.10	1.51	7.21	1.72
VIRGINIA GDNS	675	0.00	0.67	2.00	2.00	1.55	1.39	5.00	1.39
VIRGINIA ST	905	0.46	1.10	5.09	5.09	2.35	1.29	4.76	1.77
VISALIA AVE	900	1.67	1.08	4.00	4.00	0.51	0.49	10.00	1.15
VISTAMONT AVE	619	1.83	1.25	3.00	3.00	0.80	0.74	16.50	0.89
WALKER ST	1,125	0.67	0.75	4.00	4.00	1.69	0.92	3.00	2.10
WALLACE ST	1,125	1.00	1.67	4.00	4.00	1.53	0.89	4.00	2.32
WALNUT ST	968	0.83	0.93	5.10	5.10	2.37	1.53	6.70	1.98
WARD ST	979	0.70	1.09	5.05	5.05	1.79	1.19	4.00	2.21
WARRING ST	1,029	1.00	1.04	4.14	4.14	1.58	1.31	6.00	2.05
WEBSTER ST	840	0.42	0.76	4.20	4.20	4.46	1.58	3.07	1.52
WEST CIR	720	0.00	0.75	4.00	4.00	1.31	0.35	5.00	3.30
WEST CRESCENT DR	900	0.00	1.75	5.00	5.00	2.41	0.64	3.00	3.30
WEST ST	950	0.37	1.16	4.89	4.89	1.58	1.18	3.78	2.22
WHEELER ST	765	0.20	0.75	4.80	4.80	2.74	1.46	3.00	2.06
WHITAKER AVE	563	3.50	1.25	4.00	4.00	1.14	1.03	14.00	1.10
WHITNEY ST	675	0.00	0.75	4.00	4.00	1.70	1.00	3.00	2.05
WICKSON RD	750	0.00	1.08	4.00	4.00	0.77	0.27	6.00	3.30
WILDCAT CANYON RD	1,125	0.30	1.25	4.00	4.00	0.31	0.30	15.67	1.01
WILLOW WALK	1,125	0.67	1.25	2.00	2.00	0.22	0.20	7.00	1.20
WILSON CIR	225	1.67	1.25	2.00	2.00	1.29	1.25	15.00	1.24
WOODHAVEN RD	675	1.33	1.25	4.00	4.00	0.54	0.52	15.00	1.10
WOODHAVEN ST	450	1.33	1.25	2.00	2.00	0.51	0.50	16.00	1.10
WOODMONT AVE	872	1.46	1.31	3.75	3.75	0.60	0.55	15.38	0.87

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WOODMONT CT	1,125	2.00	1.25	2.00	2.00	0.46	0.41	17.00	0.89
WOODSIDE RD	825	1.78	1.25	4.67	4.67	0.52	0.49	14.00	1.10
WOOLSEY ST	779	0.41	1.06	4.88	4.88	3.12	1.38	4.58	1.83
YOLO AVE	1,050	0.33	1.17	4.00	4.00	1.12	0.90	8.00	1.27
YOSEMITE RD	844	2.08	1.25	4.00	4.00	1.12	1.03	10.25	1.06
I80 EAST (OFF RAMP) UNIV	1,433	0.33	2.80	3.00	7.44	1.34	0.34	3.89	2.11
UNIVERSITY AVE OVERPASS	3,393	1.56	2.65	4.48	4.91	0.66	0.18	3.26	2.11
I80 WEST (OFF RAMP) UNIV	1,438	0.08	2.67	2.50	7.50	1.05	0.20	3.50	2.11
RAMP	1,700	0.33	2.67	2.50	7.50	0.55	0.15	4.00	2.11
NORTHBRAE TUNNEL	750	0.33	1.25	7.00	7.00	1.27	1.13	8.00	1.13
I80 EAST (ON RAMP) UNIV	1,700	0.33	2.87	2.00	7.00	1.33	0.33	4.00	2.11
UNNAMED ALLEY	825	1.00	2.00	4.44	4.44	2.78	0.97	3.11	2.07
THE UPLANDS	875	0.85	1.27	4.33	4.33	0.76	0.64	6.11	1.20
EL CAMINO REAL	675	0.67	1.25	3.83	3.83	0.66	0.56	6.50	1.20
SPINNAKER CIRCLE	563	0.00	2.67	3.00	3.00	0.00	0.00	10.00	2.11
I80 WEST (ON RAMP) UNIV	1,350	0.00	2.67	3.33	8.33	1.01	0.19	4.00	2.11
UNNAMED LBL ROAD	1,125	0.33	1.25	4.00	4.00	0.31	0.29	8.00	3.30
EASTSHORE	1,125	0.67	2.87	4.00	4.00	2.08	0.44	3.00	2.11
THE CIRCLE	611	1.48	1.25	4.00	4.00	1.28	1.18	8.00	1.17
THE ALAMEDA	1,712	0.52	1.30	4.56	4.56	0.77	0.65	8.56	1.12
UNNAMED	1,044	0.28	1.21	2.72	2.72	0.57	0.29	8.20	2.92
REGAL	675	1.67	1.25	4.00	4.00	1.18	1.06	12.50	1.10
ROANE	450	1.67	1.25	4.00	4.00	1.57	1.36	12.00	1.10
UNNAMED UC BERKELEY	788	0.06	1.08	3.17	3.17	0.60	0.23	6.50	3.30
I80 EAST	12,375	0.58	2.67	4.00	4.00	0.63	0.06	4.00	2.11
PARK GATE	788	0.67	1.25	4.50	4.50	0.59	0.54	14.00	1.10
GREENWOOD COMMONS	675	1.00	1.25	2.00	2.00	1.06	0.97	9.00	1.24
THE CRESCENT	788	1.17	1.25	4.50	4.50	0.51	0.49	15.50	1.10
THE SHORT CUT	675	2.00	1.25	4.00	4.00	0.69	0.64	15.00	1.10
THE CROSSWAYS	675	2.33	1.25	4.00	4.00	0.68	0.63	14.00	1.10
THE SPIRAL	1,125	2.00	1.25	2.00	2.00	0.27	0.26	16.00	1.10

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EASTWAY	1,125	0.00	0.75	4.00	4.00	0.44	0.35	6.00	1.74
CHILTON ALLEY	675	1.00	0.75	4.00	4.00	2.96	1.87	4.00	2.68
EASTSHORE OFF I80	1,125	0.33	2.87	3.00	3.00	1.75	0.40	4.00	2.11
MASONIC AVE	900	0.00	0.67	6.00	6.00	0.90	0.80	4.00	1.35
ALBINA AVE	1,125	0.67	1.17	4.00	4.00	0.93	0.65	6.00	1.35
WATKINS ST	1,125	1.00	0.67	4.00	4.00	0.79	0.71	4.00	1.35
HOPKINS CT	1,125	1.67	0.67	4.00	4.00	0.92	0.64	6.00	1.35

Appendix E

Evacuation Time Study

Office of the City Manager

July 15, 2025

To: Honorable Mayor and Members of the City Council

From: Paul Buddenhagen, City Manager

Re: Evacuation Time Study

The purpose of this memo is to present the City Council with key findings from the Evacuation Time Study ("the Study").

In July 2025, KLD Associates, Inc. finished an Evacuation Time Study contracted by the City of Berkeley predicting evacuation dynamics during a wildfire, tsunami, or other major emergency. It estimates evacuation times for different parts of Berkeley, considering the time of day, day of the week, and season. It includes a series of "what-if" analyses that test strategies to improve evacuation times for Berkeley households and ingress times for emergency responders. The study also examines how future development or zoning changes that increase housing density in the Berkeley Hills may impact evacuation times. The impact of congestion patterns and traffic calming devices on traffic flow during evacuations is also analyzed. Finally, the Study offers recommendations for the City to consider to improve evacuation performance and enhance public safety during emergencies.

Memo Overview
This memo provides an overview of the Evacuation Time Study and presents key findings relevant to public safety and emergency planning. It begins by introducing the Study and summarizing evacuation time estimates across various hazard scenarios. Staff then offer a high-level analysis comparing these estimates with the expected arrival times of wildfire and tsunami threats, to better understand the implications for community safety.

The memo highlights evacuation behavior patterns specific to the Berkeley community, including projected transportation needs during a large-scale evacuation. These findings underscore the City's reliance on regional partners to provide mass transportation support during major emergencies. Community members should use these and other key study findings when creating or updating their household evacuation plans. The most important recommendations:

- Connect with neighbors and plan to help each other evacuate;

- Carpool when evacuating to reduce traffic and assist neighbors without vehicles;
- Berkeley Hills residents, especially those needing extra time or support, should plan to leave early during extreme fire weather; and
- People in Berkeley's tsunami zone (generally west of 7th Street) should include walking or biking in their tsunami evacuation plans when possible.

The memo then reviews the Study's findings on traffic flow and roadway use during evacuations. It emphasizes that all city roadways may be needed as evacuation routes and details areas where traffic congestion is expected. The Study finds that while parking restrictions may not significantly improve evacuation times for residents, they may support emergency responder access. The Study also notes that traffic congestion is expected in many areas during large-scale evacuations, and four areas consistently show congestion that is likely exacerbated by pre-timed traffic signals and street designs that slow or limit vehicle movement.

Next, the memo outlines Study findings about the impacts on evacuation times from increased density in the Berkeley Hills. Broadly speaking, adding people to the Berkeley Hills increases evacuation times for the area. Maximum permissible development of Accessory Dwelling Units (ADUs) and Junior Accessory Dwelling Units (JADUs) increases evacuation times for a 1923 Fire Repeat by 102% on average, and for a Panoramic Hill Fire by 52% on average. The model suggests that land use changes similar to the recently-approved Middle Housing Zoning could result in increases in evacuation times of up to 6% for a 1923 Fire Repeat. The percentage increases for Middle Housing are lower than ADU/JADU development because there are considerably fewer parcels likely to develop Middle Housing by 2031 as compared to maximum permissible ADU/JADU development. The memo details that even when new residents are assumed to use transit to evacuate, the additional density from maximum permissible development could increase evacuation times by as much as 70%. The memo then reports on Study findings about how a secondary egress route from Panoramic Hill could reduce evacuation times for the area, primarily benefitting Oakland residents.

Finally, the memo outlines key recommendations from the Study for City consideration. These include actions related to emergency response strategies, housing development policy, community alerting and education, traffic calming devices, traffic signal improvements, and parking and roadway design. City officials support the Study's findings and are working to incorporate these recommendations into future planning and operational efforts.

Introduction to the Evacuation Time Study

Evacuating people from hazardous areas is one of the most critical strategies for protecting the Berkeley community during wildfires, tsunamis, and other emergencies. Berkeley's roadway network is designed to balance the need for vehicle movement with safety goals—such as reducing speeds to lower the risk of severe or fatal traffic

crashes. During an emergency evacuation, this same network may be called upon to support the rapid, large-scale movement of tens of thousands of people, including:

- Residents, visitors, employees, and college students evacuating in personal vehicles and via public transit;
- Medical facilities, K-12 schools, preschools and daycares needing transit support;
- Residents without access to a vehicle requiring transit support, including specialized vehicles like wheelchair-accessible vans and ambulances; and
- Residents, employees, and college students who plan to evacuate on foot or bicycle.

These complex demands from a variety of users require a deep understanding of Berkeley's alerting systems, anticipated evacuee behaviors, estimated transportation resource needs, and roadway capacity and design. To support this understanding, the City of Berkeley contracted KLD Associates, Inc. to conduct a comprehensive Evacuation Time Study. The Study models how evacuation might unfold during a wildfire, tsunami, or other emergency, and analyzes factors such as roadway capacity, transportation resource needs, and expected evacuee behavior.

By examining each element individually and then analyzing how they interact during a large-scale evacuation, the Study provides valuable insights to guide disaster response planning, roadway design, land use and development decisions, and household-level evacuation preparation.

Evacuation Time Estimates (Section 7)
The Study groups areas of Berkeley into 14 different Evacuation Regions, each designed to answer a specific planning question—such as "How long will it take to evacuate people during a current-day repeat of the 1923 Berkeley Fire?" and "What patterns of traffic congestion could occur when Berkeley's roadway network is overtaxed?"

The Study models evacuations for both wildfire and tsunami scenarios, as well as areas likely to evacuate simultaneously. Evacuation time estimates vary based on the time of day, day of the week and season, as well as how quickly evacuees are able to prepare and get on the road (known as mobilization time).

Key evacuation time estimates include:

- 1923 Berkeley Fire Repeat: In a scenario replicating Berkeley's most destructive historical fire, evacuation orders would stretch from Berkeley's eastern edge and extend as far west as Sacramento Street, involving residents from Marin Avenue stretching as far south as the UC Berkeley campus. Evacuation times for this area range from 1 hour and 35 minutes to 4 hours and 35 minutes. Notably, phasing the evacuation (having those closest to the fire leave first) did not

improve overall evacuation times—and in some cases, worsened them for both the broader area and those nearest the fire's origin.

- Panoramic Hill Fire: In this area, which is shared with the City of Oakland and has only one road in and out, estimated evacuation times range from 45 minutes to 1 hour and 45 minutes.

- Tsunami Warning (East of I-80): In a tsunami warning scenario affecting areas east of I-80, evacuation times range from 55 minutes to 1 hour and 50 minutes to 2 hours and 15 minutes.

- Tsunami Warning (West of I-80): In a tsunami warning scenario that does not cross I-80, evacuation times range from 55 minutes to 1 hour and 45 minutes.

Evacuation is generally faster when the city's population is lower—such as during the overnight hours, weekends, or summer, when K–12 schools are out of session and college/university populations are reduced.

For individual evacuees, leaving earlier can result in a faster evacuation trip. The Study also found that evacuating earlier leads to faster travel times. For example, households that begin evacuating 30 minutes after an evacuation order experience significantly less congestion than those who leave 60 minutes after the order is issued.

Understanding Community Risk: Comparing Evacuation Times to Hazards
The Study helps us understand how long it could take to evacuate different areas of the city. But evacuation times only tell part of the story. To fully understand the risk to our community, we must compare evacuation times with how quickly different hazards—like wildfires or tsunamis—could impact the community.

<u>Tsunami</u>
Tsunamis are usually caused by underwater earthquakes and can impact Berkeley. Berkeley's tsunami zone starts at the Bay and extends eastward as far as 7th Street. Depending on a tsunami origin, Berkeley could have many hours of notice (for example, 12 hours for a tsunami originating in Japan), or only minutes for a tsunami originating in a fault in the Bay Area, which is considered less likely.

What the Modeling Shows
Depending on tsunami size and origin, the area of Berkeley that would need to evacuate could be different. The Study modeled evacuation times for two different Warning-level tsunamis:

- Tsunami Warning – Phase 3: For a tsunami reaching (but not crossing) I-80, evacuation times ranged from 0:55 to 1:20.

- Tsunami Warning - Max Phase: For a tsunami reaching as far east as 7th Street, evacuation times ranged from 1:50 to 2:15.

From this analysis, it is likely that most people will be able to evacuate out of the path of a tsunami. Although near-source tsunamis on local faults with only minutes of notice are possible, scientists consider this unlikely.

Berkeley Hills Fire

Wildfires are a serious threat to the Berkeley Hills. Fires can start in the wildlands to Berkeley's east and quickly spread into neighborhoods. Strong Diablo winds, dry fuels, and steep terrain spread fires more quickly and make them harder to stop.

In a fire, hills residents will need to evacuate using narrow, winding streets. The Study shows that these roadways can become overwhelmed with traffic during a large-scale evacuation, such as would be necessary during a major fire. To better understand the risk to the community, City staff studied a repeat of Berkeley's worst fire: the 1923 Berkeley Fire. Using historical data, staff modeled how quickly that fire might spread today and compared it with evacuation time estimates from the Study.

What the Modeling Shows

- Estimated evacuation time: 4 hours and 10 minutes (fall, midweek, midday)
- Estimated fire spread time: 5 hours from Berkeley's eastern border to Shattuck Avenue
- Key takeaway: Most people will be able to evacuate—but some could be overtaken by fire on the road as they try to escape.

This model assumes that responders will be able to issue evacuation orders one hour before a growing fire reaches the Berkeley border. Even with this early warning, evacuation time estimates indicate that fast-moving fire could overtake people who are still stuck in traffic.

A detailed version of this analysis is provided on the Evacuation StoryMap entitled "Evacuation and Fire Spread," available at https://bit.ly/EvacuationStory.

Applying the Findings

Across California and beyond, we have seen growing numbers of evacuees trapped in traffic as fast-moving fires overtake roadways—in Los Angeles, Lahaina, Paradise, and locally during the 1991 Tunnel Fire in the Oakland-Berkeley Hills. The Evacuation Time Study reinforces what Berkeley's emergency responders and many community members already understand: In a wind-driven wildfire, people in the fire's path may not have enough time to safely evacuate.

This analysis confirms the urgent need for a new, community-wide approach to evacuation planning and response in fire-prone urban areas like Berkeley—one that starts with individual households and extends to regional and State-level policy. Recognizing this risk, the Berkeley Fire Department has issued public advisories since

2018 on Extreme Fire Weather days—conditions under which a fire could spread faster than the community can evacuate. On those days, the Fire Department strongly recommends that residents leave the hills early, even before a fire starts.

In light of the Study's findings, the Department will continue this practice. To further support residents' leave early and evacuation planning, the Fire Department provides the Household Fire Weather Planning Tool and offers community workshops to help households create personal plans for Extreme Fire Weather days. In addition to these fire-focused offerings, the Berkeley Ready program will be providing family-oriented evacuation and go-bag workshops for all hazards, including tsunami, this summer and fall.

See *Community Outreach* below for details on upcoming trainings.

Additional Evacuation Time Study Findings
In addition to estimating how long it takes to evacuate different areas, the Evacuation Time Study includes important findings that can inform emergency response strategies, housing policy, public alert systems, transportation planning, and roadway design.

Community Evacuation Behaviors (Appendix D)
To better understand how residents and workers in Berkeley may respond during an evacuation, an online demographic survey was conducted. Berkeley community members completed a total of 1,453 surveys, corresponding to a sampling error of ±2.5% at the 95% confidence level based on the 2020 Census household data.

Key findings include:

- Mobilization Time: The survey asked evacuation behavior questions to calculate how long it would take people to start evacuating after receiving an order. Some community members may take up to 3.5 hours to get on the road. These longer "mobilization" times significantly increase an area's overall evacuation time.

  The survey didn't ask separate questions for different types of emergencies—for example, a fire next to the home versus a tsunami hours away. In real life, people may move faster when the danger feels more immediate. To reflect this, the study established two evacuation times for each fire scenario:

  - One based on actual survey responses
  - One using a faster "urgent mobilization" time to better represent how people might respond in a fast-moving fire.

- School Pickups During Emergencies: About 22% of households have children who attend school in Berkeley. During an emergency, 88.2% of these households plan to pick up their children or send someone they trust to do so.

This behavior is likely to create congestion around schools and in evacuating areas more broadly.

- Transportation Access: An estimated 12,870 residents do not have direct access to a vehicle and will need transportation assistance to evacuate in a vehicle. However, 87% of these individuals plan to ride with a friend or neighbor, leaving approximately 1,686 people (1.4% of the city) who will rely on government-provided transportation or other alternatives like walking and biking.

- Special Assistance Needs: About 6% of households reported that someone in their home would need help from outside the household (such as a caregiver or personal attendant) to prepare to evacuate or to get to a vehicle. Some will also require specialized transportation assistance: Citywide, approximately 1.6% of people will require a wheelchair accessible van, 0.2% require an ambulance and 0.4% require other modes of transportation. The remaining 3.8% do not require a specialized vehicle to evacuate.

- Walking and Biking: About 2.2% of residents, employees, and college students plan to evacuate on foot, while 1.4% plan to evacuate by bicycle.

- Sheltering Plans: The vast majority (89%) of respondents plan to evacuate to the home of a friend or family member, a hotel, motel, campground, short-term rental (e.g., Airbnb), or a second/seasonal home. 6% plan to use a public evacuation shelter. About 2% answered that they planned to evacuate to another location (work/office, vehicle, UC Berkeley campus, Berkeley marina, etc.). Another 2% responded that their evacuation location would depend on the emergency.

- Evacuation Order Compliance: During an emergency evacuation, 1% of people would disregard evacuation orders and stay in place.

Community Transportation Support Needs (Section 8)

The Study assessed the transportation resources required to evacuate community members who do not have access to a vehicle, including residents of special facilities (schools, preschools/day care centers, and colleges/universities), medical facilities providing inpatient care services (including skilled nursing facilities), and transit-dependent visitors and employees.

These groups would collectively require 571 buses, 161 wheelchair vans, and 253 ambulances. However, a simultaneous evacuation of all of Berkeley is not a realistic scenario. Modeling specific large-scale hazard scenarios provides more useful estimates for emergency planning. For example:

- 1923 Fire Repeat: 262 buses, 48 wheelchair-accessible vans, and 66 ambulances will be needed to evacuate all populations at risk.

- Tsunami Warning – Max Phase: 41 buses, 4 wheelchair-accessible vans, and 8 ambulances will be needed for full evacuation of affected areas.

The City of Berkeley does not have its own mass transportation resources to be used in an evacuation, with the exception of two Aging Services shuttles. In any major evacuation, the City will be almost entirely dependent on support from local, regional and State partners to provide mass transportation assistance—both standard (e.g., buses) and specialized (e.g., ambulances and wheelchair vans). While coordination with these partners is essential, there is significant uncertainty about how many resources could realistically be made available to the City of Berkeley on short notice—particularly in high-demand scenarios like a repeat of the 1923 Fire, or in scenarios with simultaneous regional impact, such as a tsunami.

Staff expects considerable challenges in utilizing any available mass transit resources for evacuation, especially in a wildfire scenario. Roads may be blocked by debris or too crowded with evacuees. Additionally, conditions may be too dangerous to enter evacuating areas: buses are not equipped, and drivers are not trained, to navigate roadways that may be on fire.

To address these challenges, Berkeley staff will continue working with local and regional partners to identify creative and collaborative solutions to expand transportation capacity.

At the same time, staff will continue to explore strategies for use at the household and neighborhood level to help residents develop realistic, self-reliant evacuation plans, recognizing that government assistance may be limited or unavailable during large-scale emergencies. Community members should use these and other key study findings when creating or updating their household evacuation plans. The most important ideas to consider are:

- Connect with neighbors and plan to help each other evacuate;
- Carpool when evacuating to reduce traffic and assist neighbors without vehicles;
- Berkeley Hills residents, especially those needing extra time or support, should plan to leave early during extreme fire weather; and
- People in Berkeley's tsunami zone (generally west of 7th Street) should include walking or biking in their tsunami evacuation plans when possible.

<u>Evacuation Routes and Signage (Section 9)</u>
In suburban and rural areas, evacuation planning often depends on designating specific "Evacuation Routes" and guiding people to them with signage. In an urban environment like Berkeley, this strategy can actually increase evacuation times. Unlike rural areas—where a single road may be the only way out—Berkeley's dense, interconnected roadway network offers multiple paths to safety. Directing all evacuees to a few

designated routes can overwhelm those corridors, leading to traffic bottlenecks and slower overall evacuation times.

Even Berkeley's highest-capacity roadways—often referred to as the city's traditional "evacuation routes"—are not designed to handle the full volume of traffic in a large-scale evacuation. The Study shows that evacuation times are shorter when vehicles are spread across all available roadways, rather than funneled onto a limited number of higher-capacity streets.

While the Study identifies roadways in Berkeley with greater traffic-handling capacity, these should not be considered exclusive or official "Evacuation Routes." Instead, all roadways should be treated as potential evacuation routes. This approach maximizes the flexibility and efficiency of the city's evacuation system.

Parking Restrictions to Improve Evacuation and Responder Ingress (Section 9)
The Study finds that temporary or permanent parking restrictions (such as red curbing) are unlikely to significantly improve evacuation flow in the Berkeley Hills. The main constraint on vehicle movement in an evacuation is not the reduced roadway width from parked cars, but rather congestion at intersections, which are limited in their capacity to manage merging traffic from multiple directions. In fact, removing parked cars may cause vehicles to reach these chokepoints more quickly, potentially worsening overall congestion.

However, the Study does identify a potential benefit for emergency responders. Parking restrictions could improve emergency vehicle ingress, both during evacuations and day-to-day operations. Targeted restrictions on key roadways used by emergency response vehicles can enhance maneuverability and reduce delays for critical services—without requiring broad parking bans that provide limited benefit to evacuation flow. This targeted approach allows the City to improve emergency access where it matters most, while minimizing unnecessary impacts to residents.

Traffic Congestion Patterns (Appendix F)
Traffic congestion is a major factor that slows evacuation and is expected to occur across all scenarios studied. Congestion is most severe during daytime, midweek, and fall conditions, when Berkeley experiences its highest levels of vehicle activity.

In a 1923 Fire Repeat scenario, extreme congestion is widespread. This significantly increases the time evacuees spend on the road and raises the risk that some may be directly impacted by the fire while still attempting to escape.

For a Tsunami Warning – Max Phase, congestion is also expected—particularly on key roads in West Berkeley and along the waterfront. In the rare event of a tsunami caused by a local earthquake, some evacuees may still be on the road when the waves arrive.

These findings emphasize the importance of early evacuation, effective public alerting, and distributing traffic across all available roadways to reduce delays and improve safety.

Evacuation Traffic Congestion Analysis (Appendix F, Appendix G, and Section 10)
The Study identifies patterns of traffic congestion during a range of evacuation scenarios (Appendix F). Modeling shows that, in certain cases, particularly during wildfires, congestion becomes widespread across the roadway network, increasing the risk that evacuees could be overtaken by fire before reaching safety.

While traffic congestion occurs citywide, four areas consistently exhibit patterns likely worsened by pre-timed traffic signals and roadway designs that slow vehicles or restrict their movement:

- South and West of the UC Berkeley Campus
- South and West of Clark Kerr Campus
- North of Ohlone Park
- Lawrence Berkeley National Laboratory

For each of these areas, the Study details how traffic calming devices (TCDs), pre-timed signals, and other attributes of Berkeley's roadway network or built and natural environment affect evacuation traffic flow (Appendix G).

Traffic calming devices, such as diverters, traffic circles, and speed humps, are intentionally designed to reduce vehicle speeds for pedestrian safety, impose capacity constraints, and/or disrupt network connectivity for vehicles. Analysis confirms that these devices are functioning as intended, effectively lowering vehicle speeds. However, this design approach can conflict with the primary objective during an evacuation: enabling the swift and efficient movement of people out of the affected area.

Berkeley's pre-timed traffic signals operate on fixed schedules, without adjusting to real-time traffic conditions. During an evacuation, this inflexibility can worsen congestion and delay evacuees. In contrast, actuated signals respond to actual demand at each approach, allowing for more efficient traffic flow. The Study found that converting Berkeley's pre-timed signals to actuated signals could reduce evacuation times by up to 13% (see Section 10).

Analyzing Increased Hills Density (Section 10.5)
The City also used the Study to better understand impacts to evacuation times from potential development in the Berkeley Hills from Accessory Dwelling Units (ADUs), Junior Accessory Dwelling Units (JADUs), and Middle Housing.

As noted above in *Understanding Community Risk: Comparing Evacuation Times to Hazards,* under present-day development levels, a catastrophic wind-driven fire could overtake evacuees as they try to escape the Berkeley Hills. There are no feasible options to significantly increase the capacity of the area's roadway network. This means that as density increases in the Berkeley Hills, so does the number of residents who may be unable to escape in time during a fast-moving wildfire.

The Study used two different approaches to measure impacts from ADUs/JADUs and from Middle Housing.

Middle Housing
In June 2025, the Council changed zoning laws to permit Middle Housing in all areas of Berkeley except for the Hillside Overlay, pending results of the Evacuation Time Study. For Middle Housing, the Study's goal was to directly inform the Berkeley City Council on impacts to evacuation times from Middle Housing in the Hillside Overlay. The Study assumed land use changes similar to allowable development levels from the recently-approved Middle Housing zoning ordinance.

ADUs/JADUs
In 2022, the California Department of Housing and Community Development (HCD) found Berkeley's local ordinance regulating ADU development in the Hillside Overlay to be out of compliance with State law. HCD stated the City did not adequately demonstrate that new ADUs in the Hillside Overlay would actually impact public safety and evacuation. HCD claimed that the UC Berkeley analysis that the City cited was not specific enough. HCD staff confirmed that if the City wanted to maintain certain provisions of the local ordinance, the City should provide more detailed and specific evidence to support the findings.

The City designed analysis under the Evacuation Time Study to be responsive to these HCD concerns. The Study considered impacts to evacuation times from theoretical maximum levels of ADU/JADU development permissible under State law, which would equate to adding 3 ADUs on every eligible parcel. While this projection vastly overestimates the likely extent of ADU development, precise estimates of long-term development levels are difficult to pinpoint. Out of an abundance of caution, and to be responsive to HCD's comments on the City's ADU ordinance, the Study assumed a maximum permissible level of ADU development in its model.

Analysis Structure and Results
The analysis examined these development types separately and together. Studies also explored how evacuation times would be affected if ADU/JADU residents living near public transit did not own vehicles and instead relied on public transit in an evacuation. Broadly speaking, the Study found that adding people to the Berkeley Hills increases evacuation times for the area.

Before analyzing the impact of ADUs/JADUs and Middle Housing in the Berkeley Hills, the Study created a Future Case to serve as a baseline. This Future Case reestablishes evacuation time estimates using Berkeley's projected population growth through 2031. When evaluating the specific effects of ADUs/JADUs and Middle Housing in the Berkeley Hills, the Future Case provides a more accurate comparison point than present-day evacuation time estimates. The Study then measured evacuation times with ADUs/JADUs and Middle Housing in the Berkeley Hills, comparing them against this Future Case to isolate their impact.

The Study considered four evacuation regions, with the 1923 Fire Repeat and the Panoramic Hills Fire best representing potential hazard scenarios. Key findings include:

- Theoretical maximum ADU/JADU development increased evacuation times for a 1923 Fire Repeat by 102% on average, and for a Panoramic Hill Fire by 52% on average.

- Likely Middle Housing development through 2031 also increased evacuation times by up to 6% for a 1923 Fire Repeat. It did not have an impact on Panoramic Hill Fire evacuation times, because City Council direction and the Housing Element did not include Panoramic Hill (designated ES-R) for proposed Middle Housing. The percentage increases for Middle Housing are lower than ADU/JADU development because there are considerably fewer parcels likely to develop Middle Housing by 2031 as compared to maximum permissible ADU/JADU development.

- Combining ADU/JADU and Middle Housing increases evacuation times above the Future Case by 105% on average for a 1923 Fire, and about 54% on average for Panoramic Hill Fire.

- Evacuation times still increase when ADU/JADU dwellers living near transit do not own cars. Analysis assumed that residents of ADUs and JADUs living within a ½ mile of a transit stop would not own cars, and would rely on public transit to evacuate. Evacuating all of the ADU/JADU dwellers in the Hillside Overlay living near transit, would require an additional 1,051 buses. If ADU/JADU dwellers living near transit do not own cars, the 1923 Fire Repeat evacuation times increase by 65% on average, and by 70% on average for Panoramic Hill Fire.

- Finally, if Middle Housing is added to the analysis above, evacuation times further increase. Middle Housing zoning changes are not expected to influence occupants' vehicle ownership, so Middle Housing dwellers are assumed to evacuate in personal vehicles. When compared to the Future Case, evacuation times increase by 68% on average for the 1923 Fire Repeat and 69% on average for the Panoramic Hill Fire.

Comparing Study Findings with Current ADU Development Levels

Currently, Berkeley sees about 100 new ADUs per year citywide, with approximately 15% located in the Hillside Overlay. While the Evacuation Time Study analyzed evacuation impacts from the theoretical maximum level of ADU development allowed under State law, it did not model impacts from current ADU development rates.

However, the Study's analysis of Middle Housing provides a basis for general comparisons. Present-day ADU development in the Hillside Overlay adds far fewer residents than likely Middle Housing development, suggesting that the resulting increases in evacuation times from ADUs are likely lower than those from Middle Housing.

Still, even at today's lower development levels, ADU-related impacts on evacuation exist—and will compound an already high-risk baseline, where current conditions could result in some evacuees being overtaken by fire.

Because any increase in density in the Hillside Overlay contributes to longer evacuation times, the City could consider adopting more restrictive local development standards for ADUs in the area. This could include limiting ADUs to the minimum size and height permitted under State law. Smaller ADUs may reduce the number of additional residents needing to evacuate, helping to slightly slow the increase in evacuation times associated with ADU development.

Analysis: Second Egress Route from Panoramic Hill (Section 10.4)

Panoramic Hill, a neighborhood shared by Berkeley and Oakland, has only one road in and out: Panoramic Way. The Study modeled whether adding a second way out of Panoramic Hill could improve evacuation times. A conceptual second exit route was considered, connecting Dwight Place in Oakland to Dwight Way in Berkeley. This conceptual route is on land at the intersection of four jurisdictions: the City of Berkeley, East Bay Regional Park District, the City of Oakland, and the University of California.

When evacuation times were modeled using the mobilization times (the time it takes people to get ready to leave) reported by the community in the demographic survey, the second exit did not reduce overall evacuation times for Panoramic Hill. This is because the overall evacuation time was extended not by traffic delays but instead by how long people reported it would take them to prepare to leave.

However, in a fast-moving wildfire, people may leave more quickly than they reported in the survey. To account for this, the Study also modeled an evacuation where everyone in Panoramic Hill leaves 30 minutes after receiving an evacuation order. In this case, the maximum time benefit from a second exit was 25 minutes (from a baseline of 1:25 to evacuate all of Panoramic Hill midday, during the week, during the fall, to 1:00 with the notional secondary route). This is a reduction of 29%.

This reduction would largely benefit the evacuation times for Oakland residents on the eastern half of Panoramic Hill (Based on Berkeley's weather patterns, a wind-driven fire would move from northeast to southwest. The general pattern of evacuation movement will be westward, meaning that residents of the western/lower/Berkeley portion of the hill would not be likely to navigate east/uphill to use the secondary route.). By providing a more direct way out for the eastern portion of Panoramic, the secondary route shortens those residents' evacuation distance and associated travel times. This consequently lowers the overall times to fully clear Panoramic Hill when Berkeley and Oakland are considered together. The City of Oakland and its residents may consider further exploration of this topic with appropriate stakeholders.

Evacuation Time Study Recommendations (Section 11)
The findings of the Evacuation Time Study offer valuable insights to guide Berkeley's disaster response planning, transportation and roadway design, land use policies, and household-level evacuation preparedness. City officials support the Study's recommendations and are actively working to integrate them into future workplans, emergency planning efforts, and policy development.

Study recommendations are:

1. Emergency Response Strategies

    1.1. Overlay evacuation time estimates with hazard-specific data (such as fire spread rates for fire regions, and tsunami arrival times on tsunami warning regions.)

    1.2. Develop regional/State planning partnerships to quantify resource shortfalls for transit-dependent evacuees.

    1.3. Use study results to prioritize specific locations for Traffic Control Points (staff intersections and help improve traffic flow) during evacuations.

    1.4. During evacuations, reduce or eliminate external/pass-through traffic. This can include use of electronic roadside signage, closure of off-ramps into Berkeley, and/or diversion of through traffic to other routes.

    1.5. Encourage schools to develop and communicate site evacuation plans that enable parents and guardians to pick up their children at sites outside the evacuation zone.

2. Extreme Fire Weather Leave Early Policy

    2.1. Maintain Berkeley Fire Department Leave Early Policy for extreme fire weather. Focus on households at relatively greater risk due to extended mobilization times and/or on neighborhoods with extended driving times due to severe congestion.

3. Housing Development Policies

   3.1. Institute separate, more restrictive ADU/JADU development provisions in the Hillside Overlay.

   3.2. Examine ETE increases from Middle Housing zoning changes in the Hillside Overlay in the context of fire spread scenarios.

   3.3. Consider impacts to evacuation when implementing zoning changes that could result in an increase in demand on roadways used by wildfire or tsunami evacuees.

4. Community Alerting

   4.1. Conduct community education about Berkeley's evacuation zones, the emergency alerting systems that will provide evacuation orders/warnings, and how community members can register for/opt-in to those systems.

   4.2. Conduct community education to encourage potential evacuees to monitor evolving conditions and stay in contact with social networks.

   4.3. Clearly define areas at risk as well as areas not at risk in public alerts. Include explicit instructions for people outside the hazard area to shelter in place.

5. Improving Household Mobilization and Evacuation Travel Times

   5.1. Encourage carpooling.

   5.2. Encourage familiarity with primary, secondary, and tertiary evacuation routes.

   5.3. Parents should make provisions with schools to pick up children outside the evacuation zone.

   5.4. Commuters should plan to remain outside of the evacuation zone and reunite with other household members outside the hazard area, instead of returning to the evacuation zone.

6. Evacuating on Bicycle and Foot

   6.1. Encourage community members to explore walking or cycling for household/business tsunami evacuation plans.

7. Traffic Calming Devices

   7.1. Existing Infrastructure: Develop a citywide connectivity and evacuation capacity improvement strategy, integrating approaches such as actuated or adaptive

signal timing and replacing TCDs with removable/retractable options, and other evolving technologies.

7.2. Future infrastructure: Develop and implement a methodology to evaluate and consider evacuation efficiency and roadway capacity during the planning and implementation phases of future roadway infrastructure development, including TCD installations.

7.3. First Responder response times: Develop and implement a methodology to assess impacts from TCDs to first responder response times in daily traffic environments.

8. Traffic Signal Improvements

8.1. Optimize Signal Timing Plans: Evaluate and implement improved signal timing strategies, including actuated and adaptive systems.

8.2. Install Battery Backup Systems: Upgrade all traffic signal cabinets to include battery backup systems that can operate for a minimum of 6-8 hours.

8.3. Enhance Emergency Vehicle Pre-emption: Evaluate potential improvements to traffic signal system to have the latest pre-emption equipment and capabilities.

8.4. Strengthen Communications Infrastructure: Install a robust fiber-optic network to improve the reliability and speed of traffic signal communications.

8.5. Deploy Smart Traffic Cameras: Install smart traffic cameras at key intersections and corridors to provide real-time detection, monitoring, and traffic data collection.

8.6. Implement Transit Signal Priority (TSP) for public transit vehicles: Upgrade traffic signal system along Berkeley's highest capacity routes.

8.7. Coordinate Regionally: Work closely with surrounding jurisdictions to ensure interoperability and synchronization of traffic signal systems during emergency evacuations.

8.8. Traffic Signal Software for Centralized Control: Assess the need for traffic signal software upgrades to enable full communication with external systems and centralized command through the City's envisioned Traffic Management Center (TMC).

9. Parking Restrictions

9.1. Explore parking restrictions along arterial roadways in the Berkeley Hills utilized by emergency response vehicles for ingress during emergency response.

9.2. Explore temporary parking restrictions implemented on certain roadway segments only during hazardous conditions (e.g., fire weather) to improve emergency responder ingress times during evacuations.

Community Evacuation Education
While the Evacuation Time Study is a technical document designed to guide emergency planning and response, City staff have taken steps to make its findings accessible and actionable for the broader Berkeley community.

Berkeley's Evacuation StoryMaps
To help translate complex Study findings into useful public information, staff developed a series of interactive ArcGIS StoryMaps, available online at https://bit.ly/EvacuationStory. These StoryMaps use clear visuals, maps, and narrative storytelling to explain key insights from the Study and provide practical guidance for residents.

The StoryMaps cover the following topics:

1. The Evacuation Time Study Project: Explains why the Study was conducted and highlights key evacuation time estimates for different hazard scenarios.

2. Household Evacuation Planning: Offers useful takeaways from the Study to help residents create their own evacuation plans.

3. Evacuation and Fire Spread: Compares wildfire spread rates in the Berkeley Hills with evacuation timelines to assess risk to the community.

4. Improving Evacuation Times: Evaluates proposed ideas such as parking restrictions and road design changes to see whether they would meaningfully improve evacuation safety or speed.

In addition to content focused on the Evacuation Time Study, the Evacuation StoryMap collection also includes content addressing State evacuation planning requirements:

1. Access Impaired Neighborhoods Analysis: Addresses the requirements of Senate Bill 99, which mandates identification of residential developments in hazard areas that lack at least two emergency evacuation routes.

2. Evacuation Route Safety, Capacity and Viability Analysis: Addresses the requirements of Assembly Bill 747, which requires local governments to assess the capacity, safety, and viability of evacuation routes under various emergency conditions.

Community Outreach
Staff have begun incorporating key findings from the Evacuation Time Study into existing community preparedness education efforts. This includes integration into

workshops such as the Household Fire Weather Planning Workshop, which guides people in creating a plan to stay safe during fire season, and the Family Emergency Preparedness Workshop, which provides essential tips and tools to stay safe during emergencies, including evacuation and go-bag planning. These workshops are held periodically online and at public venues like libraries. Upcoming trainings (with advance registration required) are listed below:

Household Fire Weather Planning Workshop

- Tuesday, August 19 from 7pm to 8pm on Zoom, link to register
- Thursday, September 4 from 5pm to 6pm at North Branch Library, link to register
- Monday, September 15 from 12pm to 1pm at Claremont Branch Library, link to register

Family Emergency Preparedness Workshops (for families with children)

- Saturday, August 23 from 11am to 12pm at North Branch Library, link to join waitlist (sold out)
- Saturday, September 27 from 3pm to 4pm at Central Library, link to join waitlist (sold out)
- Saturday, October 4 from 11am to 12pm at Claremont Branch Library, link to register

Attachments:
1. Evacuation Time Study
2. Evacuation StoryMaps Text-Only Version (Screen Reader Accessible)
3. Resolution No. 70,712-N.S. Contract: KLD Engineering, P.C. for Evacuation and Response Time Modeling (adopted March 14, 2023)
4. Resolution No. 71,368-N.S. Contract No. 32300165 Amendment: KLD Engineering, P.C. for Evacuation and Response Analysis (adopted June 4, 2024)
5. Household Fire Weather Planning Tool

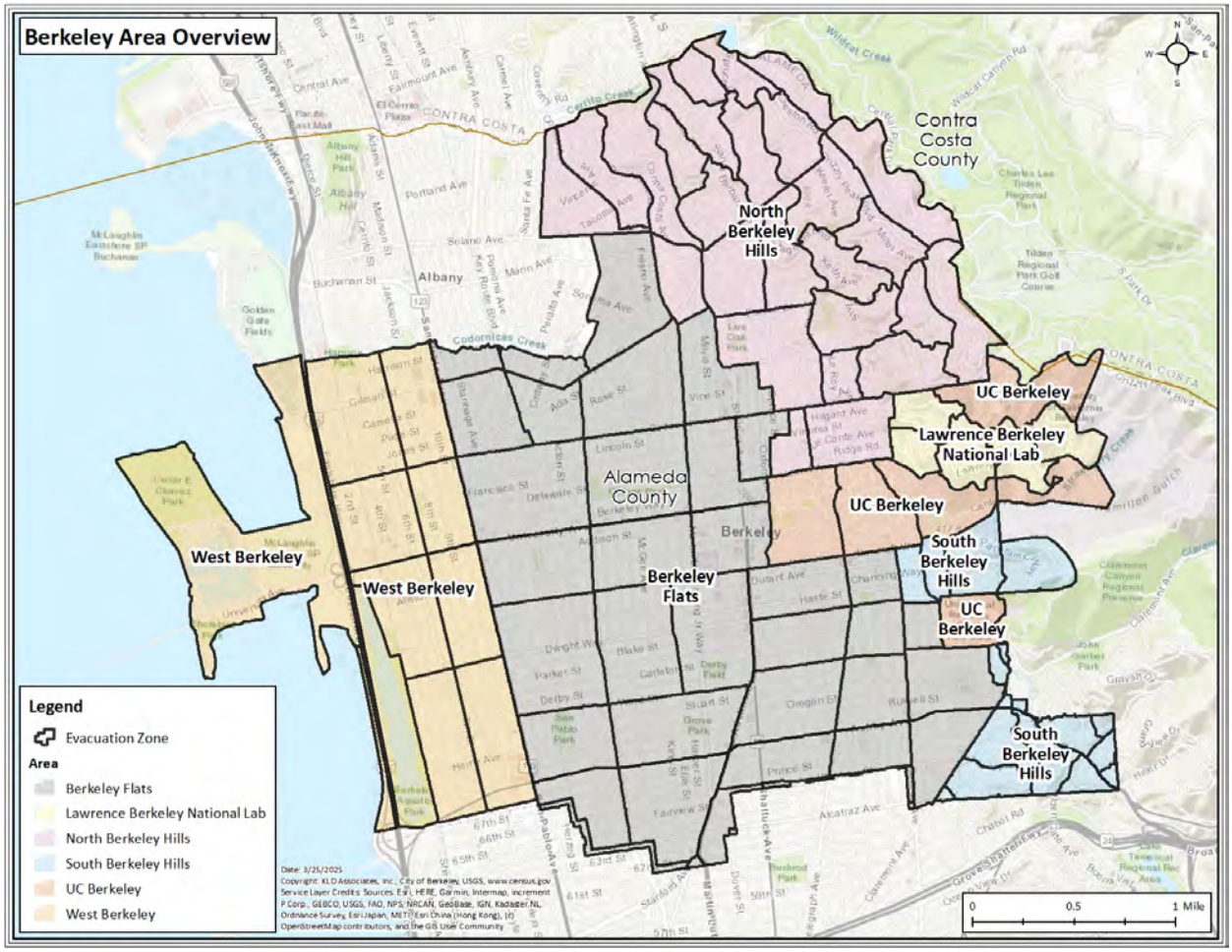
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City of Berkeley

Evacuation Time Estimate Study



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Table of Contents

1 INTRODUCTION 1-1

1.1 Overview of the ETE Process 1-2
1.2 Location of the Study Area 1-4
1.3 Preliminary Activities 1-4

2 STUDY ESTIMATES AND ASSUMPTIONS 2-1

2.1 Data Estimates 2-1
2.2 Methodological Assumptions 2-2
2.3 Assumption on Mobilization Times 2-5
2.4 Transit Dependent Assumptions 2-5
2.5 Access Control Assumptions 2-7

3 DEMAND ESTIMATION 3-1

3.1 Permanent Residents 3-2
3.2 Shadow Population 3-4
3.3 Visitor Population 3-4
3.4 Employees 3-5
3.5 Special Facility Population Demand 3-6
3.5.1 Medical Facilities 3-6
3.5.2 Juvenile Homes 3-7
3.6 College/University, School, Preschool/Day Care Center Population Demand 3-7
3.6.1 School, Preschool/Day Care Center Population 3-7
3.6.2 College/University Student Population 3-7
3.7 Transit Dependent Resident Population 3-9
3.7.1 Bay Area Rapid Transit and Caltrain (Rail) Demand 3-11
3.8 People Requiring Specialized Transportation Assistance 3-11
3.9 External Traffic 3-11
3.10 Background Traffic 3-12
3.11 Summary of Demand 3-12

4 ESTIMATION OF ROADWAY CAPACITY 4-1

4.1 Capacity Estimations on Approaches to Intersections 4-2
4.2 Capacity Estimation along Sections of Roadway 4-4
4.3 Application to the City of Berkeley Study Area 4-5
4.3.1 Two Lane Roads 4-5
4.3.2 Multilane Roadway 4-6
4.3.3 Freeways 4-6
4.3.4 Intersections 4-7
4.4 Simulation and Capacity Estimation 4-7
4.5 Boundary Conditions 4-8

5 ESTIMATION OF TRIP GENERATION TIME 5-1

5.1 Background 5-1
5.2 Fundamental Considerations 5-2
5.3 Estimated Time Distributions of Activities Preceding Event 5 5-4
5.4 Calculation of Trip Generation Time Distribution 5-5
5.4.1 Statistical Outliers 5-5

5.4.2 Phased Evacuation Trip Generation 5-7
6 EVACUATION CASES 6-1
7 GENERAL POPULATION EVACUATION TIME ESTIMATES (ETE) 7-1
7.1 Voluntary Evacuation and Shadow Evacuation 7-1
7.2 Evacuation Rates 7-2
7.3 Evacuation Time Estimate (ETE) Results 7-2
7.3.1 Prepare to Evacuate Time Can Dictate Time to Escape Hazard Area 7-4
7.3.2 Region R01: Citywide Evacuation 7-5
7.3.3 Region R02: 1923 Berkeley Fire Repeat 7-5
7.3.4 Regions R02 and R03: Analyzing the Impacts of a Phased Fire Evacuation 7-6
7.3.5 Region R04: Panoramic Hills Fire 7-8
7.3.6 Region R05: Fire Zones 2 & 3 7-8
7.3.7 Regions R06 and R07: Tsunami Warning 7-9
7.3.8 Regions R08 through R11: Geographic Areas of Berkeley 7-10
7.3.9 Regions R12 through R14: UC Berkeley and Lawrence Berkeley National Laboratory (LBNL) 7-10
7.4 ETE for Response Planning 7-12
7.5 Guidance on Using ETE Tables 7-12
8 TRANSIT-DEPENDENT AND SPECIAL FACILITY EVACUATION ACTIVITIES 8-1
8.1 Analysis of Resource Needs for Each Evacuation Region 8-2
8.2 Evacuation Activities for Transit Dependent Population Groups 8-2
8.3 Public Transit Evacuation 8-5
9 HIGHEST CAPACITY ROUTES, EVACUATION SIGNAGE, and PARKING RESTRICTIONS 9-1
9.1 Highest Capacity Routes 9-1
9.1.1 Highest Capacity Roadways 9-2
9.2 Evacuation Signage 9-3
9.3 Parking Restrictions 9-4
10 EVACUATION SENSITIVITY STUDIES 10-1
10.1 Evacuation Readiness 10-1
10.2 Effect of Changes in the Number of People who Voluntarily Relocate 10-2
10.3 Leaving Early (Reduction in Evacuation Demand) 10-3
10.4 Second Egress Out from Panoramic Hill 10-4
10.5 Accessory Dwelling Units and Middle Housing Developments 10-5
10.5.1 Future Case: No Middle Housing or ADU/JADU 10-6
10.5.2 Future Build Case - Accessory Dwelling Units and Junior Accessory Dwelling Units Only. 10-6
10.5.3 Future Build Case - Middle Housing Developments Only 10-7
10.5.4 Future Build Case - Accessory Dwelling Units, Junior Accessory Dwelling Units, & Middle Housing Developments 10-7
10.5.5 Future Build Case - Accessory Dwelling Units and Junior Accessory Dwelling Units Only including Public Transit Parking Standard Exemption 10-8
10.5.6 Future Build Case - Accessory Dwelling Units, Junior Accessory Dwelling Units, & Middle Housing including Public Exemption 10-8
10.6 Optimized Signals 10-9
11 RECOMMENDATIONS 11-1

11.1 Integrate Evacuation Study Concepts into City Policies and Response Planning 11-1
11.1.1 Emergency Response Strategies 11-1
11.1.2 Extreme Fire Weather Leave Early Policy 11-2
11.1.3 Housing Development Policies 11-2
11.2 Community Education and Household Evacuation Planning 11-3
11.2.1 Community Alerting 11-3
11.2.2 Improving Household Mobilization and Evacuation Travel Times 11-3
11.2.3 Evacuating on Bicycle and Foot 11-4
11.3 Increasing Roadway Capacity and Connectivity 11-7
11.3.1 Traffic Calming Devices 11-7
11.3.2 Traffic Signal Improvements 11-7
11.4 Parking Restrictions 11-8

List of Appendices

A. GLOSSARY OF TRAFFIC ENGINEERING TERMS A-1
B. DETAILED DESCRIPTION OF STUDY PROCEDURE B-1
C. FACILITY DATA C-1
D. DEMOGRAPHIC SURVEY D-1
D.1 Introduction D-1
D.2 Survey Instrument and Sampling Plan D-1
D.3 Survey Results D-1
D.3.1 Household Demographic Results D-2
D.3.2 Evacuation Response D-3
D.3.3 Time Distribution Results D-5
E EVACUATION REGIONS E-1
F. PATTERNS OF TRAFFIC CONGESTION DURING EVACUATION F-1
F.1 Citywide Evacuation (Region R01) F-1
F.2 1923 Fire Repeat (Region R02) F-3
F.3 1923 Fire Repeat Phased (Region R03) F-4
F.4 Panoramic Hill Fire (Region R04) F-4
F.5 Fire Zones 2 & 3 (Region R05) F-5
F.6 Tsunami Warning Phase 3 (Region R06) F-5
F.7 Tsunami Warning Max Phase (Region R07) F-6
G. TRAFFIC CALMING DEVICES, TRAFFIC SINGALS AND EXITSTING STREET NETWORK CHARACTERISTICS POSING CHALLENGES TO EVACUATION G-1
G.1 TCDs in DYNEV G-1
G.2 Traffic Calming Devices, Traffic Signals, and Other Street Network Characteristics Posing Challenges to Evacuation G-2
G.3 Recommendations G-5
H. REGION SPECIFIC FACILITY AND TRANSIT DEPENDENT POPULATION DATA H-1

List of Figures

Figure 1-1. Study Area Location 1-9
Figure 1-2. Study Area Link-Node Analysis Network 1-10
Figure 3-1. Overview of Evacuation Zone and Area Boundaries 3-25
Figure 3-2. Evacuation Zones in the Berkeley Flats Area 3-26
Figure 3-3. Evacuation Zones in the North Berkeley Hills Area 3-27
Figure 3-4. Evacuation Zones in the South Berkeley Hills Area 3-28
Figure 3-5. Evacuation Zones in the West Berkeley Area 3-29
Figure 3-6. Evacuation Zones in the Lawrence Berkeley National Lab and UC Berkeley Areas 3-30
Figure 3-7. Census Boundaries within the Study Area 3-31
Figure 3-8. Shadow Region 3-32
Figure 4-1. Fundamental Diagrams 4-9
Figure 5-1. Events and Activities Preceding the Evacuation Trip 5-15
Figure 5-2. Time Distributions for Evacuation Mobilization Activities 5-16
Figure 5-3. Comparison of Data Distribution and Normal Distribution 5-17
Figure 5-4. Comparison of Trip Generation Distributions 5-18
Figure 6-1. Evacuation Zones Boundaries 6-13
Figure 7-1. Study Area Shadow Region 7-17
Figure 7-2. Evacuation Time Estimates - Scenario 1 for Region R01 7-18
Figure 7-3. Evacuation Time Estimates - Scenario 2 for Region R01 7-18
Figure 7-4. Evacuation Time Estimates - Scenario 3 for Region R01 7-19
Figure 7-5. Evacuation Time Estimates - Scenario 4 for Region R01 7-19
Figure 7-6. Evacuation Time Estimates - Scenario 5 for Region R01 7-20
Figure 7-7. Evacuation Time Estimates - Scenario 6 for Region R01 7-20
Figure 7-8. Evacuation Time Estimates - Scenario 4 for Region R02 7-21
Figure 7-9. Evacuation Time Estimates - Scenario 4 for Region R03 7-21
Figure 7-10. Evacuation Time Estimates - Scenario 4 for Region R04 7-22
Figure 7-11. Evacuation Time Estimates - Scenario 4 for Region R05 7-22
Figure 7-12. Evacuation Time Estimates - Scenario 4 for Region R06 7-23
Figure 7-13. Evacuation Time Estimates - Scenario 4 for Region R07 7-23
Figure 7-14. Evacuation Time Estimates - Scenario 4 for Region R13 7-24
Figure 8-1. Chronology of Transit Evacuation Operations 8-9
Figure 9-1. Highest Capacity Routes - Overview 9-5
Figure 9-2. Highest Capacity Routes – Berkeley Flats 9-6
Figure 9-3. Highest Capacity Routes from Lawrence Berkeley National Lab and UC Berkeley 9-7
Figure 9-4. Highest Capacity Routes – North Berkeley Hills 9-8
Figure 9-5. Highest Capacity Routes – South Berkeley Hills 9-9
Figure 9-6. Highest Capacity Routes – West Berkeley 9-10
Figure 9-7. Transit-Dependent Bus Routes - 1 9-11
Figure 9-8. Transit-Dependent Bus Routes - 2 9-12
Figure 9-9. Transit-Dependent Bus Routes - 3 9-13
Figure 9-10. Evacuation Route Sign Example 9-14
Figure B-1. Flow Diagram of Activities B-5
Figure C-1. Overview of K-12 Schools and Higher Education Sites within the City of Berkeley C-15
Figure C-2. K-12 Schools and Higher Education Sites in Berkeley Flats Area C-16
Figure C-3. K-12 Schools and Higher Education Sites in North Berkeley Hills Area C-17

Figure C-4. K-12 Schools and Higher Education Sites in West Berkeley and South Berkeley Hills Areas C-18
Figure C-5. S K-12 Schools and Higher Education Sites in
Lawrence Berkeley National and UC Berkeley Areas C-19
Figure C-6. Overview of Preschools and Day Care Centers within the City of Berkeley C-20
Figure C-7. Preschools and Day Care Centers in Berkeley Flats Area C-21
Figure C-8. Preschools and Day Care Centers in North Berkeley Hills and South Berkeley Hills Areas ... C-22
Figure C-9. Preschools and Day Care Centers in West Berkeley and UC Berkeley Areas C-23
Figure C-10. Overview of Medical Facilities and Juvenile Homes within the City of Berkeley C-24
Figure C-11. Medical Facilities and Juvenile Homes within the City of Berkeley C-25
Figure C-12. Overview of Major Employers within the City of Berkeley C-26
Figure C-13. Overview of Tourist Population within the City of Berkeley C-27
Figure D-1. Household Size in the Study Area D-6
Figure D-2. Vehicle Availability D-6
Figure D-3. Vehicle Availability - 1 to 3 Person Households D-7
Figure D-4. Vehicle Availability – 4 to 7 Person Households D-7
Figure D-5. Rideshare with Neighbor/Friend D-8
Figure D-6. Specialized Transportation Needs for Households Requiring Evacuation Assistance D-8
Figure D-7. 5-Day-per-Week Commuters in Households in the Study Area D-9
Figure D-8. Travel Modes to Work/College in the Study Area D-9
Figure D-9. Number of Days Commuting to Work/College D-10
Figure D-10. School Children During an Evacuation D-10
Figure D-11. Number of Vehicles Used for Evacuation D-11
Figure D-12. Study Area Evacuation Destinations D-11
Figure D-13. Method to Notify a Friend/Neighbor D-12
Figure D-14. Cell Phone Coverage D-12
Figure D-15. Pet Ownership in Study Area D-13
Figure D-16. Time to Take to Notify a Neighbor/Friend to Evacuate D-13
Figure D-17. Time to Pick Up Children from School D-14
Figure D-18. Time Required to Prepare to Leave Work/College D-14
Figure D-19. Time to Travel Home from Work/College D-15
Figure D-20. Time to Prepare Home for Evacuation D-15
Figure E-1. Citywide Evacuation E-2
Figure E-2. Fire 1923 ..... E-3
Figure E-3. Fire 1923 Phase a E-4
Figure E-4. Fire 1923 Phase b E-5
Figure E-5. Fire 1923 Phase c E-6
Figure E-6. Panoramic Hill Fire E-7
Figure E-7. Fire Zone 2 and 3 Combined E-8
Figure E-8. Tsunami Phase 3 and Tsunami Max Phase E-9
Figure E-9. Berkeley Flats, North Berkeley, South Berkeley and West Berkeley E-10
Figure E-10. UC Berkeley and Lawrence Berkeley National Lab E-11
Figure F-1. Region R01 Congestion Patterns 15 Minutes after the Evacuation Order F-7
Figure F-2. Region R01 Congestion Patterns 1 Hour after the Evacuation Order F-8
Figure F-3. Region R01 Congestion Patterns 2 Hours after the Evacuation Order F-9
Figure F-4. Region R01 Congestion Patterns 3 Hours after the Evacuation Order F-10
Figure F-5. Region R01 Congestion Patterns 4 Hours after the Evacuation Order F-11
Figure F-6. Region R01 Congestion Patterns 4 Hours and 45 Minutes after the Evacuation Order F-12

Figure F-7. Region R01 Congestion Patterns 5 Hours and 15 Minutes after the Evacuation Order F-13
Figure F-8. Region R02 Congestion Patterns 1 Hour and 2 Hours after the Evacuation Order F-14
Figure F-9. Region R02 Congestion Patterns 3 Hours and 4 Hours after the Evacuation Order F-15
Figure F-10. Region R03 Congestion Patterns 1 Hour and 2 Hours after the Evacuation Order F-16
Figure F-11. Region R03 Congestion Patterns 3 Hours and 4 Hours after the Evacuation Order F-17
Figure F-12. Region R04 Congestion Patterns 30 Minutes and 1 Hour after the Evacuation Order F-18
Figure F-13. Region R04 Congestion Patterns 1 Hour and 30 Minutes and
2 Hours after the Evacuation Order F-19
Figure F-14. Region R05 Congestion Patterns 1 Hour and 2 Hours after the Evacuation Order F-20
Figure F-15. Region R05 Congestion Patterns 2 Hours and 30 minutes and
3 Hours after the Evacuation Order F-21
Figure F-16. Region R06 Congestion Patterns 30 Minutes and 1 Hour after the Evacuation Order F-22
Figure F-17. Region R06 Congestion Patterns 1 Hour and 30 Minutes and
2 Hours and 30 Minutes after the Evacuation Order F-23
Figure F-18. Region R07 Congestion Patterns 30 Minutes and 1 Hour after the Evacuation Order F-24
Figure F-19. Region R07 Congestion Patterns 1 Hour and 30 Minutes and
2 Hours and 30 Minutes after the Evacuation Order F-25
Figure G-1. Traffic Calming Devices, Traffic Signals, and Existing Street Network Characteristics G-6

List of Tables

Table 1-1. Stakeholder Interaction 1-8
Table 1-2. Roadway Characteristics 1-8
Table 2-1. Evacuation Scenario Definitions 2-8
Table 3-1. County Population Change from April 1, 2020 to July 1, 2023 3-13
Table 3-2. Municipality Population Change from April 1, 2020 to July 1, 2023 3-13
Table 3-3. Permanent Resident Population within the City of Berkeley and Shadow Region 3-14
Table 3-4. Permanent Resident Population and Vehicles 3-14
Table 3-5. Summary of Employees and Employee Vehicles Commuting into the City of Berkeley 3-15
Table 3-6. Medical Facilities Transit Demand Estimates 3-16
Table 3-7. School and Preschool/Day Care Center Population Demand Estimates 3-17
Table 3-8. College/University Student Estimates 3-21
Table 3-9. UC Berkeley and City College On/Off Student Estimates 3-21
Table 3-10. Transit-Dependent Population Estimates 3-22
Table 3-11. Rapid Transit (Rail) Demand Estimates 3-22
Table 3-12. External Traffic Estimates 3-22
Table 3-13. Summary of Population Demand 3-23
Table 3-14. Summary of Vehicle Demand 3-24
Table 5-1. Event Sequence for Evacuation Activities 5-10
Table 5-2. Time Distribution for Notifying the Public 5-10
Table 5-3. Time Distribution for Employees to Prepare to Leave Work/College 5-10
Table 5-4. Time Distribution for Commuters to Travel Home 5-11
Table 5-5. Time Distribution for Population to Prepare to Evacuate 5-11
Table 5-6. Time Distribution for Population to Pick-up School Children from School 5-12
Table 5-7. Mapping Distributions to Events 5-12
Table 5-8. Description of the Distributions 5-13
Table 5-9. Trip Generation Histograms for the City of Berkeley Population 5-14
Table 6-1. Evacuation Regions 6-5
Table 6-2. Regions by Evacuation Zones 6-6
Table 6-3. Region R03 Phased Evacuation Zones 6-9
Table 6-4. Evacuation Scenario Definitions 6-10
Table 6-5. Percent of Population Groups Evacuating for Various Scenarios 6-11
Table 6-6. Vehicle Estimates by Scenario 6-12
Table 7-1. Time to Clear the Indicated Area of *90* Percent of the Affected Population 7-14
Table 7-2. Time to Clear the Indicated Area of *100* Percent of the Affected Population 7-15
Table 7-3. Time to Clear the Indicated Area of *90* Percent of the Affected Population for 1923 Fire Repeat 7-15
Table 7-4. Time to Clear the Indicated Area for Response Planning 7-16
Table 8-1. Summary of Transportation Needs 8-6
Table 10-1. 90th Percentile Evacuation Time Estimates for Evacuation Readiness Sensitivity Study 10-10
Table 10-2. 100th Percentile Evacuation Time Estimates for Evacuation Readiness Sensitivity Study 10-11
Table 10-3. 90th Evacuation Time Estimates for Voluntary Evacuation Sensitivity Study 10-12
Table 10-4. 100th Evacuation Time Estimates for Voluntary Evacuation Sensitivity Study 10-13
Table 10-5. 90th Evacuation Time Estimates for Leaving Early Sensitivity Study 10-14
Table 10-6. 100th Evacuation Time Estimates for Leaving Early Sensitivity Study 10-14

Table 10-7. 90th Evacuation Time Estimates for Leaving Early & Urgent Mobilization Sensitivity Study....10-15
Table 10-8. 100th Evacuation Time Estimates for Leaving Early & Urgent Mobilization Sensitivity Study....10-15
Table 10-9. 90th Evacuation Time Estimates for Panoramic Hill Sensitivity Study....10-16
Table 10-10. 100th Evacuation Time Estimates for Panoramic Hill Sensitivity Study....10-16
Table 10-11. ADU/JADU/Middle Housing Units, People and Number of Evacuation Vehicles....10-17
Table 10-12. 90th Evacuation Time Estimates for ADU/JADU/Middle Housing Sensitivity Study....10-18
Table 10-13. 100th Evacuation Time Estimates for ADU/JADU/Middle Housing Sensitivity Study....10-19
Table 10-14. 90th Evacuation Time Estimates Differences Between Build and Future Cases....10-20
Table 10-15. 100th Evacuation Time Estimates Differences Between Build and No Build Cases....10-21
Table 10-16. 90th Evacuation Time Estimates for Signal Optimization (Urgent Mobilization) Sensitivity Study....10-22
Table 10-17. 100th Evacuation Time Estimates for Signal Optimization (Urgent Mobilization) Sensitivity Study....10-22
Table 11-1. Summary of Recommendations for Consideration by the City of Berkeley....11-10
Table A-1. Glossary of Traffic Engineering Terms....A-1
Table C-1. K-12 Schools and Higher Education Sites within the City of Berkeley....C-2
Table C-2. Preschools and Day Care Centers within the City of Berkeley....C-4
Table C-3. Medical Facilities within the City of Berkeley....C-7
Table C-4. Juvenile Homes within the City of Berkeley....C-8
Table C-5. Major Employers within the City of Berkeley....C-8
Table C-6. Tourists within the Study Area....C-10
Table H-1. Facility and Transit Dependent Population by Region....H-2

EXECUTIVE SUMMARY

A key element of protecting the Berkeley community during wildfires, tsunamis, and other emergencies is safely evacuating people from danger zones. On a typical day, Berkeley's road network balances traffic flow with speed reduction to minimize injuries and/or fatalities. In an emergency, however, it may need to handle the rapid evacuation of tens of thousands of people away from a hazard, including:

- Residents, visitors, employees, and college students evacuating in personal vehicles and via public transit;
- Medical facilities, K-12 schools, preschools and daycares needing transit support;
- Residents without access to a vehicle requiring transit support, including specialized vehicles like wheelchair-accessible vans and ambulances; and
- A small percentage of Berkeley residents, employees, and college students who plan to evacuate on foot or bicycle.

Managing the complex needs of diverse users during emergencies requires a clear understanding of Berkeley's emergency alerting systems, evacuee behavior, transportation needs, and road capacity. To support this, the City has contracted KLD Associates, Inc. to study evacuation dynamics during wildfires, tsunamis, and other emergencies. By analyzing these factors individually and in combination, the study will help guide disaster response, transportation planning, development policy, and household evacuation plans.

This study provides **Evacuation Time Estimates (ETE)** for different conditions—such as time of day, day of week, and season—based on congestion patterns during potential evacuations in Berkeley. **ETE measures the time needed to exit the zones under evacuation order, not to reach a final destination.** The analysis includes evacuation sensitivity studies, which analyze the impact of traffic calming measures, increased housing density, and evacuation tactics to inform emergency planning and decision-making.

City of Berkeley

The City of Berkeley is located on the eastern shore of the San Francisco Bay within Alameda County, California. The eastern edge of Berkeley, bordering Contra Costa County, is defined by the Berkeley Hills, a significant wildland-urban interface, creating a unique interface between urban development and fire-dependent natural ecosystems.

The city is densely populated and occupies an area of about 10.5 square miles.

The city houses approximately 117,000 residents. The city is divided into 106 Evacuation Zones[1]. Figure 6-1 shows a map of the Evacuation Zones which were considered for this study.

[1] https://protect.genasys.com/

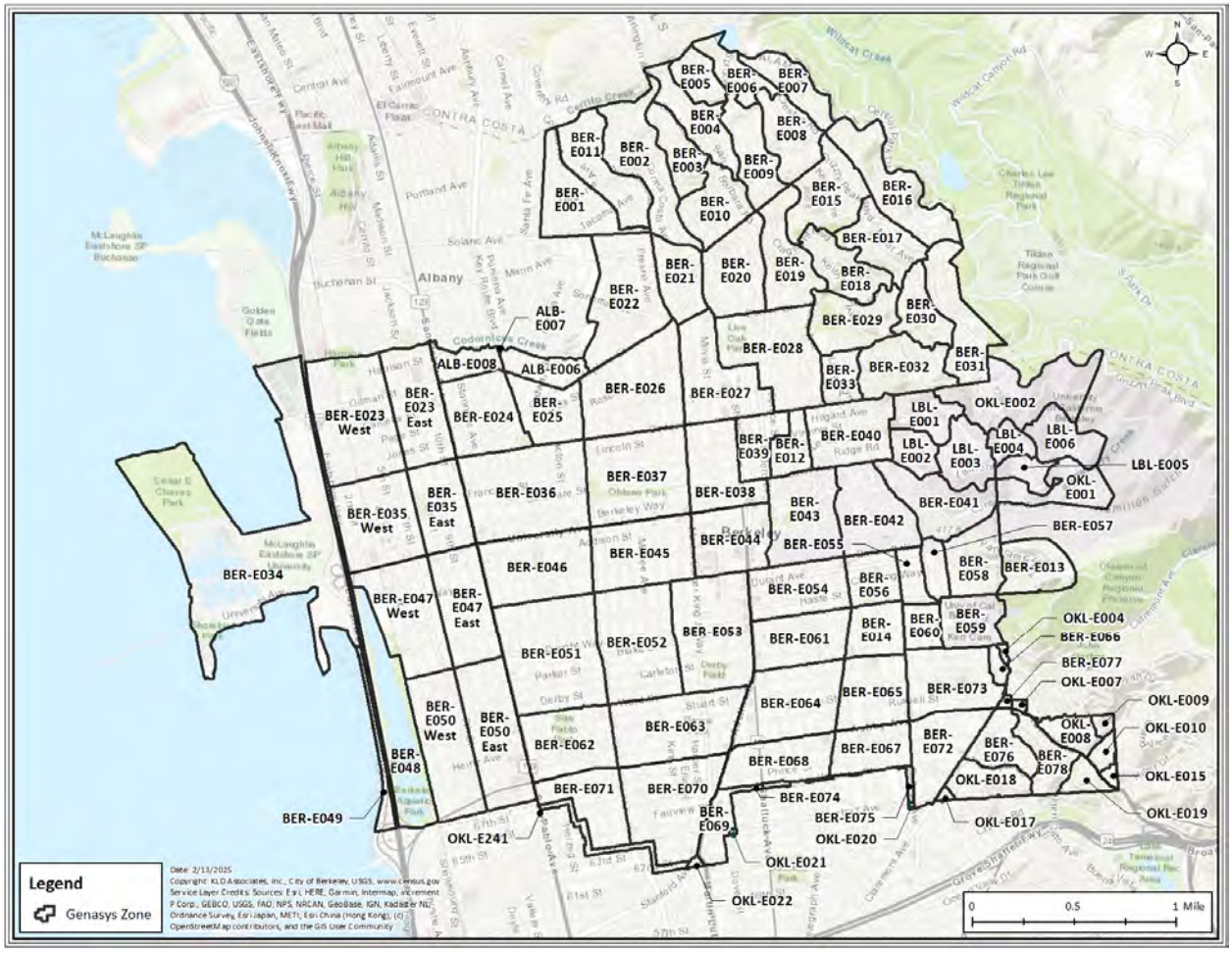


Figure 6-1. Evacuation Zones Boundaries

Berkeley's road network is characterized by predominantly north-south routes and limited east-west connectivity. In addition to the approximately 90,000 vehicles that may need to evacuate the city, Berkeley's position in the heart of the Bay Area means that another 47,000 additional vehicles passing through Berkeley as external traffic could also be traversing Berkeley roadways while evacuation was underway. All of these factors could contribute to difficulties in evacuating during an emergency.

Evacuation Regions

This study groups Berkeley's Evacuation Zones (displayed in Figure 6-1) into 14 different Evacuation Regions. Each Region is included in this study to inform a specific planning question from the City of Berkeley.

Evacuation Regions and Study Questions

See Appendix E for maps visualizing these Regions.

Region		Planning Question
R01	**Citywide Evacuation**	Transportation planning: What patterns of traffic congestion could occur when Berkeley's roadway network is overtaxed?
R02	**Fire - 1923 - All**	Hazard analysis: How long will it take to evacuate people during a current-day repeat of the 1923 Berkeley Fire?
R03	**Fire - 1923 - Phase a (0 minutes)**	Hazard analysis: Will phasing evacuation improve evacuation times for a repeat of the 1923 Berkeley Fire?
R03	**Fire - 1923 - Phase b (0 + 90 minutes)**	
R03	**Fire - 1923 - Phase c (0 + 180 minutes)**	
R04	**Panoramic Hill Fire**	Hazard analysis: How long will it take to evacuate people during a fire affecting Panoramic Hill?
R05	**Fire Zones - Fire Zones 2 & 3 Combined**	Included to analyze administrative changes that could affect development in the Berkeley Hills.
R06	**Tsunami - Phase 3**	Hazard analysis: How long will it take to evacuate people from a tsunami affecting areas west of I-80?
R07	**Tsunami - Max Phase**	Hazard Analysis: How long will it take to evacuate people from a tsunami that crosses I-80?
R08	**Berkeley Flats**	How long will it take to evacuate specific geographic areas of Berkeley?
R09	**North Berkeley Hills**	
R10	**South Berkeley Hills**	
R11	**West Berkeley**	
R12	**UC Berkeley**	
R13	**Lawrence Berkeley National Lab**	
R14	**UC Berkeley + Lawrence Berkeley National Lab**	

Evacuation Time Estimates

The study modeled evacuations associated with wildfire and tsunami, as well as areas that may evacuate together. Evacuation time estimates are influenced by scenario (time of day, day of week, and season) as well as how quickly evacuees prepare to leave and enter the roadway (mobilization time). Key evacuation time estimates include:

- In a current-day repeat of the 1923 Berkeley Fire, known as Berkeley's worst, the time to evacuate people out of the hazard area ranges from 1:35 (hh:mm) to 4:35[2]. Phasing the evacuation – evacuating areas at risk in stages, with the closest to the fire leaving first – results in similar or worse evacuation times, both for the area overall and for the populations closest to the origin of the fire.
- In a fire affecting Panoramic Hill, an area shared with the City of Oakland with one way in and out, the time to evacuate people out of the hazard area ranges from 0:45 to 1:45.
- In a Tsunami Warning affecting areas east of I-80, evacuation times range from 0:55 to 1:45. It should be noted that in the December 5, 2024 Tsunami Warning, as part of a Max Phase evacuation, this area was evacuated approximately 1 hour after the National Tsunami Warning Center issued alerts, and 45 minutes after evacuations of the area began.

Table 7-4 summarizes the ETE values recommended for use in response plans based on the analysis of this report (Section 7). Rows marked "Urgent Mobilization" present ETE expected when evacuees mobilize more quickly than would be predicted from responses to a community survey conducted from August 10 – October 8, 2023 (see "Community Evacuation Behaviors" below and Appendix D for further survey details). Urgent Mobilization times are associated with no-notice evacuations, such as wildfires that ignite in close proximity to the city.

[2] These times include base case 90th and 100th percentile ETE and urgent mobilization ETE.

Table 7-4. Time to Clear the Indicated Area for Response Plans

	Summer	Summer	Summer	Fall	Fall	Fall
	Midweek	Weekend	Midweek Weekend[3]	Midweek	Weekend	Midweek Weekend[4]
Scenario:	**1**	**2**	**3**	**4**	**5**	**6**
Region	**Midday**	**Midday**	**Nighttime**	**Midday**	**Midday**	**Nighttime**
R01 - Citywide Evacuation	5:10*	4:25*	2:30	5:35*	4:00*	2:30
R02 - Fire 1923	2:25	1:50	1:45	4:10*	1:50	1:45
R02 - Fire 1923 Urgent Mobilization	*2:25*	*1:50*	*1:35*	*4:10**	*1:45*	*1:35*
R03 - Fire 1923 Phase a	4:25*	4:30*	1:40	4:30*	4:15*	2:10
R03 - Fire 1923 Phase a Urgent Mobilization	*2:30**	*2:10**	*1:25*	*3:30**	*2:10**	*1:35*
R03 - Fire 1923 Phase b	6:10*	5:55*	2:15	6:15*	6:00*	2:30
R03 - Fire 1923 Phase b Urgent Mobilization	*4:00**	*4:00**	*1:40*	*4:00**	*2:10**	*1:40*
R03 - Fire 1923 Phase c	4:10	4:20	4:30	4:00	4:25	4:35
R03 - Fire 1923 Phase c Urgent Mobilization	*3:35*	*3:45*	*1:40*	*3:50*	*1:30*	*1:40*
R04 - Panoramic Hill Fire	1:40	1:35	1:40	1:45	1:35	1:40
R04 - Panoramic Hill Fire Urgent Mobilization	*1:05*	*0:50*	*0:45*	*1:45*	*0:50*	*0:50*
R05 - Fire Zones 2 & 3 Combined	2:05	1:55	1:45	2:20	1:55	1:45
R06 - Tsunami - Phase 3	1:20	1:20	1:05	1:45	0:55	1:10
R07 - Tsunami - Max Phase	2:15	2:10	1:50	2:15	2:05	1:50
R08 - Berkeley Flats	4:10*	2:35	2:10	4:20*	2:25	2:05
R09 - North Berkeley Hills	2:10	2:00	1:50	2:05	1:50	1:45
R10 - South Berkeley Hills	1:35	1:30	1:35	2:15	1:35	1:35
R11 - West Berkeley	1:40	1:35	1:35	1:45	1:35	1:35
R12 - UC Berkeley	1:05	1:15	1:25	1:20	1:30	1:35
R13 - Lawrence Berkeley National Lab	1:25*	0:45	0:45	2:15*	0:45	0:45
R14 - UC Berkeley + Lawrence Berkeley National Lab	1:30	1:15	1:20	2:15	1:30	1:35

[3] Nighttime scenarios (Scenarios 3 and 6) have approximately the same demand between midweek and weekends.
[4] Nighttime scenarios (Scenarios 3 and 6) have approximately the same demand between midweek and weekends.
* Entries with an asterisk are 100th percentile ETE. All other ETE presented in Table 7-4are the 90th percentile ETE. See Section 7 for details.

Overall evacuation times are faster when Berkeley's population is lower: at night, on weekends, and during summertime, when K-12 schools are not in session and college/university populations are significantly reduced.

For individual evacuees, leaving earlier can result in a faster evacuation trip. Analysis shows that all households who start evacuation trips 30 minutes after receiving an evacuation order will encounter less traffic congestion than they would leaving 60 minutes after the order is issued. For example:

- In a repeat of the 1923 Fire (R02), a 30-minute delay in beginning the evacuation trip also adds another 35 minutes to a vehicle's travel time. This 30-minute delay in leaving, coupled with the additional time on the road, almost doubles an evacuee's overall time from receiving an evacuation order to exiting the evacuated area – from 70 minutes overall to 135 minutes.
- In a Tsunami Warning affecting areas east of Interstate 80, leaving 30 minutes later would add another 45 minutes to a vehicle's travel time. See "Evacuee Experience" writeups in Section 7 for details.

Community Evacuation Behaviors

An online demographic survey was conducted of the people living and working in Berkeley; 1,453 households responded to the survey, which corresponds to a sampling error of ±2.5% at the 95% confidence level based on the 2020 Census household data.

The survey gathered demographic information (average household size, vehicle ownership, etc.), behavioral responses (would evacuees follow evacuation instructions issued by local officials), and time to complete mobilization activities.

Key takeaways include:

- Community members could take as long as 3.5 hours to start their evacuation trip ("mobilize"). Longer mobilization times lead to longer evacuation times overall (Section 7). Populations with the shortest mobilization times are employees and visitors. The population with the longest mobilization times is households with commuters who plan to pick up children from school in an emergency. See Section 5 (Table 5-9) and Appendix D.
- Approximately 22% of households have children who attend school in Berkeley. In an emergency, 88.2% of those households plan to pick up their children or send a trusted guardian to pick up their children at school. This behavior is expected to increase traffic congestion immediately around schools and in evacuating areas more broadly.
- Automobile ownership: The average number of automobiles available per household is 1.55. 73.6% of households would use 1 vehicle for evacuation; 14.6% plan to use 2. Approximately 97% of households of 2 or more people have access to at least one vehicle. 7.5% of all households do not have access to a vehicle. See Appendix D.

- Citywide, 12,870 residents do not have direct access to a vehicle and will require transportation assistance. However, approximately eighty-seven percent (87%) of Berkeley's transit-dependent population will rideshare with a neighbor or friend. This leaves 1,686 (1.4%) of residents citywide who will rely on transportation assistance from the government. (See Table 3-10 and Appendix D.)
- Six percent of households indicated that someone in the household would need help from someone outside the household (caretaker, personal attendant) to prepare to evacuate or to get to a vehicle. Some will also require specialized transportation assistance: Citywide, approximately 1.6% of people will require a wheelchair accessible van, 0.2% require an ambulance and 0.4% require other modes of transportation. The remaining 3.8% do not require a specialized vehicle to evacuate.
- Citywide 2.2% of Berkeley residents, employees, and college students plan to evacuate on foot and 1.4% plan to evacuate on bicycle. (Appendix D)
- During an emergency evacuation, 1% of people would disregard evacuation orders and stay in place. (See Appendix D)
- Emergency officials may notify people outside a hazard area that they are not in danger, and that they are requested to shelter in place (not evacuate). Ninety percent (90%) of households would comply with this request and the remaining 10% would choose to evacuate the area. (See Appendix D)
- Eighty-nine percent (89%) of emergency evacuees plan to evacuate to a friend or relative's home, a hotel, motel, campground, short-term rental (ex. AirBnB/VRBO), or second/seasonal home. Approximately 6% plan to evacuate to an evacuation shelter. See Figure D-12 for complete results.
- Approximately 50% of households have pets. Approximately 38.4% of households have small pets/animals and 11.3% have large pets/animals. Figure D-15 displays these results.

Community Transportation Support Needs

Analysis quantified the transportation resources needed to support evacuation of all Berkeley residents who lack access to a vehicle, residents of special facilities (schools, preschools/day care centers, and colleges/universities), medical facilities providing inpatient care services (including skilled nursing facilities), and transit-dependent visitors and employees. Citywide, these groups collectively require 571 buses, 161 wheelchair vans, and 253 ambulances to evacuate. See Table 8-1 for additional details. However, as discussed in Section 7, a simultaneous evacuation of all of Berkeley is not a realistic scenario. The resource needs associated with a specific large-scale hazard event better inform emergency planning, for example:

- For a repeat of the 1923 Fire (Regions R02 or R03), it is estimated that 262 buses, 48 wheelchair-accessible vans, and 66 ambulances will be needed to evacuate all populations at risk.

- For a Tsunami Warning – Max Phase, it is estimated that 41 buses, 4 wheelchair-accessible vans, and 8 ambulances will be required to evacuate all populations at risk.

These resource needs indicate that for the mass evacuation emergencies studied, the City of Berkeley will be reliant on partners in Berkeley and throughout the region to provide mass transportation assistance to people in Berkeley without access to vehicles. These needs for assistance include both generalized transportation (buses) and specialized vehicles such as wheelchair vans and ambulances.

Evacuation Routes and Signage

In suburban and rural areas, it is critical to designate specific roadways as "Evacuation Routes" and to direct the community to them with signage. In urban environments like Berkeley, this approach can actually reduce evacuation efficiency. City roadway networks generally offer multiple roadways that can serve as evacuation routes and lead evacuees to safety, as compared to suburban and rural systems where there may be only one roadway leading out of a hazard area.

Even Berkeley's highest-capacity roadways, traditionally designated Berkeley's "evacuation routes," are not designed to singlehandedly carry a large volume of vehicles associated with a large-scale evacuation. Rather, evacuation times improve when evacuating vehicles are distributed across all available roadways instead of being directed to roadways with higher (but still inadequate) capacity.

Figure 9-1 highlights Berkeley roadways possessing the greatest capacity for vehicular traffic. These roadways are likely to carry the greatest number of vehicles in an evacuation. However, **these routes are not designated "Evacuation Routes" at the exclusion of other roadways**. **All available roadways should be considered evacuation routes.** See Section 9.

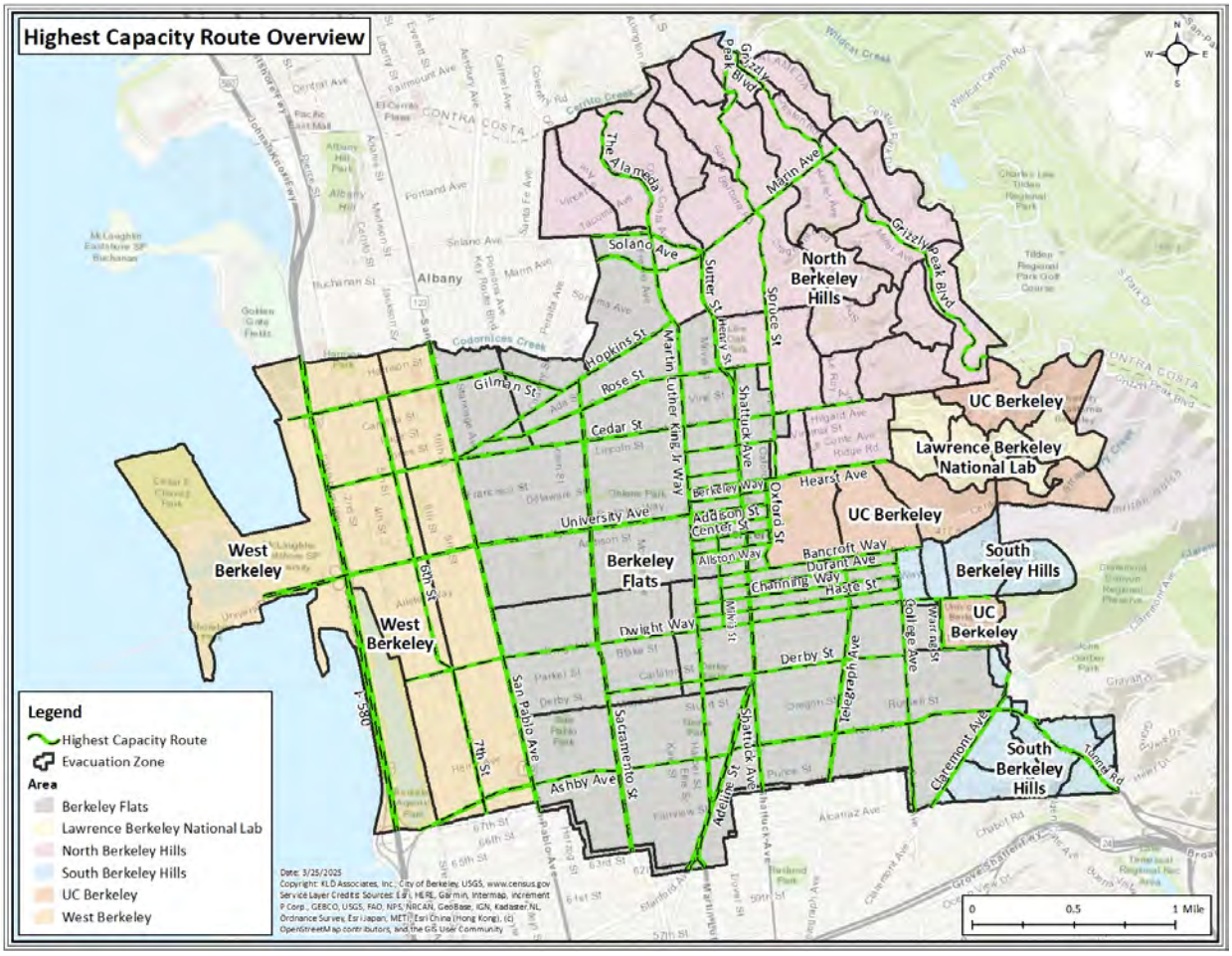


Figure 9-1. Highest Capacity Routes - Overview

Traffic Congestion Patterns

Traffic congestion slows evacuations, and severe congestion is expected to occur in all evacuation cases studied. Congestion is greatest in evacuation scenarios during the day, midweek, during the fall, when Berkeley has the highest vehicular demand.

Some evacuation cases have severe congestion across long stretches of roadway; areas of severe congestion are more limited for other cases.

Figure F-8 shows the patterns of traffic congestion for a 1923 Fire Repeat at 1 hour and 2 hours after the Evacuation Order. Severe congestion is extensive, prolonging the time that evacuees will spend on the roadways and increasing the likelihood that they will be directly impacted by the fire as they try to evacuate.

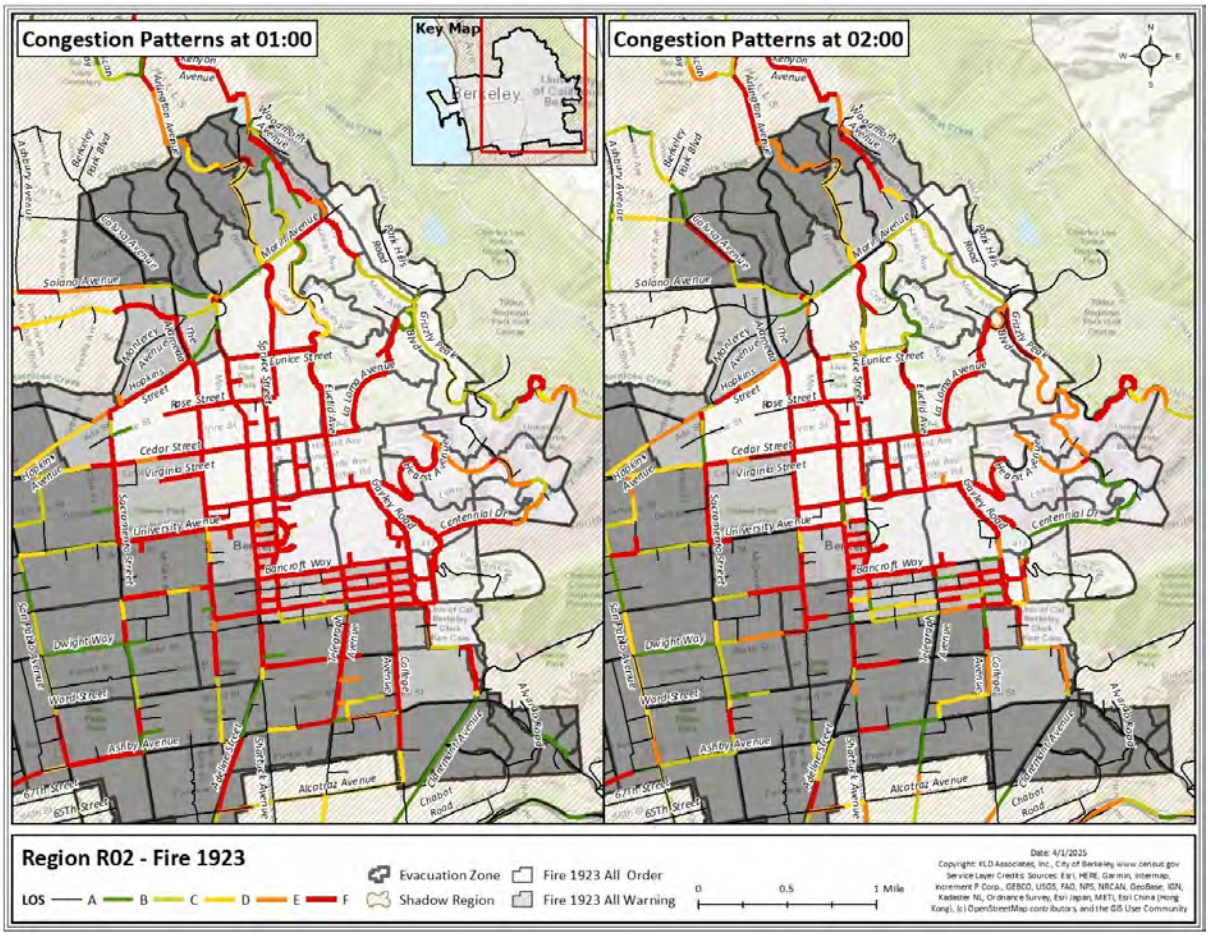


Figure F-8. Region R02 Congestion Patterns 1 Hour and 2 Hours after the Evacuation Order

Figure F-18 displays the patterns of traffic congestion for Tsunami Warning Max Phase at 30 minutes and 1 hour after the Evacuation Order. Evacuees in Region R07 can use I-580, University Ave, Gilman St, Ashby Ave and Seventh/Sixth St to leave the evacuated area. All of these roads experience some level of congestion during the evacuation.

These results indicate that traffic congestion will prolong the time that evacuees will spend on the roadways escaping the tsunami inundation area. Depending on the amount of tsunami warning provided, evacuees could still be evacuating on the roadways at the time of impact.

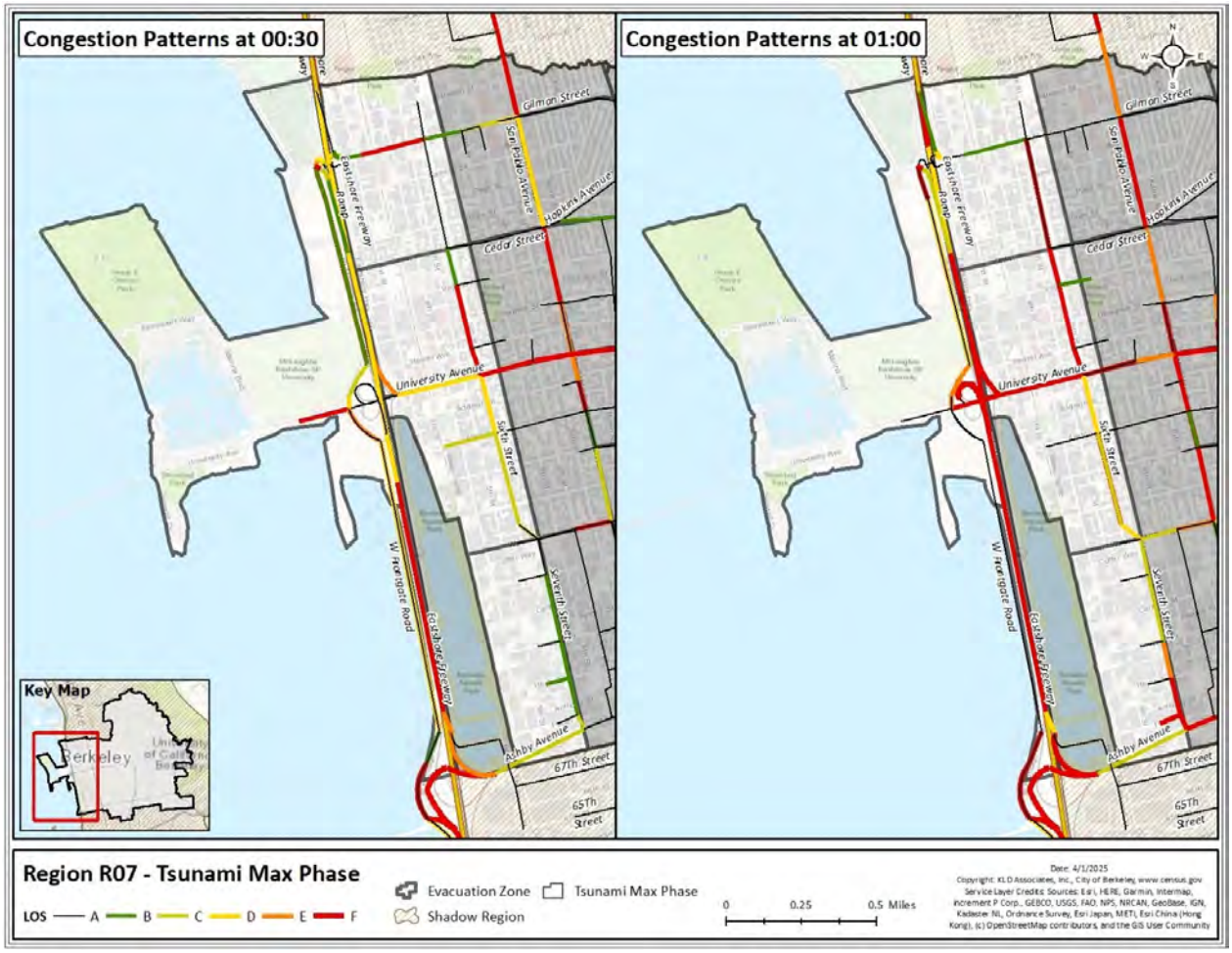


Figure F-18. Region R07 Congestion Patterns 30 Minutes and 1 Hour after the Evacuation Order

Identifying Opportunities to Improve Traffic Flow in Evacuations

Analysis in Appendix F indicates that across multiple evacuation cases, the following areas of Berkeley have patterns of traffic congestion that are likely exacerbated by traffic engineering and/or roadway design that is focused on day-to-day traffic, pedestrian, and cyclist safety:

- South and West of the UC Berkeley Campus
- South and West of Clark Kerr Campus
- North of Ohlone Park
- Lawrence Berkeley National Lab (LBNL)

Appendix G identifies the specific traffic calming devices (TCDs), traffic signals, and other street network characteristics posing challenges to evacuation, with the goal of identifying opportunities to improve traffic flow in evacuations.

Figure G-1 shows the TCDs within the City of Berkeley as of January 14, 2025.

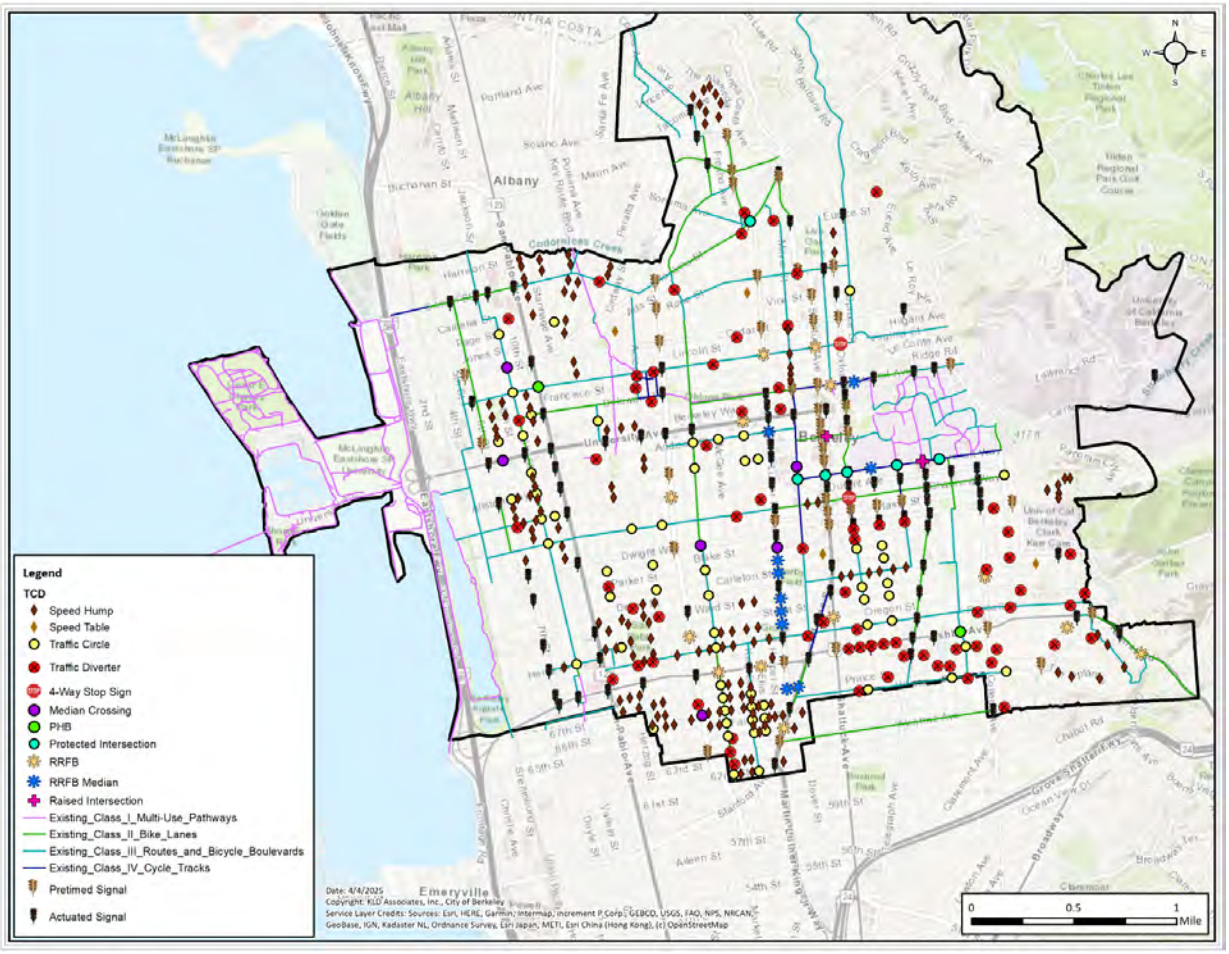


Figure G-1. Traffic Calming Devices, Traffic Signals, and Existing Street Network Characteristics

Street Network Characteristics

The existing characteristics of the road network are noted in Appendix G to provide a comprehensive analysis of the challenges to evacuation traffic flow. Some are assumed to be fixed, such as preexisting facilities and parks; others are noted as traffic design elements that could be improved for evacuation traffic flow.

Traffic Signals

Section 10 identifies improvements to evacuation traffic flow from a widescale transition to actuated/adaptive traffic signals. Appendix G highlights pre-timed signals with notable impacts across various evacuation cases studied, so that they may be considered for prioritization in a shift to actuated/adaptive signals.

Traffic Calming Devices

The impact of Traffic Calming Devices (TCDs) on evacuation illustrates the complexity of the public safety demands on Berkeley's roadway system. In a day-to-day context, traffic calming devices (including diverters, traffic circles, and speed tables) support public safety by reducing vehicle speeds for pedestrian safety, reducing capacity on residential streets, and/or disrupting network connectivity for vehicles. The analysis indicates that the TCDs throughout the city are performing as designed, effectively reducing vehicular speeds and thus reducing the risk of severe injury and/or fatal traffic crashes.

In evacuations, the public safety goal for roadways shifts to expediting traffic flow, both to help evacuees quickly escape, and also to help responders access the hazard area. In a large-scale evacuation, the roadway demands from evacuating vehicles will greatly exceed the capacities of Berkeley's highest capacity roadways (indicated on Figure 9-1). Evacuating drivers will need to decide between waiting in traffic to enter high-capacity roadways or using residential streets (with lower capacities and potentially also TCDs) as they attempt to escape the hazard area.

Because evacuating drivers will use all roadways, they will be slowed by TCDs in two ways – directly, when they encounter them while trying to escape, and indirectly, as drivers trying to avoid TCDs increase congestion on Berkeley's highest capacity routes.

The day-to-day public safety function of TCDs poses significant challenges to evacuation traffic flow. This situation illustrates the dynamic and complex public safety demands on Berkeley's roadway system.

Analyzing Increased Hills Density

The City also used this study to better understand how potential development in the Berkeley Hills could impact evacuation times. Section 10.5 includes detailed analysis addressing multiple development scenarios in the Hillside Overlay, which encompasses the City's Very High Fire Hazard Severity Zone.

These studies considered three different types of development: Accessory dwelling units (ADUs), junior accessory dwelling units (JADUs), and Middle Housing. The analysis examined these development types separately and together. Studies also explored how evacuation times would

be affected if ADU/JADU residents living near public transit did not own vehicles and instead relied on public transit in evacuation.

This analysis began with the establishment of a Future Case, assuming projected 2031 population increases in Berkeley.[5] The future case did not include the ADUs/JADUs and/or Middle Housing. Impacts to ETE from ADUs/JADUs and Middle Housing were measured against this Future Case in order to pinpoint evacuation time impacts from these particular development types in the Hillside Overlay.

The study considered four evacuation regions: Region R01 – Citywide Evacuation, Region R02 – 1923 Fire, Region R04 – Panoramic Hill Fire, and Region R05 – Fire Zones 2 & 3 Combined.

The 1923 Fire Repeat (Region R02) and the Panoramic Hills Fire (Region R04) best represent potential hazard scenarios. The 90th percentile ETEs are recommended to be used for evacuation planning purposes (see Section 7). Key findings for 90th percentile ETEs in Regions R02 and R04 include:

<u>Potential Development</u>

- **Maximum ADU/JADU development** increased evacuation times for a 1923 Fire (Region R02) by 102% on average, and for a Panoramic Hill Fire (Region R04) by 52% on average.
- **Likely Middle Housing** development results in increases of up to 8% across the analyzed regions. This increase is smaller than increases from ADU/JADU development because there are considerably fewer parcels likely to develop Middle Housing by 2031 as compared to maximum ADU/JADU development.
- **Combining Maximum ADU/JADU development with Likely Middle Housing** increases evacuation times above the Future Case by 105% on average for a 1923 Fire (Region R02), and about 54% on average for Panoramic Hill Fire (Region R04).

<u>Potential Development with Fewer New Vehicles</u>

- **Maximum ADU/JADU development, but with fewer new vehicles:** Evacuation times still increase when ADU/JADU dwellers living near transit do not own cars. Analysis assumed that residents of ADUs and JADUs living within ½ mile of a transit stop would not own cars and would rely on public transit to evacuate. The 1923 Fire (Region R02) would require an estimated additional 1,051 buses to evacuate these residents. For this case, evacuation times increase by 65% on average, and by 70% on average for Panoramic Hill Fire (Region R04).
- **Adding Middle Housing:** Finally, under this scenario where ADU/JADU dwellers living near transit do not own cars, if likely Middle Housing is added, evacuation times further increase. Middle Housing zoning changes are not expected to influence occupants' vehicle ownership, so Middle Housing dwellers are assumed to evacuate in personal vehicles.

[5] 2031 was selected to align analysis with the 2023-2031 Housing Element Update, which included a projection of likely development that could result from implementation of the "Middle Housing" zoning changes.

When middle housing is added to the scenario where ADU/JADU dwellers living near transit do not own cars, evacuation times increase 68% on average for the 1923 Fire (Region R02) and 69% on average for the Panoramic Hill Fire (Region R04).

Based on the results of the study, it is recommended that the City institute separate, more restrictive ADU/JADU development provisions in the Hillside Overlay. For Middle Housing, it is recommended that the City examine these increases in the context of fire spread scenarios. By overlaying fire spread data with evacuation time estimates, the City can better contextualize potential impacts to public health and safety from Middle Housing zoning changes.

Studies in Section 10.5 illustrate how increasing population density in an area, even when the added people do not own vehicles, can increase emergency evacuation times and create public safety impacts. More broadly, the City should consider impacts to evacuation when implementing zoning changes that could result in an increase in demand on roadways used by wildfire or tsunami evacuees.

Recommendations

The results of this report can inform Berkeley's disaster response planning, transportation and roadway planning, development policies, and the individual evacuation plans of Berkeley households. Section 11 details the following recommendations for consideration by City officials:

1. Emergency Response Strategies
    1.1. Overlay evacuation time estimates with hazard-specific data (such as fire spread rates for fire regions, and tsunami arrival times on tsunami warning regions.)
    1.2. Develop regional/State planning partnerships to quantify resource shortfalls for transit-dependent evacuees.
    1.3. Prioritize specific locations for Traffic Control Points (staffed intersections that help improve traffic flow) during evacuations.
    1.4. During evacuations, reduce or eliminate external/pass-through traffic. This can include use of electronic roadside signage, closure of I-80 and CA-24 off-ramps into Berkeley, and/or diversion of through traffic to other routes.
    1.5. Encourage schools to develop and communicate site evacuation plans that enable parents and guardians to pick up their children at sites outside the evacuation zone.
2. Extreme Fire Weather Leave Early Policy
    2.1. Maintain Berkeley Fire Department Leave Early Policy for extreme fire weather. Focus on households at relatively greater risk due to extended mobilization times and/or on neighborhoods with extended driving times due to severe congestion.
3. Housing Development Policies
    3.1. Institute separate, more restrictive ADU/JADU development provisions in the Hillside Overlay.

3.2. Examine ETE increases from Middle Housing zoning changes in the Hillside Overlay in the context of fire spread scenarios.

3.3. Consider impacts to evacuation when implementing zoning changes that could result in an increase in demand on roadways used by wildfire or tsunami evacuees.

4. Community Alerting

4.1. Conduct community education about Berkeley's evacuation zones, the emergency alerting systems that will provide evacuation orders/warnings, and how community members can register for/opt-in to those systems.

4.2. Conduct community education to encourage potential evacuees to monitor evolving conditions and stay in contact with social networks.

4.3. Clearly define areas at risk as well as areas not at risk in public alerts. Include explicit instructions for people outside the hazard area to shelter in place.

5. Improving Household Mobilization and Evacuation Travel Times

5.1. Encourage carpooling.

5.2. Encourage familiarity with primary, secondary, and tertiary evacuation routes.

5.3. Parents should make provisions with schools to pick up children outside the evacuation zone.

5.4. Commuters should plan to remain outside of the evacuation zone and reunite with other household members outside the hazard area, instead of returning to the evacuation zone.

6. Evacuating on Bicycle and Foot

6.1. Encourage community members to explore walking or cycling for household/business tsunami evacuation plans.

7. Traffic Calming Devices

7.1. Existing Infrastructure: Develop a citywide connectivity and evacuation capacity improvement strategy, integrating approaches such as actuated or adaptive signal timing and replacing TCDs with removable/retractable options, and other evolving technologies.

7.2. Future infrastructure: Develop and implement a methodology to evaluate and consider evacuation efficiency and roadway capacity during the planning and implementation phases of future roadway infrastructure development, including TCD installations.

7.3. First Responder response times: Develop and implement a methodology to assess impacts from TCDs to first responder response times in daily traffic environments.

8. Traffic Signal Improvements

8.1. Optimize Signal Timing Plans: Evaluate and implement improved signal timing strategies, including actuated and adaptive systems.

8.2. Install Battery Backup Systems: Upgrade all traffic signal cabinets to include battery backup systems that can operate for a minimum of 6-8 hours.

8.3. Enhance Emergency Vehicle Pre-emption: Evaluate potential improvements to traffic signal system to have the latest pre-emption equipment and capabilities.

8.4. Strengthen Communications Infrastructure: Install a robust fiber-optic network to improve the reliability and speed of traffic signal communications.

8.5. Deploy Smart Traffic Cameras: Install smart traffic cameras at key intersections and corridors to provide real-time detection, monitoring, and traffic data collection.

8.6. Implement Transit Signal Priority (TSP) for public transit vehicles: Upgrade traffic signal system along Berkeley's highest capacity routes.

8.7. Coordinate Regionally: Work closely with surrounding jurisdictions to ensure interoperability and synchronization of traffic signal systems during emergency evacuations.

8.8. Traffic Signal Software for Centralized Control: Assess the need for traffic signal software upgrades to enable full communication with external systems and centralized command through the City's envisioned Traffic Management Center (TMC).

9. Parking Restrictions

9.1. Explore parking restrictions along arterial roadways in the Berkeley Hills utilized by emergency response vehicles for ingress during emergency response.

9.2. Explore temporary parking restrictions implemented on certain roadway segments only during hazardous conditions (e.g., fire weather).

1 INTRODUCTION

This section introduces the study and an overview of the process used to compute Evacuation Time Estimates (ETE) for the City of Berkeley, including preliminary activities of the project.

This study analyzed traffic conditions and evacuation times for a variety of evacuation scenarios in the City of Berkeley. Alternative emergency management strategies that could be used in response to an evacuation of the City of Berkeley were also examined. This study, and the results contained within this report, will further inform the City of Berkeley's emergency planning and protective action decision making.

The Study included the following key analysis components:

1. Methods and Assumptions – Section 2, Study Estimates and Assumptions through Section 6, Evacuation Cases describe the methods used for the evacuation simulation model (DYNEV-II) and the assumptions made for the modeling.
2. Evacuation Time Estimates (ETE) – The estimated total time it takes for the population of an area to evacuate based on the evacuation simulation model. See Section 7, Evacuation Time Estimates for additional information and Section 8, Transit-Dependent Population and special facility ETE calculations.
3. Sensitivity Studies (What-if Scenarios) – Analyzes the sensitivity of the ETE results to changes in several input parameters. See Section 10, Evacuation Sensitivity Studies (What-if Scenarios) for additional information.
4. Recommendations – Recommendations based on the results and analysis of the Study as well as professional knowledge. See Section 11, Recommendations for additional information.

At the time of this Study, there were no available state or federal regulations on evacuation modeling for wildfires. However, the nuclear industry is highly regulated and offers several resources for developing evacuation studies. While the hazard is different, many of the concepts of evacuation (e.g., warning time, imminent threat of danger, outbound movements (away from the hazard), etc.) are applicable. As such, most of the references used in this Study have been published by the US Nuclear Regulatory Commission (NRC) for evacuation planning for nuclear power plants, including:

- Criteria for Development of Evacuation Time Estimate Studies, NUREG/CR-7002, Rev. 1, February 2021.
- Development of Evacuation Time Estimate Studies for Nuclear Power Plants, NUREG/CR-6863, January 2005.
- Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants, NUREG-0654/FEMA-REP-1, Rev. 1, November 1980.

There are some contrasts between nuclear evacuations and wildfire evacuations in particular. While there may be no visible warnings of an impending nuclear emergency or incoming tsunami, a large wildfire will be visible throughout the region. As a result, it is reasonable to assume many more residents will evacuate before warnings and orders are issued. This study presents more conservative results because it assumes that people will wait to evacuate until an order or warning is issued. The results quantifying the impact of leaving early are contained in Section 10.

The work effort reported herein was supported and guided by local stakeholders who contributed suggestions, critiques, and the local knowledge base required. Table 1-1 presents a summary of stakeholders and interactions.

1.1 Overview of the ETE Process

The following outline presents a brief description of the Study's effort in chronological sequence:

1. Information Gathering:
    a. Defined the scope of work in discussions with representatives from the City of Berkeley.
    b. Attended meetings with local stakeholders to define methodology and data needs.
    c. Conducted a detailed field survey of the roadway system and area traffic conditions within the City of Berkeley and the Shadow Region.[1] Aerial imagery was used to gather roadway information in areas that could not be driven, like Lawrence Berkeley National Laboratory (LBNL).
    d. Obtained demographic data from the 2020 Census. Projected the 2020 Census data to the study year: 2024 (see Section 3.1).
    e. Estimated the number of employees commuting into the City of Berkeley from areas outside the City of Berkeley using data provided by the city and the data obtained from the US Census Longitudinal Employer-Household Dynamics from the OnTheMap Census[2] analysis tool (see Section 3.4).
    f. Conducted a random sample demographic survey of the residents within the City of Berkeley (see Section 5) to gather demographic and mobilization information.
    g. Obtained data (to the extent available) to develop a database of schools, colleges, special facilities, visitors, and transportation resources available.

[1] An evacuation in the Shadow Region occurs when residents voluntarily evacuate from areas beyond the area officially given the Evacuation Order. This phenomenon can intensify traffic congestion and prolong evacuation times for people in the areas of actual risk.
[2] *OnTheMap*, onthemap.ces.census.gov/.

The majority of this data was provided by the city, supplemented with online research.

2. Estimated the Trip Generation Time Distribution representing the time required by various population groups (permanent residents, employees, and visitors) to prepare for the evacuation trip (i.e., to mobilize). These estimates were based on the demographic survey results and notification time estimate/assumptions (see Section 5 and Appendix D).
3. Defined Evacuation Scenarios. These scenarios reflect the variation in demand associated with different seasons, day of week and time of day (see Section 6).
4. Obtained Evacuation Regions from City of Berkeley. "Regions" are groupings of Evacuation Zones[3] for which ETEs are calculated, depending on the location of the hazard and the extent of the area to be evacuated (see Section 6 and Appendix E).
5. Estimated the demand for transit services for persons at special facilities and for transit-dependent persons, see Section 3.
6. Prepared the input streams for the DYNEV-II system which computes ETE for the Focus Areas (see Appendices B and C).
    a. Estimated the evacuation traffic demand, based on the available information derived from the United States (U.S.) Census Bureau data, provided by stakeholders, and from the demographic survey.
    b. Created the link-node representation of the evacuation network (see Section 1.3), which was used as the basis for the computer analysis that calculates the ETE.
    c. Applied the procedures specified in the 2022 Highway Capacity Manual (HCM) to the data acquired during the field survey, to estimate the capacity of all highway segments comprising the evacuation routes.
    d. Calculated the evacuating traffic demand for each Evacuation Region and each Evacuation Scenario.
    e. Specified selected candidate destinations for each "origin" (location of each "source" where evacuation trips are generated over the mobilization time) to support evacuation travel consistent with outbound movement relative to the location of the hazard.
7. Executed the DYNEV-II model to determine optimal evacuation routing and compute ETE for all residents, visitors, and employees with access to personal vehicles. Generated a complete set of ETEs for all Evacuation Regions and Evacuation Scenarios.

[3] https://protect.genasys.com/

8. Documented ETE results (see Section 7).
9. Estimated the resource needs for transit dependents including those for special facilities (schools, medical facilities and nursing homes) to evacuate (see Section 8).
10. Tested what-if scenarios to evaluate alternative evacuation management strategies that could be used in response to different hazard situations to potentially reduce evacuation time and/or to see the impacts to evacuation time due to specific changes to the input parameters (see Section 10).

1.2 Location of the Study Area

The City of Berkeley is located on the eastern shore of the San Francisco Bay within Alameda County, California. It shares municipal boundaries with Oakland and Emeryville to the south, and Albany and Kensington to the north. The eastern edge of Berkeley, bordering Contra Costa County, is defined by the Berkeley Hills, a significant wildland-urban interface. This location places Berkeley within close proximity to major Bay Area population centers, including San Francisco, located across the bay, and Oakland, its immediate neighbor. The city's position also means it is adjacent to substantial wildland areas in the Berkeley Hills, creating a unique interface between urban development and natural ecosystems. Figure 1-1 displays the boundary of the City of Berkeley and the neighboring communities and cities. This map identifies the major roadways and the Shadow Region as well.

1.3 Preliminary Activities

Field Surveys of the Roadway Network

KLD personnel drove the entire roadway system within the city and the Shadow Region. The Shadow Region considered for this study is bounded by I-580, Piedmont Ave and Moraga Ave to the south, State Route 13 and State Route 24 to the southeast, the eastern boundary of Tilden Park to the east, by Moeser Lane, San Pablo Avenue, Potrero Avenue, S 55th Street, and Bayview Avenue to the North, and I-580 and the San Francisco Bay to the West, as shown in Figure 1-1. The characteristics of each section of roadway in the study area were recorded. The characteristics considered are listed in Table 1-2.

Video and audio recording equipment were used to capture a permanent record of the roadway infrastructure. No attempt was made to meticulously measure such attributes as lane width and shoulder width; estimates of these measures based on visual observation and recorded images were considered appropriate for the purpose of estimating the capacity of roadway sections. For example, Exhibit 15-7 in the HCM indicates that a reduction in lane width from 12 feet (the “base” value) to 10 feet can reduce free flow speed (FFS) by 1.1 mile per hour (mph) – not a material difference – for two-lane highways. Exhibit 15-46 in the HCM shows little sensitivity for the estimates of Service Volumes at Level of Service (LOS) E (near capacity), with respect to FFS, for two-lane highways.

The data from the audio and video recordings were used to create detailed geographic information systems (GIS) shapefiles and databases of the roadway characteristics and of the

traffic control devices observed during the road survey; this information was referenced while preparing the input stream for the DYNEV II System.

As documented on page 15-6 of the HCM 2022, the capacity of a two-lane highway is 1,700 passenger cars per hour in one direction. A capacity of 2,250 vehicles per hour (vph) per lane is assigned for freeway sections, as per Exhibit 12-37 of the HCM 2022. The road survey identified several segments which are characterized by adverse geometrics (i.e., steep hills and tight curves with no shoulders) on two-lane highways which are reflected in reduced values for both capacity and speed. These estimates are consistent with the service volumes for LOS E presented in HCM Exhibit 15-46. Further discussion of roadway capacity is provided in Section 4.

Traffic signals are either pre-timed (signal timings are fixed over time and do not change with the traffic volume on competing approaches) or are actuated (signal timings vary over time based on the changing traffic volumes on competing approaches). Actuated signals require detectors to provide traffic data used by the signal controller to adjust the signal timings. These detectors are typically magnetic loops in the roadway or video cameras mounted on the signal masts and pointed toward the intersection approaches. If detectors were observed on the approaches to a signalized intersection during the road survey, detailed signal timings were not collected as the timings vary with traffic volume.

If no detectors were observed, the signal control at the intersection was considered pre-timed, and detailed signal timings were provided by the City of Berkeley. These signal timings were input to the DYNEV II system used to compute ETE.

Figure 1-2 presents the link-node analysis network that was constructed to model the evacuation roadway network in the city and the Shadow Region. The directional arrows on the links and the node numbers have been removed from Figure 1-2 to clarify the figure. The observations made during the field survey along with aerial imagery were used to calibrate the analysis network.

Demographic Survey

A demographic survey was performed to gather information needed for the evacuation study. Appendix D presents the survey instrument, the procedures used, and tabulations of data compiled from the survey returns.

This data was utilized to develop estimates of vehicle occupancy to estimate the number of evacuating vehicles during an evacuation and to estimate elements of the mobilization process. This database was also referenced to estimate the number of transit-dependent people, as well as capture attitudinal responses to evacuation.

Computing the Evacuation Time Estimates

The overall study procedure is outlined in Appendix B. Demographic data was obtained from several sources, as detailed later in this report. These data were analyzed and converted into vehicle demand data. The vehicle demand was loaded onto appropriate “source” links of the

analysis network using GIS mapping software. The DYNEV II system was then used to compute ETE for all Regions and Scenarios.

Analytical Tools

The DYNEV II System[4] that was employed for this study is comprised of several integrated computer models. One of these is the DYNEV (DYnamic Network EVacuation) macroscopic simulation model[5], a new version of the IDYNEV model that was developed by KLD under contract with the Federal Emergency Management Agency (FEMA).

DYNEV II consists of four sub-models:

- A macroscopic traffic simulation model.
- A Trip Distribution (TD) model that assigns a set of candidate destination (D) nodes for each "origin" (O) located within the analysis network, where evacuation trips are "generated" over time. This establishes a set of O-D tables.
- A Dynamic Traffic Assignment (DTA) model which assigns trips to paths of travel (routes) which satisfy the O-D tables, over time. The TD and DTA models are integrated to form the DTRAD (Dynamic Traffic Assignment and Distribution) model[5].
- A Myopic Traffic Diversion model which diverts traffic to avoid intense, local congestion, if possible.

Another software product developed by KLD, named UNITES (UNIfied Transportation Engineering System) was used to expedite data entry and to automate the production of output tables.

The dynamics of traffic flow over the network are graphically animated using the software product, EVAN (EVacuation ANimator), developed by KLD. EVAN is GIS based and displays statistics such as LOS, vehicles discharged, average speed, and percent of vehicles evacuated, output by the DYNEV II System. The use of a GIS framework enables the user to zoom in on areas of congestion and query road name, town name and other geographic information.

The procedure for applying the DYNEV II System within the framework of developing ETE is outlined in Appendix B. Appendix A is a glossary of terms.

For the reader interested in an evaluation of the original model, I-DYNEV, the following references are suggested:

- NUREG/CR-4873 – Benchmark Study of the I-DYNEV Evacuation Time Estimate Computer Code.

[4] The models of the IDYNEV System were recognized as state of the art by the Atomic Safety & Licensing Board (ASLB) in past hearings. (Sources: Atomic Safety & Licensing Board Hearings on Seabrook and Shoreham; Urbanik). The models have continuously been refined and extended since those hearings and were independently validated by a consultant retained by the NRC. The DYNEV II model incorporates the latest technology in traffic simulation and in dynamic traffic assignment. (Urbanik, T., et. al. Benchmark Study of the I-DYNEV Evacuation Time Estimate Computer Code, NUREG/CR-4873, Nuclear Regulatory Commission, June, 1988.)

[5] https://kldassociates.com/wp-content/uploads/2024/10/DTRAD-DYNEV.pdf

- NUREG/CR-4874 – The Sensitivity of Evacuation Time Estimates to Changes in Input Parameters for the I-DYNEV Computer Code.

The evacuation analysis procedures are based upon the need to:

- Route traffic along paths of travel that will expedite vehicles' travel from their respective points of origin to points outside the evacuated area.
- Restrict movement toward the wildfire to the extent practicable and disperse traffic demand so as to avoid focusing demand on a limited number of roadways.
- Move traffic in directions that are generally outbound relative to the location of the hazard.

DYNEV II provides a detailed description of traffic operations on the evacuation network. This description enables the analyst to identify bottlenecks and to develop countermeasures that are designed to represent the behavioral responses of evacuees. The effects of these countermeasures may then be tested with the model.

Model Limitations

The focus of this study is to estimate times for evacuating vehicular traffic. It does not analyze ingress times, and as a result the interaction between inbound vehicles (such as responders and/or buses) with outbound evacuees is not considered. Additionally, the model is not multimodal and does not analyze evacuation times for cyclists or pedestrians or consider the interaction between drivers, cyclists and/or pedestrians. See Section 11 for Berkeley public safety recommendations related to evacuating on bike or on foot.

Table 1-1. Stakeholder Interaction

City of Berkeley Stakeholders	Nature of Stakeholder Interaction
Fire Department Department of Public Works Planning and Development Department Police Department	• Attended project meetings. • Reviewed demographic survey questions. • Assisted in publicizing the demographic survey. • Assisted in data collection. • Reviewed and discussed all study assumptions. • Identified evacuation regions for study. • Attended bi-weekly meetings, as needed.

Table 1-2. Roadway Characteristics

- Number of lanes
- Lane width
- Shoulder type & width
- Interchange geometries
- Lane channelization & queuing capacity (including turn bays/lanes)
- Geometrics: curves, grades (>4%)
- Posted speed
- Actual free speed
- Abutting land use
- Traffic control and calming devices
- Intersection configuration (including roundabouts where applicable)
- Traffic signal type
- Unusual characteristics: Narrow bridges, sharp curves, poor pavement, inadequate delineations, toll booths, etc.

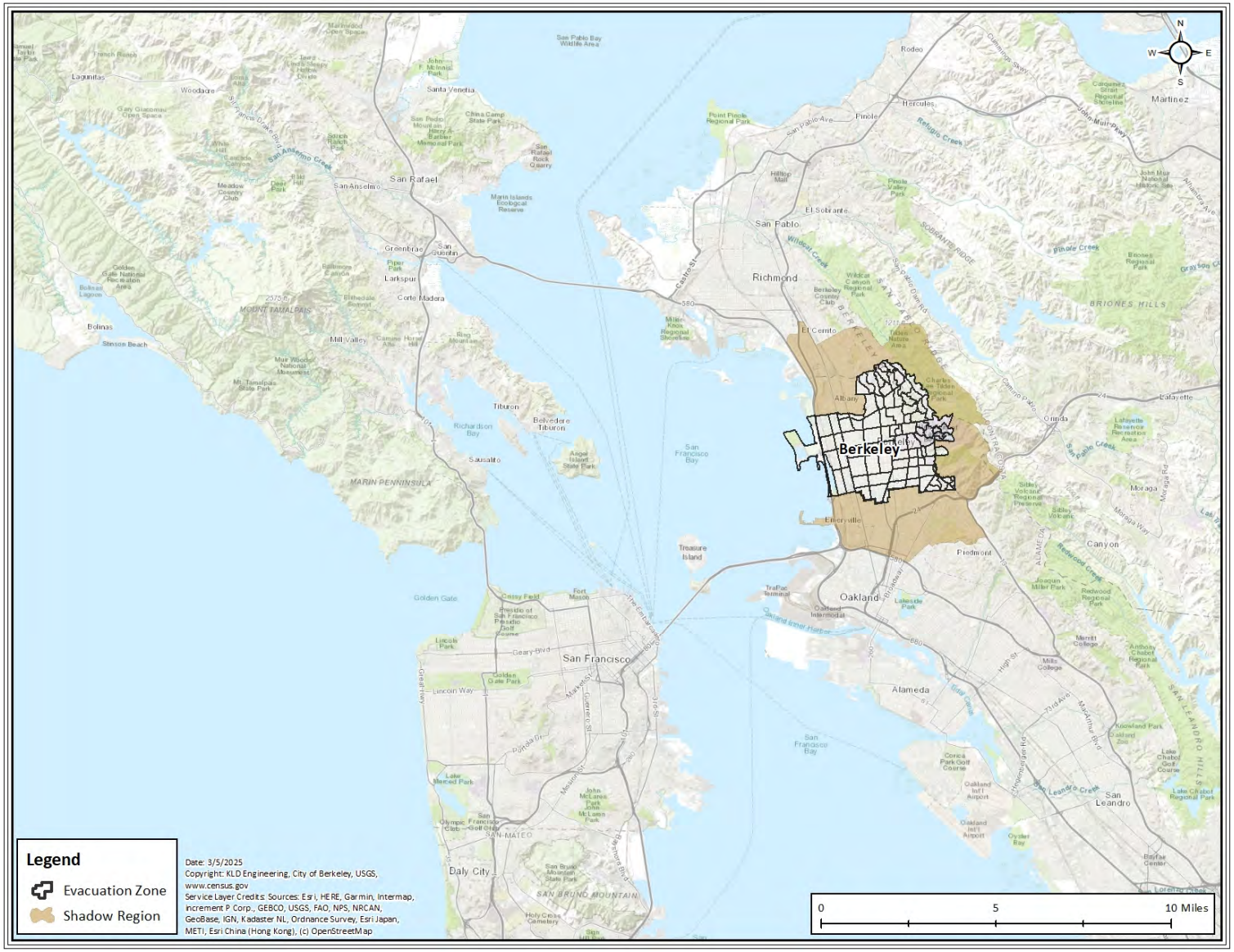


Figure 1-1. Study Area Location

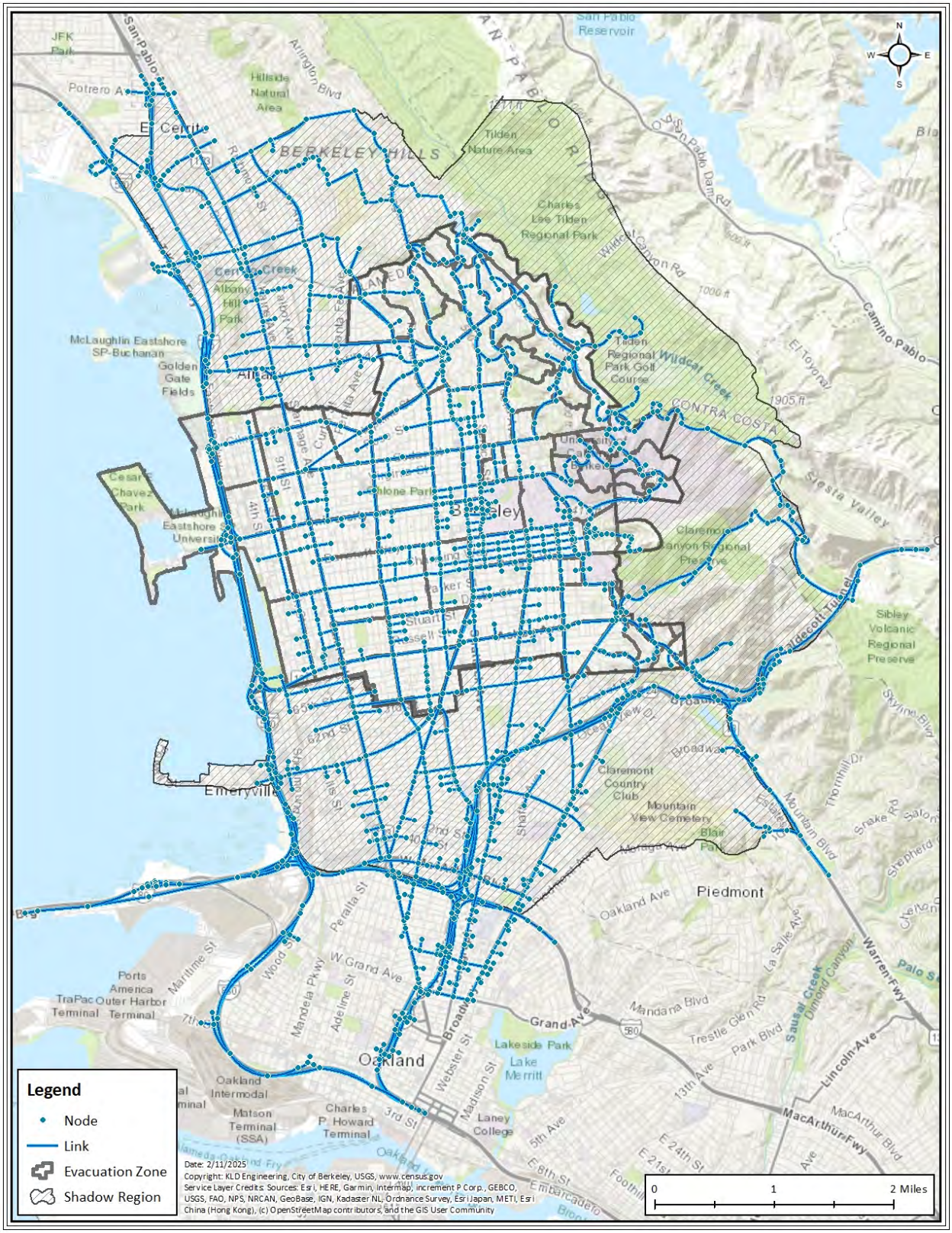


Figure 1-2. Study Area Link-Node Analysis Network

2 STUDY ESTIMATES AND ASSUMPTIONS

This section discusses the data estimates and project assumptions utilized in this study. These assumptions were discussed with representatives from the City of Berkeley. An assumptions memorandum documenting all the project assumptions was reviewed and approved by stakeholders prior to their use in this study.

2.1 Data Estimates

1. The permanent resident population estimates are based on the 2020 U.S. Census population data from the Census Bureau website[1] extrapolated to December 2024 using annual growth rates that are computed from the 2023 Census population estimates. A methodology, referred to as the "area ratio method," will be employed to estimate the population within portions of census blocks that are divided by the evacuation zone boundaries. It is assumed that the population is evenly distributed across a census block in order to employ the area ratio method.
2. Estimates of the number of employees commuting into the study area was provided by the City of Berkeley, supplemented by data from the U.S. Census Longitudinal Employer-Household Dynamics from the OnTheMap Census analysis tool[2].
3. Based on the demographic survey, the majority (64%) of households that have a commuter commute to work/college at least four days a week. Thus, no reduction in commuters was considered for remote work and learning.
4. Population estimates at special facilities (schools and medical facilities) was based on the data received from the City of Berkeley, supplemented by internet searches where data was missing.
5. Population estimates at tourist attractions (hotels, marinas, camps, parks, etc.) were based on parking lot capacities within the City of Berkeley, and the annual number of tourists that visit City of Berkeley. It is assumed that 30% of tourists visit the city via public transit and average vehicle occupancy rate is equal to the average household size (2.37).
6. The variation of tourists in different seasons and day of the week was based on the data provided by the City of Berkeley. The number of tourists within the city during nighttime scenarios (Scenario 3 and 6) was reduced by 60% compared to the daytime.
7. The relationship between permanent resident population and evacuating vehicles was based on the Census[3] and the results of the demographic survey. Values of 2.37 persons

[1] www.census.gov
[2] http://onthemap.ces.census.gov/
[3] https://www.census.gov/quickfacts/fact/table/berkeleycitycalifornia/IPE120223

per household and 1.14 evacuating vehicles per household were used for the permanent resident population.

8. Employee vehicle occupancies were based on the results of the demographic survey. In this study, 1.08 employees per vehicle were used. In addition, it is assumed there are two people per carpool, on average.
9. Roadway capacity estimates were based on field surveys performed in May 2023 and the application of the Highway Capacity Manual 2022.

2.2 Methodological Assumptions

1. The Planning Basis Assumption for the calculation of ETE is a rapidly escalating hazard that requires immediate evacuation, and includes the following:
    a. The order to evacuate is announced coincident with local emergency alerts (AC Alert/IPAWS, Genasys Protect, Outdoor Warning System Sirens, Nixle, social media, local news and similar communication systems).
    b. Mobilization of the general population will commence within 15 minutes after the order to evacuate.
    c. The ETE are measured relative to the order to evacuate being issued by officials.
    d. In a fire context, the "rapidly escalating hazard" scenario being modeled is one where a fire has ignited and is growing in a manner and location that warrants issuance of an evacuation order for all or parts of Berkeley. This study is not analyzing behaviors among evacuees for whom the hazard is actively present (i.e., there is active fire in the neighborhood). This means that mobilization times are not reflective of this type of situation. Additionally, driver behavior in the model does not reflect more unpredictable community behaviors expected when fire is present (violating traffic laws, driving erratically, etc.).
2. The DYNEV II[4] (Dynamic Network Evacuation) macroscopic simulation model was used to compute ETE in this study.
3. Evacuation movements (paths of travel) will be generally outbound relative to the hazard to the extent permitted by the highway network. All major evacuation routes were used in the analysis.
4. Evacuees will drive safely, travel away from the hazard to the extent practicable given the highway network and will obey all traffic control devices and traffic guides. It is noted that drivers under extreme duress may not drive safely, obey traffic control devices, or drive lawfully.
5. One hundred percent (100%) of the people told to evacuate will do so. Although the

[4] The models of the I-DYNEV System were recognized as state of the art by the Atomic Safety & Licensing Board (ASLB) in past hearings. (Sources: Atomic Safety & Licensing Board Hearings on Seabrook and Shoreham; Urbanik). The models have continuously been refined and extended since those hearings and were independently validated by a consultant retained by the NRC. The DYNEV II model incorporates the latest technology in traffic simulation and in dynamic traffic assignment.

demographic survey indicated that 0.8% of people will not leave an area under evacuation order, the ETE is designed to identify the time required to fully evacuate the area.

6. The Evacuation Zones were used to create the study area. Regions are defined by groupings of the Evacuation Zones. Regions to be considered are defined in Table 6-1.
7. Berkeley's evacuation zones establish the underlying geographies for evacuation measurements. For Region R05, evacuation zones do not match boundaries for Fire Zones 2 & 3 exactly. If a significant portion of the evacuation zone was part of Fire Zone 2 or 3, then the entire evacuation zone was included in Fire Zone 2 & 3.
8. The Shadow Region is defined as the area beyond the City of Berkeley and is bounded by I-80 and Grove Shafter Freeway to the south, to the boundary of Tilden Park to the east, Kensington Community to Terrace Drive to Stockton Avenue to Panama Avenue to the North, and the San Francisco Bay to the West.
9. Shadow population characteristics (household size, evacuating vehicles per household, and mobilization time) are assumed to be the same as that of the permanent resident population.
10. This study assumes that 20% of households within the Shadow Region and within the Evacuation Zones not ordered to evacuate, will choose to evacuate, based on the recommendation from Criteria for Development of Evacuation Time Estimate Studies, NUREG/CR-7002, Rev. 1, February 2021. It is noted that due to the limited geographic (North-South) extent of wildfire entry points, it is unlikely that shadow region evacuation will be homogenous. As an example, a wildfire entering Berkeley at Spruce/Wildcat Canyon/Cannon would likely result in 100% evacuation of Kensington and 0% evacuation of Oakland, Emeryville, and Piedmont. Due to the limitations of this study, a uniform 20% was assumed, acknowledging that the geographic areas of shadow evacuation will vary depending on the ignition point of the wildfire.
11. Phased evacuation is a systematic approach to evacuating people. Instead of everyone rushing out at once, the evacuation happens in stages, prioritizing those in immediate danger. This helps prevent overcrowding, making the evacuation process safer and more efficient. A phased evacuation is assumed for Region R03 (see Table 6-1), where residents in specified zones are ordered to evacuate, while residents in other zones receive an evacuation warning and/or are issued no protective order. After some time, zones that were issued a warning, or were given no action, may be issued an order to evacuate, or an evacuation warning, respectively, etc. and so on.
    a. During a phased evacuation, residents are assumed to still follow their regular mobilization curve starting at the time of the first evacuation order (0 minutes/Phase a), 30 minutes after the first evacuation order (Phase b), or 60 minutes after the evacuation order (Phase c).
        i. A voluntary evacuation of 20% is assumed for those within areas that are given no action.

b. Only residents are expected to phase their evacuation. Non-resident population groups (employees, tourists, etc.) are assumed to evacuate immediately if they are in zones that will later be given an evacuation order.

12. It is assumed that 50% of residents will voluntarily evacuate within zones that are given an evacuation warning. For phased evacuation cases, if a zone ultimately reaches an evacuation order, following a phase of no action (20% voluntary evacuation) and an evacuation warning (50% voluntary evacuation), only about 30% of residents remain.
13. Scenarios are outlined in Table 2-1. Fall means that K-12 public schools and colleges are in session. Summer means that K-12 public schools and colleges are in session at summer school enrollment levels (lower than normal enrollment).
14. Employment was assumed to be at its peak during fall scenarios. Employment is reduced slightly (96%) for summer scenarios. This is based on the estimation that 50% of the employees commuting into the evacuation zones will be on vacation for a week during the approximate 12 weeks of summer. It was further estimated that those taking vacations were uniformly dispersed throughout the summer with approximately 4% of employees vacationing each week. It was further estimated that only 10% of the employees work in the nighttime and during the weekends.
15. This study does not assume that roadways are empty at the start of an evacuation. The amount of initialization/fill traffic that is on the roadways in the study area at the start of the evacuation depends on the scenario and the region being evacuated.
16. To account for boundary conditions beyond the study area, this study assumes a 25% reduction in capacity on two-lane roads and multilane highways for roadways that have traffic signals downstream. The 25% reduction in capacity is based on the prevalence of actuated traffic signals in the study area and the fact that the evacuating traffic ("main street") volume will be more significant than the competing traffic ("side street") volume at any downstream signalized intersections, thereby warranting a more significant percentage (75% in this case) of the signal green time. There is no reduction in capacity for freeways due to boundary conditions.
17. Schools often prefer that parents and guardians not pick their children up from an evacuating school. This preference is to help facilitate an orderly evacuation, and the intention is that parents instead pick up their children from a secondary site outside of the evacuating area. Many parents will nevertheless choose to pick their children up from school while the school is evacuating. This influx of vehicles to school sites could impact evacuation flow. The results of the demographic survey indicate some parents will pick up their children from school prior to beginning their evacuation trip (see Assumption 2.a.i in Section 2.4). Based on survey responses, this study uses survey responses and assumes that 18% of households will pick up schoolchildren prior to beginning their evacuation trip.

2.3 Assumption on Mobilization Times

1. Evacuee mobilization times (also called trip generation time) were based on a statistical analysis of data acquired from a random sample demographic survey of the study area residents (documented in Section 5 and Appendix D).
2. The notification time distribution (the time required for evacuees to receive notification of an evacuation) used in the study was estimated using the results of the demographic survey, the data provided by the City of Berkeley and similar studies of this nature.
3. Based on the results of the demographic survey, 41.6% of the households in the evacuation zones have at least 1 commuter; 30.1% of households will await the return of household members before beginning their evacuation trip, based on the demographic survey results. Therefore, about 13% (41.6% x 30.1% = 12.5%) of households will await the return of household members, prior to beginning their evacuation trip. It is noted that these behaviors may not occur for active wildfire situations with ample indication (smoke and embers) of the emergent nature of the threat. In these situations, it is possible that fewer households will wait for all members to return prior to beginning their evacuation trip. Section 10 explores how evacuation time estimates change when evacuees leave more quickly.

2.4 Transit Dependent Assumptions

1. Approximately eighty-seven percent (87%) of the transit-dependent population will rideshare with a neighbor or friend, based on the demographic survey results.
2. Public transportation vehicle needs will be computed for special facilities:
    a. Schools and preschools/day care centers:
        i. Based on the demographic survey, approximately 22% of households have school children and 83% of them would pick them up from the school prior to starting their evacuation trip. The results of the demographic survey were used to estimate the trip generation distribution for this population group, which makes up about 18% (22% x 83% = 18.3%) of households within the evacuation zones.
        ii. If schools are in session, transport (buses) needs were computed based on school enrollments. In addition, the demand at schools will be reduced by 83% to account for parents that will pick up their children prior to evacuating.
        iii. Schoolchildren, if school is in session, are given priority in assigning transit vehicles, if available.
        iv. For those schools wherein buses are used to evacuate students, multiple waves of ETE were computed in the event there is shortfall of bus resources.
        v. It is assumed that infants from infant care centers are picked up by parents.

b. Colleges/Universities
    i. The colleges specifically considered were Berkeley City College and UC Berkeley. At both of these schools, some students have personal vehicles they will use to evacuate and some will rideshare. Although students may walk or cycle, the model conservatively assumes that remaining students without their own car or access to a vehicle will use a bus provided as part of emergency response to evacuate. See Section 3 for additional information.
    ii. Students at small local colleges are likely local residents living within the city or remote learning students living outside of the city.
c. Medical Facilities
    i. Buses, wheelchair transport vehicles and ambulance needs were computed for the evacuation of patients at medical facilities.
    ii. The percent breakdown of ambulatory/wheelchair-using/bedridden patients at medical facilities was assumed to be 45%/30%/25%[5], respectively, for facilities where no data was provided.
d. Numbers of people requiring specialized transportation were based on emPOWER data provided by the City of Berkeley. 348 people within the city are assumed to require specialized transportation assistance to evacuate. 99 people using motorized wheelchairs/scooters will evacuate in 50 wheelchair accessible vans. 249 bedbound people will evacuate in 125 ambulances.
e. The number of people experiencing homelessness was based on the data provided by the City of Berkeley. This population group is transit dependent and is picked up from shelters during an evacuation.
f. Households with 3 or more vehicles were assumed to have no need for transit vehicles.

3. Transit vehicle capacities and maximum speed limits:
    a. Students and children at preschools/day care centers were assumed to be 70 students per bus for elementary schools/preschools/day care centers and 50 students per bus for middle/high schools.
    b. Students at colleges/universities were assumed to be 30 students per bus.
    c. Ambulatory transit-dependent residents were assumed to be 30[6] people per bus.
    d. Employees and visitors, who will not have luggage, etc., are assumed to be 60 passengers per bus[7].
    e. Ambulatory patients at medical facilities were assumed to be 30[6] people per bus.
    f. Wheelchair accessible van was assumed to be 2 passengers per van.

[5] These percentages are based on the breakdown at the facilities at which data was obtained.
[6] The data provided by the City of Berkeley indicates that buses for ambulatory evacuees can accommodate at most 30 passengers with 45 standees. During an evacuation, however, it is likely that resident evacuees will carry personal items such as luggage and pets that will take up some of the available capacity within the bus. Hence, it is conservatively assumed that each bus can carry approximately 30 people.
[7] According to the AC Transit website, buses can accommodate between 40 and 78 passengers. An average of 60 passengers per bus was assumed.

g. Basic Life Support (BLS) (ambulances) was assumed to be 2 persons per vehicle.
h. The maximum bus speed was assumed to be 55 miles per hour in uncongested environments.

4. Transit vehicle[8] mobilization times:
    a. It is understood that the mobilization times for school and transit buses will vary. For the purpose of this study, it is assumed that school and transit buses will arrive at schools, preschools/day care centers and colleges/universities to be evacuated within 90 minutes of the order to evacuate.
    b. Buses for transit-depending evacuees will not be immediately available to pick them up. It is conservatively assumed that these buses will arrive at their designated pick-up routes within 180 minutes of the order to evacuate, which includes considering the notification, arrival and briefing times for the bus drivers.
    c. Vehicles will arrive at medical facilities to be evacuated within 90 minutes of the order to evacuate.
5. Transit vehicle loading times:
    a. School, preschool/day care center and college/university buses will be loaded in 15 minutes.
    b. Buses for transit dependent evacuees will require 1 minute of loading time per passenger[9].
    c. Buses for medical facilities will require 1 minute of loading time per ambulatory passenger.
    d. Wheelchair transport vehicles will require 5 minutes of loading time per passenger.
    e. Ambulances will require 30 minutes per bedridden passenger[10].
6. Tourists that arrive via public transit and rideshare applications, like Uber, will evacuate via the same means that they arrived in the city.

2.5 Access Control Assumptions

1. Vehicles will be traveling through the study area (external-external trips) at the start of a hazard. After the order to evacuate is announced, these pass-through travelers will also evacuate. External traffic vehicles will primarily utilize CA-24, Interstate (I)-580, I-80, and I-880 to pass through the area. It is likely that dynamic and variable message signs will be strategically positioned outside of the hazard area at logical diversion points to attempt to divert traffic away from the hazardous area within the City of Berkeley. As such, it is assumed this pass-through (external) traffic ceases at 2 hours after the order

[8] The City of Berkeley does not own or manage school and/or transit buses
[9] This includes the time for the vehicle to slow down, come to a stop, open the door, the passenger to enter the vehicle, and then for the vehicle to speed up to free flow speed on the roadway.
[10] This includes the time for the bedridden passengers to be brought to the ambulance door, load onto the ambulance, and hook up to the necessary equipment onboard the ambulance.

to evacuate to allow police to mobilize personnel and equipment to block the roadways and to allow time for commuters to return home and unite with family. Average Annual Daily Traffic (AADT) along CA-24 I-580, I-80, and I-880 will be based on the data obtained from California Department of Transportation (Caltrans)[11].

2. External traffic is estimated to be reduced by 60% during nighttime scenarios (Scenario 3 and 6). Nighttime scenarios are considered the time after everyone returns home (commuters and children) and before everyone leaves in the morning for work/school.

Table 2-1. Evacuation Scenario Definitions

Scenarios	Season[12]	Day of Week	Time of Day
1	Summer	Midweek	Midday
2	Summer	Weekend	Midday
3	Summer	Midweek, Weekend	Nighttime
4	Fall	Midweek	Midday
5	Fall	Weekend	Midday
6	Fall	Midweek, Weekend	Nighttime

[11] https://dot.ca.gov/programs/traffic-operations/census
[12] Fall means that school is in session at normal enrollment levels. Summer means that school is in session at summer school enrollment levels (lower than normal enrollment).

3 DEMAND ESTIMATION

This section discusses the estimates of demand, expressed in terms of people and vehicles, which constitute a critical element in developing an evacuation plan. This section also documents the sources of data, as well as the methodology used to extract relevant data from these sources. These estimates consist of three components:

1. An estimate of population within the City of Berkeley, stratified into groups (e.g., residents, employees, visitors, special facilities, etc.).
2. An estimate, for each population group, of average occupancy per evacuating vehicle. This estimate is used to determine the number of evacuating vehicles from the population estimates.
3. An estimate of potential double-counting of vehicles.

Appendix C presents much of the source material for the population estimates. Our primary source of population data, the 2020 Census, is not adequate for directly estimating some visitors.

Throughout the year, vacationers and visitors enter the City of Berkeley. These non-residents may dwell within the city for a short period (e.g., a few days or one or two weeks), or may enter and leave within one day. Estimates of the size of these population components must be obtained, so that the associated number of evacuating vehicles can be ascertained.

The potential for double-counting people and vehicles must be addressed. For example:

- A resident who works and shops within the city could be counted as a resident, again as an employee and once again as a shopper.
- A visitor who spends time at a park and then goes shopping could be counted two times.

Furthermore, the number of vehicles at a location depends on the time of day. For example, parking lots at area parks, which are full at noon, may be almost empty at dawn. Estimating counts of vehicles by simply adding up the capacities of different types of parking facilities will tend to overestimate the number of visitors and can lead to ETE that are too conservative.

Analysis of the population characteristics of the study area indicates the need to identify four distinct groups:

- Permanent residents - people who are year-round residents, including college students who live in Berkeley.
- Visitors - people who reside outside of the city who enter the area for a specific purpose (i.e., recreation) and then leave the area.
- Employees - people who reside outside of the city and commute to work within the city on a daily basis.
- College students who live outside Berkeley – people who reside outside of the city and commute to Berkeley colleges on a daily basis during the school year.

Estimates of the population and number of evacuating vehicles within the city are presented by different subdivisions of the city (Berkeley Flats, North Berkeley Hills, South Berkeley Hills, West

Berkeley, UC Berkeley and Lawrence Berkeley National Lab). These subdivisions are referred to as Areas throughout this report. The grouping of Evacuation Zones[1] that make up each Area are shown in Figure 3-1 and in more detail in Figure 3-2 through Figure 3-6. The evacuation zones were overlaid with the boundary of the City of Berkeley. When the zone extended beyond the City of Berkeley boundary, portions of the City of Oakland were included to reflect the area that would evacuate together. In addition, the eastern portion of Panoramic Hill, which lies completely in the City of Oakland, is included in the study as its own zone because people in this area will need to enter the City of Berkeley to evacuate.

3.1 Permanent Residents

The primary source for estimating permanent population is the latest U.S. Census data. The U.S. Census Bureau conducts a physical census of the permanent resident population in the U.S. every ten years. The latest census began on April 1, 2020, with data from the census being published on September 16, 2021. In the years between the decennial censuses, the Census Bureau works with state and local agencies to provide annual population estimates at the state and local levels. These estimates are done using data on deaths, births and migration. This annual data gathering process and analysis is extensive. As such, population estimates are a year behind – 2024 data are released in 2025[2]. However, the ETE simulations for this study were completed prior to the release of the 2024 data. Thus, this study is based on 2020 Census population data from the Census Bureau website[3] extrapolated to 2024 using annual growth rates computed from the 2023 Census population estimates as outlined in the methodology below.

The Census Bureau QuickFacts website[4] provides annual population estimates for each state, county[5], and municipality[6] in the United States. As discussed above, Census population estimates are a year behind. By the time this study started, the most recent population estimates available for the counties and municipalities are for the time period from April 1, 2020 to July 1, 2023. The population change and annual growth rate for each county and municipality in the study area (the City of Berkeley plus the Shadow Region) are provided in Table 3-1 and Table 3-2, respectively. Figure 3-7 shows the county and municipality boundaries identified by the Census Bureau.

The permanent resident population, as per the 2020 Census, for the city and the Shadow Region was projected to 2024 using the compound growth formula (Equation 1). In the compound growth formula, g is the annual growth rate, and X is the number of years projected forward from Year 2020. The compound growth formula can be solved for g as shown in Equation 2.

Equation 1

$$(Compound\ Growth\ for\ X\ years)\text{: } Population\ 202X\ =\ Population\ 2020\ (1\ +\ g)^{\,x}$$

[1] https://protect.genasys.com/
[2] The schedule for release of Census data is provided on the Census website: https://www.census.gov/programs-surveys/popest/about/schedule.html
[3] www.census.gov
[4] https://www.census.gov/quickfacts/fact/table/US/PST045222
[5] https://www.census.gov/data/datasets/time-series/demo/popest/2020s-counties-total.html
[6] https://www.census.gov/data/datasets/time-series/demo/popest/2020s-total-cities-and-towns.html

Equation 2

$$(Solving\ for\ the\ annual\ growth\ rate)\colon g = (Population\ 202X \div Population\ 2020)^{1/x} - 1$$

The 2020 and 2023 population data provided in Table 3-1 and Table 3-2 were used in Equation 2 to compute the annual growth rate for each county and municipality in the study area using X = 3.25 (3 years and 3 months from April 1, 2020 to July 1, 2023). The computed annual growth rate for each county and municipality is summarized in the final column of Table 3-1 and Table 3-2, respectively.

The most detailed data should always be used when forecasting population. In terms of detailed data, municipal data is the finest level of detail, then county data, and state data. The municipality growth rate was used first and if that was not available or applicable within the study area, then the county growth rate was used. County growth rates are available for the entire study area and were used (in the absence of municipal data) as they are the finest level of detail available for the entire study area. Thus, state data was not used.

The Census Bureau does not provide population data specific to the boundaries of the study area. As such, the county or municipality population was used to compute the annual growth rate. Then, the appropriate municipality or county growth rate was applied only to those census blocks located within the study area. All other blocks outside of the study area were not considered as part of the City of Berkeley or Shadow Region population, even if they are located within one of the municipalities or counties that intersect the study area.

The appropriate annual growth rate was applied to each census block in the study area depending on which county or municipality the block is located within. The population was extrapolated to December 1, 2024 using Equation 1 with X = 4.67 (4 years and 8 months from the April 1, 2020 Census date to December 1, 2024), as the base year for this study.

The permanent resident population is estimated by cutting the census block polygons by the boundaries of Evacuation Zones and Shadow Region using GIS software. A ratio of the original area of each census block and the updated area (after cutting) is multiplied by the total block population to estimate what the population is within the city. This methodology (referred to as the "area ratio method") assumes that the population is evenly distributed across a census block. Table 3-3 provides the permanent resident population within the city, by Area, for 2020 and for 2024 (based on the methodology above). As indicated, the permanent resident population within the city has decreased by -6.08% since the 2020 Census.

To estimate the number of vehicles, the 2024 extrapolated permanent resident population is divided by the average household size and then multiplied by the average number of evacuating vehicles per household. The average household size (2.37 persons/household) is based on the 2018-2022 American Community Survey 5-year estimates[7] and the number of evacuating vehicles per household (1.14 vehicles/household – See Appendix D, Sub-section D.3.2) was adapted from the demographic survey results. Permanent resident population and vehicle

[7] https://www.census.gov/programs-surveys/acs

estimates are presented in Table 3-4. Note, the 2020 Census includes residents living in group quarters, such as skilled nursing facilities, group homes, college/university student housing, juvenile homes, etc. These people are transit dependent (will not evacuate in personal vehicles) and are included in the special facility evacuation demand estimates. To avoid double counting vehicles, the vehicle estimates for these people have been removed. The resident vehicles in Table 3-4 have been adjusted accordingly.

3.2 Shadow Population

A portion of the population living outside the evacuation area may elect to evacuate without having been instructed to do so. This area is called the Shadow Region, which is bounded by I-580, Piedmont Ave and Moraga Ave to the south, State Route 13 and State Route 24 to the southeast, the eastern boundary of Tilden Park to the east, by Moeser Lane, San Pablo Avenue, Potrero Avenue, S 55th Street, and Bayview Avenue to the North, and I-580 and the San Francisco Bay to the West, as shown in Figure 3-8. Based upon NUREG/CR-7002, Rev. 1 guidance, it is assumed that 20% of the permanent resident population, based on U.S. Census Bureau data, in this Shadow Region will elect to evacuate.

Shadow population characteristics (household size, evacuating vehicles per household, mobilization time) are assumed to be the same as that of Berkeley's permanent resident population. As shown in Table 3-4, there are 114,671 permanent residents and 111,443 vehicles in the Shadow Region. Similar to the vehicle estimates for Berkeley residents, resident vehicles at group quarters have been removed from the shadow population vehicle demand in Table 3-4.

3.3 Visitor Population

Visitors are defined as those who are not permanent residents nor commuting employees but enter the City of Berkeley for a specific purpose (i.e., recreation or shopping). The visitor population was estimated based on the information provided by Visit Berkeley. Based on the data provided, the City of Berkeley had approximately 30,200,000 visits during a period of 364 days (from January 2023 to December 2023), and each visitor spends an average of 12 hours and 47 minutes (767 minutes) dwell time within the city. Based on the conversations with the city staff, it was assumed that 30% of these visits arrive via public transportation and the remaining 70% arrive via private vehicles. This computes to 44,192 visitors on a daily basis, on average, [(30,200,000 visits/364 days) x (767 minutes/1,440 minutes per day) = 44,192 visitors]. Of these 44,192 visitors, 13,258 (44,192 x 30%) of them arrive by public transportation, and 30,934 (44,192 – 13,258) visitors arrive in private vehicles.

Of the visitors that use public transportation (13,258 visitors), it was assumed that 50% of them would arrive by rail and 50% of them would arrive in the city using a bus. This results in 6,629 visitors arriving in the city via rail and 6,629 visitors arriving on 111 buses. (Unlike permanent residents, where the bus capacity is conservatively limited to 30 people per bus, visitors will have fewer belongings and will, therefore, need less space. Hence, it was assumed that buses for

visitors can accommodate 60 visitors per bus[8].) These visitors were loaded along the AC Transit routes within the city, see Section 9.

Since the locations of these visits/visitors could be anywhere within the city, the visitor vehicles were assumed to be located along streets where street parking is allowed as well as in the parking garages available within the City of Berkeley. Assuming the visitors travel to recreational areas and facilities as a family/household, the average household size (2.37 persons per household – see Section 3.1) was used to estimate the visitor vehicles. As a result, there are approximately 13,052 (30,934 ÷ 2.37) evacuating tourist vehicles.

In addition, visitors within the Shadow Region at Tilden Regional Park and the Tilden Park Golf Course were included in the study since they need to enter the city limits to evacuate. Based on aerial imagery, Tilden Regional Park has approximately 419 parking spaces and Tilden Park Golf Course has approximately 130 parking spaces. Assuming the parking lots are fully occupied at peak times, this study estimates a total of 549 evacuating vehicles from Tilden Regional Park and the Tilden Park Golf Course. The average household size (2.37 persons per household – see Section 3.1) was used to estimate visitor population at Tilden Regional Park and 2 persons per vehicle were used to estimate visitor population at the Tilden Park Golf Course, resulting in a population of 993 visitors (419 x 2.37) at Tilden Regional Park and 260 visitors (130 x 2.00) at the Tilden Park Golf Course.

In summary, 6,629 visitors would evacuate using rail, 6,629 visitors would evacuate in 111 buses and the remaining 32,187 visitors would evacuate in 13,601 private vehicles.

3.4 Employees

The estimate of employees commuting into the City of Berkeley is based on the employment data provided by the city and the data obtained from the U.S. Census Bureau's OnTheMap Census analysis tool[9].

The employment data provided by the City of Berkeley, as of October 2022, includes the coordinates of employers and the average number of their employees. The employer locations were plotted using GIS software. Employees who work at small companies are likely local residents. Based on federal guidance on major employers and discussions with the city, to avoid double-counting residents who live within the city, only employers with 100 or more employees are considered as *major employers*. Employers with less than 100 employees were removed from the analysis.

Staff at major employers within Berkeley fall into two categories:

- Those who live and work in the City of Berkeley
- Those who live outside of the City of Berkeley and commute to jobs within the city

[8] According to the AC Transit website, buses can accommodate between 40 and 78 passengers. An average of 60 passengers per bus was assumed.
[9] http://onthemap.ces.census.gov/

Those of the first category are already counted as part of the permanent resident population. To avoid double counting, we focus only on those employees commuting from outside the city who will evacuate along with the permanent resident population. The LEHD (Longitudinal Employer-Household Dynamics) Origin-Destination Employment Statistics (LODES) data[10] from OnTheMap website was then used to estimate the percent of employees that work within the city but live outside. The data indicates approximately 84.4% of these employees live outside of the City of Berkeley. This value was applied to the average number of employee values to compute the number of employees commuting into the city. There are an estimated 25,341 employees who work within the city but live outside.

To estimate the employee vehicles, a vehicle occupancy of 1.08 employees per vehicle obtained from the demographic survey (see Appendix D, Sub-section D.3.1) was used for the major employers. Given the limited parking spaces within the City of Berkeley, based on the demographic survey 35.7%[11] of the employees would take public transit to the city and the remaining employees who drive to work would park their vehicles within a 10-minute walking distance (approximately 0.5 miles) from their workplaces. As such, employee vehicles were distributed evenly within a 10-minute walking radius from their place of employment.

Table 3-5 and Table C-4 in Appendix C summarize the estimates of employees and employee vehicles commuting into the City of Berkeley, by Area. As shown in the tables, there are approximately 25,341 employees, including 9,046 employees who take public transit (5,247 employees would use a bus and the remaining 3,799 employees would use rail)[12], and 16,296 employees who would use personal vehicles or rideshare. This results in 15,080 employee vehicles and 88[8] buses (full of employees) commuting into the city on a daily basis.

3.5 Special Facility Population Demand

3.5.1 Medical Facilities

There are 11 medical facilities within the City of Berkeley that provide inpatient care services, indicated in Table 3-6[13]. In addition to these 11 facilities, 2020 Census data was used to identify skilled nursing facilities throughout the city at the census block level. These are labeled in Table 3-6 as “Other Medical Facilities Throughout the City”.

The breakdown of ambulatory, wheelchair-using and bedridden patients for some of the medical facilities was obtained by making phone calls to individual facilities. For those facilities wherein data could not be obtained, existing data was used to estimate the number of each type of patient (see Section 2.4, Assumption 2.c.ii) at each facility. Table C-3 in Appendix C summarizes

[10] The LODES data is part of the LEHD data products from the U.S. Census Bureau. This dataset provides detailed spatial distributions of workers' employment and residential locations and the relation between the two at the census block level. The latest LODES data available is as of 2019 when this study started. For detailed information, please refer to this site: https://lehd.ces.census.gov/data/

[11] As illustrated in Appendix D, Figure D-8, among employees commuting via bus, BART, a combination of public transit modes, driving alone, or carpooling, approximately 35.7% utilize public transportation. Employees who indicated that they would walk or bike as their primary mode of transportation were assumed to be local residents and thus excluded from the non-resident employee population.

[12] Based on the demographic survey, of the employees that take public transportation to work, approximately 58% use a bus and the remaining 42% use rail. See Appendix D Figure D-8.

[13] There are residential care facilities for the elderly (RCFE) or adult residential facilities (ARF) (maximum of 6 patients) that are not included as part of medical facilities. It is assumed that RCFE and ARF would be evacuated in personal vehicles of staff within the home and are already included in the vehicle estimates for the general population.

the data gathered. Table 3-6 presents the current census and transportation requirement of medical facilities in the City of Berkeley. As shown in this table, 861 people have been identified as living in, or being treated in, these facilities. The number of ambulances is determined by assuming that 2 bedridden patients can be accommodated per ambulance trip; the number of wheelchair vans assumes 2 wheelchairs per trip, and the number of buses estimated assumes 30 ambulatory patients per trip (see Section 2.4, Assumptions 3.c-e). As shown in Table 3-6, 20 buses, 111 wheelchair vans and 128 ambulances are needed to evacuate all medical facilities.

3.5.2 Juvenile Homes

As the 2020 Census data indicates, there are juvenile homes within the City of Berkeley. Their locations and population are listed in Appendix C, Table C-6. In total, there are 9 people in three different locations. It was assumed that these people would be evacuated with vehicles with 2 people per vehicle which would result in 5 vehicles to evacuate these facilities.

3.6 College/University, School, Preschool/Day Care Center Population Demand

3.6.1 School, Preschool/Day Care Center Population

Table 3-7 presents the population and transportation requirements for all schools and preschools/day care centers within the City of Berkeley. This information was provided by the City and supplemented by internet searches for schools where data was not provided. The column in Table 3-7 entitled "Buses Required" specifies the number of buses needed for each facility under the following set of assumptions and estimates:

- The demographic survey results indicate 83% of the households with school children would pick up their children prior to starting their evacuation trip. As such, the total enrollments were reduced by 83% to estimate the need for buses.
- Bus capacity, expressed in students per bus, was assumed to be 30 for colleges/universities, 50 for high school and middle school buses, and 70 for elementary school and preschool/day care center buses.
- Those staff members who do not accompany the students will evacuate in their private vehicles.
- No allowance is made for student absenteeism, which is typically 3 percent daily.

The need for buses could be further reduced by any high school students who have evacuated using private vehicles (if permitted by school authorities). Since the number of students who drive to school is unknown, these reductions were not considered. In total, an estimated 112 buses are required for all schools/preschools/day care centers within the city, as shown in Table 3-7. Those buses that are originally allocated to evacuate schoolchildren that are not needed due to children being picked up by their parents, can be gainfully assigned to service other facilities or those persons who do not have access to private vehicles or to ride-sharing. School buses are represented as two vehicles in the ETE simulation due to their larger size and more sluggish operating characteristics.

3.6.2 College/University Student Population

The City of Berkeley has 12 small colleges and 2 large colleges/universities: Berkeley City College

(BCC) and University of California – Berkeley (UC Berkeley). The data for all colleges/universities were provided by the City of Berkeley. It was assumed that students from most small local colleges are likely local residents living within the city or remote learning students living outside of the city. As such, these facilities were ignored to avoid double counting. Students at California Jazz Conservatory, Acupuncture and Integrative Medicine College, and Institute of Buddhist Studies would evacuate in personal vehicles. Although students may evacuate using rail, on foot, or on bike, this study conservatively assumes that students at BCC and UC Berkeley would either evacuate in personal vehicles or emergency evacuation buses.

Based on the data provided for UC Berkeley[14], there are 45,882 students and 3.94% of them telecommute or are remote. This equates to 44,075 students that are physically present on campus. Based on the data provided, 27% of students are On-Campus students (11,900 students), of which 18% own a personal vehicle (2,142 students). This equates to 1,983 On-Campus Student vehicles (using an average vehicle occupancy rate of 1.08 based on the demographic survey) for UC Berkeley. Of the remaining 82% of On-Campus students that do not own a personal vehicle, 87% of them would rideshare (based on the results of the demographic survey). The remaining students who do not own a vehicle, and will not rideshare, will require a bus to evacuate. This results in 1,269 On-Campus students evacuating on 43 buses (assuming 30 students per bus, see Section 2). Based on the data provided, 70% of students live within the city limits which includes both On-Campus students (11,900) and Off-Campus students that live within the city. As such, 18,953 ((44,075 x .070) – 11,900) Off-Campus students live within the city. The remaining 13,222 (44,075 – 11,900 – 18,953 = 13,222) are Off-Campus students that commute into UC Berkeley from outside of the city limits. Based on the data provided approximately 41% Off-Campus students drive to campus and the remaining approximately 59% utilize Bear Transit, AC Transit, BART, and other modes of public transit. Using the same vehicle occupancy rates, rideshare percentages (for those who would normally use public transit), and bus capacities as On-Campus students, this equates to 12,110 Off-Campus student vehicles and 75 Off-Campus student buses. The data indicates 25% of the non-city Off-Campus students that utilize public transit will utilize BART. As such, there are approximately 255 Off-Campus students that use BART to commute to UC Berkeley from outside of the city limits. There are a total of 14,093 student vehicles and 118 buses, and 255 students that use BART, at UC Berkeley.

Based on the data provided, there are 6,519 students that attend BCC. Of these students, 474 students live within Berkeley and commute to BCC, and 1,482 students live outside of Berkeley and commute to BCC. The remaining students do not commute to campus. Other detailed data was not available for BCC. As such, the vehicle ownership percentage (18%), vehicle occupancy rates (1.08), rideshare percentages (87%), and bus capacities (30) obtained for UC Berkeley were utilized for BCC. As such, there are an estimated 79 personal vehicles and 2 buses for students that live within Berkeley who attend BCC. Of the students that live outside of Berkeley (1,482 students), 36% of students would drive to campus and 41% would take public transportation[15]. Using the same vehicle occupancy rates, rideshare percentages, and bus capacities mentioned above, there are an estimated 494 personal vehicles and 5 buses for students that live outside of

[14] Annual Commuter Report, Berkeley University of California Parking & Transportation, 2023
[15] https://statics.teams.cdn.office.net/evergreen-assets/safelinks/1/atp-safelinks.html

Berkeley who commute to BCC. In total, there are 573 student vehicles and 7 buses evacuating from BCC.

In total, as shown in Table 3-8, students would evacuate in 14,938 personal vehicles and would require 125 buses to evacuate. Table 3-9 shows the breakdown of on/off campus students for UC Berkeley and Berkeley City College. As previously mentioned, buses are represented as two vehicles in the ETE simulation due to their larger size and more sluggish operating characteristics.

3.7 Transit Dependent Resident Population

The demographic survey (see Appendix D) results were used to estimate the portion of the population requiring transit service:

- Those people in households that do not have a vehicle available.
- Those people in households that do have vehicle(s) that would not be available at the time the evacuation is advised.

In the latter group, the vehicle(s) may be used by a commuter(s) who does not return (or is not expected to return) home to evacuate the household.

Table 3-10 presents estimates of transit-dependent people. Note:

- Estimates of people requiring transit vehicles include schoolchildren. For those evacuation scenarios where children are at school when an evacuation is ordered, separate transportation is provided for the schoolchildren. The actual need for transit vehicles by residents is thereby less than the given estimates. However, estimates of transit vehicles are conservatively not reduced when schools are in session.
- It is reasonable and appropriate to consider that many transit-dependent people will evacuate by ridesharing with neighbors, friends or family. The results from the demographic survey indicate that approximately 87% of those who do not own their own cars would share a ride with neighbors or friends. As such, 87% of transit dependent individuals were assumed to rideshare.

The estimated number of bus trips needed to service transit-dependent people is based on an estimate of average bus occupancy of 30 people at the conclusion of the bus run. Table 3-10 indicates that transportation must be provided for 1,686 people within the City of Berkeley. Therefore, a total of 57 buses are required from a capacity standpoint. In order to service all of the transit dependent population and have at least one bus drive through each of the Areas that contain transit dependent people, **112 buses** are used in the ETE calculations. These buses are represented as two vehicles in the ETE simulations due to their larger size and more sluggish operating characteristics.[16]

To illustrate this estimation procedure, we calculate the number of persons, P, requiring public transit or ride-share, and the number of buses B:

[16] Due to the inherent congestion during an evacuation, the incremental impedance caused by buses stopping for passenger boarding on roadways without dedicated shoulders or lanes is considered negligible. The pre-existing stop-and-go conditions mitigate any significant disruption.

$$P = No.\,of\ HH\ \times \sum_{i=0}^{n} \{(\%\ HH\ with\ i\ vehicles) \times [(Average\ HH\ Size) - i]\} \times A^i C^i$$

Where:

A = Percent of households with commuters

C = Percent of households who will not await the return of a commuter

$$P = 49{,}267 \times [0.0747 \times 1.51 + 0.428 \times (1.99 - 1) \times 0.416 \times 0.699 + 0.403 \times (2.74 - 2) \times (0.416 \times 0.699)^2] = 12{,}870$$

$$B = ([1 - 0.869] \times P) \div 30 = 57$$

These calculations are explained as follows:

- The number of households (HH) is computed by dividing the population by the average household size (116,762 ÷ 2.37) and is 49,267.
- All members (1.51 avg.) of households (HH) with no vehicles (7.47%) will evacuate by public transit or rideshare. The term 49,267 (number of households) x 0.0747 x 1.33, accounts for these people.
- The members of HH with 1 vehicle away (42.80%), who are at home, equal (1.99-1). The number of HH where the commuter will not return home is equal to (49,267 x 0.428 x 0.99 x 0.416 x 0.699), as 41.6% of households have a commuter, 69.9% of which would not return home in the event of an emergency. The number of persons who will evacuate by public transit or ride-share is equal to the product of these two terms.
- The members of HH with 2 vehicles that are away (40.30%), who are at home, equal (2.74 – 2). The number of HH where neither commuter will return home is equal to 49,267x 0.403 x 0.74 x $(0.416 \times 0.699)^2$. The number of persons who will evacuate by public transit or rideshare is equal to the product of these two terms (the last term is squared to represent the probability that neither commuter will return).
- Households with 3 or more vehicles are assumed to have no need for transit vehicles.
- The total number of persons requiring public transit is the sum of such people in HH with no vehicles, or with 1 or 2 vehicles that are away from home.
- The number of buses needed is computed as the product of the number of people requiring public transit and the percentage of people who will not rideshare (100% minus 87%) divided by the bus occupancy.
- Because the Census counts people experiencing homelessness, it is assumed that the homeless population are included inside these calculations of transit-dependent people.

KLD used AC Transit and other transit services within Berkeley to service the transit-dependent population within the city. These routes are shown in Figure 9-7 through Figure 9-9. It is assumed that transit dependent population would gather along the nearest transit route or transit stop to board a bus to evacuate the area.

3.7.1 Bay Area Rapid Transit and Caltrain (Rail) Demand

Data suggests that some employees, visitors and college students use Bay Area Rapid Transit (BART) and Caltrain for their daily commute. Since this study only considers vehicular demand on the City of Berkeley roadway system, it does not include evacuation using rail systems. As shown in Table 3-11, there are 6,629 visitors, 3,799 employees and 255 UC-Berkeley Off-Campus students that would evacuate using rail resources.

3.8 People Requiring Specialized Transportation Assistance

Based on data provided by the City of Berkeley, HHS emPOWER Program[17] (December 2023 update) identifies a total of 348 people within the city who are assumed to require transportation assistance to evacuate. The data from emPOWER does not provide details on the number of ambulatory, wheelchair-using and bedridden people. This study conservatively assumes that people who use motorized wheelchairs or scooters a wheelchair-accessible van and people using electric beds will require ambulances to evacuate. This equates to 99 motorized wheelchair/scooter users in 50 wheelchair accessible vans, and 249 bedbound people in 125 ambulances.

3.9 External Traffic

Vehicles will be traveling through the study area (external-external trips) at the time of an incident. After the evacuation order is announced, these through-travelers will also need to evacuate. These through vehicles are assumed to travel on the freeways traversing the study area – CA-24, Interstate 880 (I-880), I-580 and I-80. It is likely dynamic and variable message signs, and/or manual diversion, will be strategically positioned outside of the study area at logical diversion points to attempt to divert traffic away from the area at risk. As such, it is assumed this external traffic will cease at 2 hours after the evacuation order to allow emergency responders to facilitate evacuation.

Average Annual Daily Traffic (AADT) data was obtained from Caltrans[18] to estimate the number of vehicles per hour on the aforementioned routes. The AADT was multiplied by the K-Factor, which is the proportion of the AADT on a roadway segment or link during the design hour, resulting in the Design Hour Volume (DHV). The design hour is usually the 30th highest hourly traffic volume of the year, measured in vehicles per hour (vph). The DHV is then multiplied by the D-Factor, which is the proportion of the DHV occurring in the peak direction of travel (also known as the directional split).

The resulting values are the directional design hourly volumes (DDHV) and are presented in Table 3-12. The DDHV is then multiplied by 2 hours (dynamic messaging signs are assumed to be activated within the 120 minutes of the evacuation order) to estimate the total number of external vehicles loaded on the analysis network. As indicated, there are 47,962 external traffic vehicles within the study area prior to the activation of the roadblocks and the diversion of this

[17] https://empowerprogram.hhs.gov/
[18] https://dot.ca.gov/programs/traffic-operations/census/

traffic. This number is reduced by 60% for nighttime scenarios (Scenarios 3 and 6) as discussed in Section 6.

3.10 Background Traffic

Section 5 discusses the time needed for the people in the study area to mobilize and begin their evacuation trips. There are 14 time periods during which traffic is loaded on to roadways in the study area to model the mobilization time of people in the study area, see Table 5-9. All traffic is loaded within these 14 time periods. Note, there is no traffic generated during the 15th time period, as this time period is intended to allow traffic that has already begun evacuating to clear the study area boundaries.

In traffic simulations, the network is initially empty. Thus, for this study, the network needs to be filled (to represent routine travel conditions just prior to an evacuation order) so that system performance can be assessed under a more realistic set of conditions. As such, there is an initialization time period (often referred to as "fill time" in traffic simulation) wherein a portion of the traffic volumes from the start of the evacuation (Time Period 1) are loaded onto roadways in the study area. The amount of initialization/fill traffic that is on the roadways in the study area at the start of Time Period 1 depends on the scenario and the region being evacuated (see Section 6). For example, there are 5,545 vehicles on the roadways in the study area for Region R01 under Scenario 4 (winter, midweek, midday, normal conditions).

3.11 Summary of Demand

A summary of population and vehicle demand is provided in Table 3-13 and Table 3-14, respectively. This summary includes all population groups described in this section. A total of 274,376 people and 150,994 vehicles are considered in this study.

Table 3-1. County Population Change from April 1, 2020 to July 1, 2023

County	2020 Population	2023 Population	Percent Change	Annual Growth Rate
City of Berkeley				
Alameda	1,682,349	1,622,188	-3.58%	-1.11%
Shadow Region				
Contra Costa	1,165,930	1,155,025	-0.94%	-0.29%

Table 3-2. Municipality Population Change from April 1, 2020 to July 1, 2023

Municipality	2020 Population	2023 Population	Percent Change	Annual Growth Rate
Alameda County, CA				
City of Berkeley				
Berkeley	124,326	118,962	-4.31%	-1.35%
Shadow Region				
Albany	20,271	19,097	-5.79%	-1.82%
Emeryville	12,902	12,732	-1.32%	-0.41%
Oakland	440,669	436,504	-0.95%	-0.29%
Piedmont	11,277	10,635	-5.69%	-1.79%
Contra Costa County, CA				
Shadow Region				
El Cerrito	25,955	25,552	-1.55%	-0.48%
Orinda	19,505	19,364	-0.72%	-0.22%
Richmond	116,324	114,106	-1.91%	-0.59%

Table 3-3. Permanent Resident Population within the City of Berkeley and Shadow Region

Refer to Figure 3-1 for geographic representation of these areas.

Area	2020 Population	2024 Extrapolated Population
Berkeley Flats	81,753	76,770
North Berkeley Hills	23,223	21,819
South Berkeley Hills	7,238	6,799
West Berkeley	9,785	9,188
UC Berkeley	2,327	2,186
Lawrence Berkeley National Lab	0	0
TOTAL	**124,326**	**116,762**
Population Growth (2020-2024):		**-6.08%**
Shadow Region	**114,671**	**111,443**
STUDY AREA TOTAL	**238,997**	**228,205**

Table 3-4. Permanent Resident Population and Vehicles

Area	2024 Extrapolated Population	2024 Resident Vehicles
Berkeley Flats	76,770	32,193
North Berkeley Hills	21,819	9,426
South Berkeley Hills	6,799	2,078
West Berkeley	9,188	3,680
UC Berkeley[19]	2,186	237
Lawrence Berkeley National Lab	0	0
TOTAL	**116,762**	**47,614**
Shadow Region	**111,443**	**52,094**
STUDY AREA TOTAL	**228,205**	**99,708**

[19] The population estimates shown within the UC Berkeley Area only include the data produced by the Census, not the estimated student population. The estimated student population, and evacuating student vehicles (including transit dependent students), is contained within Section 3.6.2 and Table 3-8.

Table 3-5. Summary of Employees and Employee Vehicles Commuting into the City of Berkeley

Area	Employees	Employee Vehicles[20,21]
Berkeley Flats	5,553	6,059
North Berkeley Hills	0	853
South Berkeley Hills	172	103
West Berkeley	5,035	2,831
UC Berkeley	11,553	3,563
Lawrence Berkeley National Lab	3,028	1,847
TOTAL	**25,341**	**15,256**

[20] As described in Section 3.4, the employees driving to the city would park their vehicles within a 10-minute walking distance from their workplaces due to the limited parking spaces. As a result, the vehicle numbers in Berkeley Flats and North Berkely Hills are greater than the population numbers, while the vehicle number in UC Berkeley is significantly less than the vehicle estimate.
[21] Includes 88 buses (176 vehicles) for employees who commute using buses.

Table 3-6. Medical Facilities Transit Demand Estimates

Area	Facility Name	Municipality	Current Census	Ambu-latory	Wheel-chair Users	Bed-ridden	Buses	Wheelchair Vans	Ambu-lances
Berkeley Flats	Silverado Memory Care Center	Berkeley	87	37	22	28	2	11	14
Berkeley Flats	Chaparral House	Berkeley	42	6	18	18	1	9	9
Berkeley Flats	Elegance Berkeley	Berkeley	47	20	12	15	1	6	8
Berkeley Flats	Alta Bates Summit Medical Center - Herrick Campus	Berkeley	58	58	0	0	2	0	0
Berkeley Flats	Kyakameena Care Center	Berkeley	60	26	15	19	1	8	10
Berkeley Flats	Berkeley Pines Care Center	Berkeley	32	4	18	10	1	9	5
Berkeley Flats	Elmwood Care Center	Berkeley	77	33	19	25	2	10	13
Berkeley Flats	Alta Bates Summit Medical Center - Alta Bates Campus	Berkeley	183	73	37	73	3	19	37
Berkeley Flats	Ashby Care Center	Berkeley	29	5	14	10	1	7	5
North Berkeley Hills	New Bridge Foundation	Berkeley	45	20	14	11	1	7	6
UC Berkeley	Redwood Gardens Apartments	Berkeley	168	76	50	42	3	25	21
Berkeley Flats	Other Medical Facilities Throughout the City	Berkeley	33	33	0	0	2	0	0
TOTAL:			**861**	**391**	**219**	**251**	**20**	**111**	**128**

Table 3-7. School and Preschool/Day Care Center Population Demand Estimates

Area	School Name	Enrollment	Buses Required
Berkeley Flats	Berkeley Rose Waldorf School	97	1
Berkeley Flats	Ruth Acty Elementary School	433	2
Berkeley Flats	The Crowden School	75	1
Berkeley Flats	Martin Luther King Middle School	1,007	4
Berkeley Flats	School of the Madeleine	337	1
Berkeley Flats	Bayhill High School	73	1
Berkeley Flats	Berkeley Arts Magnet at Whittier School	407	1
Berkeley Flats	Berkeley High School	3,427	12
Berkeley Flats	Pacific Boychoir Academy	30	1
Berkeley Flats	Berkwood Hedge School	128	1
Berkeley Flats	Oxford Elementary at West Campus	256	1
Berkeley Flats	The Berkeley School	236	1
Berkeley Flats	Longfellow Arts and Technology Middle School	504	2
Berkeley Flats	Berkeley Technology Academy	36	1
Berkeley Flats	Walden Center & School	84	1
Berkeley Flats	Washington Elementary School	416	2
Berkeley Flats	East Bay School for Boys	105	1
Berkeley Flats	Sylvia Mendez Elementary School	409	1
Berkeley Flats	The Elmwood Academy	100	1
Berkeley Flats	Willard Middle School	669	3
Berkeley Flats	Malcolm X Elementary School	552	2
Berkeley Flats	Escuela Bilingue Internacional	324	1
Berkeley Flats	Emerson Elementary	323	1
Berkeley Flats	Maybeck High School	121	1
North Berkeley Hills	Thousand Oaks Elementary	382	1
North Berkeley Hills	Cragmont Elementary School	331	1
South Berkeley Hills	John Muir Elementary School	306	1

Area	School Name	Enrollment	Buses Required
West Berkeley	Black Pine Circle School	347	1
West Berkeley	Rosa Parks Environmental Science School	442	2
West Berkeley	VIA Center	20	1
	SCHOOL TOTAL:	**11,977**	**51**

Area	Preschool/Daycare Name	Enrollment	Buses Required
Berkeley Flats	Berkeley Rose Waldorf School	24	1
Berkeley Flats	Hearts Leap Beginnings	40	1
Berkeley Flats	Hearts Leap ICRI Preschool	70	1
Berkeley Flats	Berkeley Little School	42	1
Berkeley Flats	Ala Costa Center for the Developmentally Disabled	58	1
Berkeley Flats	BUSD - Hopkins Street	140	1
Berkeley Flats	Mustard Seed Preschool	66	1
Berkeley Flats	Jewish Community Ctr of The East Bay-Berkeley	75	1
Berkeley Flats	Cedar Creek Montessori School	40	1
Berkeley Flats	Woolly Mammoth Childcare & Preschool	69	1
Berkeley Flats	Berkeley Montessori School	119	1
Berkeley Flats	The New School of Berkeley	48	1
Berkeley Flats	The New School of Berkeley-Schoolage	45	1
Berkeley Flats	Hearts Leap North	45	1
Berkeley Flats	Berkeley Special Education Preschool	90	1
Berkeley Flats	Berkeley YMCA EHS - Vera Casey	26	1
Berkeley Flats	Congregation Beth Israel-Gan Shalom	32	1
Berkeley Flats	Little Elephant Montessori, Inc.	24	1
Berkeley Flats	Shu Ren International School	179	1
Berkeley Flats	Berkeley International Montessori School	21	1
Berkeley Flats	Child Education Center	107	1
Berkeley Flats	Congregation Netivot Shalom	30	1

Area	School Name	Enrollment	Buses Required
Berkeley Flats	Little Beans Preschool	40	1
Berkeley Flats	Rosemarie's Motivational Preschool	22	1
Berkeley Flats	BUSD - King Child Development Center	108	1
Berkeley Flats	Cornerstone Children's Center	112	1
Berkeley Flats	UCB - Dwight Way Center	42	1
Berkeley Flats	UCB - Harold E. Jones Child Study Ctr/Childcare	56	1
Berkeley Flats	UCB - Haste Street Child Development Center	92	1
Berkeley Flats	Berkeley YMCA Head Start - South YMCA	94	1
Berkeley Flats	Model School Comprehensive Humanistic Learning Ctr	63	1
Berkeley Flats	Through the Looking Glass Early Head Start	24	1
Berkeley Flats	American International Montessori School	117	1
Berkeley Flats	Ephesian Children's Center	36	1
Berkeley Flats	Mi Mundo Preschool	29	1
Berkeley Flats	VIA Nova Children's School	45	1
Berkeley Flats	The Monteverde School	30	1
Berkeley Flats	St. John's Child Care Center	45	1
North Berkeley Hills	Step One School	108	1
North Berkeley Hills	Berkeley Hills Nursery School	40	1
North Berkeley Hills	Childrens Community Center	52	1
North Berkeley Hills	Dandelion Nursery School, Inc	24	1
North Berkeley Hills	Beth El Nursery School	74	1
UC Berkeley	UCB - Clark Kerr Campus Children's Center	29	1
UC Berkeley	UCB - Clark Kerr Preschool	29	1
South Berkeley Hills	Kids In Motion	70	1
South Berkeley Hills	Arbor Preschool East	22	1
West Berkeley	BUSD - Franklin Preschool	192	1
West Berkeley	Centro Vida Bilingual Childcare Center	64	1
West Berkeley	Duck's Nest - Berkeley	91	1

Area	School Name	Enrollment	Buses Required
West Berkeley	Golden Gate Learning Center	57	1
West Berkeley	Bahia School Age Program	65	1
West Berkeley	Dolma Child Care Center	14	1
West Berkeley	Berkeley YMCA Head Start - West	86	1
West Berkeley	Nia House Learning Center	94	1
West Berkeley	Ecole Bilingue De Berkeley	426	2
West Berkeley	Global Montessori International School	90	1
West Berkeley	Pixar Child Development Center	108	1
West Berkeley	Sunshine Preschool (CEID)	45	1
West Berkeley	Aquatic Park School	77	1
	PRESCHOOL/DAYCARE TOTAL:	**4,202**	**61**
	GRAND TOTAL	**16,179**	**112**

Table 3-8. College/University Student Estimates

Area	College/University Name	Enrollment	Student Vehicles	Buses Required
Berkeley Flats	Berkeley School of Theology	65	0	0
Berkeley Flats	Berkeley City College	6,519	573	7
Berkeley Flats	California Jazz Conservatory	88	81	0
Berkeley Flats	Acupuncture and Integrative Medicine College-Berkeley	153	142	0
Berkeley Flats	Institute of Buddhist Studies	53	49	0
North Berkeley Hills	Pacific Lutheran Theological Seminary	50	0	0
North Berkeley Hills	Dominican School of Philosophy & Theology	100	0	0
North Berkeley Hills	Church Divinity School of the Pacific	122	0	0
North Berkeley Hills	Graduate Theological Union	275	0	0
North Berkeley Hills	Jesuit School of Theology	112	0	0
North Berkeley Hills	Pacific School of Religion	139	0	0
North Berkeley Hills	Zaytuna College	43	0	0
South Berkeley Hills	The Wright Institute	638	0	0
UC Berkeley	University of California - Berkeley	44,075	14,093	118
COLLEGE/UNIVERSITY TOTAL:		**52,432**	**14,938**	**125**

Table 3-9. UC Berkeley and City College On/Off Student Estimates

Area	College/University Name[22]	Enrollment	On-Campus Students	Off-Campus Commuter Students	Total Student Vehicles	On-Campus Student Vehicles	Off-Campus Student Vehicles	Buses Required	On-Campus Student Buses	Off-Campus Student Buses
Berkeley Flats	Berkeley City College	6,519	474[23]	1,482	573	79	494	7	2	5
UC Berkeley	University of California - Berkeley	44,075	11,900	13,222	14,093	1,983	12,110	118	43	75
TOTAL:		**50,594**	**12,374**	**14,704**	**14,666**	**2,062**	**12,604**	**125**	**45**	**80**

[22] The difference between on/off campus students are students who reside within Berkeley and are included as permanent residents

[23] Berkeley City College does not offer On-Campus housing, these 474 students live within Berkeley and are assumed to be near houses/apartments within the vicinity of the college. Census Blocks within the vicinity of the college were adjusted to avoid double counting these students as residents.

Table 3-10. Transit-Dependent Population Estimates

2024 Extrapolated Population	Survey: Average HH Size with Indicated No. of Vehicles			Estimated No. of Households	Survey: Percent HH with Indicated No. of Vehicles			Survey: Percent HH with Commuters	Survey: Percent HH with Non-Returning Commuters	Total People Requiring Transport	Survey: Estimated Ridesharing Percentage	People Requiring Public Transit	Percent Population Requiring Public Transit
	0	1	2		0	1	2						
116,762	1.51	1.99	2.74	49,267	7.47%	42.80%	40.30%	41.60%	69.90%	12,870	86.9%	1,686	1.4%

Table 3-11. Rapid Transit (Rail) Demand Estimates

Population group	People
Visitors	6,629
Employees	3,799
College Students	255
TOTAL:	**10,683**

Table 3-12. External Traffic Estimates

Road Name	Direction	CA DOT AADT[24]	K-Factor[25]	D-Factor[25]	Hourly Volume	External Traffic
CA-24	Southbound	169,000	0.082	0.25	3,465	6,930
I-880	Northbound	128,000	0.082	0.33	3,464	6,928
I-580	Northbound	169,000	0.082	0.33	4,573	9,146
I-580	Southbound	257,000	0.067	0.25	4,305	8,610
I-80	Northbound	231,000	0.067	0.25	3,869	7,738
I-80	Southbound	257,000	0.067	0.25	4,305	8,610
					TOTAL	**47,962**

[24] California Department of Transportation (Caltrans), https://dot.ca.gov/programs/traffic-operations/census/
[25] Highway Capacity Manual (HCM) 2022

Table 3-13. Summary of Population Demand

Area	Residents[26]	Transit-Dependent Residents[27]	Visitors	Employees	Special Facilities[28]	College Students[29]	Schools and Preschools	Shadow Population[30]	External Traffic	Total
Berkeley Flats	76,770	1,111		5,553	650[32]	6,878	12,494	0	0	110,968
North Berkeley Hills	21,819	315		0	45	841	1,011	0	0	31,544
South Berkeley Hills	6,799	96	37,563[31]	172	0	638	398	0	0	15,616
West Berkeley	9,188	134		5,035	7[33]	0	2,218	0	0	24,095
UC Berkeley	1,955	31		11,553	168	44,075	58	0	0	65,583
Lawrence Berkeley National Lab	0	0	0	3,028	0	0	0	0	0	3,028
Shadow Region	0	0	1,253	0	0	0	0	22,289	0	23,542
Total	**116,762**	**1,686**	**32,187**	**25,341**	**870**	**52,432**	**16,179**	**22,289**	**0**	**274,376**

[26] Computed from the Census.
[27] Computed from the Census and the demographic survey.
[28] Special Facilities represent the population at medical facilities and juvenile homes.
[29] College students includes on-campus student populations.
[30] Shadow Population has been reduced to 20%. Refer to Section 2.
[31] For simplicity, these visitors were distributed equally within each Area inside the Total column of this table for a representative value of the total number of visitors within each Area.
[32] Includes 2 people at a juvenile home.
[33] Includes 7 people at two juvenile homes within this Area.

Table 3-14. Summary of Vehicle Demand[34]

Area	Residents	Transit-Dependent Residents	Visitors	Employees	Special Facilities[35]	College Students	Schools and Preschools	Shadow Population[30]	External Traffic	Total
Berkeley Flats	32,193	112	13,274[31]	6,059	213[36]	859	164	0	0	42,254
North Berkeley Hills	9,426	56		853	15	0	14	0	0	13,019
South Berkeley Hills	2,078	27		103	0	0	6	0	0	4,869
West Berkeley	3,680	24		2,831	4[37]	0	36	0	0	9,230
UC Berkeley	193	5		3,563	52	14,329	4	0	0	20,845
Lawrence Berkeley National Lab	0	0	0	1,847	0	0	0	0	0	1,847
Shadow Region	0	0	549	0	0	0	0	10,419	47,962	58,930
Total	**47,614**	**224**	**13,823**	**15,256**	**285**	**15,188**	**224**	**10,419**	**47,962**	**150,994**

[34] Buses (including Transit-Dependent Buses) are represented as two passenger vehicles. Excludes rapid transit demand since rail has its own dedicated roadway.
[35] Special Facilities represent the vehicles at medical facilities and juvenile homes.
[36] Includes 1 vehicle at a juvenile home.
[37] Includes 4 vehicles at two juvenile homes within this Area.

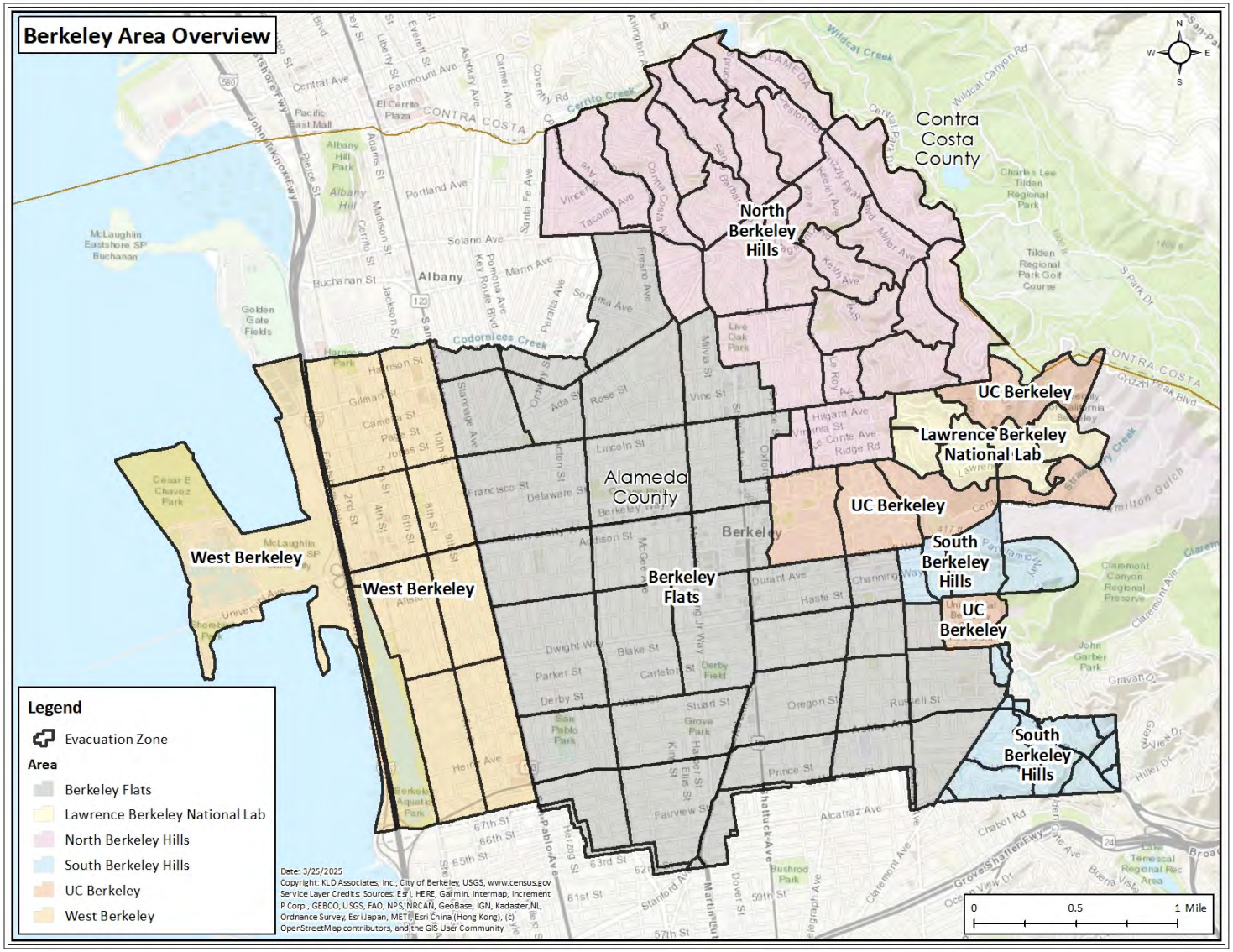


Figure 3-1. Overview of Evacuation Zone and Area Boundaries

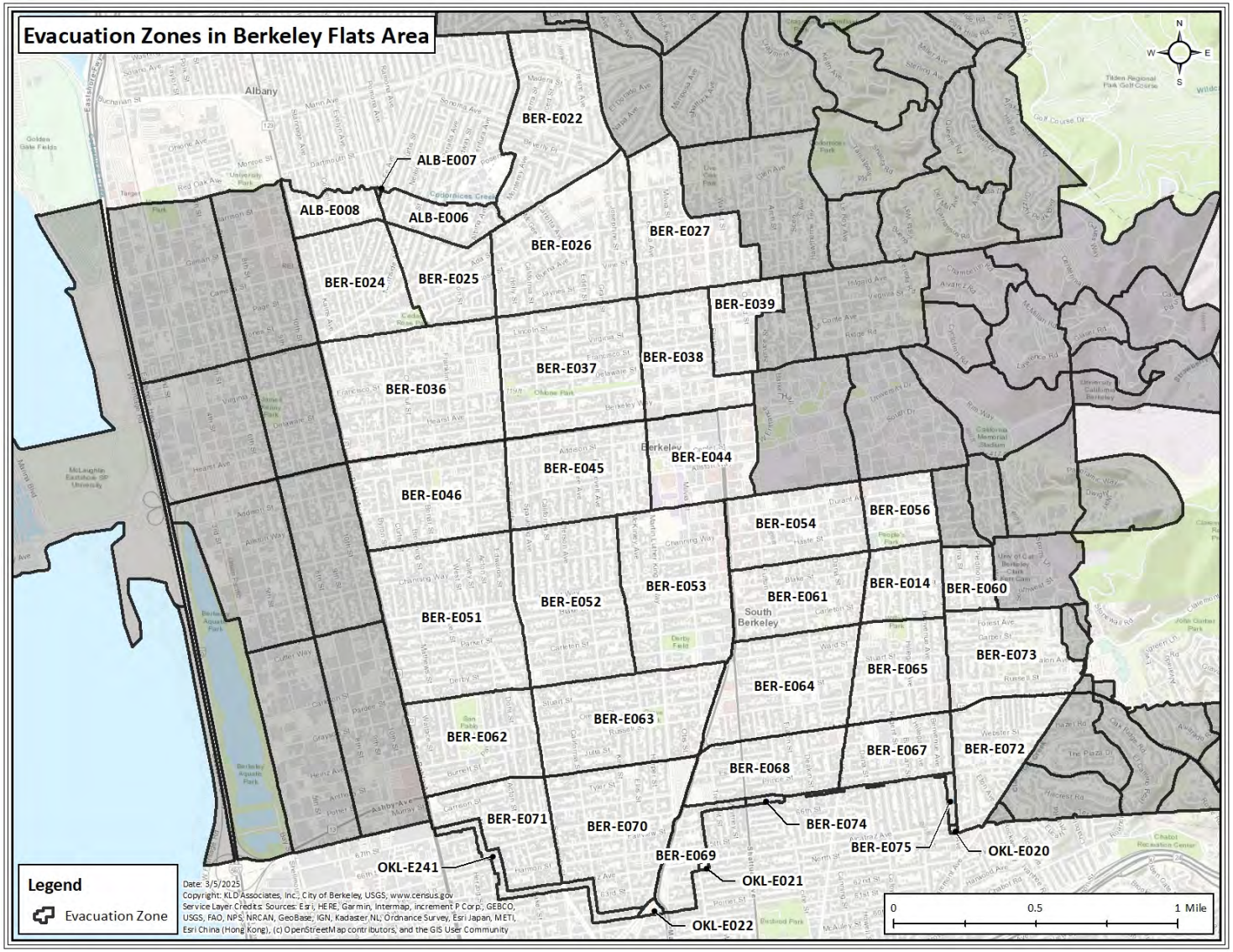


Figure 3-2. Evacuation Zones in the Berkeley Flats Area

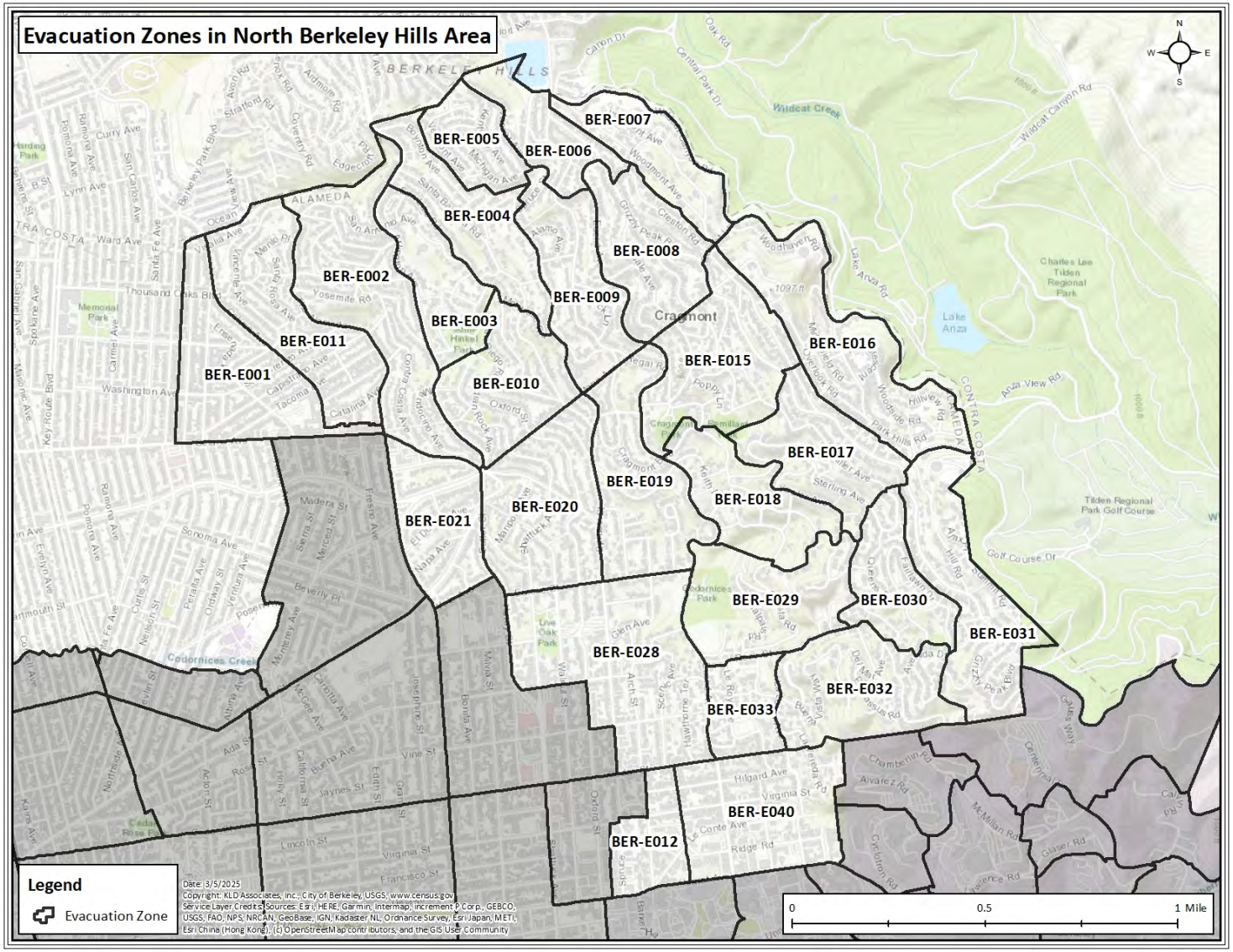


Figure 3-3. Evacuation Zones in the North Berkeley Hills Area

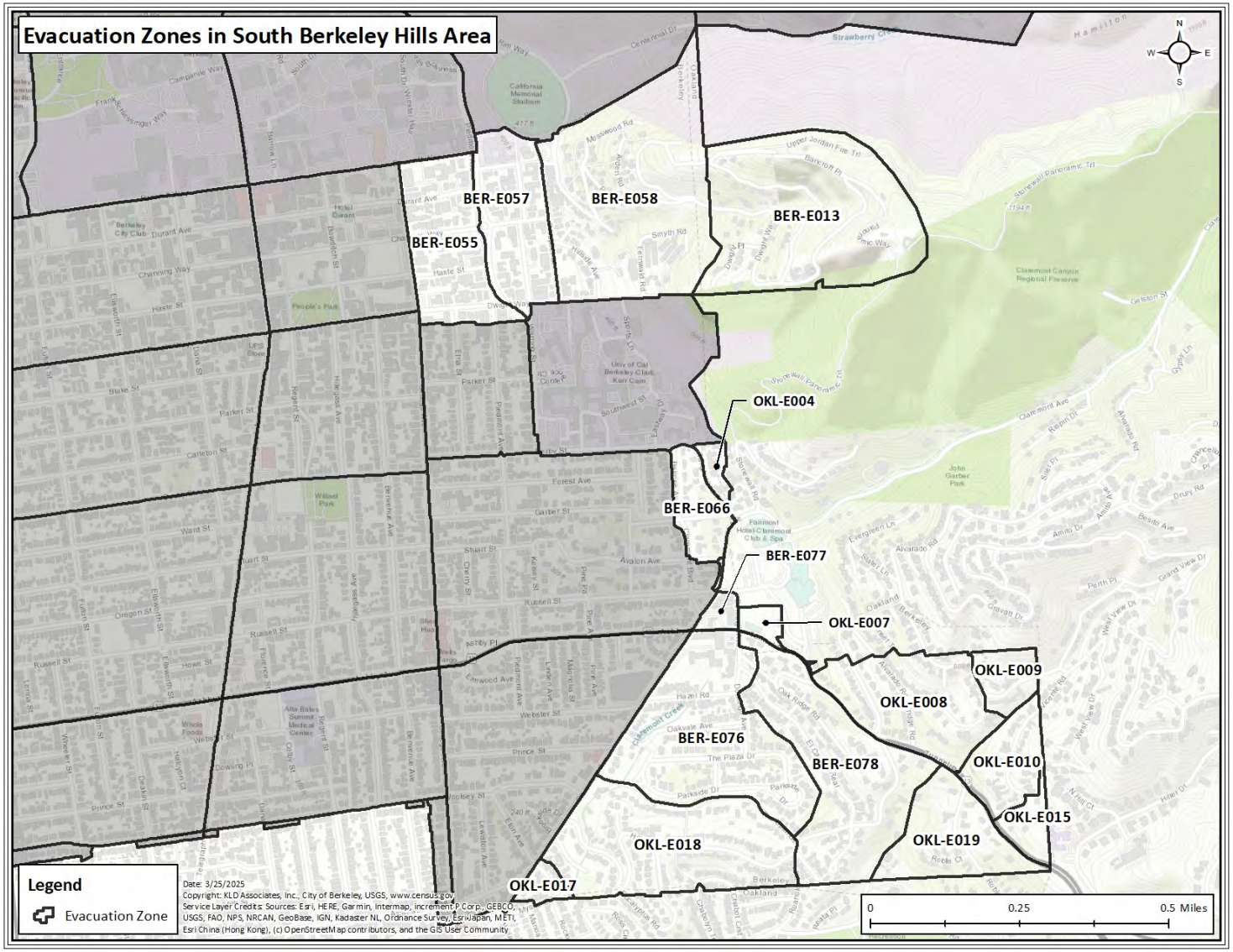


Figure 3-4. Evacuation Zones in the South Berkeley Hills Area

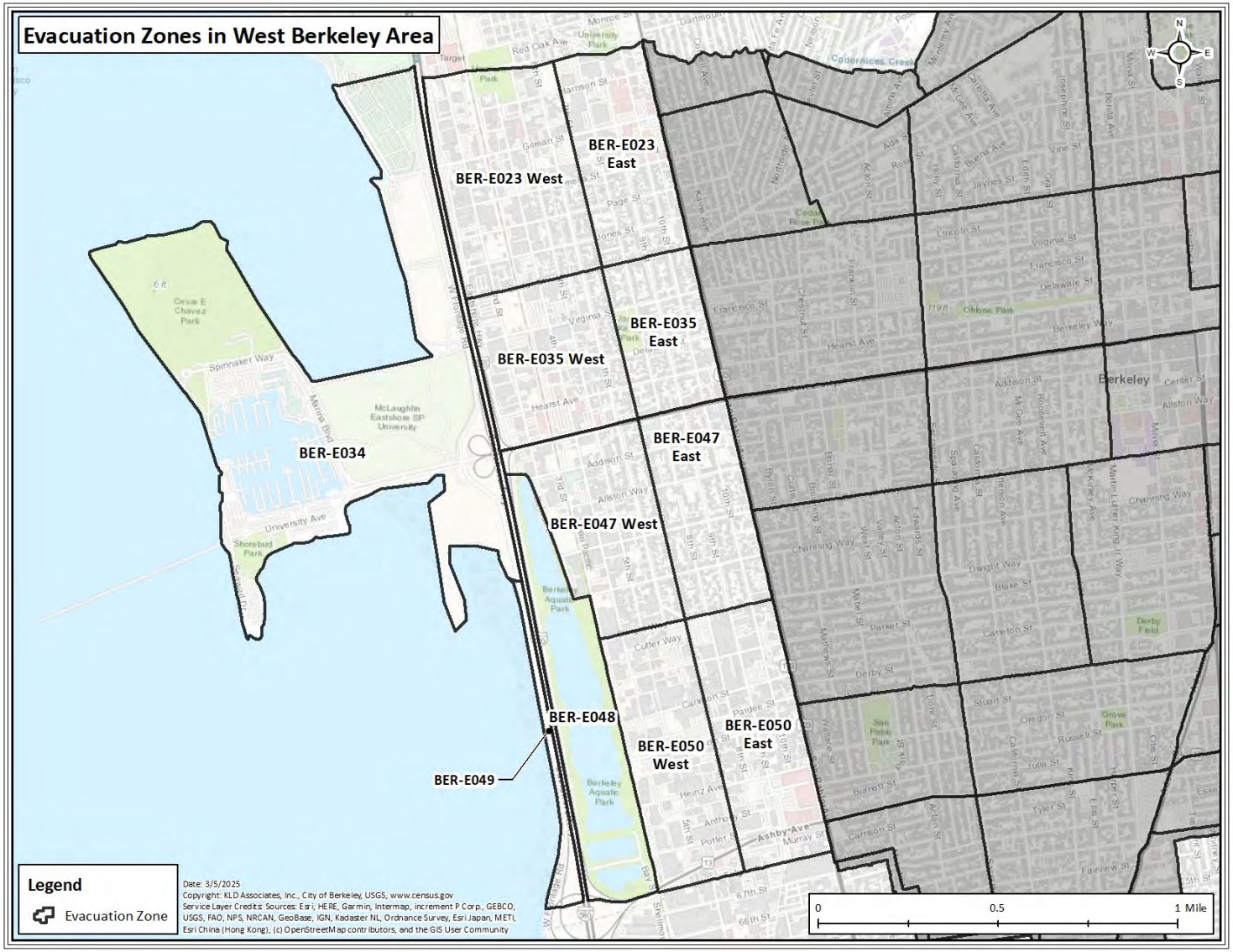


Figure 3-5. Evacuation Zones in the West Berkeley Area

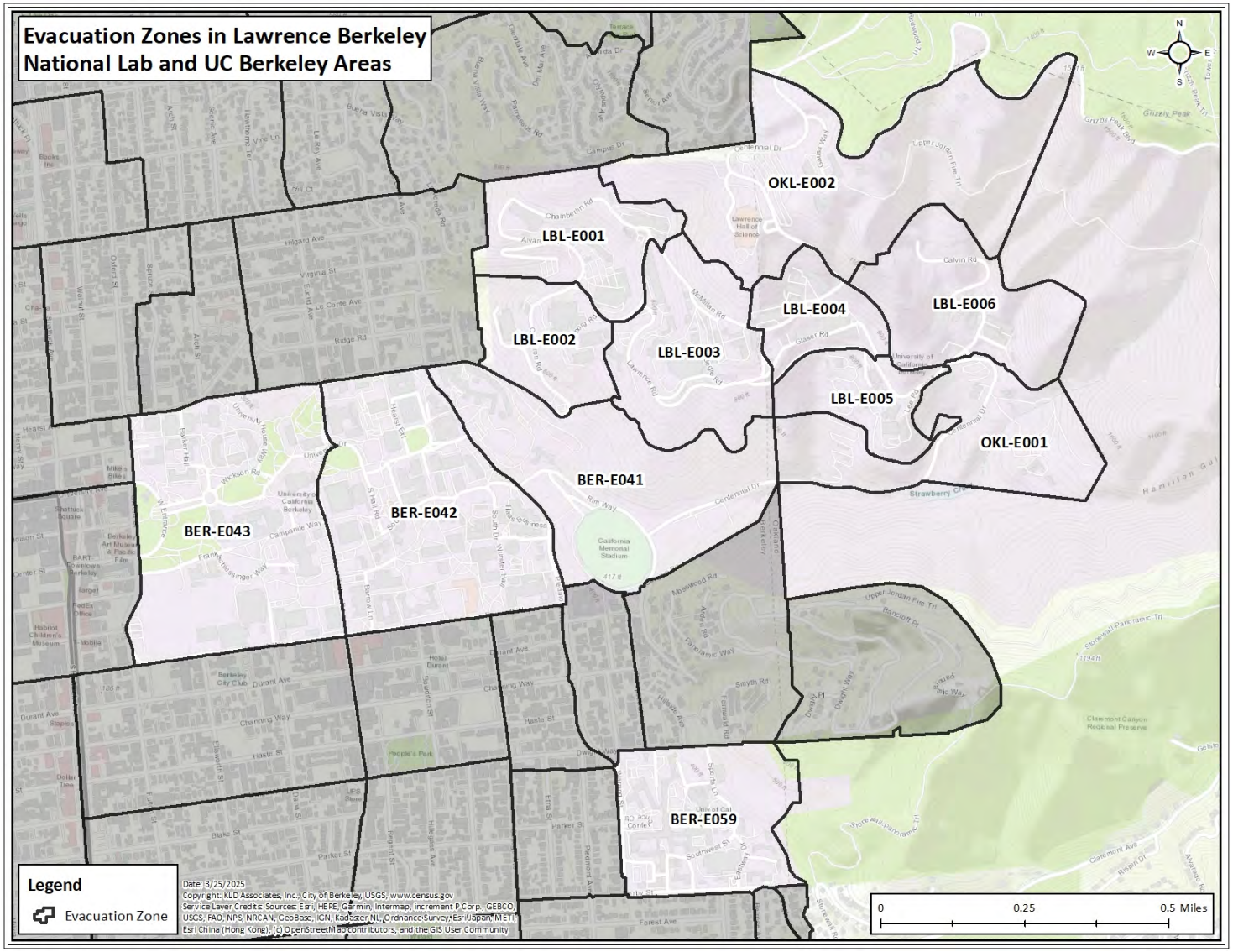


Figure 3-6. Evacuation Zones in the Lawrence Berkeley National Lab and UC Berkeley Areas

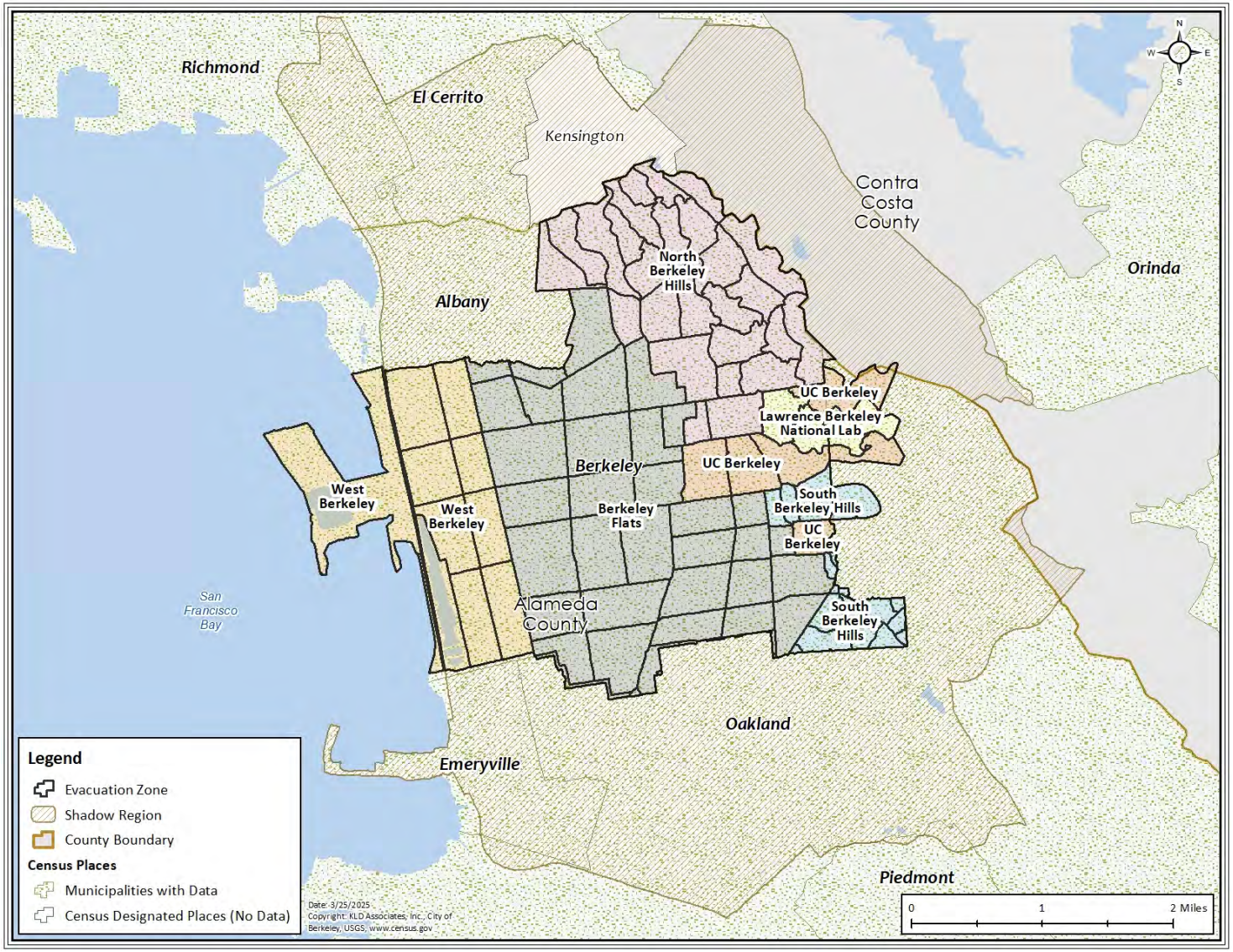


Figure 3-7. Census Boundaries within the Study Area

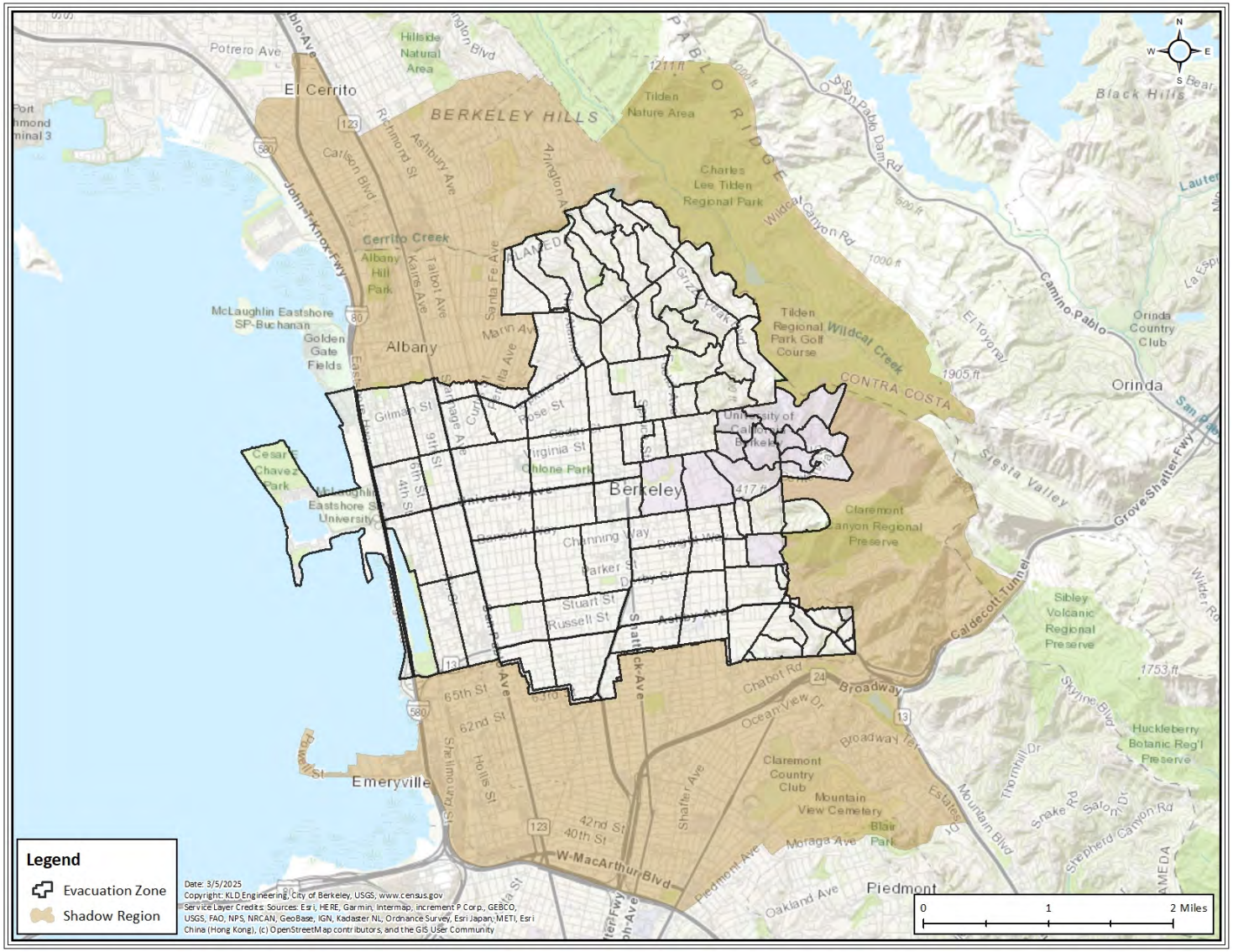


Figure 3-8. Shadow Region

4 ESTIMATION OF ROADWAY CAPACITY

The ability of the road network to service vehicle demand is a major factor in determining how rapidly an evacuation can be completed. The capacity of a road is defined as the maximum sustainable hourly rate at which persons or vehicles can reasonably be expected to traverse a point or uniform section of a lane of roadway during a given time period under prevailing roadway, environmental, traffic and control conditions, as stated in the 2022 Highway Capacity Manual 7th Edition (HCM 2022). This section discusses how the capacity of the roadway network was estimated.

In discussing capacity, different operating conditions have been assigned alphabetical designations, A through F, to reflect the range of traffic operational characteristics. These designations have been termed "Levels of Service" (LOS). For example, LOS A represents free-flow and high-speed operating conditions; LOS F represents a forced flow condition. LOS E describes traffic operating at or near capacity.

Another concept, closely associated with capacity, is “Service Volume”. Service volume (SV) is defined as “The maximum hourly rate at which vehicles, bicycles or persons reasonably can be expected to traverse a point or uniform section of a roadway during an hour under specific assumed conditions while maintaining a designated level of service.” This definition is similar to that for capacity. The major distinction is that values of SV vary from one LOS to another, while capacity is the SV at the upper bound of LOS E, only.

Thus, in simple terms, SV is the maximum traffic that can travel on a road and still maintain a certain perceived level of quality to a driver based on the A, B, C, rating system (LOS). Any additional vehicles above the SV would drop the rating to a lower letter grade.

This distinction is illustrated in Exhibit 12-37 of the HCM 2022. As indicated there, the SV varies with Free Flow Speed (FFS), and LOS. The SV is calculated by the DYNEV II simulation model, based on the specified link attributes, FFS, capacity, control device and traffic demand.

Other factors also influence capacity. These include, but are not limited to:

- Lane width
- Shoulder width
- Pavement condition
- Horizontal and vertical alignment (curvature and grade)
- Percent truck traffic
- Control device (and timing, if it is a signal)
- Weather conditions (rain, fog, wind speed, smoke)

These factors are considered during the road survey and in the capacity estimation process; some factors have greater influence on capacity than others. For example, lane and shoulder width have only a limited influence on FFS and capacity based on the HCM 2022. Consequently, lane and shoulder widths at the narrowest points were observed during the road survey (or aerial imagery for roadways that could not be driven) and these observations were recorded,

but no detailed measurements of lane or shoulder width were taken. Horizontal and vertical alignment can influence both FFS and capacity. The estimated FFS were measured using the survey vehicle's speedometer and observing local traffic, under free flow conditions. The FFS ranged from 10 mph to 70 mph within the City of Berkeley area. Capacity is estimated from the procedures of the HCM 2022. For example, HCM 2022 Exhibit 7-1(b) shows the sensitivity of SV at the upper bound of LOS D to grade (capacity is the SV at the upper bound of LOS E).

The amount of traffic that can flow on a roadway is effectively governed by vehicle speed and spacing. The faster that vehicles can travel when closely spaced, the higher the amount of flow.

Since congestion arising from evacuation may be significant, estimates of roadway capacity must be determined with great care. Because of its importance, a brief discussion of the major factors that influence roadway capacity is presented in this section.

4.1 Capacity Estimations on Approaches to Intersections

At-grade intersections are apt to become the first bottleneck locations under local heavy traffic volume conditions. This characteristic reflects the need to allocate access time to the respective competing traffic streams by exerting some form of control. During evacuation, control at critical intersections will often be provided by traffic control personnel assigned for that purpose, whose directions may supersede traffic control devices. See Section 9 for more information.

The per-lane capacity of an approach to a signalized intersection can be expressed (simplistically) in the following form:

$$Q_{cap,m} = \left(\frac{3600}{h_m}\right) \times \left(\frac{G-L}{C}\right)_m = \left(\frac{3600}{h_m}\right) \times P_m$$

where:

$Q_{cap,m}$	=	Capacity of a single lane of traffic on an approach, which executes movement, *m*, upon entering the intersection; vehicles per hour (vph)
h_m	=	Mean queue discharge headway of vehicles on this lane that are executing movement, *m*; seconds per vehicle
G	=	Mean duration of GREEN time servicing vehicles that are executing movement, *m*, for each signal cycle; seconds
L	=	Mean "lost time" for each signal phase servicing movement, *m*; seconds
C	=	Duration of each signal cycle; seconds
P_m	=	Proportion of GREEN time allocated for vehicles executing movement, *m*, from this lane. This value is specified as part of the control treatment.
m	=	The movement executed by vehicles after they enter the intersection: through, left-turn, right-turn, and diagonal.

The turn-movement-specific mean discharge headway h_m, depends in a complex way upon many factors: roadway geometrics, turn percentages, the extent of conflicting traffic streams, the control treatment, and others. A primary factor is the value of "saturation queue discharge headway", h_{sat}, which applies to through vehicles that are not impeded by other conflicting traffic streams. This value, itself, depends upon many factors including motorist behavior. Formally, we can write,

$$h_m = f_m(h_{sat}, F_1, F_2, \ldots)$$

where:

h_{sat}	=	Saturation discharge headway for through vehicles; seconds per vehicle
F_1,F_2	=	The various known factors influencing h_m
$f_m( )$	=	Complex function relating h_m to the known (or estimated) values of h_{sat}, F_1, F_2, …

The estimation of h_m for specified values of h_{sat}, F_1, F_2, ... is undertaken within the DYNEV II simulation model by a mathematical model[1]. The resulting values for h_m always satisfy the condition:

$$h_m \geq h_{sat}$$

That is, the turn-movement-specific discharge headways are always greater than, or equal to the saturation discharge headway for through vehicles. These headways (or its inverse equivalent, “saturation flow rate”), may be determined by observation or using the procedures of the HCM 2022.

The above discussion is necessarily brief given the scope of this Evacuation Time Estimate (ETE) study and the complexity of the subject of intersection capacity. In fact, Chapters 19, 20 and 21 in the HCM 2022 address this topic. The factors, F_1, F_2, ..., influencing saturation flow rate are identified in equation (19-8) of the HCM 2022.

The traffic signals within the Evacuation Zones and Shadow Region are modeled using representative phasing plans and phase durations obtained as part of the field data collection. Traffic responsive signal installations allow the proportion of green time allocated (P_m) for each approach to each intersection to be determined by the expected traffic volumes on each approach during evacuation circumstances. The amount of green time (G) allocated is subject to maximum and minimum phase duration constraints; 4 seconds of yellow time are indicated for each signal phase and 1 second of all-red time is assigned between signal phases, typically. If

[1]Lieberman, E., "Determining Lateral Deployment of Traffic on an Approach to an Intersection", McShane, W. & Lieberman, E., "Service Rates of Mixed Traffic on the far Left Lane of an Approach". Both papers appear in Transportation Research Record 772, 1980. Lieberman, E., Xin, W., “Macroscopic Traffic Modeling For Large-Scale Evacuation Planning”, presented at the TRB 2012 Annual Meeting, January 22-26, 2012.

a signal is pre-timed, the yellow and all-red times observed during the road survey are used. A lost time (L) of 5.0 seconds is used for each signal phase in the analysis.

4.2 Capacity Estimation along Sections of Roadway

The capacity of roadway sections[2] - as distinct from approaches to intersections- is a function of roadway geometrics, traffic composition (-e.g. percent heavy trucks and buses in the traffic stream) and, of course, motorist behavior. There is a fundamental relationship which relates SV (i.e. the number of vehicles serviced within a uniform roadway section in a given time period) to traffic density. The top curve in Figure 4-1 illustrates this relationship.

As indicated, there are two flow regimes: (1) Free Flow (left side of curve); and (2) Forced Flow (right side). In the Free Flow regime, the traffic demand is fully serviced; the SV increases as demand volume and density increase, until the service volume attains its maximum value, which is the capacity of the roadway section. As traffic demand and the resulting roadway density increase beyond this "critical" value, the rate at which traffic can be serviced (i.e. the SV) can actually decline below capacity ("capacity drop"). Therefore, in order to realistically represent traffic performance during congested conditions (i.e. when demand exceeds capacity), it is necessary to estimate the service volume, V_F, under congested conditions.

The value of V_F can be expressed as:

$$V_F = R \times Capacity$$

where:

R = Reduction factor which is less than unity

We have employed a value of R=0.90. The advisability of such a capacity reduction factor is based upon empirical studies that identified a fall-off in the service flow rate when congestion occurs at "bottlenecks" or "choke points" on a freeway system. Zhang and Levinson[3] describe a research program that collected data from a computer-based surveillance system (loop detectors) installed on the Interstate Highway System, at 27 active bottlenecks in the twin cities metro area in Minnesota over a 7-week period. When flow breakdown occurs, queues are formed which discharge at lower flow rates than the maximum capacity prior to observed breakdown. These queue discharge flow (QDF) rates vary from one location to the next and also vary by day of week and time of day based upon local circumstances. The cited reference presents a mean QDF of 2,016 passenger cars per hour per lane (pcphpl). This figure compares with the nominal capacity estimate of 2,250 pcphpl estimated for the ETE. The ratio of these two numbers is 0.896 which translates into a capacity reduction factor of 0.90.

Since the principal objective of the ETE analyses is to develop a "realistic" estimate of evacuation times, use of the representative value for this capacity reduction factor (R=0.90) is justified. This factor is applied only when flow breaks down, as determined by the simulation

[2] This analysis is based on computed capacity alone and does not consider the time-varying demand impact on actual capacity.
[3] Lei Zhang and David Levinson, "Some Properties of Flows at Freeway Bottlenecks," Transportation Research Record 1883, 2004.

model.

The estimated value of capacity is based primarily upon the type of facility and on roadway geometrics. Sections of roadway with adverse geometrics are characterized by lower free-flow speeds and lane capacity. The impact of narrow lanes and shoulders on free-flow speed and on capacity is not material, particularly when flow is predominantly in one direction as is the case during an evacuation.

The procedure used here was to estimate "section" capacity, V_E, based on observations made traveling over each section of the evacuation network, based on the posted speed limits and travel behavior of other motorists and by reference to the HCM 2022. The DYNEV II simulation model determines for each roadway section, represented as a network link, whether its capacity would be limited by the "section specific" service volume, V_E, or by the intersection specific capacity. For each link, the model selects the lower value of capacity.

4.3 Application to the City of Berkeley Study Area

As part of the development of the link-node analysis network for the study area, an estimate of roadway capacity is required. The source material for the capacity estimates presented herein is contained in:

2022 Highway Capacity Manual 7th Edition (HCM 2022)
Transportation Research Board
National Research Council
Washington, D.C.

The roadway system in the study area consists primarily of three categories of roads and, of course, intersections:

- Two-Lane roads: Local, State
- Multilane Highways (at-grade)
- Freeways

Each of these classifications will be discussed below.

4.3.1 Two Lane Roads

Note: Data collected on the road survey conducted in May 20-26, 2023, and aerial imagery for roadways that could not be driven (like LBNL), was used to accurately model the speeds on roads within Berkeley. See Section 1.3 for details.

Ref: HCM 2022 Chapter 15

Two lane roads comprise the majority of roadways within the study area. The per-lane capacity of a two-lane roadway is estimated at 1,700 passenger cars per hour (pc/h). This estimate is essentially independent of the directional distribution of traffic volume except that, for extended distances, the two-way capacity will not exceed 3,200 pc/h. The HCM 2022 procedures then estimate LOS and Average Travel Speed. The DYNEV II simulation model

accepts the specified value of capacity as input and computes average speed based on the time-varying demand: capacity relations.

Based on the field survey and on expected traffic operations associated with evacuation scenarios:

- Most sections of two-lane roads within the study area are classified as “Class I”, with "level terrain"; some are “rolling terrain”.
- “Class II” highways [roadways] are mostly those within urban and suburban centers.

4.3.2 Multilane Roadway

Ref: HCM 2022 Chapter 12

Exhibit 12-8 of the HCM 2022 presents a set of curves that indicate a per-lane capacity ranging from approximately 1,900 to 2,300 pc/h, for free-speeds of 45 to 70 mph, respectively. Based on observation, the multilane roadways outside of urban areas within the study area service traffic with free-speeds in this range. The actual time-varying speeds computed by the simulation model reflect the demand and capacity relationship and the impact of control at intersections.

4.3.3 Freeways

Ref: HCM 2022 Chapters 10, 12, 13, 14

Chapter 10 of the HCM 2022 describes a procedure for integrating the results obtained in Chapters 12, 13 and 14, which compute capacity and LOS for freeway components. Chapter 10 also presents a discussion of simulation models. The DYNEV II simulation model automatically performs this integration process.

Chapter 12 of the HCM 2022 presents procedures for estimating capacity and LOS for “Basic Freeway Segments". Exhibit 12-37 of the HCM 2022 presents capacity vs. free speed estimates, which are provided below.

Free Speed (mph):	55	60	65	70+
Per-Lane Capacity (pc/h):	2,250	2,300	2,350	2,400

The inputs to the simulation model are roadway geometrics, free-speeds and capacity based on field observations. The simulation logic calculates actual time-varying speeds based on demand: capacity relationships. A conservative estimate of per-lane capacity of 2,250 pc/h is adopted for this study for freeways.

Chapter 13 of the HCM 2022 presents procedures for estimating capacity, speed, density and LOS for freeway weaving sections. The simulation model contains logic that relates speed to demand volume: capacity ratio. The value of capacity obtained from the computational

procedures detailed in Chapter 13 depends on the "Type" and geometrics of the weaving segment and on the "Volume Ratio" (ratio of weaving volume to total volume).

Chapter 14 of the HCM 2022 presents procedures for estimating capacities of ramps and of "merge" areas. There are three significant factors to the determination of capacity of a ramp-freeway junction: The capacity of the freeway immediately downstream of an on-ramp or immediately upstream of an off-ramp; the capacity of the ramp roadway; and the maximum flow rate entering the ramp influence area. In most cases, the freeway capacity is the controlling factor. Values of this merge area capacity are presented in Exhibit 14-10 of the HCM 2022 and depend on the number of freeway lanes and on the freeway free speeds. Ramp capacity is presented in Exhibit 14-12 and is a function of the ramp's FFS. The DYNEV II simulation model logic simulates the merging operations of the ramp and freeway traffic in accord with the procedures in Chapter 14 of the HCM 2022. If congestion results from an excess of demand relative to capacity, then the model allocates service appropriately to the two entering traffic streams and produces LOS F conditions (The HCM 2022 does not address LOS F explicitly).

4.3.4 Intersections

Ref: HCM 2022 Chapters 19, 20, 21, 22

Procedures for estimating capacity and LOS for approaches to intersections are presented in Chapter 19 (signalized intersections), Chapters 20, 21 (un-signalized intersections) and Chapter 22 (roundabouts). The complexity of these computations is indicated by the aggregate length of these chapters. The DYNEV II simulation logic is likewise complex.

The simulation model explicitly models intersections: Stop/yield-controlled intersections (both 2-way and all-way) and traffic signal-controlled intersections. Where intersections are controlled by fixed time controllers, traffic signal timings are set to reflect average (non-evacuation) traffic conditions. Actuated traffic signal settings respond to the time-varying demands of evacuation traffic to adjust the relative capacities of the competing intersection approaches.

The model is also capable of modeling the presence of manned traffic control. At specific locations where it is advisable or where existing plans call for overriding existing traffic control to implement manned control, the model will use actuated signal timings that reflect the presence of traffic guides. At locations where a special traffic control strategy (continuous left-turns, contra-flow lanes) is used, the strategy is modeled explicitly.

4.4 Simulation and Capacity Estimation

Chapter 6 of the HCM 2022 is entitled, "HCM and Alternative Analysis Tools." The chapter discusses the use of alternative tools such as simulation modeling to evaluate the operational performance of roadway networks. Among the reasons cited in Chapter 6 to consider using simulation as an alternative analysis tool is:

"The system under study involves a group of different facilities or travel modes with mutual interactions involving several HCM chapters. Alternative tools are able to analyze these facilities as a single system."

This statement succinctly describes the analyses required to determine traffic operations across an area encompassing a study area operating under evacuation conditions. The model utilized for this study is DYNEV II[4]. It is essential to recognize that simulation models do not replicate the methodology and procedures of the HCM – they *replace* these procedures by describing the complex interactions of traffic flow and computing Measures of Effectiveness (MOE) detailing the operational performance of traffic over time and by location. The DYNEV II simulation model includes some HCM 2022 procedures only for the purpose of estimating capacity.

All simulation models must be calibrated properly with field observations that quantify the performance parameters applicable to the analysis network. Two of the most important of these are: (1) FFS; and (2) saturation headway, h_{sat}. The first of these is estimated by direct observation during the road survey or aerial imagery; the second is estimated using the concepts of the HCM 2022, as described earlier.

It is important to note that simulation represents a mathematical representation of an assumed set of conditions using the best available knowledge and understanding of traffic flow and available inputs. Simulation should not be assumed to be a prediction of what will happen under any event because a real evacuation can be impacted by an infinite number of things – many of which will differ from these test cases – and many others cannot be taken into account with the tools available.

4.5 Boundary Conditions

As illustrated in Figure 1-2, the link-node analysis network used for this study is finite. The analysis network extends well beyond the Evacuation Zones in order to model intersections with other major population areas and evacuation routes beyond the study area. However, the network does have an end at the destination (exit) nodes[4]. Beyond these destination nodes, there may be signalized intersections or merge points that impact the capacity of the evacuation routes leaving the study area. Rather than neglect these "boundary conditions," this study assumes a 25% reduction in capacity on two-lane roads (Section 4.3.1 above) and multilane roadways (Section 4.3.2 above). There is no reduction in capacity for freeways due to boundary conditions. The 25% reduction in capacity is based on the prevalence of actuated traffic signals outside the study area and the fact that the evacuating traffic volume ("main street") will be more significant than the competing traffic volume ("side street") at any downstream signalized intersections, thereby warranting a more significant percentage (75% in this case) of the signal green time.

[4] https://kldassociates.com/wp-content/uploads/2024/10/DTRAD-DYNEV.pdf

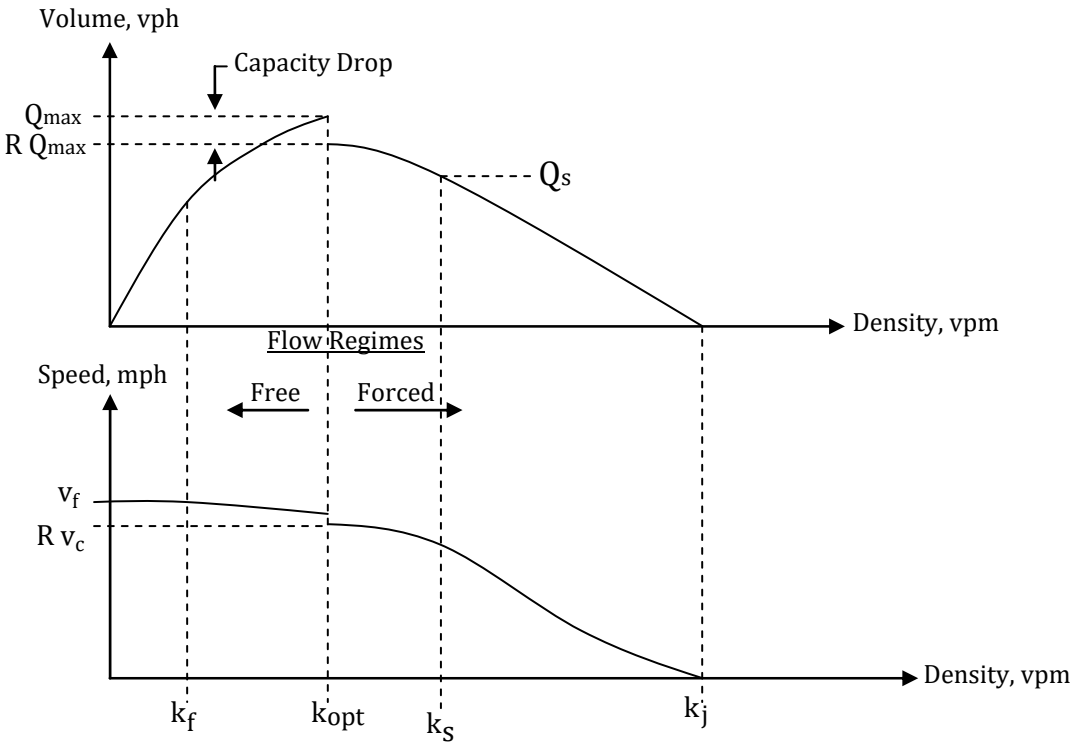


Figure 4-1. Fundamental Diagrams

5 ESTIMATION OF TRIP GENERATION TIME

It is general practice for planners to estimate the distributions of elapsed times associated with mobilization activities undertaken by the public to prepare for the evacuation trip. The elapsed time associated with each activity is represented as a statistical distribution reflecting differences between members of the public. The quantification of these activity-based distributions relies largely on the results of the demographic survey. We define the sum of these distributions of elapsed times as the Trip Generation Time Distribution. This section documents how the trip generation time distributions were estimated.

5.1 Background

In general, during an emergency, priorities are given to life safety, preservation of property and resource conservation. To ensure life safety, depending on the severity of the emergency, emergency officials may issue warnings or orders that include evacuation.

As a Planning Basis, we will adopt a conservative posture, a rapidly escalating wildfire or tsunami situation, wherein evacuation is required, ordered promptly and no early protective actions have been implemented when calculating the Trip Generation Time. In these analyses, we have assumed:

1. The evacuation order will be announced coincident with local emergency alerts (e.g., AC Alert/IPAWS, Genasys Protect, Outdoor Warning System Sirens, Nixle, social media, local news and similar communication systems).
2. Mobilization of the general population will commence within 15 minutes after the order to evacuate.
3. The ETE are measured relative to the order to evacuate being issued by officials.

We emphasize that the adoption of this planning basis is not a representation that these events will occur within the indicated time frame. Rather, these assumptions are necessary in order to:

1. Establish a temporal framework for estimating the Trip Generation distribution
2. Identify temporal points of reference that uniquely define "Clear Time" and ETE.

The notification process consists of two events:

1. Transmitting information using the alert and notification systems mentioned above.
2. Receiving and correctly interpreting the information that is transmitted.

The population within Berkeley is engaged in a wide variety of activities. It must be anticipated that some time will elapse between the transmission and receipt of the information advising the public of an event.

The amount of elapsed time will vary from one individual to the next depending on where that person is, what that person is doing, and related factors. Furthermore, some persons who will be directly involved with the evacuation process may be outside the city at the time the evacuation is ordered. These people may be commuters, and other travelers who reside within the city and who will return to join the other household members upon receiving notification of an emergency.

As indicated in Section 2.13 of NUREG/CR-6863, the estimated elapsed times for the receipt of notification can be expressed as a distribution reflecting the different notification times for different people within, and outside, the city. By using time distributions, it is also possible to distinguish between different population groups and different day-of-week and time-of-day scenarios, so that accurate ETE may be computed.

For example, people at home or at work within Berkeley might be notified by wireless emergency alerts, other alerts to their mobile or home phones, emails, outdoor warning sirens, television and/or radio (if available). Those well outside the city might be notified by word-of--mouth, with potentially longer time lags. Furthermore, the spatial distribution of the population will differ with time of day: families- will be united in the evenings but dispersed during the day. In this respect, weekends will differ from weekdays.

The information required to compute trip generation times is typically obtained from a demographic survey of residents. Such a survey was conducted for this study. Appendix D discusses the survey sampling plan, the number of completed surveys obtained, documents the survey instrument utilized, and provides the survey results. The remaining discussion will focus on the application of the trip generation data obtained from the online demographic survey to the development of the ETE documented in this report.

5.2 Fundamental Considerations

The environment leading up to the time that people begin their evacuation trips consists of a sequence of events and activities. Each event (other than the first) occurs at an instant in time and is the outcome of an activity.

Activities are undertaken over a period of time. Activities may be in "series" (i.e. to undertake an activity implies the completion of all preceding events) or may be in parallel (two or more activities may take place over the same period of time). Activities conducted in series are functionally dependent on the completion of prior activities; activities conducted in parallel are functionally independent of one another. The relevant events associated with the public's preparation for evacuation are:

Event Number	Event Description
1	Notification
2	Awareness of Situation
3	Depart Work
4	Arrive Home
5	Depart on Evacuation Trip

Associated with each sequence of events are one or more activities, as outlined in Table 5-1.

These relationships are shown graphically in Figure 5-1.

- An Event is a 'state' that exists at a point in time (e.g., depart work, arrive home)
- An Activity is a 'process' that takes place over some elapsed time (e.g., prepare to leave work, travel home)

As such, a completed Activity changes the 'state' of an individual (i.e., the activity, 'travel home' changes the state from 'depart work' to 'arrive home'). Therefore, an Activity can be described as an 'Event Sequence'; the elapsed times to perform an event sequence vary from one person to the next and are described as statistical distributions on the following pages.

An employee who lives outside of Berkeley will follow sequence (c) of Figure 5-1. A household within Berkeley that has one or more commuters at work and will await their return before beginning the evacuation trip will follow the first sequence of Figure 5-1(a). A household within the city that has no commuters at work, or that will not await the return of any commuters, will follow the second sequence of Figure 5-1(a), regardless of day of week or time of day.

Households with no commuters on weekends or in the evening/night-time will follow the applicable sequence in Figure 5-1(b). Visitors will always follow one of the sequences of Figure 5-1(b). Some visitors away from their residence could elect to evacuate immediately without returning to the residence, as indicated in the second sequence.

It is seen from Figure 5-1, that the Trip Generation time (i.e., the total elapsed time from Event 1 to Event 5) depends on the scenario and will vary from one household to the next. Furthermore, Event 5 depends, in a complicated way, on the time distributions of all activities preceding that event. That is, to estimate the time distribution of Event 5, we must obtain estimates of the time distributions of all preceding events. For this study, we adopt the conservative posture that all activities will occur in sequence.

In some cases, assuming certain events occur in series rather than in parallel (for instance, commuter returning home before beginning preparation to leave, or picking up school children only after the preparation to leave) can result in rather *conservative* (that is, longer) estimates of mobilization times. It is reasonable to expect that at least some parts of these events will overlap for many households, but that assumption is not made in this study.

5.3 Estimated Time Distributions of Activities Preceding Event 5

The time distribution of an event is obtained by "summing" the time distributions of all prior contributing activities. (This "summing" process is quite different than an algebraic sum since it is performed on distributions – not scalar numbers).

Time Distribution No. 1, Notification Process: Activity 1 $\rightarrow$ 2

A demographic survey of Berkeley residents was conducted to study the evacuation behavior of the population. The survey results were used to create the notification time distribution. The survey asked specific questions about notifying neighbors and friends during an emergency using various methods like phone calls, text messages, social media, and in person conversation. The City of Berkeley also uses Outdoor Warning System sirens, Genasys Protect, and AC Alert/IPAWS/Nixle to notify their residents. Because of the indiscriminate reach of these systems, it is possible that people who receive the alerts and are outside of the intended evacuation area will choose to leave, adding to demand on the roadways.

Given the presence of the existing emergency alert systems and the responses to the demographic survey regarding notification of friends and neighbors, assumptions were made about the notification of people in Berkeley (including residents outside of the Berkeley City limits at the time of the emergency). It was assumed that about 37% of residents are notified within 5 minutes of an emergency, 93% of the residents are notified within 25 minutes, and 100% of the residents are notified within 35 minutes. The distribution of Activity 1 → 2 shown in Table 5-2 and plotted in Figure 5-2 reflects data obtained by the demographic survey and the above assumptions.

Distribution No. 2, Prepare to Leave Work: Activity 2 $\rightarrow$ 3

It is reasonable to expect that the vast majority of business enterprises within Berkeley will elect to shut down following an evacuation order and most employees would leave work quickly. Commuters who work outside the city could, in all probability, also leave quickly since facilities outside Berkeley would remain open and other personnel would remain to maintain business operations. The distribution of Activity 2 → 3 shown in Table 5-3 reflects data obtained by the demographic survey. This distribution is also applicable for residents to leave stores, restaurants, parks and other locations within the city. This distribution is plotted in Figure 5-2.

Distribution No. 3, Travel Home: Activity 3 $\rightarrow$ 4

These data are provided directly by households that responded to the demographic survey. This distribution is plotted in Figure 5-2 and listed in Table 5-4.

Distribution No. 4, Prepare to Leave Home: Activity 2, 4 $\rightarrow$ 5

These data are provided directly by households that responded to the demographic survey. This distribution is plotted in Figure 5-2 and listed in Table 5-5.

Distribution No. 5, Pickup School Children:

Approximately 22% of households have children within the city (see Appendix D). Of these households, approximately 83% of them will pick up their children at the school during an emergency. Picking up children from school take time; this time must be incorporated into the trip generation time distributions. This distribution is Figure 5-2 and listed in Table 5-6.

5.4 Calculation of Trip Generation Time Distribution

The time distributions for each of the mobilization activities presented herein must be combined to form the appropriate Trip Generation Distributions. As discussed above, this study assumes that the stated events take place in sequence such that all preceding events must be completed before the current event can occur. For example, if a household awaits the return of a commuter, the work-to-home trip (Activity 3 $\rightarrow$ 4) must precede Activity 4 $\rightarrow$ 5.

To calculate the time distribution of an event that is dependent on two sequential activities, it is necessary to "sum" the distributions associated with these prior activities. The distribution summing algorithm is applied repeatedly to form the required distribution. As an outcome of this procedure, new time distributions are formed; we assign "letter" designations to these intermediate distributions to describe the procedure. Table 5-7 presents the summing procedure to arrive at each designated distribution.

Table 5-8 presents a description of each of the final trip generation distributions achieved after the summing process is completed.

5.4.1 Statistical Outliers

As already mentioned, some portion of the survey respondents answer "don't know/prefer not to say" to some questions or choose to not respond to a question. The mobilization activity distributions are based upon actual responses. But it is the nature of surveys that a few numeric responses are inconsistent with the overall pattern of results. An example would be a case in which for 500 responses, almost all of them estimate less than two hours for a given answer, but 3 say "four hours" and 4 say "six or more hours".

These "outliers" must be considered: are they valid responses, or so atypical that they should be dropped from the sample?

In assessing outliers, there are three alternatives to consider:

1. Some responses with very long times may be valid, but reflect the reality that the respondent really needs to be classified in a different population subgroup, based upon special transportation needs;
2. Other responses may be unrealistic (6 hours to return home from commuting distance, or 2 days to prepare the home for departure);
3. Some high values are representative and plausible, and one must not cut them as part of the consideration of outliers.

The issue is how to make the decision that a given response or set of responses are to be considered "outliers" for the component mobilization activities, using a method that objectively quantifies the process.

There is considerable statistical literature on the identification and treatment of outliers singly or in groups, much of which assumes the data is normally distributed and some of which uses non-parametric methods to avoid that assumption. The literature cites that limited work has been done directly on outliers in sample survey responses.

In establishing the overall mobilization time/trip generation distributions, the following principles are used:

1. It is recognized that the overall trip generation distributions are conservative estimates, because they assume a household will do the mobilization activities sequentially, with no overlap of activities;
2. The individual mobilization activities (receive notification, prepare to leave work, travel home, prepare home, pickup school children) are reviewed for outliers, and then the overall trip generation distributions are created (see Figure 5-1, Table 5-7, Table 5-8);
3. Outliers can be eliminated either because the response reflects a special population (e.g., special transportation needs, transit dependent) or lack of realism, because the purpose is to estimate trip generation patterns for personal vehicles;
4. To eliminate outliers,
    a) the mean and standard deviation of the specific activity are estimated from the responses,
    b) the median of the same data is estimated, with its position relative to the mean noted,
    c) the histogram of the data is inspected, and
    d) all values greater than 3.0 standard deviations are flagged for attention, taking special note of whether there are gaps (categories with zero entries) in the histogram display.

    In general, only flagged values more than 3.5 standard deviations from the mean are allowed to be considered outliers, with gaps in the histogram expected.

    When flagged values are classified as outliers and dropped, steps "a" to "d" are repeated.
5. As a practical matter, even with outliers eliminated by the above, the resultant histogram, viewed as a cumulative distribution, is not a normal distribution. A typical situation that results is shown in Figure 5-3.
6. In particular, the cumulative distribution differs from the normal distribution in two key aspects, both very important in loading a network to estimate evacuation times:
    - Most of the real data is to the left of the "normal" curve above, indicating that the network loads faster for the first 80-85% of the vehicles, potentially causing more (and earlier) congestion than otherwise modeled;

- The last 10-15% of the real data "tails off" slower than the comparable "normal" curve, indicating that there is significant traffic still loading at later times.

Because these two features are important to preserve, it is the histogram of the data that is used to describe the mobilization activities, not a "normal" curve fit to the data. One could consider other distributions, but using the shape of the *actual* data curve is unambiguous and preserves these important features;

7. With the mobilization activities each modeled according to Steps 1-6, including preserving the features cited in Step 6, the overall (or total) mobilization times are constructed.

This is done by using the data sets and distributions under different scenarios (e.g., commuter returning, no commuter returning, and children pickup or no children pickup). In general, these are additive, using weighting based upon the probability distributions of each element; Figure 5-4 presents the combined trip generation distributions designated for each population group considered. These distributions are presented on the same time scale. (As discussed earlier, the use of strictly additive activities is a conservative approach, because it makes all activities sequential – preparation for departure follows the return of the commuter; children pickup follows the preparation for departure, and so forth. In practice, it is reasonable that some of these activities are done in parallel, at least to some extent – for instance, preparation to depart begins by a household member at home while the commuter is still on the road.)

The mobilization distribution results are used in their tabular/graphical form as direct inputs to later computations that lead to the ETE.

The DYNEV II simulation model is designed to accept varying rates of vehicle trip generation for each origin centroid, expressed in the form of histograms. These histograms, which represent Distributions A, C, D, E, and F properly displaced with respect to one another, are tabulated in Table 5-9 (Distribution B, Arrive Home, omitted for clarity).

The final time period (15) is 600 minutes long. This time period is added to allow the analysis network to clear, in the event congestion persists beyond the trip generation period. Note that there are no trips generated during this final time period.

5.4.2 Phased Evacuation Trip Generation

As detailed in Section 6: Evacuation Cases, Region R03 studies a phased evacuation for a repeat of the 1923 Berkeley Fire.

In a phased evacuation, permanent residents in imminent danger will be given an evacuation order while other areas will receive an evacuation warning or no protective action. The evacuation orders are issued subsequently at specified times after the initial evacuation order.

Region R03 considers the spread pattern from the 1923 fire. Per Berkeley Fire Department direction, zone status may change up to three times over the course of the tri-phased analysis as the simulated fire spreads. This means that individual zones may shift from no action necessary, to Evacuation Warning and/or Evacuation Order status based on patterns of fire spread.

Assumptions

1. It is assumed that 100% of residents in Evacuation Zones ordered to evacuate will evacuate, 50% of residents in Evacuation Zones that receive an evacuation warning will evacuate, and 20% of residents in Evacuation Zones with no protective action instructions will evacuate.
2. The population in the Shadow Region beyond Berkeley boundaries will react as they do for all non-phased evacuation scenarios. That is 20% of these households will elect to evacuate without delay.
3. Only permanent residents are expected to phase their evacuation. Non-resident population groups (employees, tourists, etc.) start following their mobilization times immediately.
4. Residents still follow their regular mobilization curve starting at the time of the first evacuation order (0 minutes/Phase a), 90 minutes after the first evacuation order (Phase b), or 180 minutes after the evacuation order (Phase c).

Procedure

1. Permanent residents in Evacuation Zones in Region R03 will be phased as follows:
    a. Phase a (0 minutes):
        i. The following Evacuation Zones will be under Evacuation Order - BER-E031, LBL-E006, OKL-E002, BER-E016
        ii. The following Evacuation Zones will be under Evacuation Warning - BER-E015, BER-E032, LBL-E004, LBL-E005, LBL-E001, BER-E008, BER-E017, BER-E007, BER-E030, OKL-E001, LBL-E003
    b. Phase b (90 minutes):
        i. The following Evacuation Zones will be under Evacuation Order - BER-E031, BER-E015, BER-E032, LBL-E006, LBL-E004, LBL-E005, LBL-E001, BER-E017, BER-E030, OKL-E001, LBL-E003, OKL-E002, BER-E016
        ii. The following Evacuation Zones will be under Evacuation Warning - BER-E018, BER-E040, BER-E013, BER-E041, LBL-E002, BER-E019, BER-E029, BER-E008, BER-E007, BER-E058, BER-E033
    c. Phase c (180 minutes):
        i. The following Evacuation Zones will be under Evacuation Order - BER-E018, BER-E057, BER-E012, BER-E040, BER-E013, BER-E031, BER-E041, BER-E015, BER-E032, LBL-E006, LBL-E004, LBL-E005, LBL-E001, LBL-E002, BER-E026, BER-E019, BER-E029, BER-E017, BER-E030, OKL-E001, LBL-E003, BER-E058, BER-E059, BER-E027, BER-E020, BER-E033, BER-E028, BER-E038, BER-E039, BER-E043, BER-E042, OKL-E002, BER-E016

ii. The following Evacuation Zones will be under Evacuation Warning - BER-E056, BER-E021, BER-E044, BER-E009, BER-E037, BER-E022, BER-E010, BER-E055, BER-E066, BER-E025, BER-E008, BER-E007, OKL-E004, BER-E073, BER-E060, BER-E054, ALB-E006

Table 5-1. Event Sequence for Evacuation Activities

Event Sequence	Activity	Distribution
1 → 2	Receive Notification	1
2 → 3	Prepare to Leave Work	2
2,3 → 4	Travel Home	3
2,4 → 5	Prepare to Leave to Evacuate	4
N/A	Children Pickup	5

Table 5-2. Time Distribution for Notifying the Public

Elapsed Time (Minutes)	Cumulative Percent of Population Notified
0	0.0%
5	37.0%
10	41.0%
15	46.0%
20	71.0%
25	93.0%
30	99.0%
35	100.0%

Table 5-3. Time Distribution for Employees to Prepare to Leave Work/College[1]

Elapsed Time (Minutes)	Cumulative Percent Employees Leaving Work
0	0.0%
5	25.7%
10	56.0%
15	75.6%
20	86.9%
25	90.3%
30	98.7%
35	100.0%

[1] The survey data was normalized to distribute the "prefer not to say" response. That is, the sample was reduced in size to include only those households who responded to this question. The underlying assumption is that the distribution of this activity for the "prefer not to say" responders, if the event takes place, would be the same as those responders who provided estimates.

Table 5-4. Time Distribution for Commuters to Travel Home

Elapsed Time (Minutes)	Cumulative Percent Returning Home
0	0.0%
5	9.8%
10	16.3%
15	25.2%
20	36.1%
25	48.2%
30	60.5%
35	71.9%
40	81.4%
45	88.6%
50	93.5%
55	96.6%
60	98.4%
75	99.7%
90	100.0%

NOTE: The survey data was normalized to distribute the "prefer not to say" response.

Table 5-5. Time Distribution for Population to Prepare to Evacuate

Elapsed Time (Minutes)	Cumulative Percent Ready to Evacuate
0	0.0%
15	15.3%
30	33.9%
45	57.7%
60	78.9%
75	92.1%
90	97.8%
105	99.6%
120	99.9%
135	100.0%

NOTE: The survey data was normalized to distribute the "prefer not to say" response.

Table 5-6. Time Distribution for Population to Pick-up School Children from School

Elapsed Time (Minutes)	Cumulative Percent Ready to Evacuate
0	0.0%
5	4.5%
10	23.0%
15	48.1%
20	63.8%
25	71.1%
30	85.4%
35	89.2%
40	94.8%
45	100.0%

NOTE: The survey data was normalized to distribute the "prefer not to say" response.

Table 5-7. Mapping Distributions to Events

Apply "Summing" Algorithm To:	Distribution Obtained	Event Defined
Distributions 1 and 2	Distribution A	Event 3
Distributions A and 3	Distribution B	Event 4
Distributions B and 4	Distribution C	Event 5
Distributions 1 and 4	Distribution D	Event 5
Distributions C and 5	Distribution E	Event 5
Distributions D and 5	Distribution F	Event 5

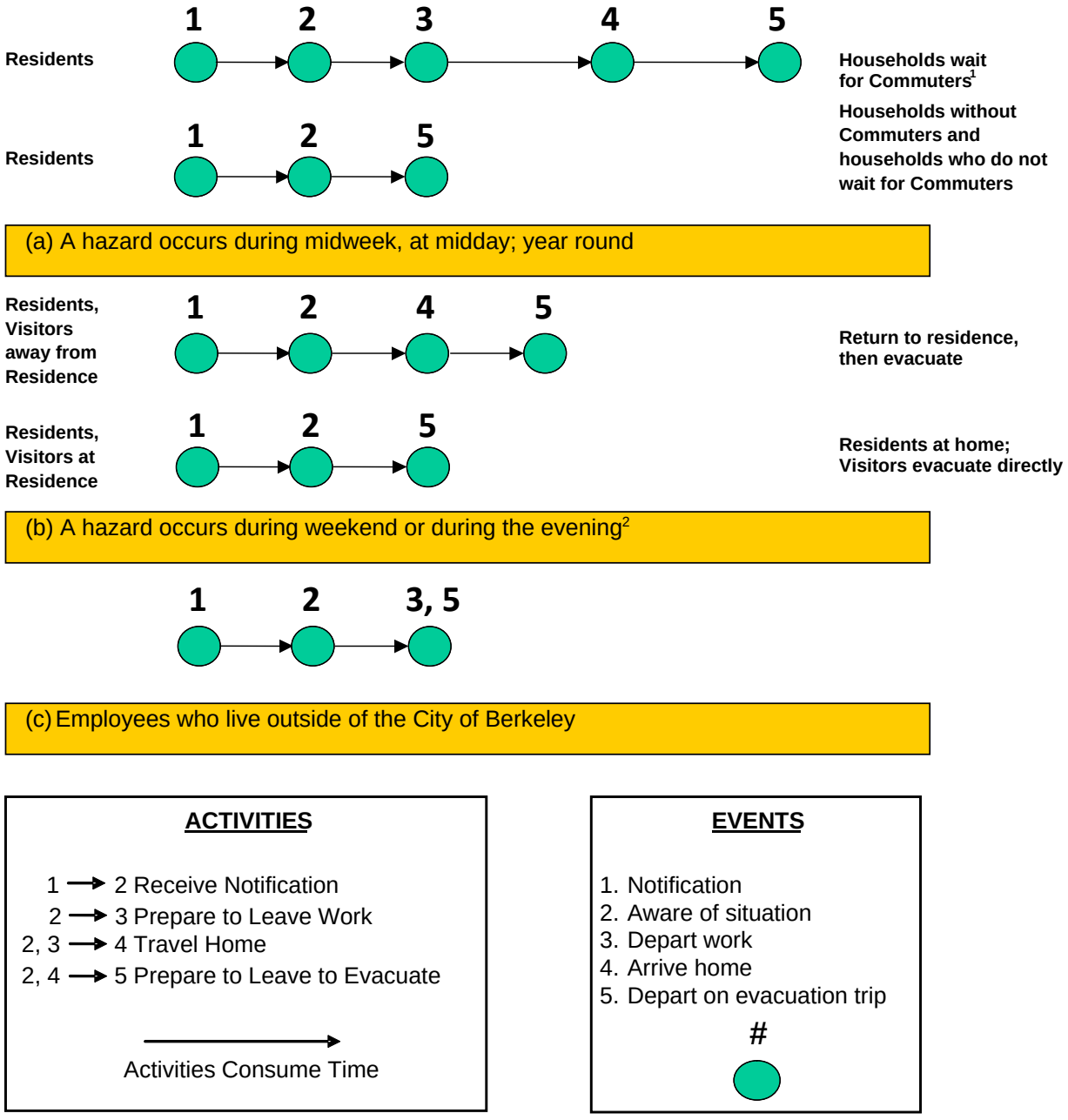
Table 5-8. Description of the Distributions

Distribution	Description
A	Time distribution of commuters departing place of work (Event 3). Also applies to employees who work within the city who live outside, and to visitors within the city.
B	Time distribution of commuters arriving home (Event 4).
C	Time distribution of residents with commuters who return home, leaving home to begin the evacuation trip (Event 5).
D	Time distribution of residents without commuters returning home, leaving home to begin the evacuation trip (Event 5).
E	Time distribution of residents with commuters who pick-up school children from school, return home, leaving home to begin the evacuation trip (Event 5).
F	Time distribution of residents with no commuters who pickup school children from school, leaving home to begin the evacuation trip (Event 5).

Table 5-9. Trip Generation Histograms for the City of Berkeley Population[2]

Time Period	Duration (Min)	Percent of Total Trips Generated Within Indicated Time Period					
		Employees (Distribution A)	Visitors (Distribution A)	Residents with Commuters (Distribution C)	Residents without Commuters (Distribution D)	Residents with Commuters Child Pick Up (Distribution E)	Residents without Commuters Child Pick Up (Distribution F)
1	15	22%	22%	0%	4%	0%	0%
2	15	38%	38%	0%	12%	0%	3%
3	15	33%	33%	3%	18%	0%	9%
4	15	7%	7%	7%	22%	2%	16%
5	15	0%	0%	13%	20%	6%	20%
6	15	0%	0%	17%	14%	10%	20%
7	15	0%	0%	19%	7%	16%	15%
8	15	0%	0%	17%	2%	17%	10%
9	15	0%	0%	12%	1%	17%	5%
10	15	0%	0%	7%	0%	14%	1%
11	15	0%	0%	3%	0%	9%	1%
12	15	0%	0%	1%	0%	5%	0%
13	15	0%	0%	1%	0%	3%	0%
14	15	0%	0%	0%	0%	1%	0%
15	600	0%	0%	0%	0%	0%	0%

[2] Shadow vehicles are loaded onto the analysis network (Figure 1-2) using Distribution C.



[1] Applies for evening and weekends also if commuters are at work.
[2] Applies throughout the year for visitors.

Figure 5-1. Events and Activities Preceding the Evacuation Trip

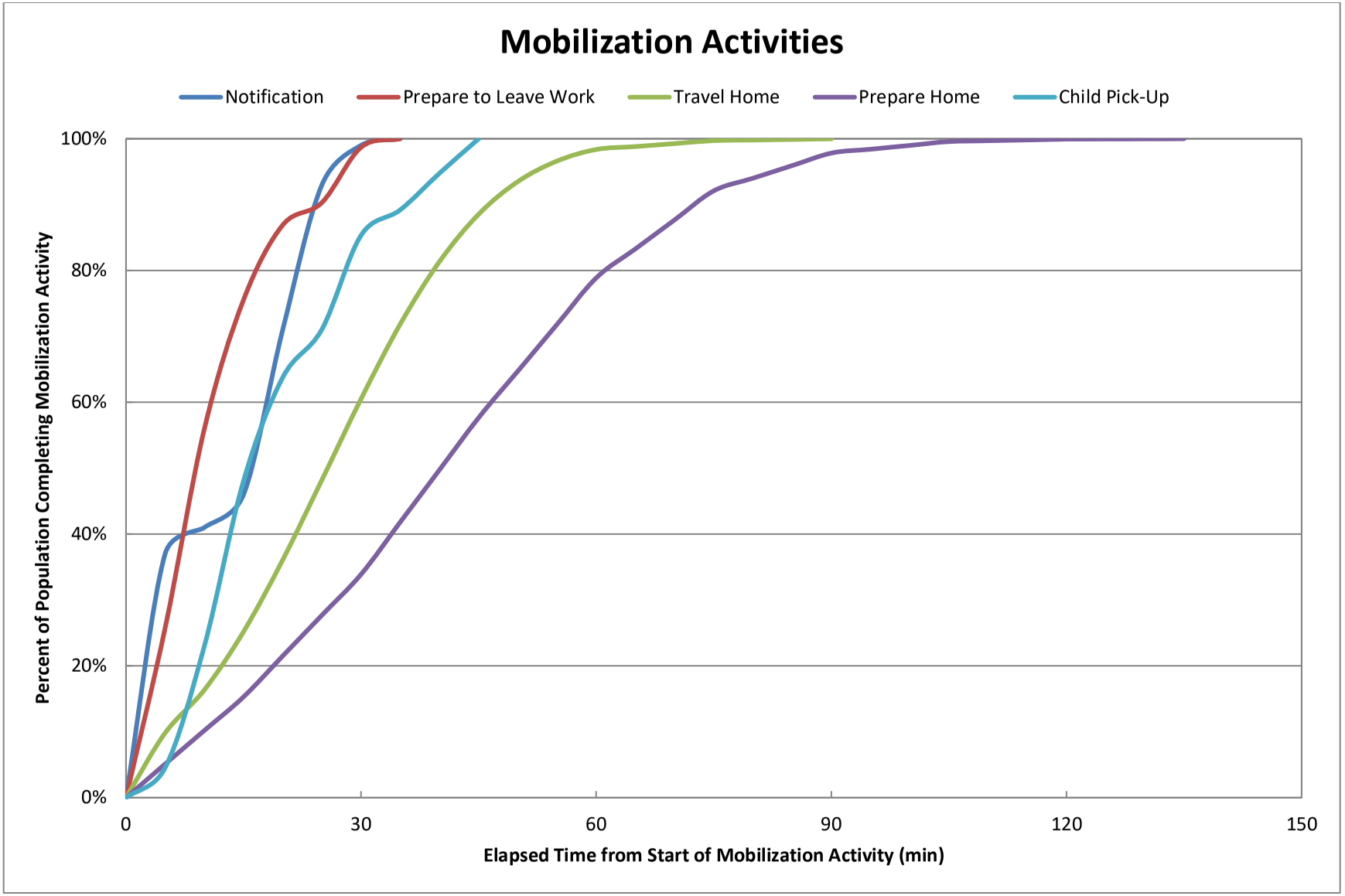


Figure 5-2. Time Distributions for Evacuation Mobilization Activities

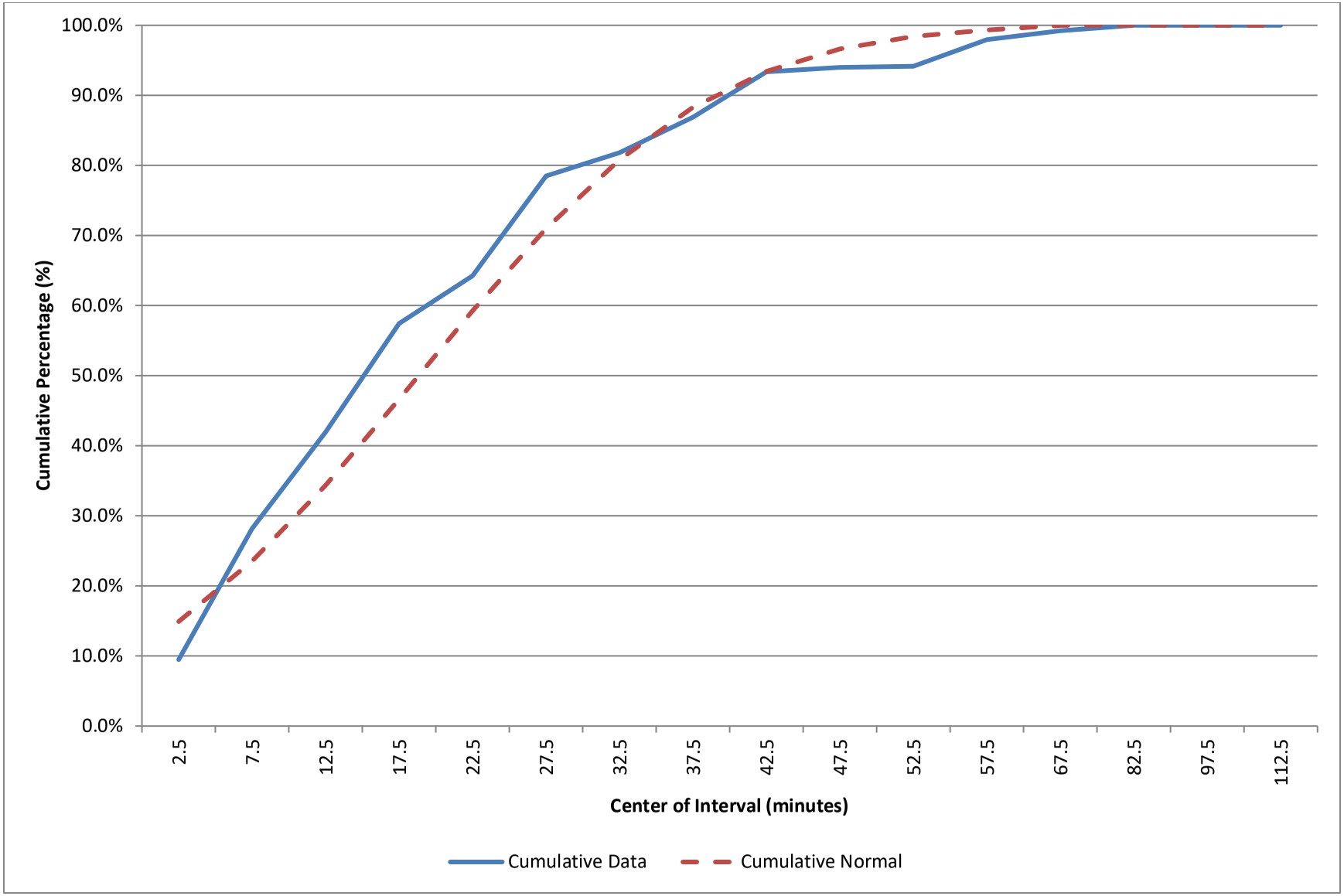


Figure 5-3. Comparison of Data Distribution and Normal Distribution

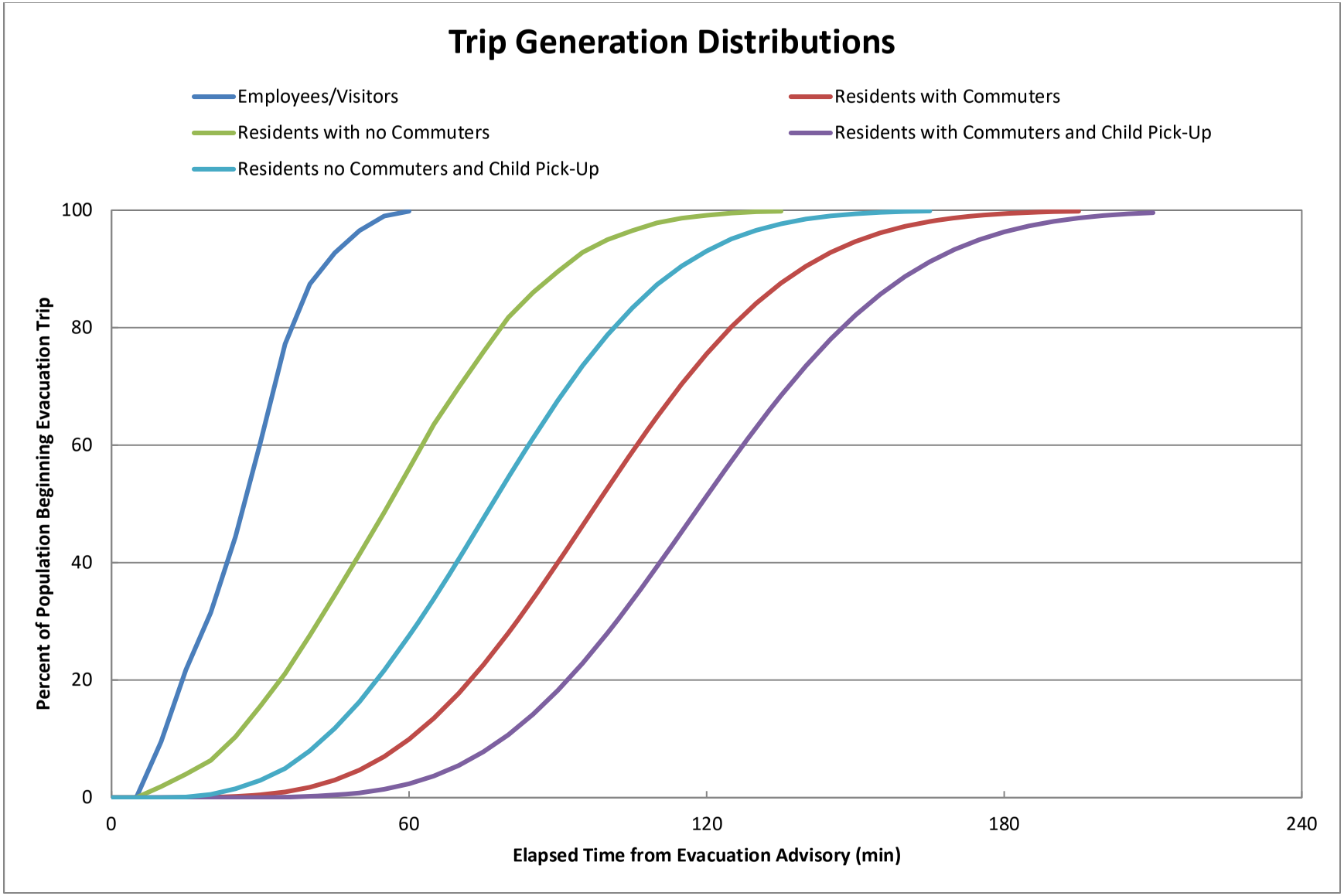


Figure 5-4. Comparison of Trip Generation Distributions

6 EVACUATION CASES

This section discusses the spatial and temporal variations in evacuation situations. The regions outlined in the study were created based on various geometric areas that would be evacuated in response to a wildfire, tsunami, or other potential emergency. The Evacuation Zones[1]were used as Zone boundaries for this study. The scenarios outlined in the study were created based on the various temporal changes that affect the number of vehicles evacuating. This section provides an overview of all the possible evacuation cases that were studied. An evacuation "case" defines a combination of Evacuation Region and Evacuation Scenario. For this specific study, the definitions of "Region" and "Scenario" are as follows:

Region A grouping of evacuating Evacuation Zones that must be evacuated in response to a wildfire, tsunami, or other emergency.

Scenario A combination of circumstances, including time of day, day of week, and season. Scenarios define the number of people in each of the affected population groups and their respective mobilization time distributions.

A total of 14 Regions were defined which encompass all the groupings of Evacuation Zones considered. These Regions are defined in Table 6-1. Table 6-2 shows which Evacuation Zones evacuate for each Region, as well as which Evacuation Zones receive an Evacuation Order and/or an Evacuation Warning (specifically for Region R03, the only phased evacuation case). Table 6-3 shows the phases, or stages, of the phased evacuation case (Region R03). A phased evacuation means that the Evacuation Zones receive Evacuation Orders and/or Evacuation Warnings in phases, rather than all at once. The Evacuation Zone boundaries are identified in Figure 6-1. Appendix E shows individual maps of all the regions shown in Table 6-1.

Region R01 is the evacuation of all Evacuation Zones within the city at once.

Region R02 and Region R04 are fire evacuations in which some Evacuation Zones receive an Evacuation Order while other Evacuation Zones simultaneously receive an Evacuation Warning. As discussed in Section 2, 50% of people are assumed to voluntarily evacuate from Evacuation Zones that receive an Evacuation Warning. One hundred percent (100%) of people are assumed to evacuate Evacuation Zones that receive an Evacuation Order.

Region R03 is a fire evacuation in which groups of Evacuation Zones receive an Evacuation Warning and/or an Evacuation Order in phases. It should be noted that Region R02 is the same geographic evacuation as Region R03 Phase C, but Region R03 is phased and Region R02 is all at once.

Regions R05 through R14 are evacuations of combinations of Evacuation Zones likely to be evacuated concurrently. These regions were defined based on discussions with Planning and

[1] https://protect.genasys.com/search

Fire Department personnel at the City of Berkeley.

- Region R05 is an evacuation of Berkeley Fire Zones 2 and 3.
- Regions R06 and R07 simulate a warning-level tsunami.
- Regions R08-R11 are geographic groupings of Berkeley that could be evacuated concurrently based on their geographic proximity but do not have a distinct hazard identified to trigger evacuation.
- Regions R12-R14 are geographic groupings of UC Berkeley and LBNL properties, which have distinct evacuation authorities from the City of Berkeley and could be evacuated in tandem with, or separate from, City property.

A total of 6 Scenarios were evaluated for all Regions. Thus, there are a total of 84 (14 x 6 = 84) unique evacuation cases. Table 6-4 provides a description of all Scenarios that were considered.

Each combination of Region and Scenario implies a specific population to be evacuated. The population group and the vehicle estimates presented in Section 3 and in Appendix C are peak values. These peak values are adjusted depending on the scenario and region being considered, using Scenario and Region-specific percentages, such that the average population is considered for each evacuation case. The Scenario percentages are presented in Table 6-5. Table 6-6 presents the vehicle counts for each scenario for an evacuation of Region R01 – all Evacuation Zones within the City.

The percentages presented in Table 6-5 were determined as follows:

The number of residents with commuters during the week (when workforce is at its peak) is equal to the product of 41.6% (the number of households with at least one commuter) and 30.1% (the number of households with a commuter that would await the return of the commuter prior to evacuating) – approximately 13%. See assumption 3 in Section 2.3. It is estimated for weekend and nighttime scenarios that 10% of households with returning commuters will have a commuter at work during those times.

It can be argued that the estimate of permanent residents overstates, somewhat, the number of evacuating vehicles, especially during the summer. It is certainly reasonable to assert that some portion of the population would be on vacation during the summer and would travel elsewhere. A rough estimate of this reduction can be obtained as follows:

- Assume 50 percent of all household's vacation for a two-week period over the summer.
- Assume these vacations, in aggregate, are uniformly dispersed over 10 weeks, i.e. 10 percent of the population is on vacation during each two-week interval.
- Assume half of these vacationers leave the area.

On this basis, the permanent resident population would be reduced by 5 percent in the summer and by a lesser amount in the off-season. Given the uncertainty in this estimate, we elected to apply no reductions in permanent resident population for the summer scenarios to account for residents who may be out of the area.

When schools are in session (Scenarios 4 and 6), approximately 18 percent of households citywide who a) have school children, and b) would elect to pick their school children from school during an emergency (see Section 2.4).

Employment is assumed to be at its peak during the fall, midweek, midday scenarios. Employment is reduced slightly (96%) for summer, midweek, midday scenarios. This is based on the estimation that 50% of the employees commuting into the City of Berkeley will be on vacation for a week during the approximately 12 weeks of summer. It is further estimated that those taking vacation will be uniformly dispersed throughout the summer with approximately 4% of employees vacationing each week. It is further estimated that only 10% of the employees are at work during the evening/overnight and on weekends.

Based on the data provided by Visit Berkeley[2], there are approximately 30,200,000 visits on average throughout the year. This equates to approximately 2,516,667 visits per month on average. During the fall and summer months, there are 2,166,667 and 3,225,000 visits on average, respectively. Since the average yearly number of visits was used to calculate the number of average daily visitors in Berkeley (see Section 3), factors of 0.86 (2,166,667 ÷ 2,516,667 = 0.86) and 1.28 (3,225,000 ÷ 2,516,667 = 1.28) were used to estimate the number of daily visitors for fall and summer, respectively.

Furthermore, there are 4,314,286 weekly average visits in Berkeley. For weekdays, the number of visits is 4,300,000 visits and for the weekend it is 4,666,667 visits. As previously mentioned, the average weekly number was used to estimate the number of total visitors. Hence, factors of (4,300,000 ÷ 4,314,286 ≈ 1) 1.00 and (4,666,667 ÷ 4,314,286 = 1.08) 1.08 were used to estimate the number of visits for weekdays and weekends, respectively. As shown in Table 6-5, these factors were used to estimate the number of tourists for fall weekends (0.86 x 1.08 = 0.93), fall weekdays (0.86 x 1.00 = 0.86), summer weekends (1.28 x 1.08 = 1.39) and summer weekdays (1.28 x 1.00 = 1.28). Since nighttime data was not available, it was assumed that there are 60% fewer visits during the nighttime. As such, scenario percentages for summer and fall during the night were estimated to be (0.40 x 1.39 = 0.56) 0.56 and (0.40 x 0.93 = 0.37) 0.37 in the summer and fall, respectively.

As noted in the shadow footnote to Table 6-5, the shadow percentages are computed using a base of 20% (see assumption 10 in Section 2.2).

Transit buses for the transit-dependent population and medical patients and vehicles for juvenile homes are set to 100% for all scenarios as it is assumed that these population groups are present in the City of Berkeley for all evacuation scenarios.

As discussed in Section 8, schools are in session during the fall season, midweek, midday and 100% of buses and student vehicles will be needed and present under those circumstances. It is estimated that summer school/college enrollment is approximately 10% of enrollment during

[2] https://www.visitberkeley.com/

the regular school year for summer scenarios. K-12 schools are not in session during weekends and at nighttime, thus buses for school children are not needed and off campus college students are not present under those circumstances; It is estimated that 10% of on campus students will be present during the summer, and 100% of on campus students will be present during fall.

External traffic is estimated to be reduced by 60% during nighttime scenarios and is 100% for all other scenarios.

Table 6-1. Evacuation Regions

See Appendix E for maps visualizing these Regions.

Region	
R01	Citywide Evacuation
R02	Fire - 1923 - All
R03	Fire - 1923 - Phase a (0 minutes)
	Fire - 1923 - Phase b (0 + 90 minutes)
	Fire - 1923 - Phase c (0 + 180 minutes)
R04	Panoramic Hill Fire
R05	Fire Zones - Fire Zones 2 & 3 Combined
R06	Tsunami - Phase 3
R07	Tsunami - Max Phase
R08	Berkeley Flats
R09	North Berkeley Hills
R10	South Berkeley Hills
R11	West Berkeley
R12	UC Berkeley
R13	Lawrence Berkeley National Lab
R14	UC Berkeley + Lawrence Berkeley National Lab

Table 6-2. Regions by Evacuation Zones

Region	Description	Evacuation Zones
R01	Citywide Evacuation	BER-E018, BER-E005, BER-E057, BER-E012, BER-E040, BER-E046, BER-E056, OKL-E010, OKL-E021, BER-E021, BER-E074, BER-E077, BER-E044, BER-E023 West, BER-E013, BER-E031, BER-E009, BER-E078, BER-E037, BER-E004, BER-E041, BER-E015, BER-E052, BER-E062, BER-E064, BER-E002, BER-E032, BER-E011, BER-E022, BER-E061, BER-E075, BER-E036, BER-E063, LBL-E006, LBL-E004, LBL-E005, LBL-E001, LBL-E002, BER-E026, BER-E003, BER-E010, BER-E019, BER-E029, BER-E055, BER-E066, BER-E025, BER-E051, BER-E008, BER-E017, BER-E048, BER-E068, BER-E007, BER-E030, OKL-E004, BER-E071, OKL-E008, OKL-E009, OKL-E007, OKL-E241, BER-E065, OKL-E001, OKL-E019, ALB-E008, BER-E047 West, LBL-E003, BER-E073, BER-E058, BER-E049, BER-E059, BER-E006, BER-E035 West, OKL-E018, BER-E027, BER-E020, BER-E024, OKL-E022, BER-E060, OKL-E020, BER-E053, BER-E014, BER-E033, BER-E054, OKL-E015, BER-E067, BER-E028, BER-E034, BER-E045, BER-E038, BER-E070, BER-E039, BER-E043, BER-E001, BER-E069, BER-E042, BER-E072, OKL-E002, BER-E016, BER-E050 East, OKL-E017, ALB-E006, BER-E076, ALB-E007, BER-E023 East, BER-E047 East, BER-E035 East, BER-E050 West
R02	Fire 1923	**Order** BER-E018, BER-E057, BER-E012, BER-E040, BER-E013, BER-E031, BER-E041, BER-E015, BER-E032, LBL-E006, LBL-E004, LBL-E005, LBL-E001, LBL-E002, BER-E026, BER-E019, BER-E029, BER-E017, BER-E030, OKL-E001, LBL-E003, BER-E058, BER-E059, BER-E027, BER-E020, BER-E033, BER-E028, BER-E038, BER-E039, BER-E043, BER-E042, OKL-E002, BER-E016, **Warning** BER-E056, BER-E021, BER-E044, BER-E009, BER-E037, BER-E022, BER-E010, BER-E055, BER-E066, BER-E025, BER-E008, BER-E007, OKL-E004, BER-E073, BER-E060, BER-E054, ALB-E006
R03 a	Fire 1923 Phased	**Order** BER-E031, LBL-E006, OKL-E002, BER-E016 **Warning** BER-E015, BER-E032, LBL-E004, LBL-E005, LBL-E001, BER-E008, BER-E017, BER-E007, BER-E030, OKL-E001, LBL-E003

Region	Description	Evacuation Zones
R03 b	Fire 1923 Phased	**Order** BER-E031, BER-E015, BER-E032, LBL-E006, LBL-E004, LBL-E005, LBL-E001, BER-E017, BER-E030, OKL-E001, LBL-E003, OKL-E002, BER-E016 **Warning** BER-E018, BER-E040, BER-E013, BER-E041, LBL-E002, BER-E019, BER-E029, BER-E008, BER-E007, BER-E058, BER-E033
R03 c	Fire 1923 Phased	**Order** BER-E018, BER-E057, BER-E012, BER-E040, BER-E013, BER-E031, BER-E041, BER-E015, BER-E032, LBL-E006, LBL-E004, LBL-E005, LBL-E001, LBL-E002, BER-E026, BER-E019, BER-E029, BER-E017, BER-E030, OKL-E001, LBL-E003, BER-E058, BER-E059, BER-E027, BER-E020, BER-E033, BER-E028, BER-E038, BER-E039, BER-E043, BER-E042, OKL-E002, BER-E016 **Warning** BER-E056, BER-E021, BER-E044, BER-E009, BER-E037, BER-E022, BER-E010, BER-E055, BER-E066, BER-E025, BER-E008, BER-E007, OKL-E004, BER-E073, BER-E060, BER-E054, ALB-E006
R04	Panoramic Hill Fire	**Order** OAK-E003, OAK-E004, OAK-E005, BER-E013, BER-E058, BER-E059, BER-E066 **Warning** OAK-E006, OAK-E007, OAK-E009, BER-E041, BER-E055, BER-E057, BER-E060, BER-E073, BER-E077
R05	Fire Zones 2 & 3 Combined	BER-E018, BER-E005, BER-E057, BER-E012, BER-E040, OKL-E010, BER-E021, BER-E031, BER-E009, BER-E078, BER-E004, BER-E041, BER-E015, BER-E002, BER-E032, BER-E011, BER-E003, BER-E010, BER-E019, BER-E029, BER-E055, BER-E066, BER-E008, BER-E017, BER-E007, BER-E030, OKL-E004, OKL-E008, OKL-E009, OKL-E007, OKL-E019, BER-E058, BER-E059, BER-E006, OKL-E018, BER-E020, BER-E033, OKL-E015, BER-E028, BER-E016, OKL-E017, BER-E076
R06	Tsunami – Phase 3	BER-E049, BER-E034

Region	Description	Evacuation Zones
R07	Tsunami – Max Phase	BER-E023 West, BER-E048, BER-E047 West, BER-E049, BER-E035 West, BER-E034, BER-E050 West
R08	Berkeley Flats	BER-E046, BER-E056, OKL-E021, BER-E074, BER-E044, BER-E037, BER-E052, BER-E062, BER-E064, BER-E022, BER-E061, BER-E075, BER-E036, BER-E063, BER-E026, BER-E025, BER-E051, BER-E068, BER-E071, OKL-E241, BER-E065, ALB-E008, BER-E073, BER-E027, BER-E024, OKL-E022, BER-E060, OKL-E020, BER-E053, BER-E014, BER-E054, BER-E067, BER-E045, BER-E038, BER-E070, BER-E039, BER-E069, BER-E072, ALB-E006, ALB-E007
R09	North Berkeley Hills	BER-E018, BER-E005, BER-E012, BER-E040, BER-E021, BER-E031, BER-E009, BER-E004, BER-E015, BER-E002, BER-E032, BER-E011, BER-E003, BER-E010, BER-E019, BER-E029, BER-E008, BER-E017, BER-E007, BER-E030, BER-E006, BER-E020, BER-E033, BER-E028, BER-E001, BER-E016
R10	South Berkeley Hills	BER-E057, OKL-E010, BER-E077, BER-E013, BER-E078, BER-E055, BER-E066, OKL-E004, OKL-E008, OKL-E009, OKL-E007, OKL-E019, BER-E058, BER-E059, OKL-E018, OKL-E015, OKL-E017, BER-E076
R11	West Berkeley	BER-E023 West, BER-E048, BER-E047 West, BER-E035 West, BER-E050 East, BER-E023 East, BER-E047 East, BER-E035 East, BER-E050 West, BER-E049, BER-E034
R12	UC Berkeley	BER-E041, OKL-E001, BER-E059, BER-E043, BER-E042, OKL-E002
R13	Lawrence Berkeley National Lab	LBL-E006, LBL-E004, LBL-E005, LBL-E001, LBL-E002, LBL-E003
R14	UC Berkeley and Lawrence Berkeley National Lab	BER-E041, LBL-E006, LBL-E004, LBL-E005, LBL-E001, LBL-E002, OKL-E001, LBL-E003, BER-E059, BER-E043, BER-E042, OKL-E002

Table 6-3. Region R03 Phased Evacuation Zones

Region R03			
Zone	Phase a - Immediate Action	Phase b - 30 Minutes After Initial Action	Phase c - 60 Minutes After the Initial Action
ALB-E006	N/A	N/A	Warning
BER-E007	Warning	Warning	Warning
BER-E008	Warning	Warning	Warning
BER-E009	N/A	N/A	Warning
BER-E010	N/A	N/A	Warning
BER-E012	N/A	N/A	Order
BER-E013	N/A	Warning	Order
BER-E015	Warning	Order	Order
BER-E016	Order	Order	Order
BER-E017	Warning	Order	Order
BER-E018	N/A	Warning	Order
BER-E019	N/A	Warning	Order
BER-E020	N/A	N/A	Order
BER-E021	N/A	N/A	Warning
BER-E022	N/A	N/A	Warning
BER-E025	N/A	N/A	Warning
BER-E026	N/A	N/A	Order
BER-E027	N/A	N/A	Order
BER-E028	N/A	N/A	Order
BER-E029	N/A	Warning	Order
BER-E030	Warning	Order	Order
BER-E031	Order	Order	Order
BER-E032	Warning	Order	Order
BER-E033	N/A	Warning	Order
BER-E037	N/A	N/A	Warning
BER-E038	N/A	N/A	Order
BER-E039	N/A	N/A	Order
BER-E040	N/A	Warning	Order
BER-E041	N/A	Warning	Order
BER-E042	N/A	N/A	Order
BER-E043	N/A	N/A	Order
BER-E044	N/A	N/A	Warning
BER-E054	N/A	N/A	Warning
BER-E055	N/A	N/A	Warning
BER-E056	N/A	N/A	Warning
BER-E057	N/A	N/A	Order
BER-E058	N/A	Warning	Order

Region R03			
Zone	**Phase a - Immediate Action**	**Phase b - 30 Minutes After Initial Action**	**Phase c - 60 Minutes After the Initial Action**
BER-E059	N/A	N/A	Order
BER-E060	N/A	N/A	Warning
BER-E066	N/A	N/A	Warning
BER-E073	N/A	N/A	Warning
LBL-E001	Warning	Order	Order
LBL-E002	N/A	Warning	Order
LBL-E003	Warning	Order	Order
LBL-E004	Warning	Order	Order
LBL-E005	Warning	Order	Order
LBL-E006	Order	Order	Order
OKL-E001	Warning	Order	Order
OKL-E002	Order	Order	Order
OKL-E004	N/A	N/A	Warning
All Other Zones	N/A	N/A	N/A
No Protective Action (N/A) (20% Evacuate)		**Evacuation Warning (50% Evacuate)**	**Evacuation Order (100% Evacuate)**

Table 6-4. Evacuation Scenario Definitions

Scenario	Season	Day of Week	Time of Day
1	Summer	Midweek	Midday
2	Summer	Weekend	Midday
3	Summer	Midweek, Weekend	Nighttime
4	Fall	Midweek	Midday
5	Fall	Weekend	Midday
6	Fall	Midweek, Weekend	Nighttime

Table 6-5. Percent of Population Groups Evacuating for Various Scenarios

Scenario	Households With Returning Commuters	Households Without Returning Commuters	Employees	Tourists	Shadow Region	Special Facilities[3]	Transit Buses	Off Campus College Vehicles	On Campus College Vehicles	School Buses	External Through Traffic
1	13%	87%	96%	128%	20%	100%	100%	10%	10%	10%	100%
2	1%	99%	10%	139%	20%	100%	100%	0%	10%	0%	100%
3	1%	99%	10%	56%	20%	100%	100%	0%	10%	0%	40%
4	13%	87%	100%	86%	20%	100%	100%	100%	100%	100%	100%
5	1%	99%	10%	93%	20%	100%	100%	0%	100%	0%	100%
6	1%	99%	10%	37%	20%	100%	100%	0%	100%	0%	40%

Notes:

Households with Returning Commuters are Households of the City of Berkeley residents who await the return of commuters prior to beginning the evacuation trip.

Households Without Returning Commuters are Households of the City of Berkeley residents who do not have commuters or will not await the return of commuters prior to beginning the evacuation trip.

Employees are those who live outside the City of Berkeley but work within.

Tourists are people who are in the City of Berkeley at the time of an event for recreational or other (non-employment) purposes.

Shadow Region represents residents in the shadow region (outside of the City of Berkeley) who will spontaneously decide to relocate during the evacuation. The basis for the values shown is a 20% relocation of shadow residents.

Off Campus College Vehicles are students who live off campus, both inside and outside of Berkeley, and will evacuate using a private vehicle or public transit (bus or rail).

On Campus College Vehicles are students who live on campus at the time of an event and will evacuate using a private vehicle or public transit (bus or rail).

Special Facility, School and Transit Buses represent vehicle-equivalents present on the road during evacuation servicing medical facilities, schools and transit-dependent people (1 bus is equivalent to 2 passenger vehicles).

External Through Traffic is traffic on interstates and major arterial roads at the start of the evacuation. This traffic is assumed to stop within approximately 2 hours of the evacuation begins.

[3] Special Facilities represent the vehicles at medical facilities and juvenile homes.

Table 6-6. Vehicle Estimates by Scenario[4]

Scenarios	Households with Returning Commuters	Households without Returning Commuters	Employees	Tourists	Shadow[5]	Special Facilities	Transit Buses	Off Campus College Vehicles	On Campus College Vehicles	School Buses	External Traffic	Total Scenario Vehicles
1	5,952	41,662	14,646	17,693	10,419	285	224	1,312	207	22	47,962	140,384
2	598	47,016	1,526	19,214	10,419	285	224	0	207	0	47,962	127,451
3	598	47,016	1,543	7,741	10,419	285	224	0	207	0	19,185	87,218
4	5,952	41,662	15,256	11,888	10,419	285	224	13,119	2,069	224	47,962	149,060
5	598	47,016	1,526	12,855	10,419	285	224	0	2,069	0	47,962	122,954
6	598	47,016	1,526	5,115	10,419	285	224	0	2,069	0	19,185	86,437

[4] Vehicle estimates are for an evacuation of the entire city (Region R01).
[5] Shadow vehicles have been reduced to 20%. Refer to Section 2.

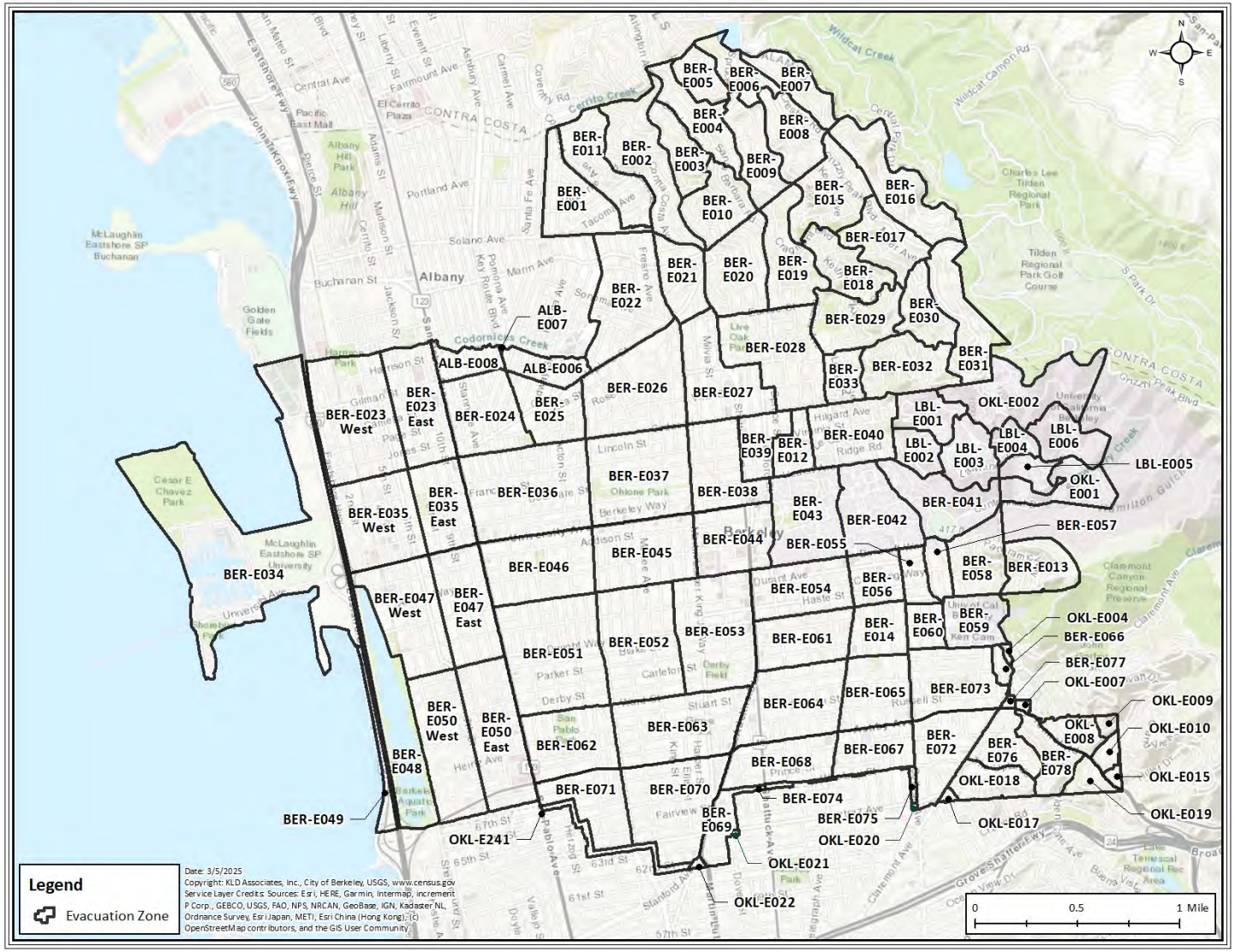


Figure 6-1. Evacuation Zones Boundaries

7 GENERAL POPULATION EVACUATION TIME ESTIMATES (ETE)

This section presents the ETE results of the computer analyses using the DYNEV II System[1]. These results cover 14 Evacuation Regions and the 6 Evacuation Scenarios discussed in Section 6.

The ETE for all Evacuation Cases are presented in Table 7-1 and Table 7-2. These tables present the estimated **times to clear** the indicated population percentages from the Evacuation Regions for all Evacuation Scenarios. **The ETE does not represent the time experienced by an individual evacuee nor does it account for the time to reach a destination.** Table 6-1 defines the Evacuation Regions considered. The tabulated values of ETE are obtained from the DYNEV II System outputs which are generated at 5-minute intervals.

7.1 Voluntary Evacuation and Shadow Evacuation

"Voluntary evacuees" are people within the city for which an Evacuation Order or Warning has not been issued, yet who elect to evacuate. "Shadow evacuation" is the outward movement of some people from outside of the city limits (also for whom no Evacuation Order or Warning has been issued). Both voluntary and shadow evacuations are assumed to take place over the same time frame as the evacuation from within the impacted Evacuation Region.

Within the city:

- 100% of permanent residents who are issued an Evacuation Order are assumed to evacuate. (See Section 6).
- 50% of permanent residents who are issued an Evacuation Warning are assumed to evacuate.
- 20% of permanent residents located outside of the evacuation region who are not given an Evacuation Order or Warning, are assumed to evacuate. Outside of the city, it is assumed that 20% of people in the Shadow Region will also choose to leave the area.

Figure 7-1 presents the area identified as the Shadow Region. The Shadow Region extends beyond the City of Berkeley. The Shadow Region is bounded by I-580, Piedmont Ave and Moraga Ave to the south, State Route 13 and State Route 24 to the southeast, the eastern boundary of Tilden Park to the east, by Moeser Lane, San Pablo Avenue, Potrero Avenue, S 55th Street, and Bayview Avenue to the North, and I-580 and the San Francisco Bay to the west. The population and number of evacuating vehicles in the Shadow Region were estimated using the same methodology that was used for permanent residents within the City of Berkeley (see Section 3.1). As discussed in Section 3.2, it is estimated that a total of 111,443 permanent residents reside in the Shadow Region; 20% of them would evacuate. See Table 6-6 for the number of evacuating vehicles from the Shadow Region.

[1] https://kldassociates.com/wp-content/uploads/2024/10/DTRAD-DYNEV.pdf

Traffic generated within this Shadow Region including external-external traffic, traveling away from the hazard, has the potential for impeding evacuating vehicles from within the city or Evacuation Region. All ETE calculations include this shadow traffic movement.

7.2 Evacuation Rates

Evacuation is a continuous process, as implied by Figure 7-2 through Figure 7-7. These figures indicate the rate at which traffic flows out of the city (Region R01) under the indicated conditions. One figure is presented for each scenario considered.

The distance between the trip generation and ETE curves is the travel time. Plots of trip generation versus ETE are indicative of the level of traffic congestion during evacuation. The evacuation population mobilizes over 3 hours and 15 minutes, or 3 hours and 30 minutes on school days, as discussed in Section 5. Despite evacuees mobilizing over a lengthy period of time, pronounced congestion can be seen throughout the city when the entire city evacuates at once (as shown in Appendix F). Thus, as seen in Figure 7-2 through Figure 7-7, the two curves are spatially separated. In Scenario 4 (fall, midweek, midday) for example, evacuees that leave within 30 minutes of the evacuation order experience travel times of up to 40 minutes. Those that leave later experience travel times of up to 2 hours and 35 minutes.

It should be noted that slower mobilization can actually reduce congestion, as it distributes vehicles over a longer period, allowing the road network to handle evacuation traffic more effectively. This could lead to shorter evacuation times and reduced travel times, assuming there is sufficient time for longer mobilization before the hazard reaches the city limits.

7.3 Evacuation Time Estimate (ETE) Results

Table 7-1 and Table 7-2 present the ETE values for all 14 Evacuation Regions and all 6 Evacuation Scenarios.

This analysis presents ETE for both the 90^{th} and 100^{th} percentile, as described below:

Table	Contents
7-1	**90th Percentile ETE:** ETE represents the time required for 90 percent of the population within a Region **to evacuate out of the Zone(s) of the Region under Evacuation Order**. An evacuation is considered 90% complete when 90% of all evacuating vehicles/people in Evacuation Order zones have arrived in Zones that are either a) under Evacuation Warning or b) not under threat. This includes vehicles used by the transit-dependent population. All Scenarios (time of day, day of week, season) are considered.
7-2	**100th Percentile ETE:** ETE represents the time required for 100 percent of the population within a Region **to evacuate out of the Zone(s) of the Region under Evacuation Order**. An evacuation is considered 100% complete when 100% of all evacuating vehicles/people in Evacuation Order zones have arrived in Zones that are either a) under Evacuation Warning or b) not under threat. This includes vehicles used by the transit-dependent population. All Scenarios (time of day, day of week, season) are considered.
7-4	**ETE for Response Planning:** Presents the ETE (90th or 100th) most appropriate for response planning.

The 90th and 100th percentile ETEs present different information. The US NRC recommends emergency planners and responders use the 90th percentile ETE when making protective action decisions, instead of the 100th percentile. This is because frequently, the last 10% of vehicles take an unusually long time to prepare to leave ("Trip Generation"). This extended trip generation time results in a long evacuation "tail" that is unrelated to traffic congestion. This tail can reflect highly variable individual evacuee behaviors (such as individual households with an extremely long mobilization time as compared to their neighbors). Therefore, using the 100th percentile ETEs for community-wide evacuation planning is not recommended, although it is provided in this report for completeness.

Although counterintuitive, the 90th percentile ETE for a case with a large number of evacuating vehicles can be less than a case with fewer evacuating vehicles. This is because the 90th percentile ETE depends on the composition of the evacuating vehicular traffic (e.g., residents, employees, visitors). Areas with a higher proportion of quickly mobilizing evacuees (such as employees or visitors) can reach the 90th percentile ETE more quickly compared to areas predominantly populated by permanent residents, who typically require a longer time to mobilize even if they have a higher total demand. Often, this anomaly is seen in cases without traffic congestion, or where traffic congestion clears prior to the end of trip generation.

This analysis determined the Trip Generation Time using the results of the community survey (Appendix D). Survey respondents reported how long it would take them to prepare to leave (trip generation time.) Some respondents indicated that it would take multiple hours to leave, which creates this long evacuation "tail." However, survey results may not accurately reflect the Trip Generation times for no-notice events such as a fire immediately adjacent to the home. Therefore, a truncation of the mobilization time was tested in Section 10 for Region R02 and R04.

It can be seen that when mobilization times are shorter, the 100th percentile ETE are also shorter, validating the NRC concepts.

Snapshots of congestion at certain times into the evacuation for some cases are presented in Appendix F. These diagrams reflect the ETE statistics for the evacuation scenarios and regions for which they represent. The majority of the congestion is located on higher capacity routes that serve a majority of the evacuating population – discussed further in Section 9.

7.3.1 Prepare to Evacuate Time Can Dictate Time to Escape Hazard Area

As described above, an analysis comparing the 90th and 100th percentile ETE shows that for most of the 14 Evacuation Regions and their 6 Evacuation Scenarios, the 100th percentile ETE is dictated by trip generation[2]. This means that generally, the extended time it takes the final evacuees to get on the road is the reason for the extended evacuation time.

However, there are exceptions to this statement listed below. This means that under the circumstances below, traffic congestion causes extended evacuation times, and even if evacuees got on the road more quickly, the area would not be cleared more quickly.

- Region R01: A citywide evacuation, during the day
- Region R02: An unphased evacuation of the 1923 Fire during the fall, midweek, midday
- Region R03 Phase a and Phase b: A phased evacuation of the Fire 1923 (due to the "spike"), during the day, and
- Region R08: An evacuation of Berkeley Flats on weekdays during the day.
- Region R13: An evacuation of LBNL on weekdays during the day.

For the cases above, it is recommended that the City considers the 100th percentile ETE when making protective action decisions. For all other cases, trip generation time dictates 100th percentile ETE, and for those other cases it is recommended that the city considers the 90th percentile ETE when making protective action decisions.

Section 10 presents analysis of how evacuation times change when mobilization times are truncated, representing what would happen if evacuees got onto roadways more quickly when they receive an evacuation order. The impacts of reduced trip generation times varied across different Evacuation Regions and cases. ETEs were reduced by up to 65% in some cases. In others the reductions were smaller. In others, the ETE actually increased because the concentrated demand on the roadway network overwhelmed the system. See Section 10 for details.

Roadway Impacts from Picking up Schoolchildren

It should be noted that some parents will pick up their children from school prior to beginning their evacuation trip (see Assumption 2.a.i in Section 2.4). While the estimated trip mobilization time includes the time for parents to pick up their children prior to evacuating (see Section 5), the potential for localized congestion at schools during this process was not factored into the study. It's important to note that while the total number of evacuating vehicles remains the same,

[2] Since LBNL only has employees within the region, the mobilization of this region is 1:05, rather than 3:40 or 3:25, which is only for residents as discussed in Section 5.

the shift in trip origin from homes to schools for these evacuees could create altered congestion patterns than those represented in this study. Consequently, the Estimated Evacuation Time (ETE) could experience slight variations depending on the efficiency of parent pick-up procedures and the resulting traffic flow around school zones.

7.3.2 Region R01: Citywide Evacuation

It should be first noted that **Region R01 does not reflect a realistic emergency or disaster**. An event requiring simultaneous evacuation of all of Berkeley would have regional impacts to roadway and transportation systems that are far beyond the scope of this analysis.

Rather, Citywide evacuation was included in this document in order to stress Berkeley's roadway network to identify areas of potential traffic congestion that may not have been apparent from other evacuation cases.

Analysis Results

For a citywide evacuation, the 90th percentile ETE for midweek midday scenarios is 3 hours and 50 minutes, 3 hours for weekend middays and 2 hours and 30 minutes for nighttime scenarios, on average. The 90th percentile ETE is the highest for midweek midday scenarios because of the increased traffic demand due to employees within the city. The 90th percentile ETE is at its peak (4 hours) for fall midweek midday scenarios as schools are in session, especially UC Berkeley, compared to the summer scenarios where the school population is lower. Nighttime scenarios have the lowest 90th ETE due to the decreased numbers of employees, visitors and commuting students within the city. As mentioned before, the 100th percentile ETE is dictated by congestion for midday scenarios and trip mobilization time for nighttime scenarios. During the day, increased vehicular demand overwhelms the roadway network within the city, causing delays and increasing ETE. At night, the demand is reduced, hence, the 100th percentile ETE is dictated by when the last vehicle departs for an evacuation.

7.3.3 Region R02: 1923 Berkeley Fire Repeat

The city pursued an ETE analysis for a repeat of the 1923 Berkeley Fire. Region R02 uses the final perimeter of the fire and assigns zones to evacuation order or warning status based on the final impact of the fire. This means that the Region R02 analysis identifies the ETE if the full area of impact received evacuation warnings/orders at the same time.

Analysis Results

For Region R02, the 90th percentile ETE ranges between 1 hour and 45 minutes and 2 hours and 55 minutes. The 100th percentile ETE ranges between 3 hours and 25 minutes to 4 hours and 10 minutes. Similar to a citywide evacuation (Region R01), the variance in ETE between different scenarios is to the fluctuations in demand in different seasons, time of day, and day of the week within Berkeley. Additionally, for Region R02, there are Evacuation Warning zones around the periphery of the fire extent. The increase in shadow evacuation (50% compared to 20% in other areas) in these areas slows down vehicles leaving the zones that receive an Evacuation Order, further delaying their evacuation time.

Evacuee Experience

Figure 7-8 shows the ETE and trip generation time (mobilization time) for Region R02 Scenario 4. As discussed in Section 7.2, the distance between these curves is the average travel time experienced for an evacuee that mobilizes at a specific time after the Evacuation Order. For example, if an evacuee mobilizes 45 minutes after the Evacuation Order, it will take them approximately 65 minutes to leave the area at risk. (Find 0:45 on the x-axis, follow a straight vertical line up until it hits the red line, follow a straight horizontal line to the right until it hits the blue line, follow a straight vertical line down until it hits the x-axis; read the time and subtract 0:45 to compute the average travel time for a vehicle that departs at 0:45 after the evacuation order.)

The travel time experienced for different time periods are summarized below (the sum of these two times can be used to calculate the ETE):

- Mobilized 30 minutes after the Evacuation Order – Travel Time 40 minutes
- Mobilized 60 minutes after the Evacuation Order – Travel Time 75 minutes
- Mobilized 90 minutes after the Evacuation Order – Travel Time 80 minutes
- Mobilized 150 minutes after the Evacuation Order – Travel Time 80 minutes

7.3.4 Regions R02 and R03: Analyzing the Impacts of a Phased Fire Evacuation

The city pursued two separate ETE analyses for a repeat of the 1923 Berkeley Fire.

- As discussed above, the Region R02 analysis identifies the ETE if the full area of impact received evacuation warnings/orders at the same time.
- Region R03 uses the same fire perimeter, exploring the impact to evacuation times from issuing evacuation warnings/orders sequentially based on real-time fire spread. The zones in the fire area are assigned to phases based on historical fire spread data. The phases are a (eastern zones), b (middle zones), and c (western zones).

This analysis is designed to answer 2 questions:

- Does phasing evacuation speed or slow the overall evacuation times for the entire region affected by a repeat of the 1923 Fire?
- How does phasing the evacuation affect the evacuation times for individual evacuation zones? The fire is presumed to move from the east to the west. Even if the overall evacuation time slows with a phased evacuation, does the phased evacuation enable people nearest to the fire to more quickly get out of the way of the hazard?

Overall Analysis Results

Analysis shows that overall, phasing the evacuation of the same area increases the overall evacuation time for the area. Comparing the simultaneous (R02) and phased (R03 – phase c) evacuations, Table 7-1 reveals that the phased evacuation has an average increase of 2 hours and 15 minutes at the 90th percentile ETE across all scenarios. The extended ETE in the R03 Phased evacuation is caused by a combination of:

- The delayed evacuation order timing for Phase c: The final and westernmost area in the Region receives the evacuation order 180 minutes after Phase a; and
- A "spike" (sharp increase) in the mobilization (trip-generation rate) of evacuating vehicles. Once evacuation orders were issued for Phase a, many people in surrounding areas (phase b and c) were preparing to evacuate. Once Phase b and then c received their official evacuation warning or order, many of these evacuees were more ready to go than they would have been if they received their evacuation order/warning at the beginning of the event. This decreases the mobilization times for Phases b and c, and the associated spike in vehicles entering the roadway oversaturates evacuation routes, which increases traffic congestion and prolongs ETE.

Impacts on Areas Closest to Fire Ignition

To determine how phasing affects evacuation times for areas closest to a fire ignition (phases a and b), additional data was extracted from the simulation results for the simultaneous (R02) and phased (R03) evacuations. The results are shown in Table 7-3. They indicate that a phased evacuation approach can actually increase the ETE for those areas closest to the hazard, (phase a and phase b).

This counterintuitive phenomenon is attributable to vehicles evacuating eastward toward the fire area and into phase a and b, in an attempt to escape severe congestion further west. The model generally routes evacuating vehicles away from the hazard, but if roadways are not specifically blocked from entry, drivers may still temporarily route toward the hazard if they find a less congested roadway option. As such, evacuation times are not improved for areas closer to the fire when a phased evacuation is implemented. Details include the following:

- For Phase a, the easternmost zones closest to the fire, the 90th percentile ETE increases by 10 minutes, on average, when remaining zones are phased. This increase is due to traffic from outside of Phase a entering Phase a. This traffic starts entering Phase a when the initial evacuation order is issued, as voluntary evacuees (outside of Phase a) move through the area. It continues and increases after the 90-minute mark when Phase b is instructed to evacuate.
- For central zones (Phase b), the 90th percentile ETE increases by an average of 25 minutes in a phased evacuation (Region R03) compared to the corresponding phase under Region R02 (simultaneous evacuation). Combined with a longer mobilization time, the results indicate a spike in evacuating traffic that increases congestion and prolongs ETE.
- As stated above, for the western zones of impact (Phase c), the 90th percentile ETE increases by 65 to 170 minutes in a phased evacuation (Region R03) compared to the simultaneous evacuation (Region R02).

These results support implementing a simultaneous evacuation, rather than a phased evacuation, in a case similar to the 1923 Fire.

Evacuee Experience

Simultaneous Evacuation: Discussed above in Section 7.3.3.

Phased Evacuation: shows the ETE and trip generation time (mobilization time) for Region R03 Scenario 4. The travel time experienced for different time periods are summarized below (the sum of these two times can be used to calculate the ETE):

- Mobilized 30 minutes after the Evacuation Order – Travel Time 65 minutes
- Mobilized 60 minutes after the Evacuation Order – Travel Time 110 minutes
- Mobilized 90 minutes after the Evacuation Order – Travel Time 100 minutes
- Mobilized 150 minutes after the Evacuation Order – Travel Time 60 minutes

7.3.5 Region R04: Panoramic Hills Fire

This region was selected due to the extremely limited roadway options in the Panoramic Hills area, which has one way in and out. This area is also Berkeley Fire Zone 3, reflecting the high risk to residents from its wildland-urban interface, along with its evacuation challenges.

Analysis Results

For Region R04, the 90th percentile ETE ranges between 1 hour and 35 minutes and 1 hour and 45 minutes. The 100th percentile ETE ranges between 3 hours and 25 minutes to 3 hours and 40 minutes. Due to its comparatively smaller area, Region R04 involves fewer evacuation zones than other regions. Consequently, the reduced vehicular demand on the roadway system results in congestion that clears quickly, as shown in Figure F-12 and Figure F-13. The 100th percentile ETE is primarily governed by the time required for complete mobilization.

Evacuee Experience

Figure 7-10 shows the ETE and trip generation time (mobilization time) for Region R04 Scenario 4. The figure further reinforces the fact that there is little congestion, ETE mimics trip generation, and travel times to exit the region are low. The travel time experienced for different time periods are summarized below (the sum of these two times can be used to calculate the ETE):

- Mobilized 15 minutes after the Evacuation Order – Travel Time 5 minutes
- Mobilized 30 minutes after the Evacuation Order – Travel Time 5 minutes
- Mobilized 45 minutes after the Evacuation Order – Travel Time 10 minutes
- Mobilized 90 minutes after the Evacuation Order – Travel Time 5 minutes

7.3.6 Region R05: Fire Zones 2 & 3

It is unlikely that there would be a simultaneous evacuation of Fire Zones 2 and 3 (the Berkeley hills) in association with a particular emergency or disaster. This region is included to help analyze impacts of the Berkeley Hills from administrative changes that could affect development in the area.

Analysis Results

For Region R05, the 90th percentile ETE ranges between 1 hour and 45 minutes and 2 hours and 20 minutes. The 100th percentile ETE ranges between 3 hours and 25 minutes to 3 hours and 40 minutes. Depending on the scenario, 90% of the population could mobilize within 1 hour and 30

minutes to 1 hour and 45 minutes for Region R05. This indicates the 90th percentile ETE is dictated by congestion for midday scenarios and mobilization time nighttime scenarios. The 100th percentile ETE is primarily governed by the time required for complete mobilization.

Evacuee Experience

Figure 7-11 shows the ETE and trip generation time (mobilization time) for Region R05 Scenario 4. The travel time experienced for different time periods are summarized below (the sum of these two times can be used to calculate the ETE):

- Mobilized 30 minutes after the Evacuation Order – Travel Time 20 minutes
- Mobilized 60 minutes after the Evacuation Order – Travel Time 40 minutes
- Mobilized 90 minutes after the Evacuation Order – Travel Time 45 minutes
- Mobilized 150 minutes after the Evacuation Order – Travel Time 35 minutes

7.3.7 Regions R06 and R07: Tsunami Warning

These regions are included to analyze areas of potential impact from a warning-level tsunami, which is the highest level of tsunami alert. Two separate regions are included in alignment with the State of California's Tsunami Evacuation Playbooks. Region R07 is the "Max Phase," including all areas of Berkeley that could be impacted by tsunami inundation. Region R06 is a slightly scaled back area limited to the zones to the east of I-80. Under select Warning-level tsunamis, State responders may be able to confirm that the tsunami's impact will be less than the worst-case scenario and may in turn be able to advise local responders to limit areas of evacuation to this narrower area represented by Region R06. Both regions are included for analysis.

Analysis Results

For Region R06 and R07, the 90th percentile ETE ranges between 55 minutes and 2 hours and 15 minutes. The 100th percentile ETE ranges between 3 hours and 25 minutes to 3 hours and 40 minutes. For Region R06, 90% of the evacuating traffic can mobilize within approximately 45 minutes and approximately 1 hour 30 minutes for Region R07. All 90th percentile ETE are higher than the mobilization time indicating that there is congestion within the network that dictates the 90th percentile ETE. Region R06 has two ways to exit the region: University Avenue and Frontage Road. Congestion on these two roadways delays the 90th percentile ETE by 30 minutes on average. For Region R07, there are more ways out of the area being evacuated, but there is more demand as the area under the Evacuation Order is expanded to Seventh St. As shown in Figure F-17 and Figure F-19, most of the congestion clears by 2 hours and 30 minutes for Region R06 and R07, respectively. The 100th percentile ETE is dictated by mobilization for both regions.

Evacuee Experience

Tsunami Warning (East of I-80): Figure 7-12 shows the ETE and trip generation time (mobilization time) for Region R06 Scenario 4. The travel time experienced for different time periods are summarized below (the sum of these two times can be used to calculate the ETE):

- Mobilized 15 minutes after the Evacuation Order – Travel Time 10 minutes
- Mobilized 30 minutes after the Evacuation Order – Travel Time 20 minutes

- Mobilized 45 minutes after the Evacuation Order – Travel Time 60 minutes
- Mobilized 60 minutes after the Evacuation Order – Travel Time 65 minutes

Tsunami Warning (Max Phase): Figure 7-13 shows the ETE and trip generation time (mobilization time) for Region R07 Scenario 4. The travel time experienced for different time periods are summarized below (the sum of these two times can be used to calculate the ETE):

- Mobilized 15 minutes after the Evacuation Order – Travel Time 5 minutes
- Mobilized 30 minutes after the Evacuation Order – Travel Time 30 minutes
- Mobilized 45 minutes after the Evacuation Order – Travel Time 65 minutes
- Mobilized 90 minutes after the Evacuation Order – Travel Time 50 minutes

7.3.8 Regions R08 through R11: Geographic Areas of Berkeley

Regions R08 through R11 are not associated with particular hazards, and instead break down Berkeley's geography into associated areas "Berkeley Flats, North Berkeley Hills," etc. These regions are included in the analysis to provide responders with details for use should a hazard without a geographic limit (such as a hazardous materials release) impact one of these areas.

Analysis Results

The 90th and 100th percentile ETE for these regions are as follows:

- Region R08 (Berkeley Flats)
  - 90th percentile – Between 2 hours and 5 minutes to 3 hours and 10 minutes.
  - 100th percentile – Between 3 hours and 25 to 4 hours and 20 minutes.
- Region R09 (North Berkeley Hills)
  - 90th percentile – Between 1 hour and 45 minutes to 2 hours and 10 minutes.
  - 100th percentile – Between 3 hours and 25 to 3 hours and 40 minutes.
- Region R10 (South Berkeley Hills)
  - 90th percentile – Between 1 hour and 30 minutes to 2 hours and 15 minutes.
  - 100th percentile – Between 3 hours and 25 to 3 hours and 40 minutes.
- Region R11 (West Berkeley)
  - 90th percentile – Between 1 hour and 35 minutes to 1 hour and 45 minutes.
  - 100th percentile – Between 3 hours and 25 to 3 hours and 40 minutes.

The 90th percentile ETE for these regions depends on the number of evacuating vehicles. As expected, the 90th percentile ETE for Berkeley Flats is the highest as it has the highest demand among these regions. The 100th percentile ETE is dictated by mobilization time with the exception of the Berkeley Flats (Region R08) during weekdays during the day (when employment is highest).

7.3.9 Regions R12 through R14: UC Berkeley and Lawrence Berkeley National Laboratory (LBNL)

UC Berkeley and Lawrence Berkeley National Laboratory (LBNL) zones have been included in the study as Regions R12 (UC Berkeley, including Clark Kerr Campus), R13 (LBNL) and R14 (UC Berkeley and LBNL). These Regions were established in this analysis in acknowledgement of these entities' evacuation authorities separate from the City of Berkeley. In addition, these regions

were separately analyzed to understand the impacts of an evacuation limited to UC Berkeley property (Region R12), LBNL (Region R13), and UC Berkeley and LBNL together (Region R14).

Analysis Results

For UC Berkeley, the 90th percentile ETE is between 1 hour and 5 minutes to 1 hour 35 minutes. Evacuating traffic within UC Berkeley is mostly comprised of employees and college students, with a maximum mobilization time of 60 minutes (more than 90% are mobilized in 45 minutes). The 20-to-50-minute difference between the mobilization time of employees and college students, when compared against the higher 90th percentile ETE values, indicates how congestion impacts the 90th percentile ETE. The 100th percentile ETE is dictated by trip mobilization time.

LBNL experiences the lowest 90th percentile ETE (45 minutes) during weekend and nighttime scenarios. During the day, the increased numbers of shadow evacuees outside of LBNL coupled with the higher LBNL evacuee demand lead to congestion at the intersection of Gayley Rd/La Loma Ave/Hearst Ave, delaying the 90th percentile ETE for an evacuation of LBNL and resulting in ETEs as high as 2 hours during the day. This increase in ETE when compared to weekend and nighttime scenarios is attributed to the Lab's reduced operational activity and consequently lower vehicular demand during weekend and nighttime scenarios, compared to midweek and midday scenarios. The 100th percentile ETE for midday scenarios is dictated by traffic congestion at the Gayley Rd/La Loma Ave/Hearst Ave intersection. The 100th percentile ETE during the weekend and nighttime is dictated by trip mobilization time.

When LBNL and UC Berkeley evacuate together, the 90th percentile ETE ranges from 1 hour and 15 minutes to 2 hours and 15 minutes. The 100th percentile ETE for LBNL and UC Berkeley combined mimics the ETE for UC Berkeley as the mobilization (and ultimately the evacuation) of UC Berkeley dictates the ETE of the UC Berkeley plus LBNL region.

An anomaly can be seen when inspecting Region R12 and R14 in Table 7-1. One might expect the 90th percentile ETE for UC Berkeley evacuating by itself (R12) to be shorter than the 90th percentile ETE for UC Berkeley and LBNL evacuating (R14). As shown in Table 7-1, there is one case where this is not true (Scenario 3). This is a result of the composition of vehicular demand within each of these evacuating regions. LBNL is purely made up of employees. UC Berkeley has employees, commuting students, and residents within its zones. When more quickly mobilizing vehicles (LBNL employees) are added in, the 90th percentile ETE can be reached more quickly, in the absence of traffic congestion from external traffic (during Scenario 3).

This anomaly, however, cannot be seen (and is not possible) at the 100th percentile. Figure 7-14 shows the ETE and trip generation time (mobilization time) for an LBNL evacuation, during fall, midweek, midday (Region R13 Scenario 4). The travel times experienced for different time periods are summarized below (the sum of these two times can be used to calculate the ETE):

- Mobilized 15 minutes after the Evacuation Order – Travel Time 15 minutes
- Mobilized 30 minutes after the Evacuation Order – Travel Time 50 minutes
- Mobilized 45 minutes after the Evacuation Order – Travel Time 80 minutes
- Mobilized 60 minutes after the Evacuation Order – Travel Time 75 minutes

7.4 ETE for Response Planning

Table 7-4 summarizes the ETE values recommended for use in response plans based on the analysis of this report.

Per US NRC recommendation, the table presents 90th percentile ETE, except when marked with an asterisk (*). Entries with an asterisk are 100th percentile ETE. In these cases, traffic congestion dictates ETE, meaning that the 100th percentile is more appropriate for planning purposes (see Section 7.3).

Rows marked "Urgent Mobilization" present ETEs expected when evacuees mobilize more quickly (30 minutes) than would be predicted from responses to the Demographic Survey (Appendix D). These times were identified through the Sensitivity Study for Evacuation Readiness, described in detail in Section 10.1. These times are associated with no-notice evacuations, such as active wildfires in close proximity to the city.

7.5 Guidance on Using ETE Tables

The user first determines the percentile of population for which the ETE is sought (federal guidance for nuclear emergencies calls for the 90th percentile). The applicable value of ETE within the chosen table may then be identified using the following procedure:

1. Identify the applicable **Scenario** (Table 6-4):
   - Season
     - Summer
     - Fall
   - Day of Week
     - Midweek
     - Weekend
   - Time of Day
     - Midday
     - Nighttime

While these Scenarios are designed, in aggregate, to represent conditions throughout the year, some further clarification is warranted:

- The seasons are defined as follows:
  - Summer assumes that public schools are not in session.
  - Fall considers that public schools are in session.
- Time of Day: Midday implies the time over which most commuters are at work or are travelling to/from work.

2. With the desired percentile ETE and Scenario identified, now identify the **Evacuation Region**:
   - Determine which Region is evacuating using Table 6-1:
3. Determine the **ETE Table** based on the **percentile** selected (Table 7-1 or Table 7-2)**.** Then, for the **Scenario** identified in Step 1 and the **Region** identified in Step 2, proceed as follows:
   - The columns of Table 7-1 and Table 7-2 are labeled with the Scenario numbers. Identify

the proper column in the selected Table using the Scenario number defined in Step 1.
- Identify the row in this table that provides ETE values for the Region identified in Step 2.
- The unique data cell defined by the column and row so determined contains the desired value of ETE expressed in Hours:Minutes.

Example

To identify the ETE for the following conditions:

- Wednesday, October 14th at 12:00 PM.
- The hazard threatens the North Berkeley Hills.
- The desired ETE is that of an evacuation of 90 percent of the population from within the impacted Region.

Table 7-1 is applicable because the 90th percentile ETE is desired. Proceed as follows:

1. Identify the Scenario as fall, midweek, midday conditions. Entering Table 6-4 (or Table 7-1), it is seen that this combination of circumstances describes Scenario 4.
2. In Table 6-1, locate the Region that has North Berkeley Hills: Region R09.
3. In Table 7-1 (90th percentile ETE table), locate the data cell containing the value of ETE for Scenario 4 and Region R09. This data cell is in column (4) and in the row for Region R09; it contains the ETE value of 2 hours and 5 minutes.

Table 7-1. Time to Clear the Indicated Area of *90* Percent of the Affected Population

	Summer			Fall		
	Midweek	Weekend	Midweek Weekend	Midweek	Weekend	Midweek Weekend
Scenario:	(1)	(2)	(3)	(4)	(5)	(6)
Region	**Midday**	**Midday**	**Nighttime**	**Midday**	**Midday**	**Nighttime**
R01 - Citywide Evacuation	3:40	3:10	2:30	4:00	2:55	2:30
R02 - Fire 1923	2:25	1:50	1:45	2:55	1:50	1:45
R03 - Fire 1923 Phase a	2:05	1:40	1:40	2:45	1:35	2:10
R03 - Fire 1923 Phase b	2:15	2:00	2:15	2:45	2:10	2:30
R03 - Fire 1923 Phase c	4:10	4:20	4:30	4:00	4:25	4:35
R04 - Panoramic Hill Fire	1:40	1:35	1:40	1:45	1:35	1:40
R05 - Fire Zones 2 & 3 Combined	2:05	1:55	1:45	2:20	1:55	1:45
R06 - Tsunami - Phase 3	1:20	1:20	1:05	1:45	0:55	1:10
R07 - Tsunami - Max Phase	2:15	2:10	1:50	2:15	2:05	1:50
R08 - Berkeley Flats	2:55	2:35	2:10	3:10	2:25	2:05
R09 - North Berkeley Hills	2:10	2:00	1:50	2:05	1:50	1:45
R10 - South Berkeley Hills	1:35	1:30	1:35	2:15	1:35	1:35
R11 - West Berkeley	1:40	1:35	1:35	1:45	1:35	1:35
R12 - UC Berkeley	1:05	1:15	1:25	1:20	1:30	1:35
R13 - Lawrence Berkeley National Lab	1:15	0:45	0:45	2:00	0:45	0:45
R14 - UC Berkeley + Lawrence Berkeley National Lab	1:30	1:15	1:20	2:15	1:30	1:35

Table 7-2. Time to Clear the Indicated Area of *100* Percent of the Affected Population

	Summer			Fall		
	Midweek	Weekend	Midweek Weekend	Midweek	Weekend	Midweek Weekend
Scenario:	(1)	(2)	(3)	(4)	(5)	(6)
Region	Midday	Midday	Nighttime	Midday	Midday	Nighttime
R01 - Citywide Evacuation	5:10	4:25	3:25	5:35	4:00	3:25
R02 - Fire 1923	3:40	3:25	3:25	4:10	3:25	3:25
R03 - Fire 1923 Phase a	4:25	4:30	4:40	4:30	4:15	4:35
R03 - Fire 1923 Phase b	6:10	5:55	6:00	6:15	6:00	6:10
R03 - Fire 1923 Phase c	6:20	6:20	6:20	6:20	6:20	6:20
R04 - Panoramic Hill Fire	3:40	3:25	3:25	3:40	3:25	3:25
R05 - Fire Zones 2 & 3 Combined	3:40	3:25	3:25	3:40	3:25	3:25
R06 - Tsunami - Phase 3	3:40	3:25	3:25	3:40	3:25	3:25
R07 - Tsunami - Max Phase	3:40	3:25	3:25	3:40	3:25	3:25
R08 - Berkeley Flats	4:10	3:25	3:25	4:20	3:25	3:25
R09 - North Berkeley Hills	3:40	3:25	3:25	3:40	3:25	3:25
R10 - South Berkeley Hills	3:40	3:25	3:25	3:40	3:25	3:25
R11 - West Berkeley	3:40	3:25	3:25	3:40	3:25	3:25
R12 - UC Berkeley	3:40	3:25	3:25	3:40	3:25	3:25
R13 - Lawrence Berkeley National Lab	1:25	1:05	1:05	2:15	1:05	1:05
R14 - UC Berkeley + Lawrence Berkeley National Lab	3:40	3:25	3:25	3:40	3:25	3:25

Table 7-3. Time to Clear the Indicated Area of *90* Percent of the Affected Population for 1923 Fire Repeat

	Summer			Fall		
	Midweek	Weekend	Midweek Weekend	Midweek	Weekend	Midweek Weekend
Scenario:	(1)	(2)	(3)	(4)	(5)	(6)
Region	Midday	Midday	Nighttime	Midday	Midday	Nighttime
R02 Phase a	2:00	1:35	1:25	2:45	1:35	1:40
R03 Phase a	2:05	1:40	1:40	2:45	1:35	2:10
R02 Phase b	2:15	1:45	1:35	2:40	1:40	1:30
R03 Phase b	2:15	2:00	2:15	2:45	2:10	2:30
R02 Phase c	2:25	1:50	1:45	2:55	1:50	1:45
R03 Phase c	4:10	4:20	4:30	4:00	4:25	4:35

Table 7-4. Time to Clear the Indicated Area for Response Planning

	Summer			Fall		
	Midweek	Weekend	Midweek Weekend	Midweek	Weekend	Midweek Weekend
Scenario:	**1**	**2**	**3**	**4**	**5**	**6**
Region	**Midday**	**Midday**	**Nighttime**	**Midday**	**Midday**	**Nighttime**
R01 - Citywide Evacuation	5:10*	4:25*	2:30	5:35*	4:00*	2:30
R02 - Fire 1923	2:25	1:50	1:45	4:10*	1:50	1:45
R02 - Fire 1923 Urgent Mobilization	*2:25*	*1:50*	*1:35*	*4:10**	*1:45*	*1:35*
R03 - Fire 1923 Phase a	4:25*	4:30*	1:40	4:30*	4:15*	2:10
R03 - Fire 1923 Phase a Urgent Mobilization	*2:30**	*2:10**	*1:25*	*3:30**	*2:10**	*1:35*
R03 - Fire 1923 Phase b	6:10*	5:55*	2:15	6:15*	6:00*	2:30
R03 - Fire 1923 Phase b Urgent Mobilization	*4:00**	*4:00**	*1:40*	*4:00**	*2:10**	*1:40*
R03 - Fire 1923 Phase c	4:10	4:20	4:30	4:00	4:25	4:35
R03 - Fire 1923 Phase c Urgent Mobilization	*3:35*	*3:45*	*1:40*	*3:50*	*1:30*	*1:40*
R04 - Panoramic Hill Fire	1:40	1:35	1:40	1:45	1:35	1:40
R04 - Panoramic Hill Fire Urgent Mobilization	*1:05*	*0:50*	*0:45*	*1:45*	*0:50*	*0:50*
R05 - Fire Zones 2 & 3 Combined	2:05	1:55	1:45	2:20	1:55	1:45
R06 - Tsunami - Phase 3	1:20	1:20	1:05	1:45	0:55	1:10
R07 - Tsunami - Max Phase	2:15	2:10	1:50	2:15	2:05	1:50
R08 - Berkeley Flats	4:10*	2:35	2:10	4:20*	2:25	2:05
R09 - North Berkeley Hills	2:10	2:00	1:50	2:05	1:50	1:45
R10 - South Berkeley Hills	1:35	1:30	1:35	2:15	1:35	1:35
R11 - West Berkeley	1:40	1:35	1:35	1:45	1:35	1:35
R12 - UC Berkeley	1:05	1:15	1:25	1:20	1:30	1:35
R13 - Lawrence Berkeley National Lab	1:25*	0:45	0:45	2:15*	0:45	0:45
R14 - UC Berkeley + Lawrence Berkeley National Lab	1:30	1:15	1:20	2:15	1:30	1:35

* Entries with an asterisk are 100th percentile ETE. All other ETE presented in Table 7-4 are the 90th percentile ETE.

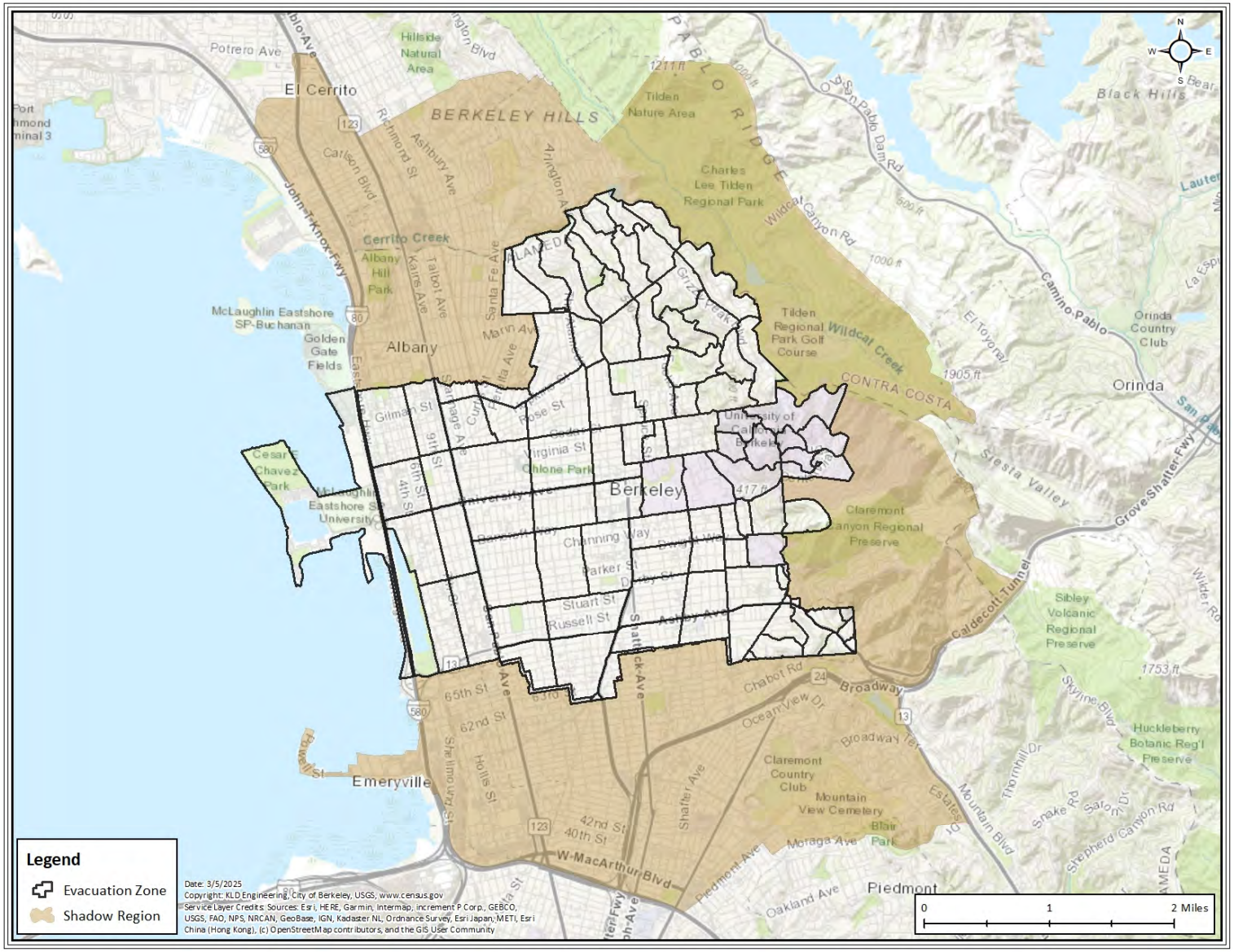


Figure 7-1. Study Area Shadow Region

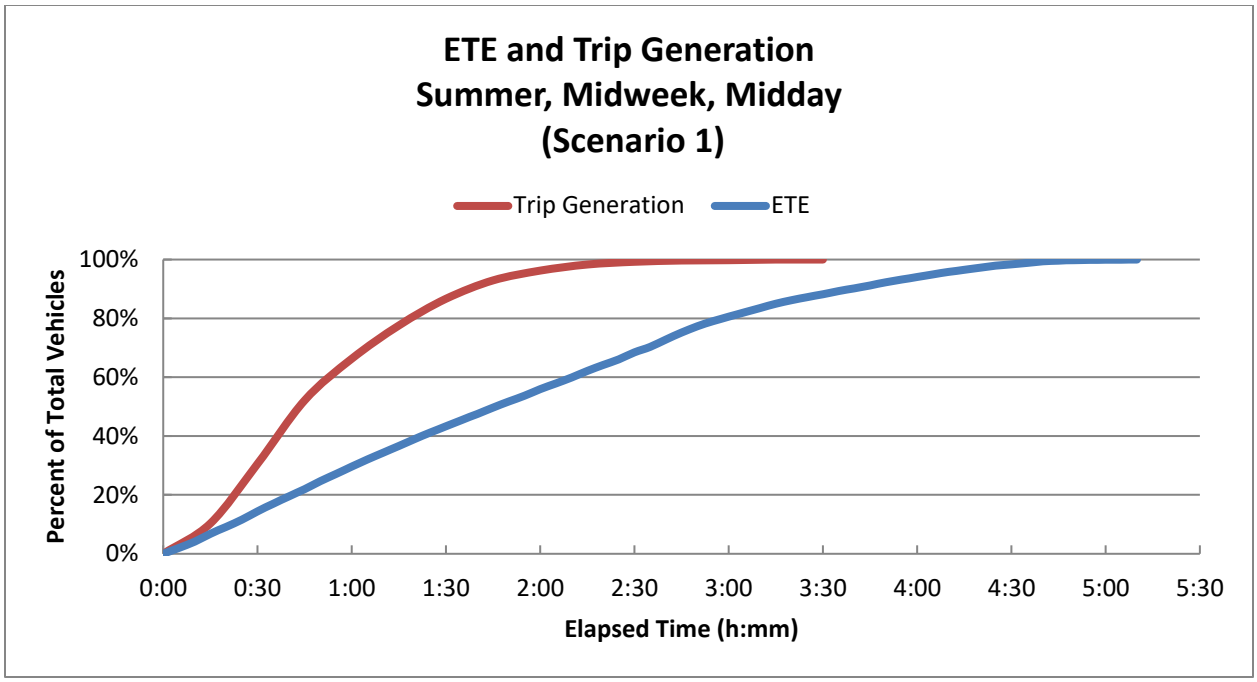


Figure 7-2. Evacuation Time Estimates - Scenario 1 for Region R01

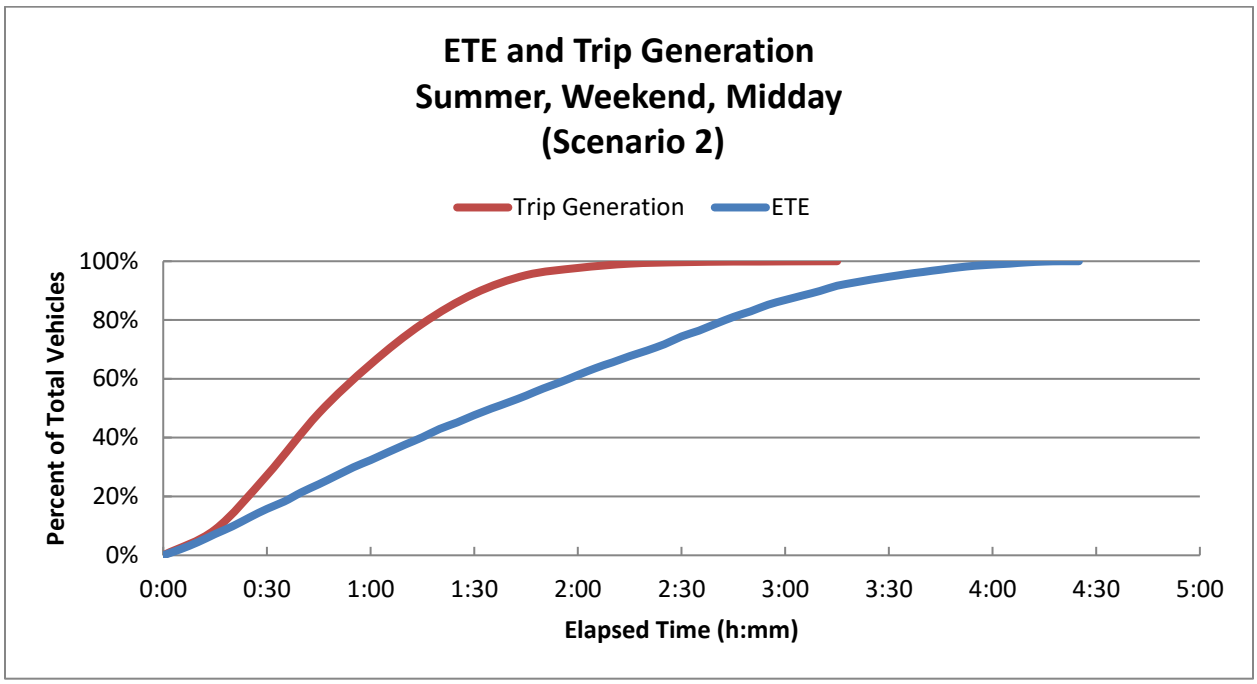


Figure 7-3. Evacuation Time Estimates - Scenario 2 for Region R01

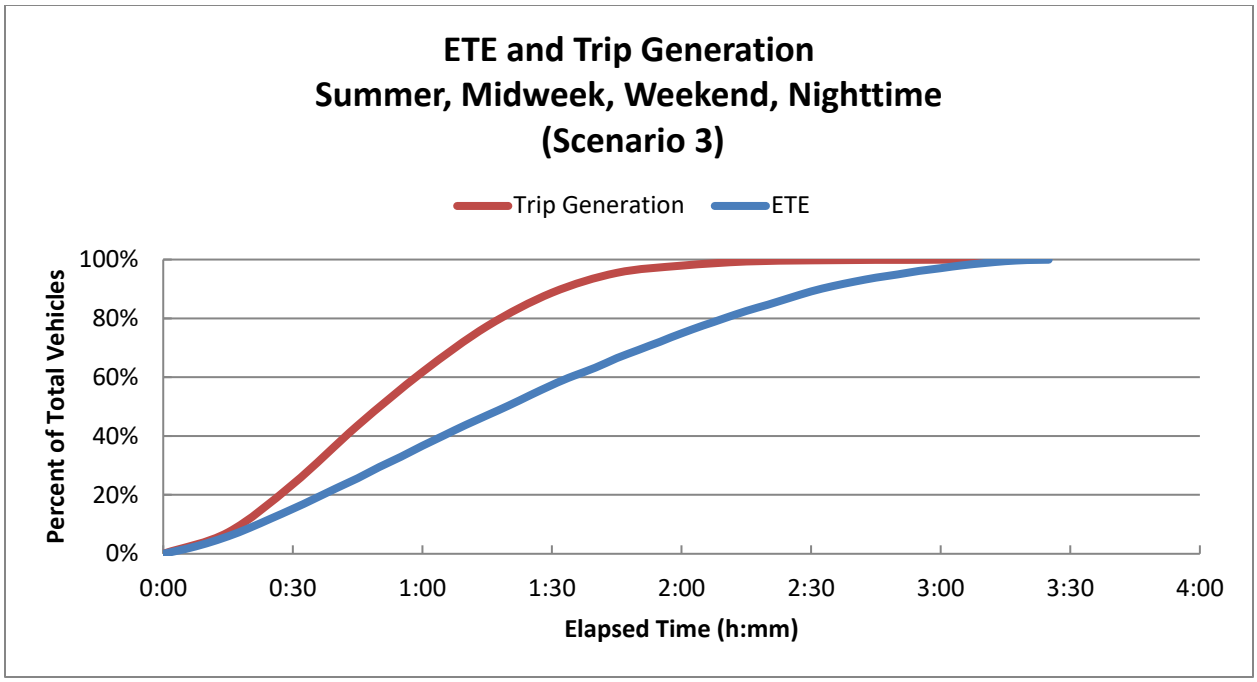


Figure 7-4. Evacuation Time Estimates - Scenario 3 for Region R01

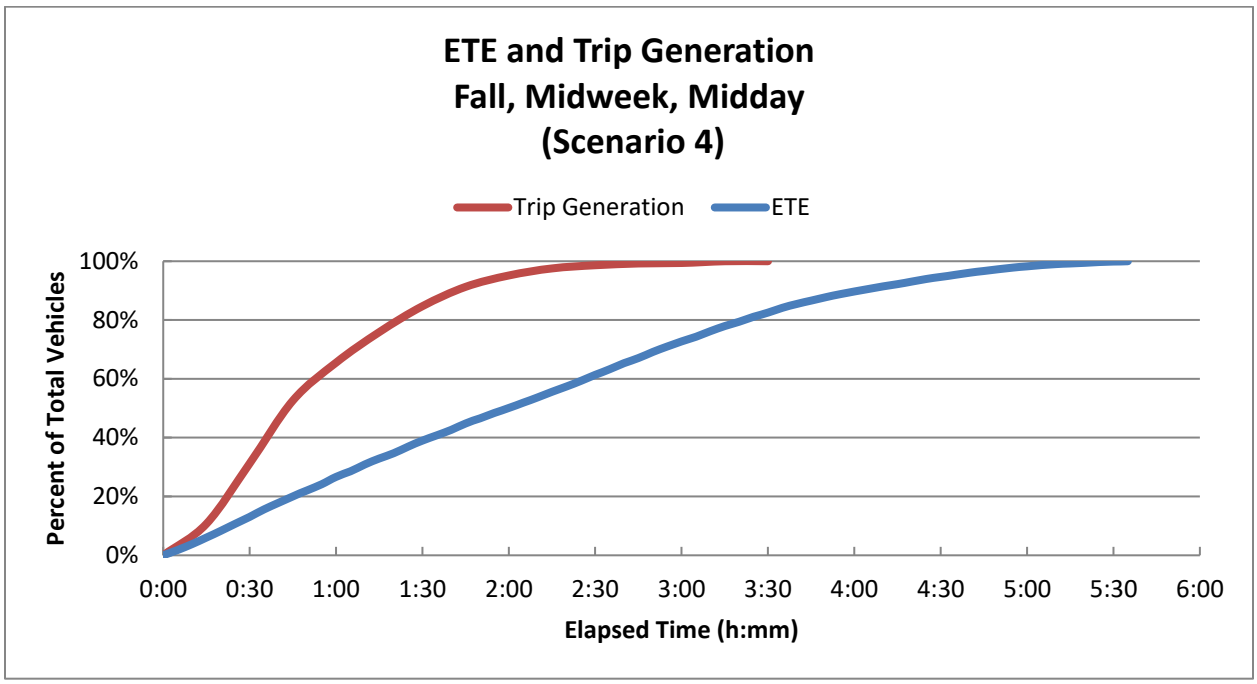


Figure 7-5. Evacuation Time Estimates - Scenario 4 for Region R01

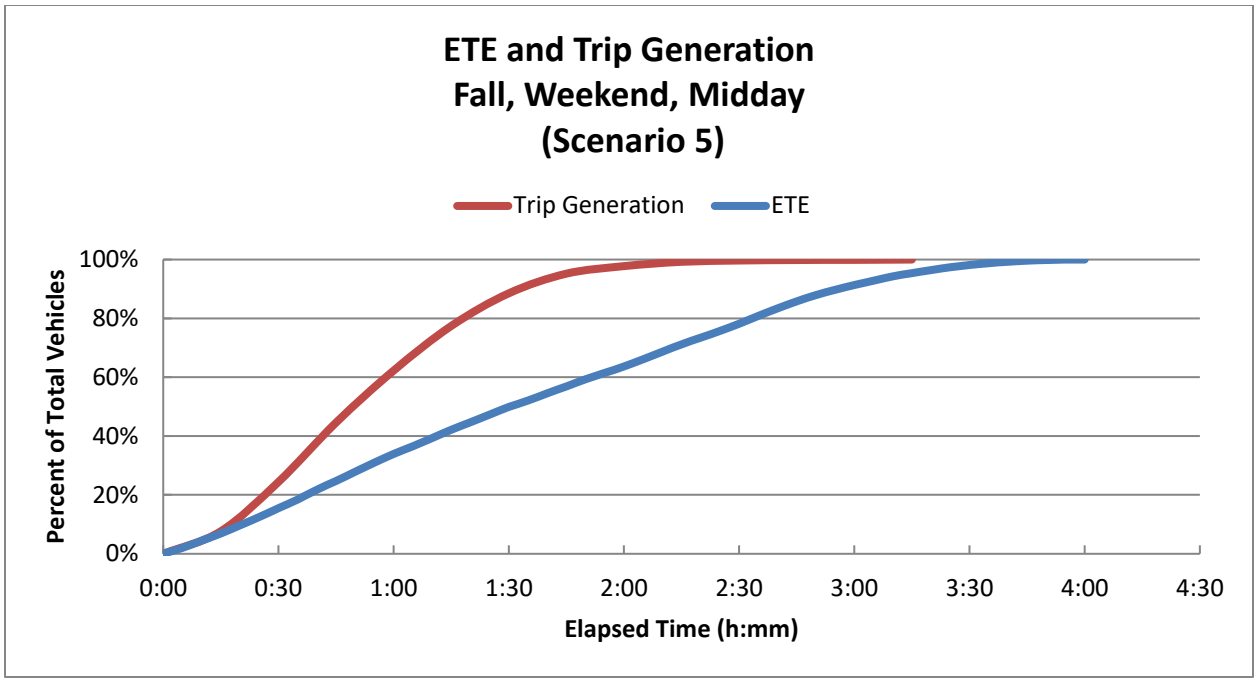


Figure 7-6. Evacuation Time Estimates - Scenario 5 for Region R01

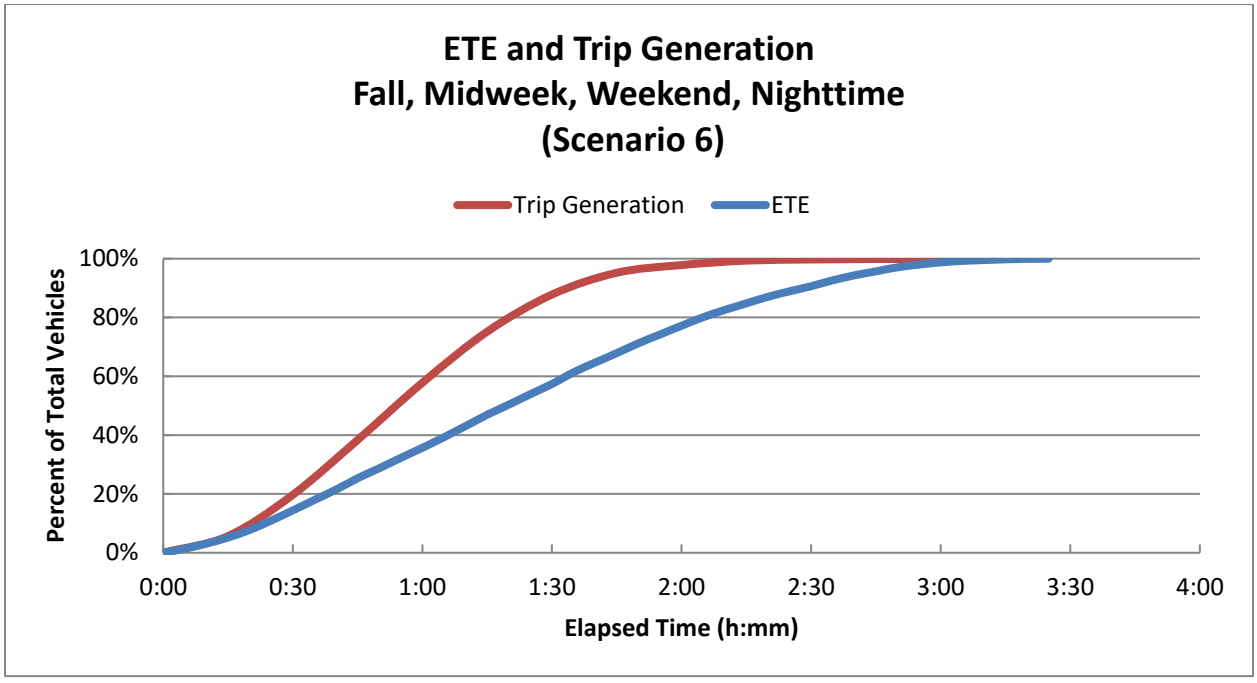


Figure 7-7. Evacuation Time Estimates - Scenario 6 for Region R01

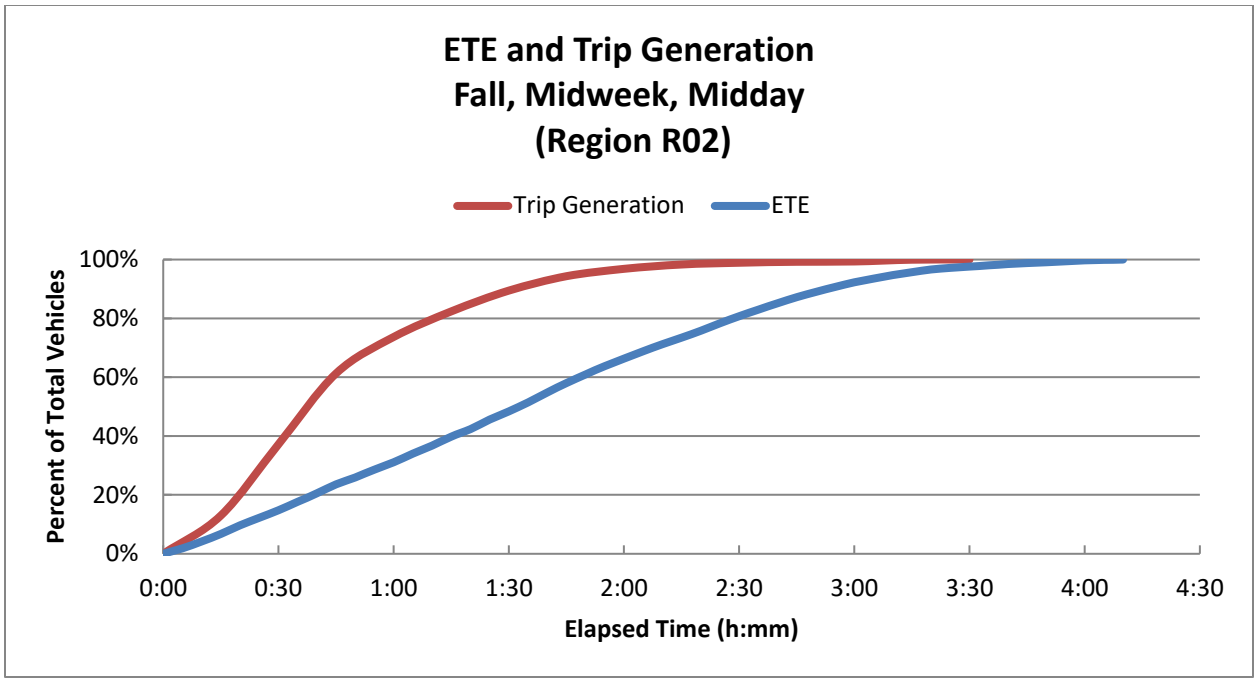


Figure 7-8. Evacuation Time Estimates - Scenario 4 for Region R02

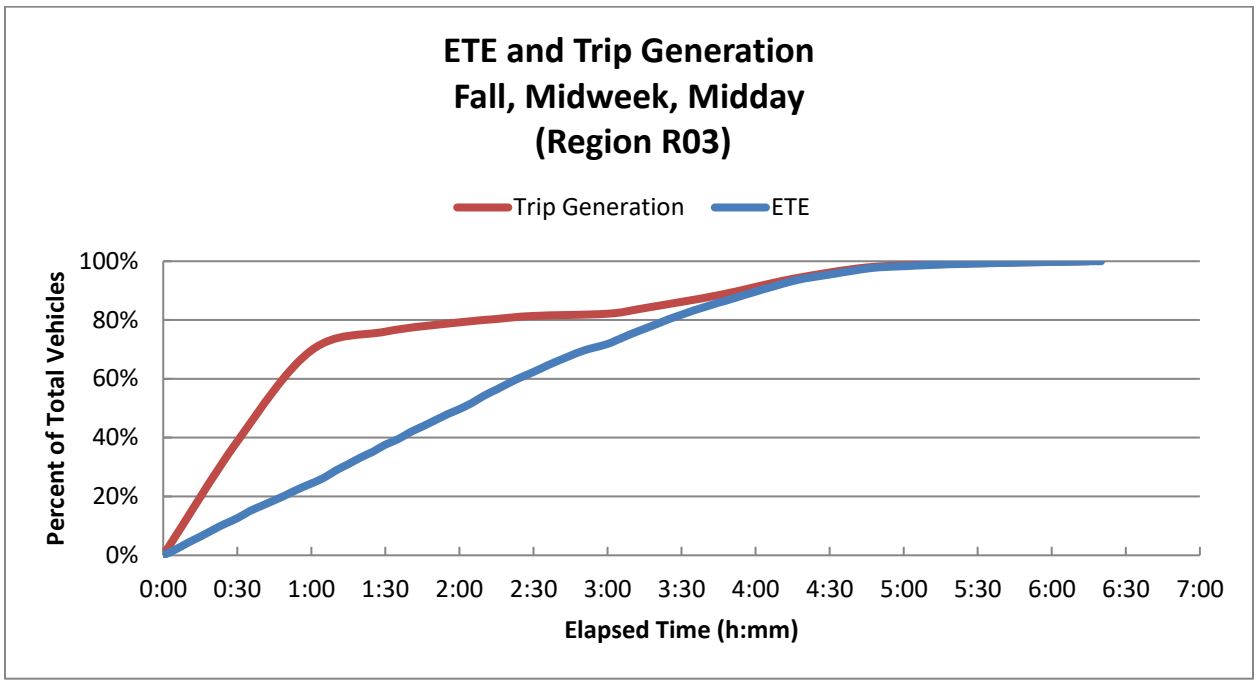


Figure 7-9. Evacuation Time Estimates - Scenario 4 for Region R03

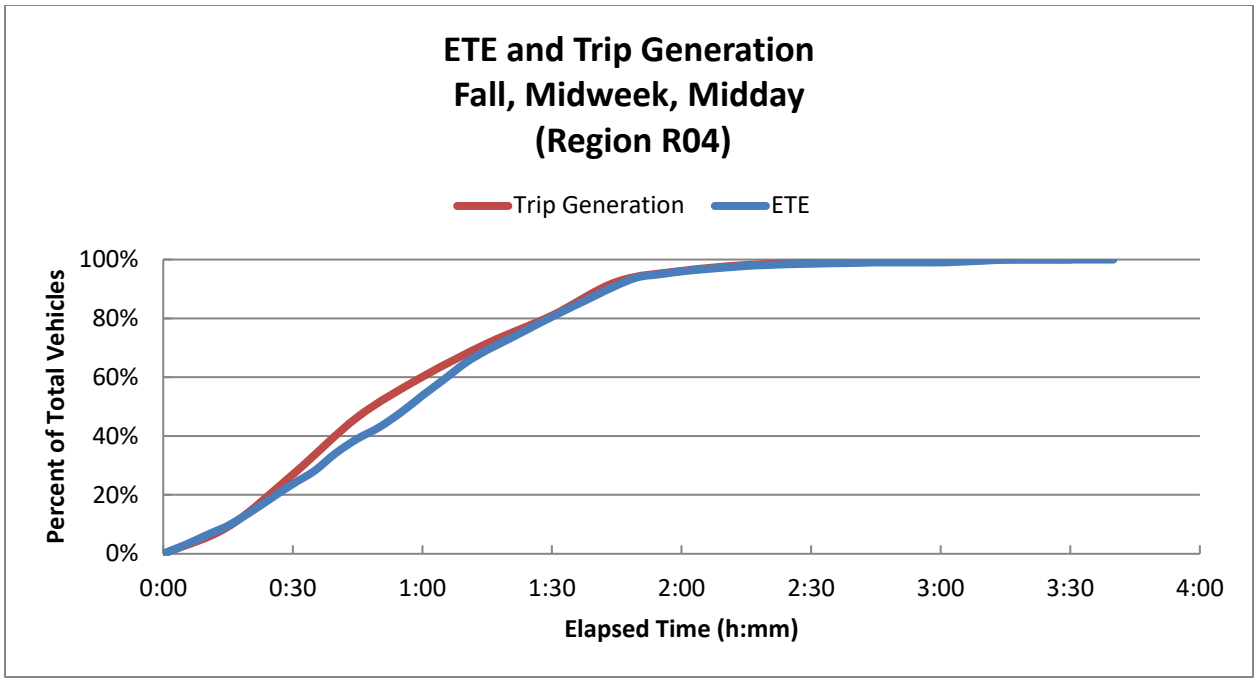


Figure 7-10. Evacuation Time Estimates - Scenario 4 for Region R04

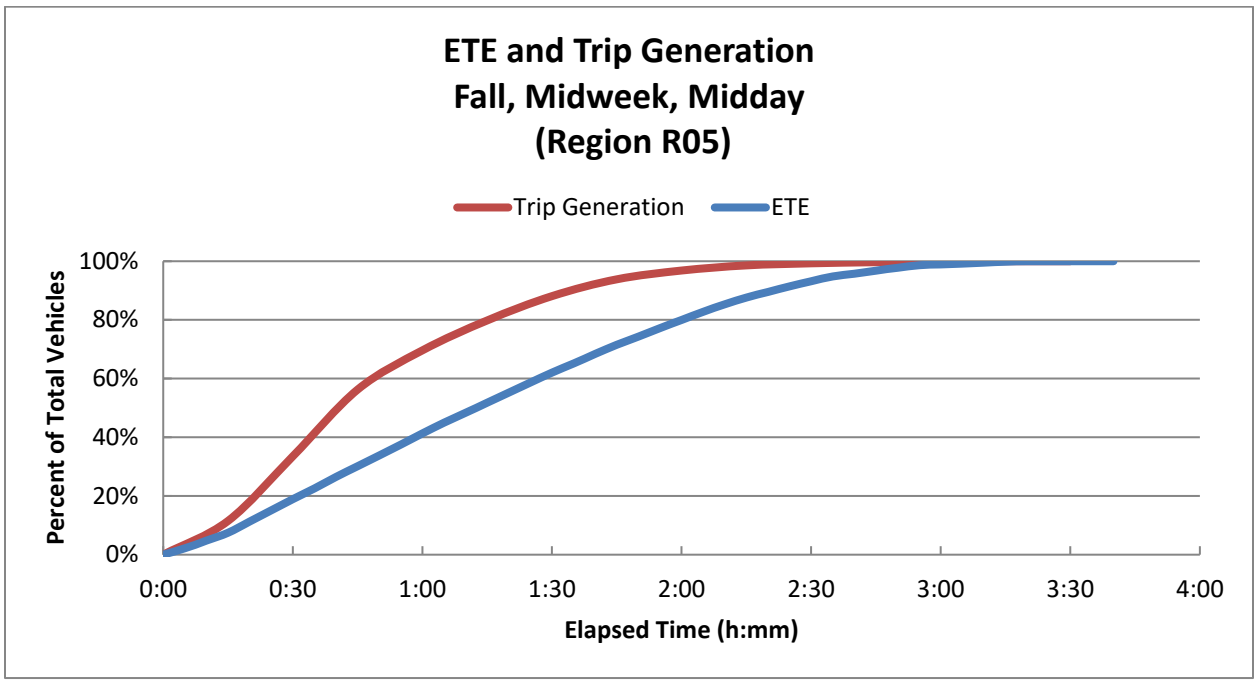


Figure 7-11. Evacuation Time Estimates - Scenario 4 for Region R05

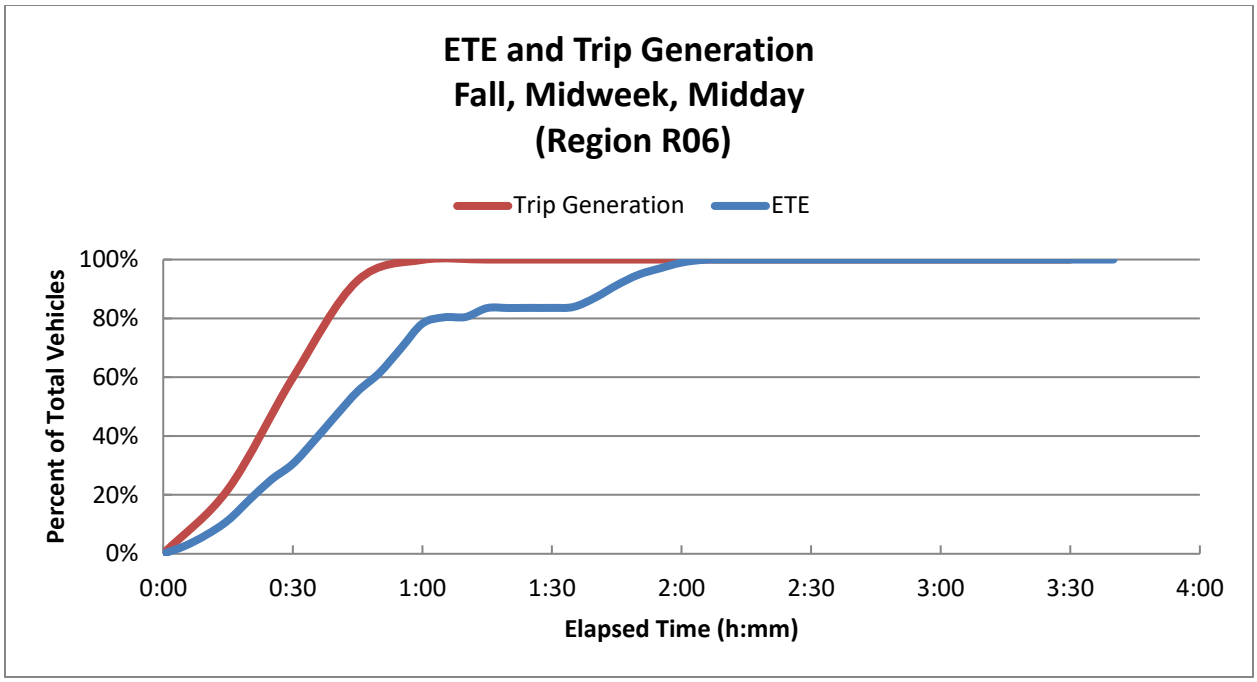


Figure 7-12. Evacuation Time Estimates - Scenario 4 for Region R06

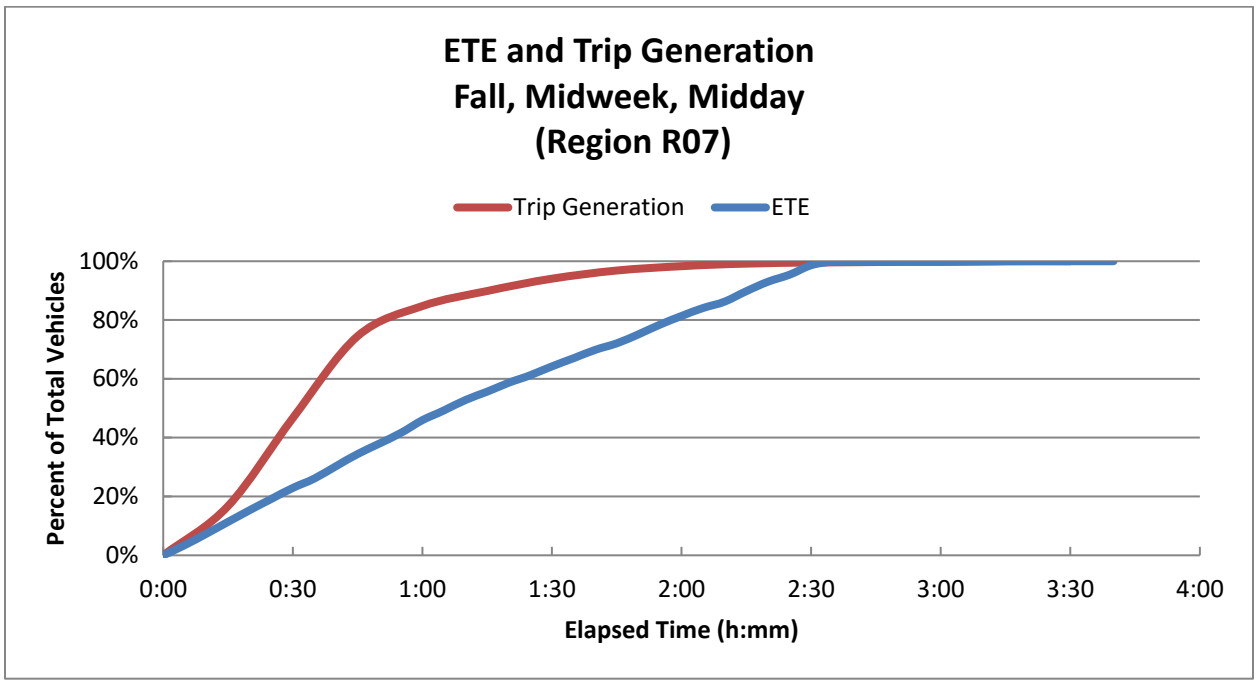


Figure 7-13. Evacuation Time Estimates - Scenario 4 for Region R07

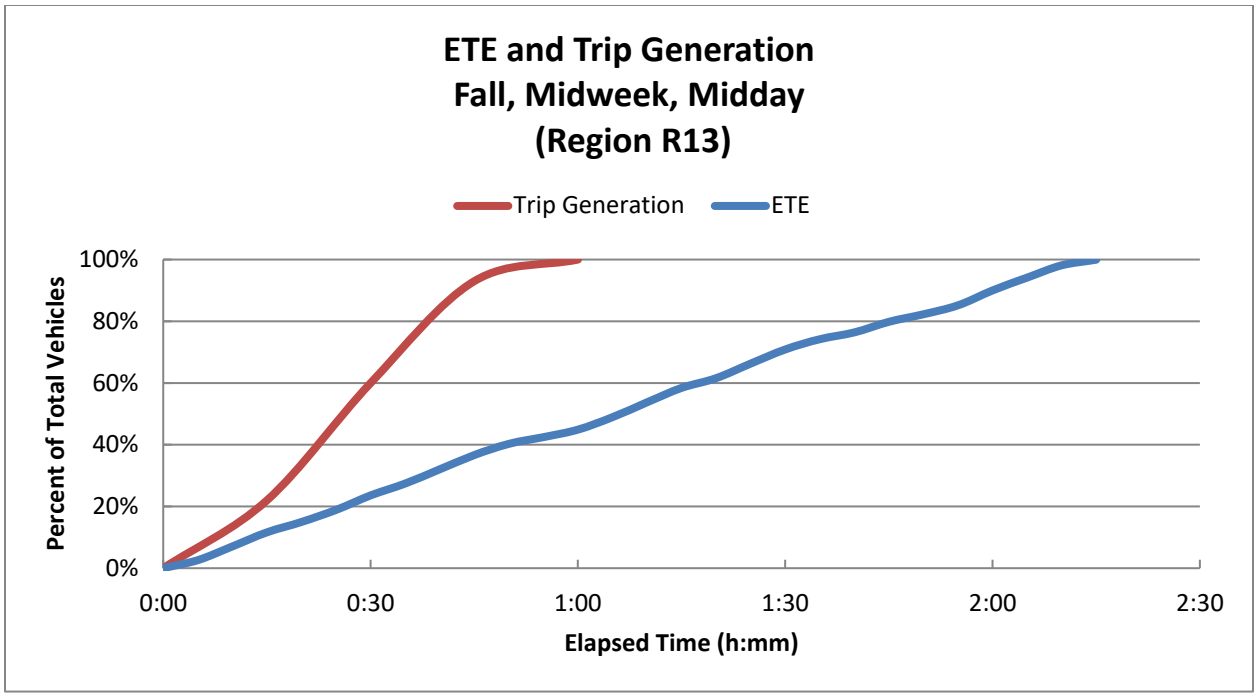


Figure 7-14. Evacuation Time Estimates - Scenario 4 for Region R13

8 TRANSIT-DEPENDENT AND SPECIAL FACILITY EVACUATION ACTIVITIES

This section details the analyses applied and the results obtained in the form of evacuation time estimates for transit vehicles. The demand for transit services reflects the needs of three population groups:

- residents with no vehicles available;
- residents of special facilities (i.e., schools, preschools/day care centers, colleges/universities, and medical facilities); and
- transit-dependent visitors and employees.

These transit vehicles mix with the general evacuation traffic that is comprised mostly of "passenger cars" (pc's). The presence of each transit vehicle in the evacuating traffic stream is represented within the modeling paradigm as equivalent to two pc's. This equivalence factor represents the longer size and more sluggish operating characteristics of a transit vehicle, relative to those of a pc.

Transit vehicles must be mobilized in preparation for their respective evacuation missions. Specifically:

- Drivers must be alerted
- They must travel to the depot
- They must be briefed there and assigned to a route or facility.

These activities consume time. In the absence of standards or studies, for the purposes of this analysis, it is assumed that bus mobilization time will average approximately 90 minutes extending from the evacuation order to the time when buses first arrive at schools/preschools/day care centers, colleges/universities, or medical facilities, and 180 minutes for the transit dependent population (see Section 2.4). It is noted that the bus mobilization time can expand or contract based on available resources and the situation regionally (for example, if regional resources are being requested by multiple jurisdictions).

During this mobilization period, other mobilization activities are taking place. One of these is the action taken by parents, neighbors, relatives and friends to pick up children from school prior to the arrival of buses, so that they may join their families. Virtually all studies of evacuations have concluded that this "bonding" process of uniting families is universally prevalent during emergencies and should be anticipated in the planning process. As discussed in Section 2, this study assumes that some children will likely be picked up by parents or guardians prior to an evacuation and that the time to perform this activity is included in the trip generation times discussed in Section 5. This report provides estimates of buses under the assumption 83% of children at schools and preschools/day care centers will be picked up by their parents based on the results of the demographic survey.

The procedure for computing transit dependent ETE is to:

- Estimate demand for transit service
- Estimate time to perform all transit functions
- Estimate route travel times out of the area at risk.

These procedures were done for Citywide Evacuation (Region R01), Fire 1923 (Regions R02 and R03), Panoramic Hill Fire (Region R04), Fire Zone 2 & 3 (Region R05), Tsunami Phase 3 (Region R06), and Tsunami Max Phase (Region R07). A fall midway midweek scenario was selected for this analysis as it represents the highest vehicular demand.

8.1 Analysis of Resource Needs for Each Evacuation Region

Table 8-1 summarizes the number of vehicles needed to evacuate schools, preschools/day care centers, colleges/universities, medical facilities, and the transit-dependent population[1] for different Regions. For an evacuation of the entire City, 10,683 people would utilize rail services, people would rely on 586 buses, 259 wheelchair accessible vehicles and 148 ambulances. For the other regions considered, approximately 40% or less of these resources are needed, the second highest demand being the 1923 Fire region (Region R02) and lowest being Tsunami Phase 3 region (Region R06).

The City can work to quantify likely resource shortfalls associated with the evacuation scenarios in this report through planning partnerships with transit providers serving Berkeley and the region, as well as emergency management and mutual aid partners at the Operational Area (County) and State. Section 8 identifies resource needs for transit-dependent evacuees. Planning partners can clarify regional and State capacity to provide support, as well as time estimates to mobilize those resources in localized and regional disaster scenarios.

8.2 Evacuation Activities for Transit Dependent Population Groups

Figure 8-1 presents the chronology of events relevant to transit operations. The elapsed time for each activity will now be discussed with reference to Figure 8-1.

Activity: Mobilize Drivers (A→B→C)

Mobilization is the elapsed time from the Evacuation Order until the time buses arrive at the facility to be evacuated or first bus stop along a pickup route. It is assumed that for a rapidly escalating emergency with no observable indication before the fact, drivers would likely require 90 minutes to be contacted, to travel to the depot, be briefed, and to travel to the route for the special facilities[2]. It is assumed this process takes 180 minutes for transit dependent individuals,

[1] It was conservatively assumed that all transit dependent residents would utilize buses to evacuate, rather than rapid transit. This assumption provides an upper bound of the number of vehicles that would be needed to evacuate this population. It also provides a more conservative evacuation time estimate for those with and without their own vehicles since it results in more evacuating vehicles on the roadway (rather than utilizing rapid transit vehicles that have their own dedicated railway). It was assumed that visitors who would need transit assistance would be split 50/50 between buses and rail to evacuate. It was assumed that employees who would need transit assistance would be split 58/42 between buses and rail to evacuate, based on results of the demographic survey (see Figure D-8).

[2] The special facilities considered within the study area are schools, preschools/day care centers, colleges/universities and medical facilities.

including residents, employees, and visitors to utilize public transit buses, see Assumption 4b in Section 2.4.

Activity: Board Passengers (C→D)

A loading time of 15 minutes is assumed for buses servicing schools, preschools/day care centers and colleges/university. Loading times of 1 minute, 5 minutes, and 30 minutes per patient are assumed for ambulatory patients, wheelchair using patients, and bedridden patients, respectively. A loading time of 1 minute per person is used for the general transit dependent population. Concurrent loading on multiple vehicles is assumed.

For multiple stops along a pick-up route (transit-dependent bus routes) estimation of travel time must allow for the delay associated with stopping and starting at each pick-up point. The time, t, required for a bus to decelerate at a rate, "a", expressed in ft/sec/sec, from a speed, "v", expressed in ft/sec, to a stop, is t = v/a. Assuming the same acceleration rate and final speed following the stop yields a total time, T, to service boarding passengers:

$$T = t + B + t = B + 2t = B + \frac{2v}{a},$$

Where B = Dwell time to service passengers. The total distance, "s" in feet, travelled during the deceleration and acceleration activities is: $s = v^2/a$. If the bus had not stopped to service passengers, but had continued to travel at speed, v, then its travel time over the distance, s, would be: s/v = v/a. Then the total delay (i.e. pickup time, P) to service passengers is:

$$P = T - \frac{v}{a} = B + \frac{v}{a}$$

Assigning reasonable estimates:

- B = 50 seconds: a generous value for a single passenger, carrying personal items, to board per stop
- v = 25 mph = 37 ft/sec
- a = 4 ft/sec/sec, a moderate average rate

Then, P ≈ 1 minute per stop. Allowing 30 minutes of pick-up time per bus run implies 30 stops per run.

Activity: Travel Time to Safety (D→E)

Mobilizing buses, wheelchair accessible vans and ambulances and loading them with transit dependent individuals take time. Unlike other population groups, transit dependent individuals need to wait for these two events to take place before they can start their evacuation trip. The total time to complete these events is as follows:

- Schools/Preschools/Colleges – 105 minutes (90 minutes to mobilize resources and 15 minutes of loading time)
- Transit-Dependent Population – 210 minutes (180 minutes to mobilize resources and 30 minutes of loading time)
- Medical Facilities:
    - Ambulatory Patients – 120 minutes (90 minutes to mobilize resources and 30

minutes max loading time per vehicle)
    - Wheelchair Bound Patients – 100 minutes (90 minutes to mobilize resources and 10 minutes max loading time per vehicle)
    - Bedridden Patients – 150 minutes (90 minutes to mobilize resources and 60 minutes max loading time per vehicle)
- Access and/or Functional Needs Population: The mobilization of buses for Access and/or Functional needs population is the same as transit-dependent population (180 minutes) but the loading time depends on the number of stops the resources need to make which vary for each Region.

As discussed in Section 7.3, the difference between the trip generation and ETE curves provides the average travel time for a specific departure time. Plots of trip generation versus ETE are indicative of the level of traffic congestion during evacuation. The travel time to safety activity can only start after the resources for the transit-dependent individuals leave the facility being evacuated and/or when buses complete all their stops for the transit-dependent population.

The trip generation versus ETE plots in Section 7 can be used to estimate the travel time for each transit dependent population group for specific Regions depending on when the transportation resources are mobilized, and passengers are loaded.

For example: Using Figure 7-8, the evacuation time out of the Fire 1923 region can be computed as the sum of time associated with Activities A→B→C, C→D, and D→E as follows:

- Schools/Preschools/Colleges – 90 + 15 + 80 = 190 minutes or 3:10 (Here, 80 minutes is the difference of the ETE curve and the trip generation curve at 105 minutes (1:45) into the evacuation. First find 1:45 on the x axis; follow a straight line up to when it hits the red curve; estimate the percentage of evacuating demand [about 94%]; follow a straight line to when the blue curve reaches 94% [3:10]; the travel time is the distance between these two curves = 3:10 – 1:45 = 80 minutes.)
- Transit-Dependent Population – 180 + 30 + 40 = 250 minutes or 4:10
- Medical Facilities:
    - Ambulatory Patients – 90 + 30 + 85 = 205 minutes or 3:25
    - Wheelchair Bound Patients – 90 + 10 + 80 = 180 minutes or 3:00
    - Bedridden Patients – 90 + 60 + 75 = 225 minutes or 3:45
- Access and/or Functional Needs:
    - Ambulatory People – 180 + 45 + 25 = 250 minutes or 4:10
    - Wheelchair Bound People – 180 + 45 + 25 = 250 minutes or 4:10
    - Bedridden People – 180 + 50 + 20 = 250 minutes or 4:10

This methodology could be applied to all the facilities and population groups shown in Appendix H for Region R02 for a more *facility-specific* ETE.

It should be noted that ETE for schools can vary slightly depending on the efficiency of parent pick-up procedures and the resulting traffic flow around school zones.

8.3 Public Transit Evacuation

The demand that relies on public transit – both bus service and rail (Bay Area Rapid Transit or Amtrak) should be evaluated against those resources. The scope of this study is limited to vehicular evacuation and does not integrate evacuation time estimates for people evacuating on rapid transit (rail).

Table 8-1. Summary of Transportation Needs

Transportation Resource	Rail	Buses	Wheelchair Accessible Vans	Ambulances
Resources Needed (Citywide - Region R01)				
School and Preschool/Day Care Center Transportation Needs (Table 3-7):	0	112	0	0
College/University Transportation Needs (Table 3-8):	255 (people)	125	0	0
Medical Facility Transportation Needs (Table 3-6):	0	20	111	128
Specialized Transportation Assistance Needs (Section 3.8):	0	0	50	125
Transit-Dependent Transportation Needs (Section 3.7 and Table 3-9):	0	115	0	0
Employee Transportation Needs (Section 3.4 and Table 3-10):	3,799 (people)	88	0	0
Visitor Transportation Needs (Section 3.4 and Table 3-10):	6,629 (people)	111	0	0
TOTAL TRANSPORTATION NEEDS:	**10,683 (people)**	**571**	**161**	**253**
Resources Needed (1923 Fire Repeat - Region R02 and 1923 Fire Repeat Phased - Region R03)				
School and Preschool/Day Care Center Transportation Needs:	0	19	0	0
College/University Transportation Needs:	255 (people)	118	0	0
Medical Facility Transportation Needs:	0	3	32	27
Specialized Transportation Assistance Needs (Section 3.8):	0	0	16	39
Transit-Dependent Transportation Needs:	0	34	0	0
Employee Transportation Needs:	2,303 (people)	54	0	0
Visitor Transportation Needs:	2,002 (people)	34	0	0
TOTAL TRANSPORTATION NEEDS:	**4,560 (people)**	**262**	**48**	**66**
Resources Needed (Panoramic Hill Fire - Region R04)				
School and Preschool/Day Care Center Transportation Needs:	0	2	0	0
College/University Transportation Needs:	0	0	0	0
Medical Facility Transportation Needs:	0	3	25	21
Specialized Transportation Assistance Needs (Section 3.8):	0	0	3	6
Transit-Dependent Transportation Needs:	0	5	0	0
Employee Transportation Needs:	0	0	0	0
Visitor Transportation Needs:	163 (people)	3	0	0

Transportation Resource	Rail	Buses	Wheelchair Accessible Vans	Ambulances
TOTAL TRANSPORTATION NEEDS:	**163 (people)**	**13**	**28**	**27**
Resources Needed (Fire Zones 2 & 3 Combined - Region R05)				
School and Preschool/Day Care Center Transportation Needs:	0	11	0	0
College/University Transportation Needs:	0	0	0	0
Medical Facility Transportation Needs:	0	4	32	27
Specialized Transportation Assistance Needs (Section 3.8):	0	0	20	50
Transit-Dependent Transportation Needs:	0	38	0	0
Employee Transportation Needs:	26 (people)	1	0	0
Visitor Transportation Needs:	1,897 (people)	32	0	0
TOTAL TRANSPORTATION NEEDS:	**1,923 (people)**	**86**	**52**	**77**
Resources Needed (Tsunami Warning - Phase 3 - Region R06)				
School and Preschool/Day Care Center Transportation Needs:	0	0	0	0
College/University Transportation Needs:	0	0	0	0
Medical Facility Transportation Needs:	0	0	0	0
Specialized Transportation Assistance Needs (Section 3.8):	0	0	1	3
Transit-Dependent Transportation Needs:	0	3	0	0
Employee Transportation Needs:	19 (people)	1	0	0
Visitor Transportation Needs:	417 (people)	7	0	0
TOTAL TRANSPORTATION NEEDS:	**436 (people)**	**11**	**1**	**3**
Resources Needed (Tsunami Warning - Max Phase - Region R07)				
School and Preschool/Day Care Center Transportation Needs:	0	4	0	0
College/University Transportation Needs:	0	0	0	0
Medical Facility Transportation Needs:	0	0	0	0
Specialized Transportation Assistance Needs (Section 3.8):	0	0	4	8
Transit-Dependent Transportation Needs:	0	8	0	0
Employee Transportation Needs:	532 (people)	13	0	0
Visitor Transportation Needs:	874 (people)	15	0	0

Transportation Resource	Rail	Buses	Wheelchair Accessible Vans	Ambulances
TOTAL TRANSPORTATION NEEDS:	**1,406 (people)**	**40**	**4**	**8**



Event	
A	Evacuation Order
B	Bus Dispatched from Depot
C	Bus Arrives at Facility/Transit Bus Stop
D	Bus Departs Facility/ Transit Bus Stop
E	Bus Exits Evacuated Area
Activity	
A→B	Driver Mobilization
B→C	Travel to Facility or Transit Bus Stop
C→D	Passengers Board the Bus
D→E	Bus Travels Toward Boundary of the Evacuated Area

Figure 8-1. Chronology of Transit Evacuation Operations

9 HIGHEST CAPACITY ROUTES, EVACUATION SIGNAGE, AND PARKING RESTRICTIONS

This section documents main thoroughfares within the City of Berkeley that can serve the most vehicles in an evacuation. It discusses potential impacts to evacuation times and traffic flow from "red curbing." It also provides considerations on evacuation signage based on Berkeley's situation and current traffic engineering standards.

9.1 Highest Capacity Routes

In suburban and rural areas there may be relatively few routes that can lead evacuees out of a hazard area. In these situations, it is critical to designate these roadways as "Evacuation Routes" and to direct the community to those specific routes. Alternatively, in urban environments such as Berkeley, there will generally be multiple roadways that can transport vehicles out of hazard areas to safety.

Even Berkeley's highest-capacity roadways are not designed to handle a large volume of vehicles associated with a large-scale evacuation alone. It is important that evacuating vehicles are distributed across all available roadways to improve overall evacuation times. When multiple routes are available for evacuation, each with inadequate capacity alone, designating particular roadways as "Evacuation Routes" and directing community members to them will slow down overall evacuation times by not using all available roadway capacity.

As such, this study considers all roadways in Berkeley to potentially serve as evacuation routes, and identifies roadways with the highest capacity based on their characteristics. Emergency management personnel may use information from this analysis to prioritize available traffic management resources during evacuations. City leaders may also consider prioritizing preservation of vehicular capacity on these roadways when analyzing future roadway improvement projects.

Evacuees will select routes within the city in such a way as to minimize their risk exposure. This expectation is met by the DYNEV II model routing traffic away from the location of the wildfire, tsunami, or other hazard to the extent practicable. The DTRAD model[1] satisfies this behavior by routing traffic so as to balance traffic demand relative to the available highway capacity (the number of vehicles that can be processed in a given amount of time) to the extent possible.

[1] https://kldassociates.com/wp-content/uploads/2024/10/DTRAD-DYNEV.pdf

9.1.1 Highest Capacity Roadways

Although the city has numerous exit routes, the following roadways possess the greatest capacity for vehicular traffic. Thus, they are likely to carry the greatest number of vehicles in an evacuation:

- Interstate 580 (I-580)
- San Pablo Ave (SR 123)
- Sacramento St
- Martin Luther King Jr Way
- Adeline St/Shattuck Ave
- Telegraph Ave
- College Ave
- Arlington Ave
- Grizzly Peak Blvd
- Ashby Ave

The following roadways do not provide direct exits out of the city, but connect into those that do and are likely to also carry the greatest number of vehicles in an evacuation:

- Solano Ave
- Marin Ave
- Hopkins St
- Durant Ave
- Oxford St
- Spruce Street
- Bancroft Way
- Haste St
- Cedar St
- University Ave
- Dwight Way
- Euclid Ave

These roadways are highlighted in Figure 9-1. While numerous roadways exit the city, these are the roadways that can process the most vehicles. **These routes are not designated "Evacuation Routes" at the exclusion of other roadways. All available roadways should be considered evacuation routes.** These routes, along with others will be used by the general population evacuating in private vehicles. Because of their high capacity, these routes are preferable for use by transit-dependent population evacuating on buses. The general population may evacuate to some alternate destination (e.g., lodging facilities, relative's home, emergency shelter) outside the city or evacuated area. Transit-dependent evacuees will be routed to safety, outside of the evacuation area.

Figure 9-7 through Figure 9-9 display the public transit routes within the City of Berkeley, which were obtained from the California State Geoportal[2], which includes routes from all transit operators (including UC Berkeley Bear Transit and Alameda-Contra Costa Transit District, or AC Transit). It is assumed that transit-dependent people will gather at the transit stops along the routes shown to evacuate using a bus. This does not imply that these exact routes would be used in an emergency. It would also be prudent to send buses along routes serving major population centers to pick up transit-dependent individuals who do not live close to existing routes and/or bus stops.

For the purpose of this study, schools, preschools/day care centers, colleges/universities, medical facilities and juvenile homes were routed along the most likely path from the facility being evacuated to the boundary of the evacuation region, which may not have been along a high-capacity route. A single route was used for facilities that would use a similar path for evacuation.

[2] https://gis.data.ca.gov/datasets/dd7cb74665a14859a59b8c31d3bc5a3e_0/explore?location=37.865645%2C-122.267599%2C14.84

See Section 3.5, Section 3.6, and Section 3.7 for more information on Berkeley's transit dependent population and Section 8 for transit dependent resource needs.

9.2 Evacuation Signage

Evacuation signage can help people quickly and safely find their way to safety in an emergency. In a chaotic situation, evacuation route signage can help people stay calm and focused, and they can prevent people from getting lost or feeling trapped.

However, evacuees can generally head in a generic direction (north toward Albany, south toward Oakland, east toward the hills, west toward the water) to get to safety. For optimal throughput, evacuees should be distributed on all available roadways as equitably as possible. Furthermore, posting signage directing people to Berkeley's highest capacity roadways may actually increase overall evacuation times. There can be issues with evacuation signage, including:

- Evacuation routes and direction of travel change depending on the type of emergency (fire, flood, earthquake, etc.). A sign that's useful for one situation might be useless or even dangerous in another.
- Generic signs lack specificity. These signs often say, "Evacuation Route" and provide a general direction of travel, as shown in Figure 9-10. However, these signs don't tell people *where* to go. In a large-scale emergency, people may need directions to specific reception sites, which in large-scale emergencies may be outside the city limits.
- Generally, cities are full of signs. Adding more signs can create "sign pollution" and make it harder to spot the truly critical directions.
- Most city residents are already familiar with the major roads and thoroughfares. Adding evacuation signs might not provide much new information.
- Moving evacuees onto specific designated roadways does not increase the capacity of those roadways. As Evacuation Cases show (see Section 7), evacuees will experience traffic congestion. Human behavior dictates that drivers will re-route in order to avoid gridlock. This redistribution of traffic to include lower-capacity roadways can ultimately improve both individual and overall evacuation times.

This report does not specify the precise locations for evacuation signage. Chapter 2N of the 2023 MUTCD[3] presents guidelines for placing emergency management signs. The installation of evacuation route signage, however, must comply with the guidance provided in the MUTCD.

Whether or not evacuation signage is implemented, it is still crucial to have a comprehensive evacuation plan that includes:

- Emergency alerts to provide real-time instructions and updates.
- Trained personnel to guide people and manage the evacuation.
- Pre-identified priority routes to receive evacuation management resources. Adaptable strategies to respond to the specific needs of different emergencies.

[3] Manual on Uniform Traffic Control Devices for Streets and Highways, 2023 Edition, US Department of Transportation, Federal Highway Administration

Ultimately, effective evacuation relies on a multi-faceted approach that considers the strengths and limitations of evacuation signage, even in a well-organized grid system.

9.3 Parking Restrictions

Implementing parking restrictions (red curbing) in the Berkeley hills is unlikely to substantially improve evacuation flow. The principal limitations to vehicle movement are not primarily due to reduced roadway widths caused by parked cars. Instead, bottlenecks occur at intersections, which have a finite capacity to manage the merging of traffic from multiple directions. Widening lanes by prohibiting parking would likely cause vehicles to arrive at these already congested intersections more rapidly, potentially worsening the congestion. Moreover, the inherent geometric characteristics of Berkeley's hillside roadways, including their curvature and steepness, impose natural speed limitations, further reducing the impact of on-street parking on evacuation times. Additionally, during an evacuation, most privately owned vehicles currently parked along roadways will be in active use for egress, thereby diminishing the effect of side street parking on overall evacuation speed in the hills.

It's possible that parking restrictions could improve the ingress of emergency responders both in day-to-day response and during evacuations. The City could consider the strategic implementation of parking restrictions along arterial roadways in the hills, with a focus on those roadways predominantly utilized by emergency response vehicles for ingress during emergency response. This targeted approach would optimize maneuverability and reduce potential impedance for essential services without imposing broad restrictions that are unlikely to significantly improve overall evacuation egress flow.

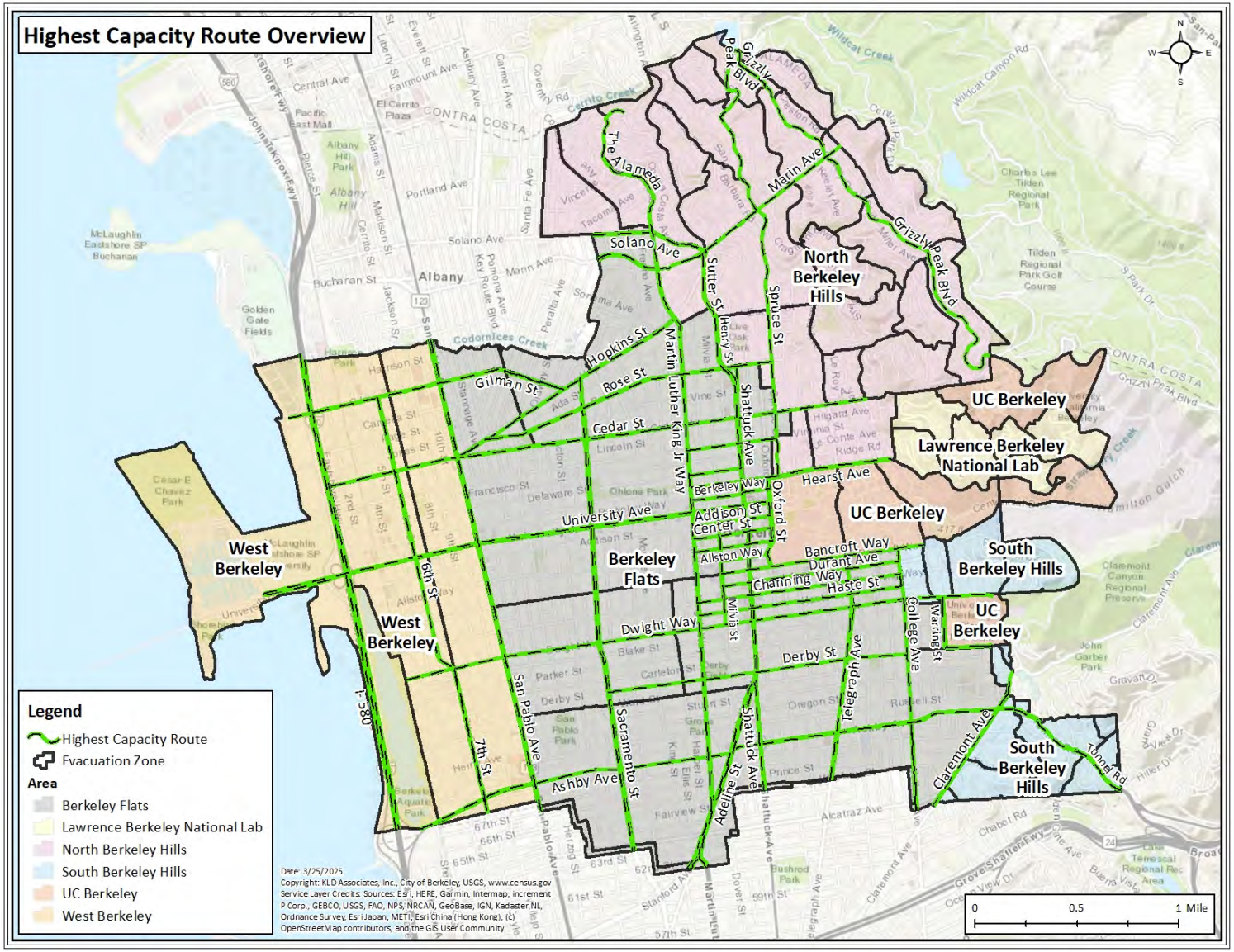


Figure 9-1. Highest Capacity Routes - Overview

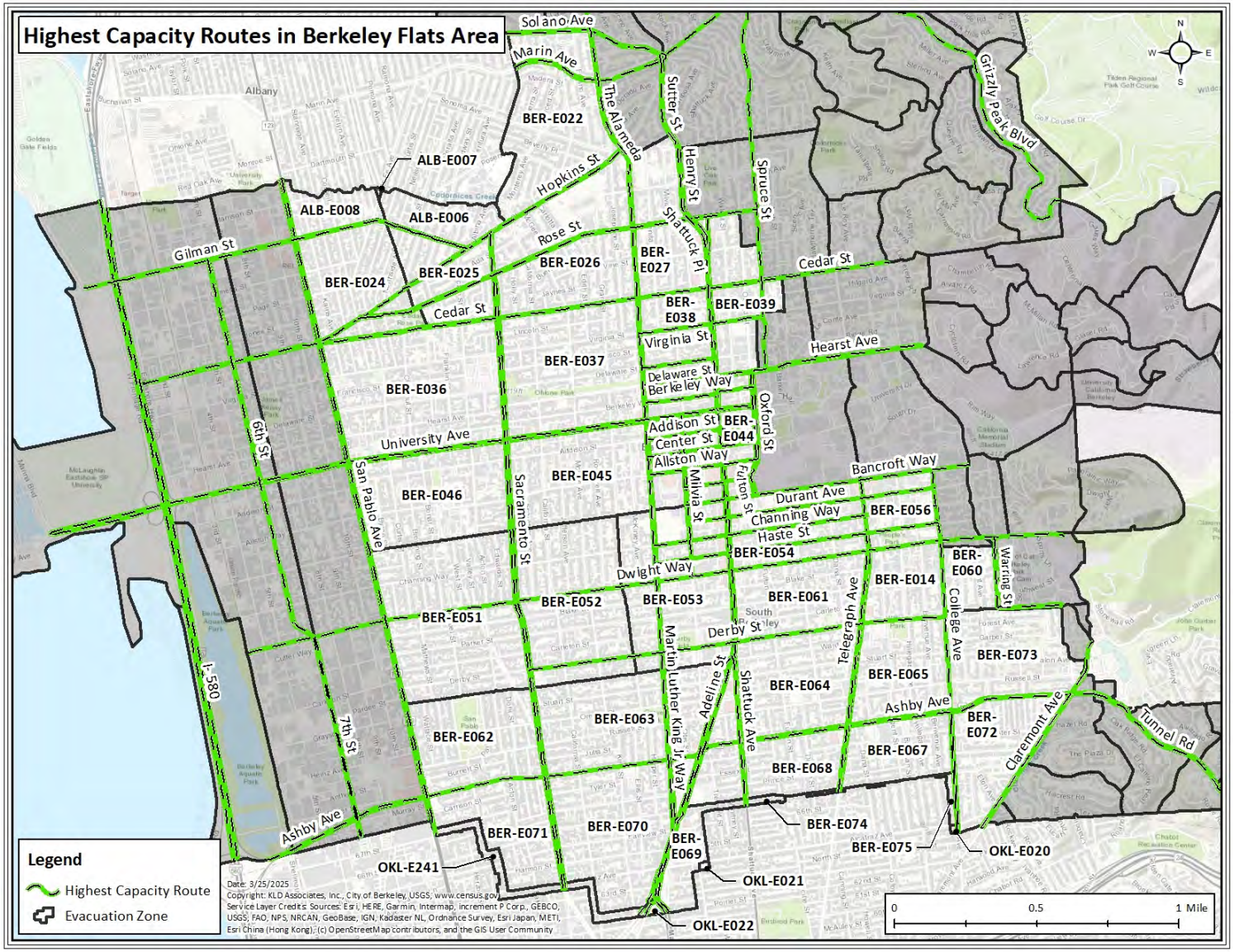


Figure 9-2. Highest Capacity Routes – Berkeley Flats

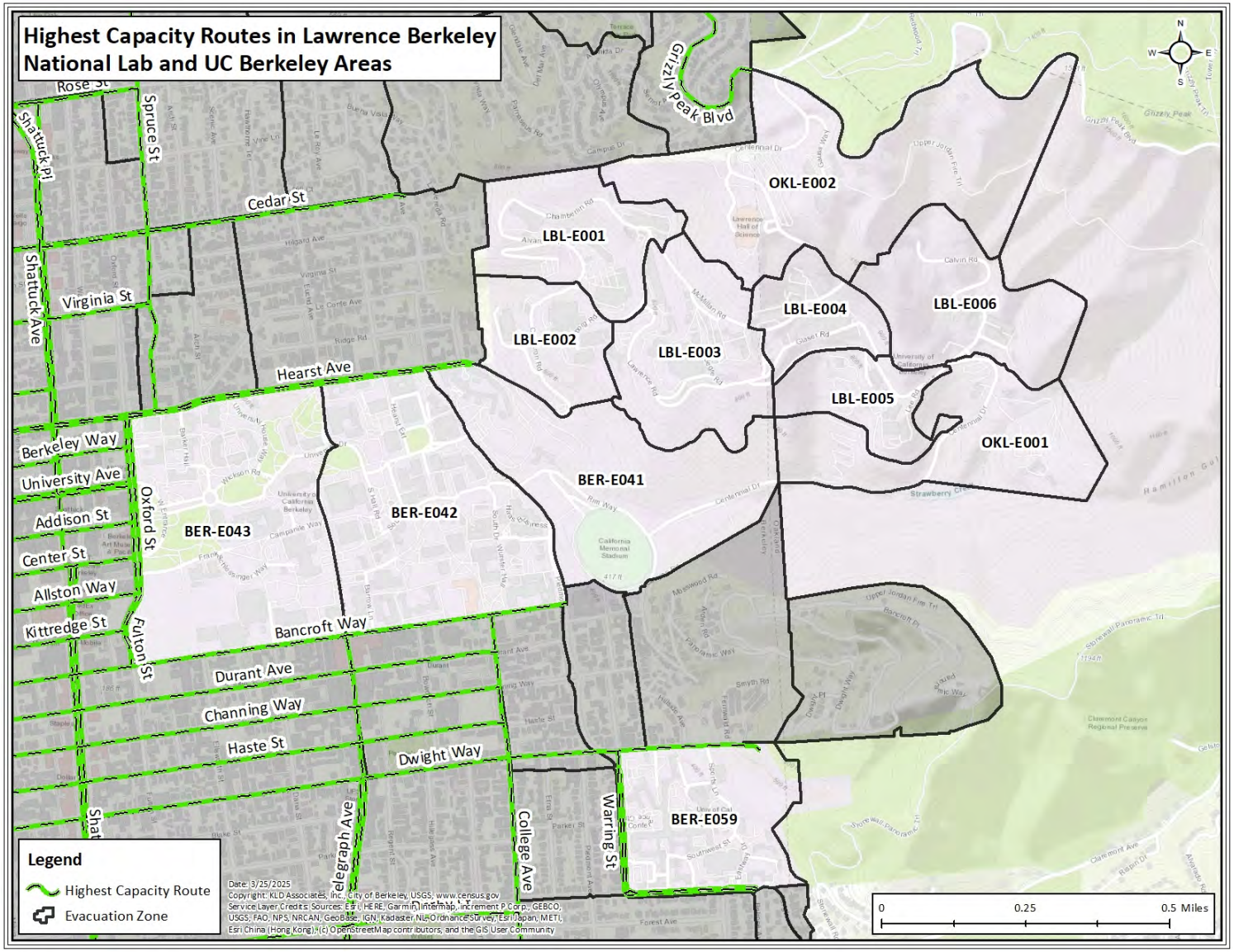


Figure 9-3. Highest Capacity Routes from Lawrence Berkeley National Lab and UC Berkeley

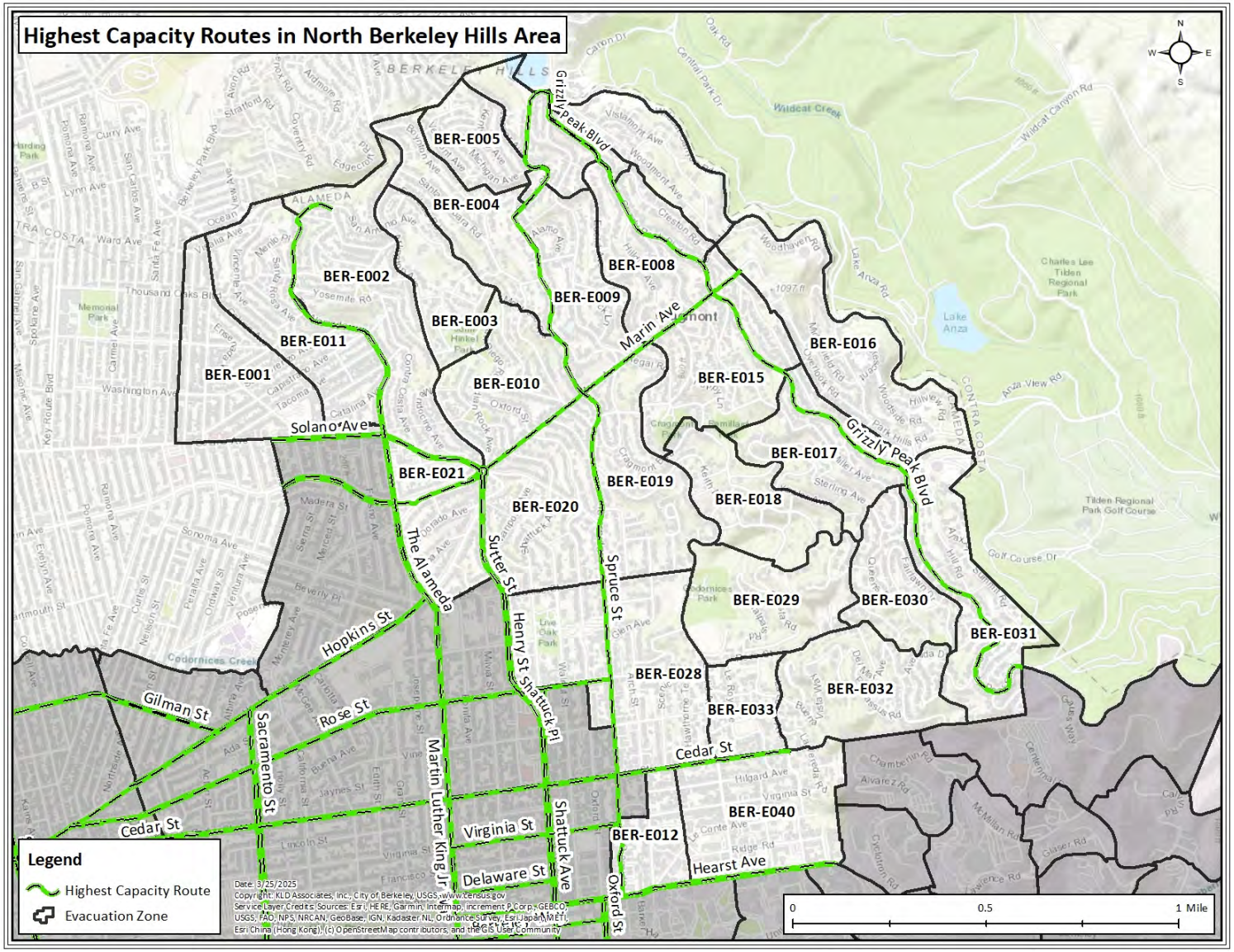


Figure 9-4. Highest Capacity Routes – North Berkeley Hills

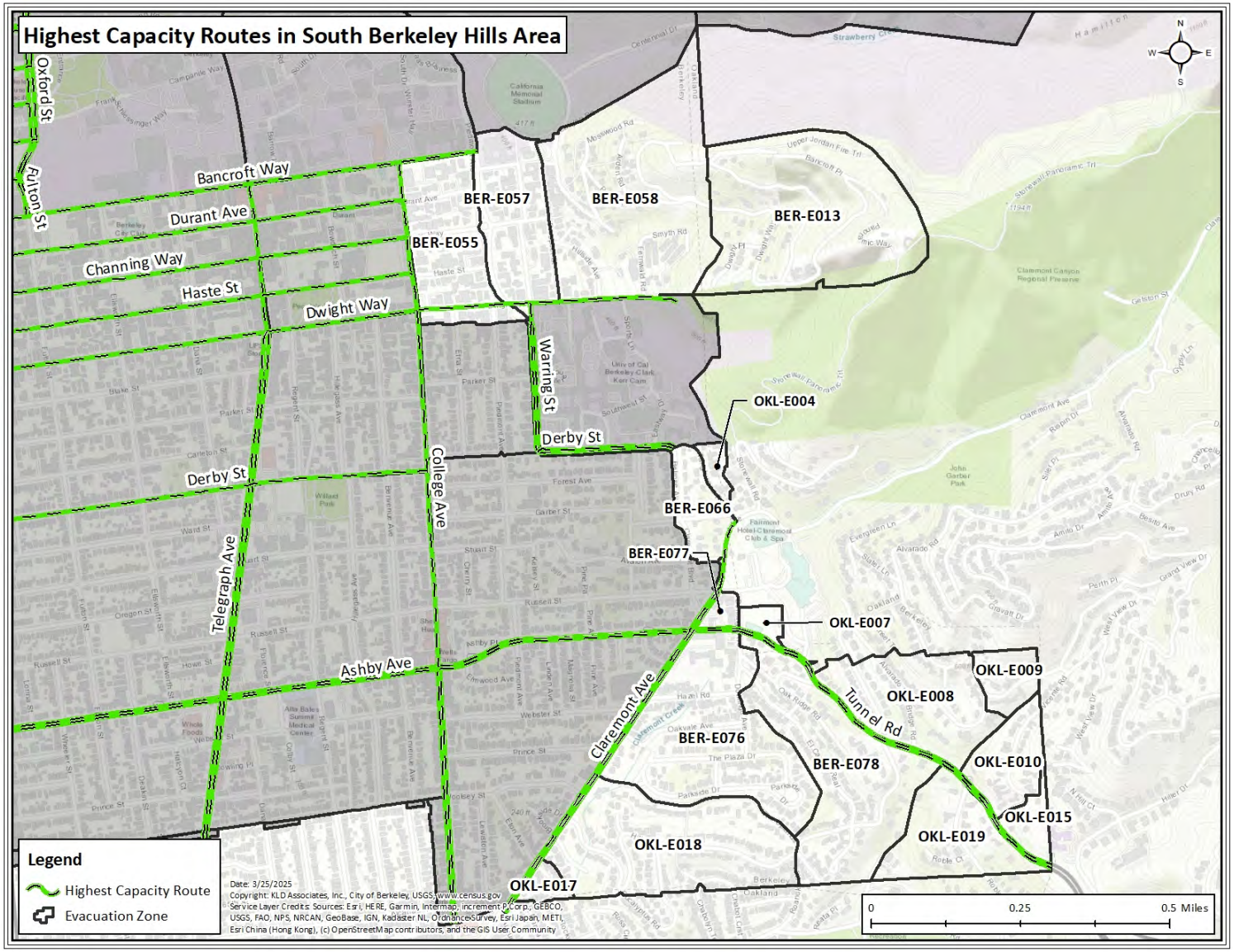


Figure 9-5. Highest Capacity Routes – South Berkeley Hills

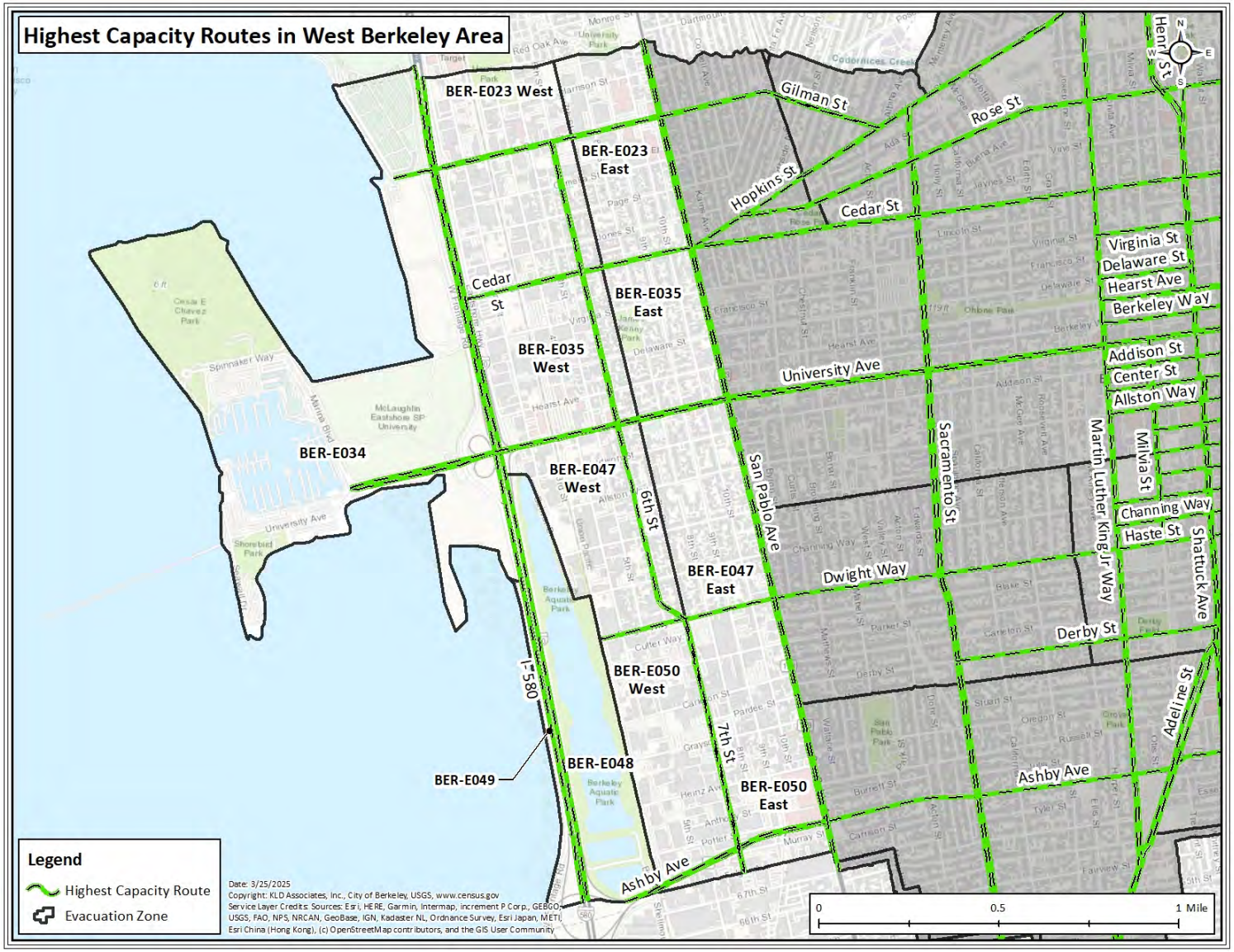


Figure 9-6. Highest Capacity Routes – West Berkeley

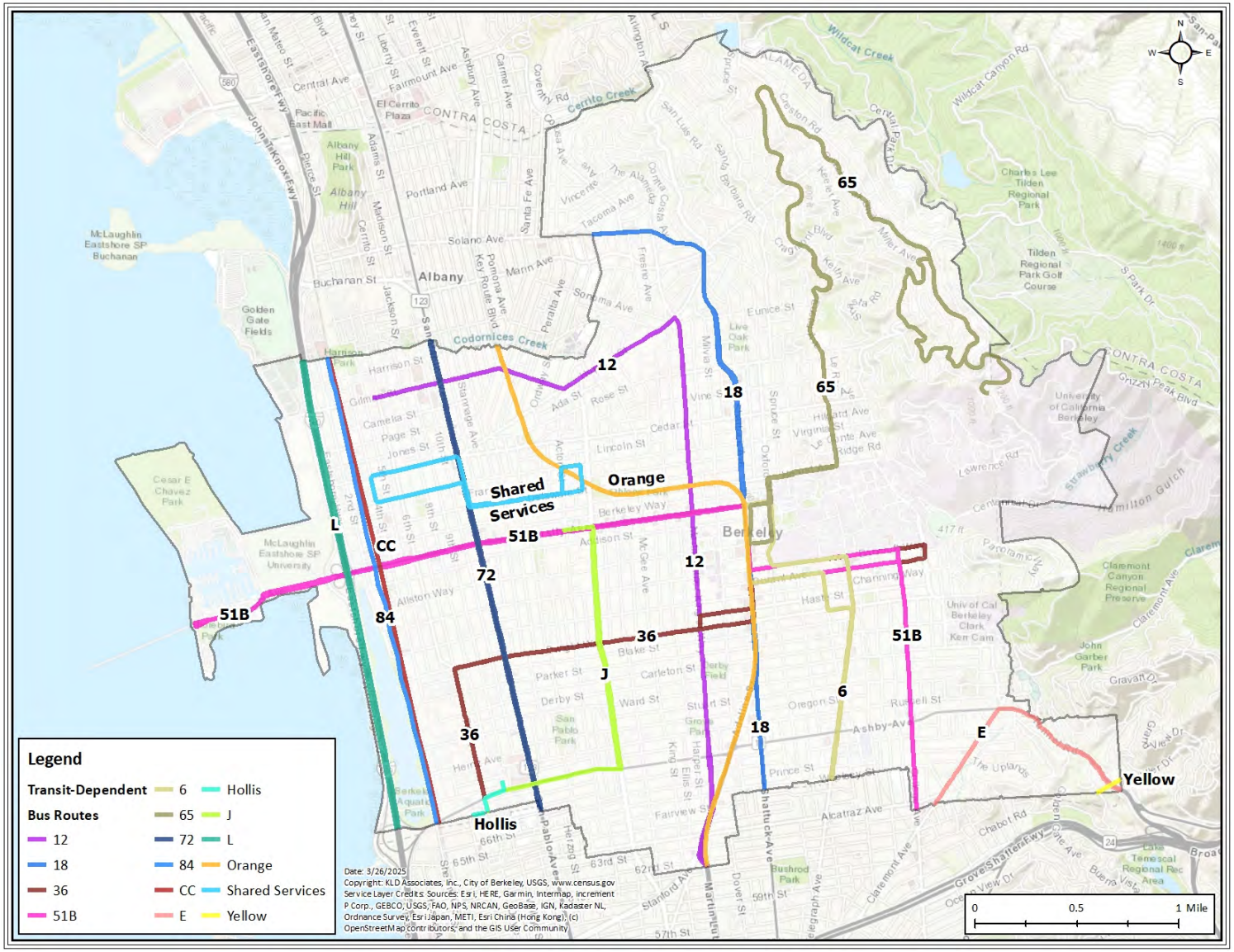


Figure 9-7. Transit-Dependent Bus Routes - 1

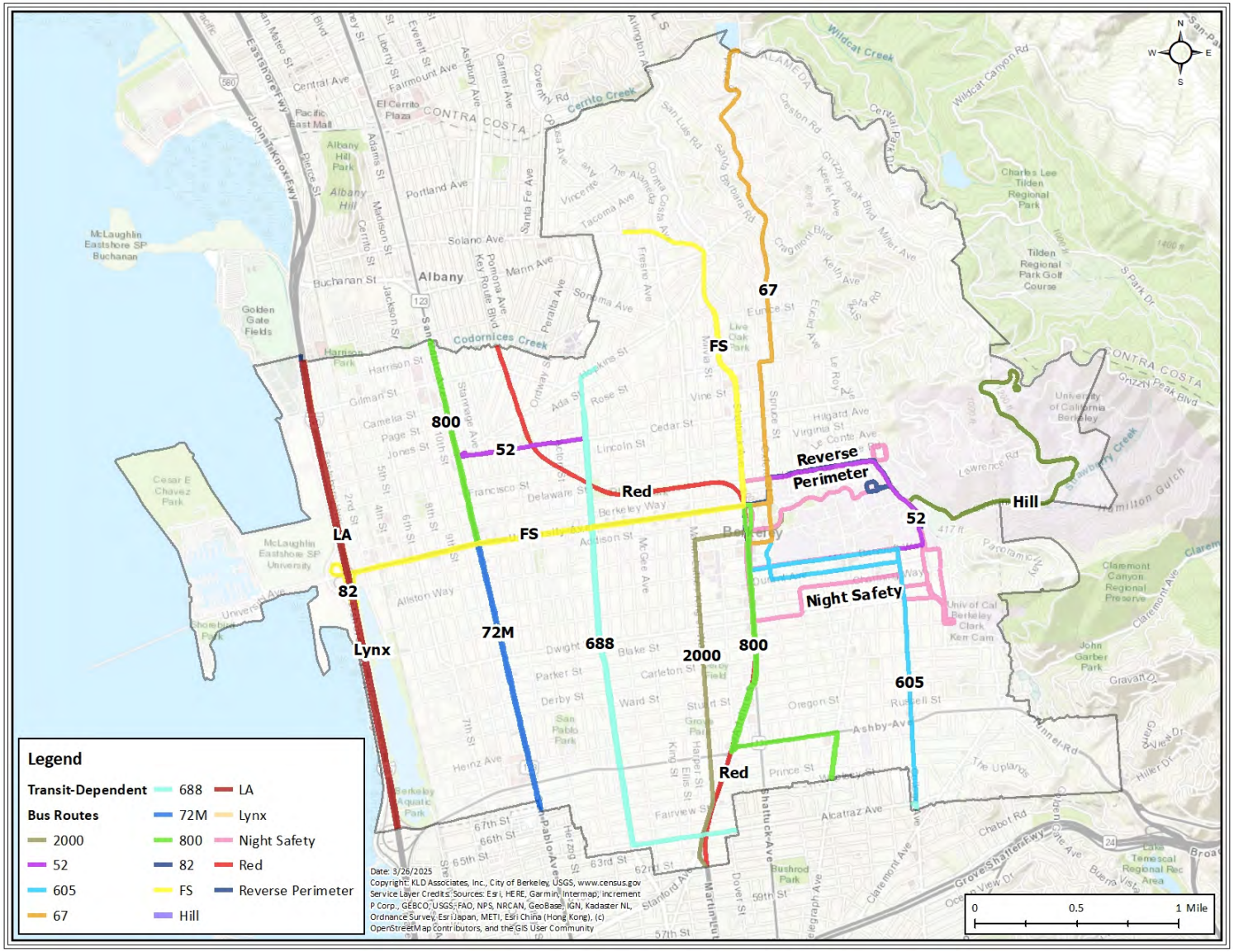


Figure 9-8. Transit-Dependent Bus Routes - 2

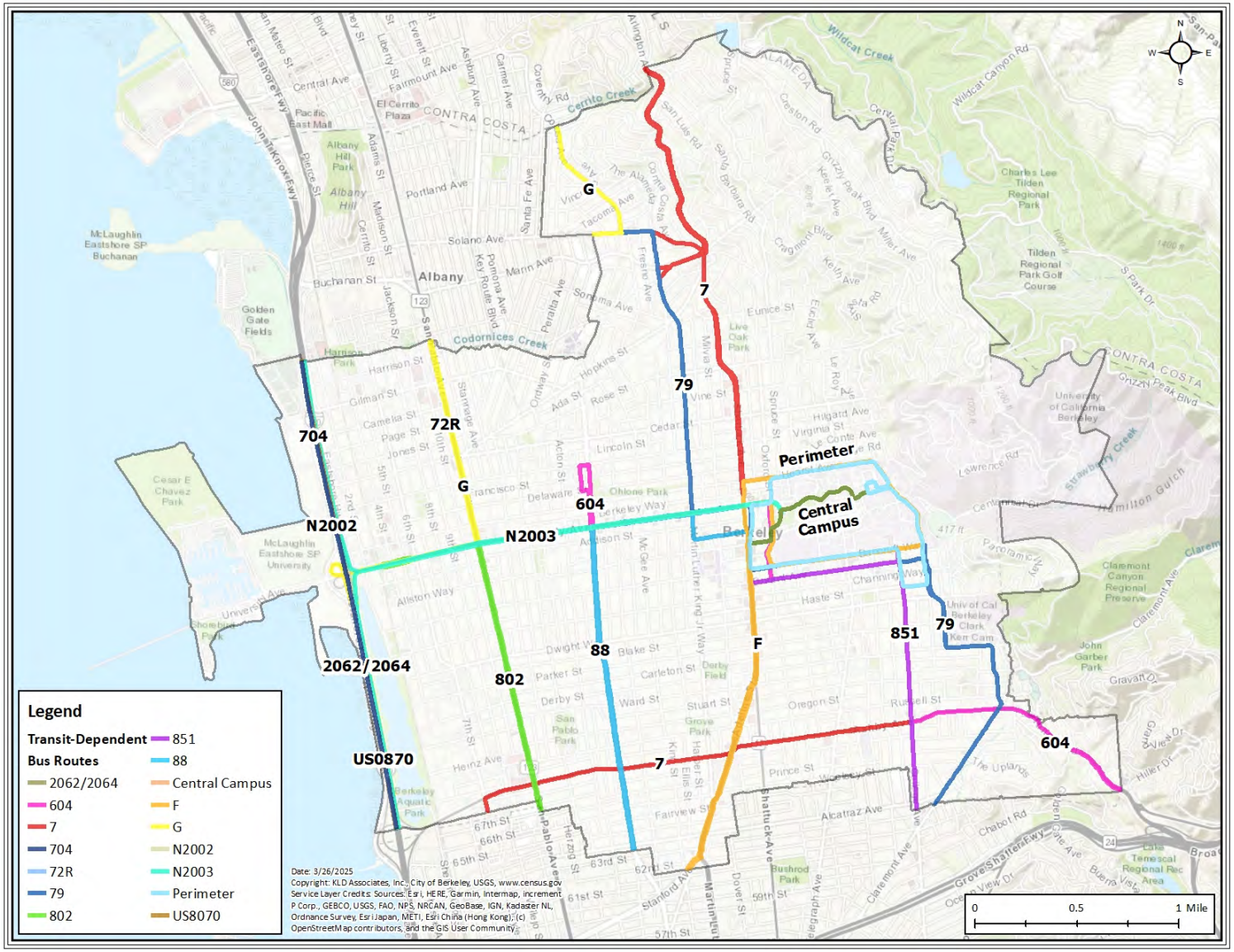


Figure 9-9. Transit-Dependent Bus Routes - 3



Figure 9-10. Evacuation Route Sign Example

10 EVACUATION SENSITIVITY STUDIES

This section presents the results of a series of sensitivity analyses, or "what-if" analyses. These analyses are designed to identify the sensitivity of the ETE to changes in some base evacuation conditions. The cases that were selected are based on special interests from City of Berkeley as well as KLD's expertise in evacuations.

10.1 Evacuation Readiness

A sensitivity study was performed to determine whether changes in the estimated trip generation (mobilization) time influence the ETE for an evacuation. Specifically, if the tail of the mobilization distribution were truncated (i.e., if those who responded most slowly to the Evacuation Order, could be persuaded to respond much more rapidly) how would the ETE be affected? Optimization of evacuation mobilization may be achieved through pre-emptive readiness protocols, facilitated by public education initiatives promoting 'go-bag' preparedness during periods of elevated wildfire risk. Furthermore, scenarios where urgent mobilization is necessary, and evacuees have little to no time to prepare to evacuate (no-notice evacuations) were also considered. All Scenarios for 1923 Fire (Region R02), 1923 Fire Phased (Region R03) and Panoramic Hill Fire (Region R04) were simulated for this sensitivity study. The results are tabulated in Table 10-1 and Table 10-2.

For the 1923 Fire case, a 1-hour reduction in mobilization time reduces the 90th percentile ETE by approximately 3%, as shown in Table 10-1. The 90th percentile ETE for this case is dictated by traffic congestion and a reduction in the time needed to perform pre-evacuation activities results in minimal change to the ETE. Furthermore, an urgent (30-minute mobilization time) mobilization can actually increase the ETE (specifically for the peak demand case) since the demand is now loaded onto the roadway network in a smaller time period, overwhelming the roadway system, resulting in more congestion and delay and, ultimately, longer ETE.

The 100th percentile ETE for the 1923 Fire case is reduced by approximately 9%[1] at most with a 1-hour reduction in mobilization for the 1923 Fire case, as shown in Table 10-2. When the mobilization time is reduced to 30 minutes, the ETE for the 1923 Fire is dictated by the time for transit vehicles to mobilize. In the base case, 100th percentile ETE for the fall midweek (Scenario 4) scenario increases due to the compression of the mobilization time overwhelming the roadway system.

When the 1923 Fire region is phased, the 90th percentile and 100th percentile ETE are reduced by at most 9% and 29%, respectively, when the mobilization time is reduced by 1-hour. However, when the mobilization time is reduced by 3 hours, there are at most 65% changes in both the 90th and 100th percentile ETE for the 1923 Fire phased region. The ETE decreases by over 4 hours (nighttime scenarios for certain phases).

[1] The mobilization time for transit-dependent population groups remains constant at 180 minutes following an evacuation order. Consequently, for scenarios where the ETE is governed by mobilization time, the 100th percentile ETE is 3 hours and 10 minutes.

For Panoramic Hill (Region R04), the 90th percentile ETE decreases by at most 5% and the 100th percentile ETE is reduced by 14% for all cases when the mobilization time is reduced by 1-hour (dictated by transit dependent mobilization time). However, when the mobilization time is reduced by 3 hours, the 90th percentile ETE is reduced by at most 55% at the 90th percentile ETE. When the mobilization time for Panoramic Hill is 30 minutes, the 90th percentile ETE is dictated by congestion and no longer the mobilization time of evacuees. The 100th percentile ETE becomes dictated by the time needed to mobilize transit vehicles. When buses can be more quickly mobilized to support evacuation of transit-dependent evacuees, the overall ETE can also be reduced.

10.2 Effect of Changes in the Number of People who Voluntarily Relocate

A sensitivity study was conducted to measure the effects on ETE due to changes in the percentage of people who decide to relocate from the Shadow Region (see Figure 7-1) and areas within the city not under Evacuation Order. The movement of people outside of the area being evacuated has the potential to impede vehicles from leaving areas that are ordered to evacuate. Refer to Sections 3.2 and 7.1 for additional information on Shadow and Voluntary Evacuation. A Citywide Evacuation (Region R01), 1923 Fire (Region R02), Panoramic Hill Fire (Region R04), Tsunami Phase 3 (Region R06) and Tsunami Max Phase (Region R07) were considered for this sensitivity study.

Table 10-3 and Table 10-4 present the ETE for the simulated scenarios. The results indicate that reducing the shadow population to 10% yields a 7% reduction on ETE across all regions, with the notable exception of Region R06, Tsunami – Phase 3. A Phase 3 tsunami represents a Warning-level tsunami that requires evacuation of the Berkeley Marina and Waterfront areas up to Interstate 80. In this specific region, a reduction in shadow and voluntary evacuation percentages results in 48% decrease in the 90th percentile ETE. Evacuees from Region R06 rely on Frontage Road and University Avenue as primary egress routes. As a result, this evacuation region is particularly sensitive to shadow and voluntary evacuee traffic that may utilize these roadways, which can impede Tsunami Phase 3 evacuation.

Furthermore, increasing the shadow population (to 60% or 100%, for example) for Region R06 results in 309% increase at the 90th percentile with a 100% shadow population participation.

For other regions, the 90th percentile ETE increases by 21% and 66%, on average, when the shadow percentage is increased to 60% and 100%, respectively. The most noticeable impacts to ETE are on weekdays during the day (Scenarios 1 and 4) as these cases have the highest number of evacuating vehicles.

The 100th percentile ETE exhibits minimal sensitivity to a reduction in shadow population to 10%, primarily due to the ETE being predominantly constrained by mobilization time. Conversely, increasing the shadow population to 60% and 100% results in 100th percentile ETE increases of as much as 17% and 68%, respectively.

The more people that voluntarily evacuate but are not ordered to do so, the less roadway capacity is available for evacuees. As such, specifically for the Berkeley area, voluntary evacuations by those not under evacuation warning or order contribute to traffic congestion, increasing evacuation times

for those who are ordered to evacuate. Public information and public messaging as to who is at risk should be clear before and during an emergency so that community members who are not at risk are less likely to contribute to traffic congestion.

10.3 Leaving Early (Reduction in Evacuation Demand)

The relationship between supply and demand is very important in computing ETE. The evacuation travel supply is the ability of the roadway network to serve the traffic demand (number of evacuating vehicles) during an emergency. In this context, when the demand exceeds the supply (available capacity), congestion occurs, causing delay and prolonging the evacuation. The roadway capacity is often challenging to increase as it is expensive and difficult to widen existing infrastructure or build additional roadways. An effective way of reducing evacuation demand is to have people leave during high-risk fire weather, before a fire starts. To that end, the City of Berkeley recommends that residents of the Berkeley hills (Fire Zones 2 & 3) leave the hills during Extreme Fire Weather.

For the purposes of this sensitivity study, Fire Zones 2 & 3 were considered to be 'high-risk' and residents in these areas were assumed to leave early. Thus, the evacuation demand was reduced. To account for those who would leave early, the vehicular demand for Fire Zones 2 & 3 was reduced by 10%, 50% and 75%. Of these people that left early (during Extreme Fire Weather but before a fire ignited and evacuations were ordered), it was assumed that 50% would stay in the Berkeley Flats Area outside of the evacuated region and the remaining 50% would relocate outside of the city limits. As such, these people would, therefore, become part of the shadow and voluntary evacuating population when a fire ignites. All Scenarios for 1923 Fire (Region R02) and Panoramic Hill Fire (Region R04) were considered. Table 10-5 and Table 10-6 summarize the results of this sensitivity study.

There are approximately 27,830 vehicles evacuating from Region R02 (1923 Fire). But a significant portion of Region R02 is not in Fire Zones 2 and 3, so only 10,330 of those vehicles would belong to households subject to Berkeley's leave early recommendation. Scenarios involving 10%, 50%, and 75% early evacuation result in 1,033, 5,165, and 7,748 vehicles within Region R02, respectively, departing early (leaving 26,797, 22,665, and 20,082 evacuating vehicles, respectively, upon the order to evacuate). As such, the effective demand of the 1923 Fire region (Region R02) decreases by 3.7%, 19%, and 28%, respectively. Furthermore, of the vehicles that departed early, half of them were included within Berkeley Flats and will subsequently participate in voluntary evacuation following the issuance of an Evacuation Order. The other half were assumed to be out of the study area, increasing the voluntary and shadow demand.

All of the evacuated portions of Region R04 are located within Fire Zones 2 and 3. As such, a 10%, 50%, and 75% reduction in high-risk evacuees due to those leaving early reduces the effective demand of the region by 10%, 50%, and 75%, respectively.

As shown in Table 10-5 and Table 10-6, relative to the Base Case, the 90th percentile ETE exhibits a maximum reduction of 3%, 14%, and 14% for the 10%, 50%, and 75% leave early cases, respectively. The 100th percentile ETE demonstrates a maximum reduction of 4%, 10%, and 10% for the 10%, 50%, and 75% leave early cases, respectively.

The reduced demand reduces traffic congestion in the simulated cases. As a result, the 90th percentile ETE becomes dictated by trip generation time, rather than traffic congestion. The ETE only drops as low as the mobilization will allow and, as a result, the reduction in ETE due to the reduction in evacuation demand for those that leave early is limited and incremental.

As discussed in Section 10.1, reducing the mobilization time to 30 minutes can decrease ETE (except for an evacuation of the 1923 Fire region (Region R02) under a Fall, Midweek, Midday Scenario (Scenario 4) where congestion actually worsens an increases ETE). To analyze the impact of people leaving early with compressed mobilization (30-minutes), these cases were simulated and the results are presented in Table 10-7 and Table 10-8.

Comparing values within Table 10-7 and Table 10-8, it can be seen that under urgent mobilization (30 minutes) conditions, the 90th percentile ETE exhibits a maximum reduction of 20%, 23%, and 40% for the 10%, 50%, and 75% leave early cases, respectively. The 100th percentile ETE demonstrates a maximum reduction of 13% and 22% for the 50% and 75% leave early cases, respectively. There is no change at the 10% leave early level.

When comparing the combined leave early and compressed mobilization approaches (shown in Table 10-7 and Table 10-8 to the base cases simulated (first two rows of Table 10-5 and Table 10-6), it can be seen that compressing the mobilization and encouraging residents in Fire Zones 2 and 3 to leave early provides a benefit of up to 68% at the 90th percentile and up to 14% at the 100th percentile. Once again, it should be noted that compressing the mobilization (with a 10% reduction in ETE) still increases congestion and increases ETE for the 1923 Fire case (by up to 25 minutes at the 100% percentile) as discussed in Section 10.1. A reduction in demand of 10% is not enough to outweigh the increase in congestion caused by the compressed mobilization time for the Fall, midweek, midday scenario for the 1923 Fire case (Region R02).

10.4 Second Egress Out from Panoramic Hill

The steep, single-access, and curvilinear road network of Panoramic Hill, coupled with its proximity to the Claremont Canyon Regional Preserve, presents critical logistical constraints for emergency egress. The area's unique topography and natural setting pose substantial evacuation challenges for residents in the event of wildfire. This sensitivity analysis investigates the impact of a secondary egress point, connecting Dwight Way to Dwight Place, on the ETE for Panoramic Hill, which is currently served by a single egress route, Panoramic Way. All Scenarios for the 1923 Fire (Region R02) and Panoramic Hill Fire (Region R04) were considered. Even though Panoramic Hill is included inside both Regions R02 and R04, the ETE presented for this sensitivity study shows when vehicles have evacuated beyond either Panoramic Way or Dwight Way, rather than the final times when the entire evacuating Regions are clear. This focuses the analysis on the specific impact from an additional route out of Panoramic Hill.

As shown in Table 10-9 and Table 10-10, when mobilization times are not altered, the addition of a secondary egress point from Panoramic Hill does not alter the 90th or 100th percentile ETE (compare the “Two Ways out of Panoramic Hill” to “One Way out of Panoramic Hill (Base)”). The ETE in this case is dictated by the 3 hour and 30 minute-maximum mobilization period, rather

than traffic congestion. Consequently, the introduction of a second egress point does not yield a reduction in ETE.

However, a fast-moving wildfire that threatens the Panoramic Hill area may not allow evacuees 3.5 hours to mobilize. To explore the impact of a secondary egress route on a fast-spreading fire, a combination of urgent mobilization was combined with a secondary egress route. When an urgent mobilization is ordered (mobilization time of 30 minutes for population groups with personal vehicles)[2] and there are two ways out of Panoramic Hill, the 90th percentile ETE reduces by at most 29% for the 1923 Fire and 33% for Panoramic Hill Fire (compared to the urgent mobilization case with one way out).

10.5 Accessory Dwelling Units and Middle Housing Developments

The purpose of this sensitivity study is to provide analysis of any public safety impacts resulting from the maximum potential amount of new residential development of accessory dwelling units (ADUs), junior accessory dwelling units (JADUs), and their associated vehicles in the Hillside Overlay, which encompasses the Very High Fire Hazard Severity Zones (VHFHSZ)[3], under the current interpretation of State law per the Department of Housing and Community Development (HCD), as well as a projection of likely development that could result from implementation of the "Middle Housing" zoning changes evaluated in the 2023-2031 Housing Element Update. The Middle Housing zoning changes would amend the Berkeley Municipal Code to allow for multi-unit development on individual parcels that are zoned for lower-density residential development. The zoning districts under consideration in the Hillside Overlay are:

- Single-family Residential (R-1),
- Limited Two-family Residential (R-1A),
- Restricted Two-family Residential (R-2), and
- Restricted Multiple-family Residential (R-2A).

The results of this study will inform the City's approach to regulating development of ADUs, JADUs, and Middle Housing in the Hillside Overlay, which encompasses the City's VHFHSZ.

To determine the public safety impact of the projected development resulting from ADUs, JADUs, and Middle Housing, this report considers: Region R01 – Citywide Evacuation, Region R02 – 1923 Fire, Region R04 – Panoramic Hill Fire, and Region R05 – Fire Zones 2 & 3 Combined. All temporal variations (Scenarios) were simulated.

The results for Accessory Dwelling Units and Middle Housing Developments are presented in Table 10-12 through Table 10-15. Table 10-14 and Table 10-15 illustrate the change in ETE between the 'Future Case' scenario and the proposed development cases. These tables utilize a

[2] It should be noted that these results do not account for transit-dependent populations within Panoramic Hill requiring bus transportation (walking down the hill to an AC Transit – or similar – stop). Despite the potential presence of such individuals, transit dependent bus routes were not modeled within Panoramic Hill as detailed in Section 9. Consequently, the 180-minute mobilization time associated with bus deployment does not influence the calculated ETE for Panoramic Hill.

[3] Since this analysis was performed, Fire Hazard Severity Zone boundaries have been updated. The Hillside Overlay encompasses both the old and updated Fire Hazard Severity Zone boundaries.

color gradient, ranging from white (minimal ETE difference) to blue (maximum ETE difference), to facilitate visual interpretation of the results.

10.5.1 Future Case: No Middle Housing or ADU/JADU

The Future Case represents the projected conditions without any Middle Housing or ADU/JADU developments. Based on the population projection assumptions used in the 2023-2031 Housing Element EIR, by 2031, the City of Berkeley is projected to have 18,205 additional units excluding any increases resulting from ADUs, JADUs, or Middle Housing. Based on the average household size and vehicle evacuation rates established in the base ETE study (Section 3) from the results of the demographic survey, these number of units equate to 43,146 additional people and 20,754 additional evacuating vehicles (Table 10-11) for the Future Case.

As shown in Table 10-14 and Table 10-15, analysis of the Future Case indicates that this increased vehicle volume results in a maximum increase in ETE of 40% at the 90th percentile (Region R01, Scenario 3) and 39% at the 100th percentile (Region R01, Scenario 3). Given the absence of planned roadway infrastructure improvements (e.g. increasing capacity by converting a stop-controlled intersection to a signalized intersection to help facilitate or improve traffic flow) to accommodate an increase in projected demand, the additional vehicle volume contributes to increased congestion and a corresponding rise in ETE for most cases, specifically at the 90th percentile.

10.5.2 Future Build Case - Accessory Dwelling Units and Junior Accessory Dwelling Units Only

This case considers the 2031 population increase plus the maximum theoretical development of new ADUs and JADUs only (no Middle Housing considered). According to the data provided, there are approximately 9,020 parcels located in the Hillside Overlay that are eligible for ADUs and JADUs. The Hillside Overlay is located within North and South Berkeley Hills. Each parcel can accommodate at maximum 2 ADUs and 1 JADU, consistent with the current interpretation of State law per HCD. Taking into account existing ADUs and JADUs based on permit data, this totals 27,060 total units (Table 10-11). Using the average household size and vehicle evacuation rates established as part of this study, this case considers an additional 107,278 people (64,132 people from ADU/JADU and 43,146[4] people from future population growth) and 51,602 evacuating vehicles (30,848 vehicles from ADU/JADU and 20,754 from future growth) in the Hillside Overlay when compared to the base cases considered.

Compared to the Future Case, development of the maximum possible number of ADUs & JADUs in the Hillside Overlay results in 25% or more increases in ETE, as detailed in Table 10-15 and Table 10-14. Specifically, the 90th percentile ETE for a citywide evacuation (Region R01) increases by approximately 54% on average, for the 1923 Fire (Region R02) by 102% on average, for Panoramic Hill Fire (Region R04) by 52% on average, and for Fire Zones 2 & 3 Combined (Region

[4] It is important to note that the 2031 future growth data encompass the entire city, whereas the analysis of new ADU, JADU, Middle Housing developments is specifically focused on the Hillside Overlay. Consequently, the 18,205 new units projected for 2031 represent the city as a whole, and only a subset of these units will be located within the Hillside Overlay. Of these 18,205 new units, it is estimated that 4,238 of them would be within the Hillside Overlay.

R05) by about 154% on average. Similarly, at the 100th percentile, ETE increases by approximately 114% on average for Region R01 and Region R05 and 121% for Region R02. Region R04 experiences minimal impact at the 100th percentile, as its 100th percentile ETE remains primarily determined by trip mobilization time rather than congestion. Improvements to roadway capacity would need to be made in order to offset these increases. To mitigate these projected increases, significant roadway network modifications and/or changes in the vicinity of these ADU/JADU developments would be necessary, as the current infrastructure capacity is insufficient to accommodate the anticipated additional demand.

10.5.3 Future Build Case - Middle Housing Developments Only

This case considers the 2031 population increase plus the projected likely development under the proposed Middle Housing zoning changes only (no ADUs or JADUs considered). There are approximately 6,440 parcels within the Hillside Overlay (generally the North and South Berkeley Hills) and of those parcels, only 4.5% of them are likely to develop by 2031, resulting in 290 (6,440 x 0.045 = 289.8) available parcels that are eligible for Middle Housing developments. Each hillside parcel can accommodate a maximum of 3 units, totaling 870 potential new Middle Housing units within the Hillside Overlay, for a total of 19,075[4] units citywide, 45,208 people (2,062 people from Middle Housing and 43,146 people from future population growth), and 21,746 evacuating vehicles (992 vehicles from Middle Housing and 20,754 from future growth) more than the amount considered under the base cases (Table 10-11).

As shown in Table 10-14 and Table 10-15, implementation of new housing under the Middle Housing zoning changes results in increases of up to 8% at the 90th [Region R05, Scenario 3] and 100th percentile [Region R01, Scenario 5] to the ETE compared to the Future Case. Specifically, the additional 992 vehicles associated with Middle Housing could add between 5 and 10 minutes overall to ETEs for a repeat of the 1923 Fire (R02). This suggests that the Middle Housing developments should be further assessed in the context of fire spread scenarios. By overlaying fire spread data with evacuation time estimates, the City can better understand potential impacts to public health and safety from Middle Housing zoning changes.

10.5.4 Future Build Case - Accessory Dwelling Units, Junior Accessory Dwelling Units, & Middle Housing Developments

The combined implementation of development with the maximum possible amount of ADU/JADU units and likely Middle Housing units projects a total of 27,930 new housing units in the Hillside Overlay. This results in an additional 46,135 units[4], 109,340 residents and 52,594 evacuating vehicles by 2031 citywide. Increases in ETE are observed at both the 90th and 100th percentiles. Specifically, the 90th percentile ETE increases by about 61% on average for a Citywide Evacuation (Region R01), 105% on average for a 1923 Fire (Region R02), 166% on average for Fire Zones 2 & 3 Combined (Region R05), and about 54% on average for Panoramic Hill Fire (Region R04), as shown in Table 10-14 and Table 10-15. At the 100th percentile, ETE increases by 102% for Region R01, 126% for Region R02 and 147% for Region R05. Region R04 shows at most 2% increase at the 100th percentile, with its 100th percentile ETE remaining primarily influenced by

trip mobilization time. To address these substantial increases, comprehensive roadway network improvements in the vicinity of these developments are essential, as the current infrastructure is inadequate to handle the projected demand.

10.5.5 Future Build Case - Accessory Dwelling Units and Junior Accessory Dwelling Units Only including Public Transit Parking Standard Exemption

In accordance with State law, JADUs are not required to provide off-street parking spaces, and ADUs are only required to provide off-street parking spaces if the parcel is located more than 1/2 mile walking distance of public transit, which is defined as "a location, including, but not limited to, a bus stop or train station, where the public may access buses, trains, subways, and other forms of transportation that charge set fares, run on fixed routes, and are available to the public." This case assumes that any ADU or JADU resident living on a parcel that is not required to have off-street parking would not have a personal vehicle and would instead rely on public transit to evacuate. Of the total 9,020 ADU/JADU parcels, 4,434 of them fall within the transit exemption zone. It was conservatively assumed that people living on these 4,434 parcels would utilize a public transit bus to leave the area during an emergency. Using the standard assumptions of household size and vehicle occupancies in this study, a total of 13,302 units (4,434 x 3 = 13,302), which would house 31,526 people, would require buses to evacuate. Using an assumption of 30 people per bus, an additional 1,051 buses are estimated to be needed to evacuate the new ADU/JADU residents that do not have a personal vehicle above the base cases. The remaining 4,586 parcels would evacuate in personal vehicles. In total for this case, there are an additional 15,681 personal vehicles and 1,051 buses when compared to the Future Case.

Even with the estimation that approximately half of the eligible parcels will utilize public transportation for evacuation instead of a personal vehicle, the 90th and 100th percentile ETE exhibit increases compared to the Future Case, as shown in Table 10-14 and Table 10-15. Specifically, the 90th percentile ETE increases by about 28% on average for Citywide Evacuation (Region R01), 65% on average for the 1923 Fire (Region R02), 70% on average for Panoramic Hill Fire (Region R04) and 129% on average for Fire Zones 2 & 3 Combined (Region R05). Compared to the 'Future Build - ADU/JADU Only' case without the parking exemption, the 100th percentile ETE demonstrates a decrease of approximately 9% on average for Regions R01, R02 and R05. This reduction is attributed to the presence of 1,051 buses (2,102 personal car equivalents) and a decrease of 15,167 vehicles on the road.

10.5.6 Future Build Case - Accessory Dwelling Units, Junior Accessory Dwelling Units, & Middle Housing including Public Exemption

This case represents a similar scenario discussed in Section 10.5.5 with the Middle Housing units. Unlike State law governing the development of ADUs and JADUs, development under the proposed Middle Housing zoning changes does not include a parking exemption within transit-rich areas. For this reason, it is assumed that all Middle Housing developments are evacuated in personal vehicles. As shown in Table 10-11, there are approximately 16,673 additional evacuating vehicles and 1,051 buses for this case compared to the Future Case.

When compared to the Future Case, the 90th percentile ETE increases by 29% on average for Citywide Evacuation (Region R01), 68% on average for the 1923 Fire (Region R02), 69% on average for Panoramic Hill Fire (Region R04) and 135% on average for Fire Zones 2 & 3 Combined (Region R05). Compared to the 'Future Build - ADU/JADU and Middle Housing' case without the parking exemption, the 100th percentile ETE demonstrates a decrease of approximately 11% on average for Regions R01, R02 and R05. This reduction is attributed to the presence of 1,051 buses and a decrease of 16,673 vehicles on the road.

10.6 Optimized Signals

As discussed in Section 7 and Appendix F, there are some pre-timed signals within the city. Pre-timed signals utilize a fixed timing plan, rather than allowing the signal to optimize the splits between directions based on the demand at each approach. Actuated signals allow the signal to choose the appropriate timing plan based on the demand on each approach, with some limits to minimum and maximum green time. A sensitivity study was conducted to determine the impact to ETE if the pre-timed signals in the city were changed to actuated signals. The two fire cases (Fire 1923 non-phased [R02] and Panoramic Hill [R04]) were simulated for urgent mobilization (since many cases are dictated by trip generation time and the results of this sensitivity analysis would likely show no impact on the regular mobilization cases). All scenarios were considered. The results are presented in Table 10-16 and Table 10-17 at the 90th and 100th percentile, respectively.

When compared to Table 10-1 and Table 10-2, respectively, it can be seen that converting the pre-timed signals to actuated signals can improve evacuation times by up to 13% at the 90th percentile and up to 4% at the 100th percentile. In most cases, the 100th percentile ETE remains dictated by the time needed to mobilize transit vehicles. When buses can be more quickly mobilized to support evacuation of transit-dependent evacuees, the 100th percentile ETE can also be reduced.

Table 10-1. 90th Percentile Evacuation Time Estimates for Evacuation Readiness Sensitivity Study

	Summer			Fall		
	Midweek	Weekend	Midweek Weekend	Midweek	Weekend	Midweek Weekend
Scenario:	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Region	**Midday**	**Midday**	**Nighttime**	**Midday**	**Midday**	**Nighttime**
30 Minute Mobilization Time						
R02	2:25	1:50	1:35	3:20	1:45	1:35
R03 Phase a	2:05	1:40	1:25	2:45	1:25	1:35
R03 Phase b	2:10	1:50	1:40	2:40	1:30	1:40
R03 Phase c	3:35	3:45	1:40	3:50	1:30	1:40
R04	1:05	0:50	0:45	1:45	0:50	0:50
2 Hour and 30 Minute Mobilization Time						
R02	2:20	1:50	1:45	2:55	1:50	1:45
R03 Phase a	2:05	1:40	1:40	2:30	1:35	2:10
R03 Phase b	2:10	2:00	2:15	2:45	2:10	2:25
R03 Phase c	4:05	4:15	4:25	4:00	4:20	4:30
R04	1:35	1:30	1:35	1:40	1:35	1:35
3 Hour and 30 Minute Mobilization Time (Base)						
R02	2:25	1:50	1:45	2:55	1:50	1:45
R03 Phase a	2:05	1:40	1:40	2:45	1:35	2:10
R03 Phase b	2:15	2:00	2:15	2:45	2:10	2:30
R03 Phase c	4:10	4:20	4:30	4:00	4:25	4:35
R04	1:40	1:35	1:40	1:45	1:35	1:40

Table 10-2. 100th Percentile Evacuation Time Estimates for Evacuation Readiness Sensitivity Study

	Summer			Fall		
	Midweek	Weekend	Midweek Weekend	Midweek	Weekend	Midweek Weekend
Scenario:	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Region	**Midday**	**Midday**	**Nighttime**	**Midday**	**Midday**	**Nighttime**
30 Minute Mobilization Time						
R02	3:25	3:10	3:10	4:35	3:10	3:10
R03 Phase a	2:30	2:10	2:05	3:30	2:10	2:10
R03 Phase b	4:00	4:00	2:05	4:00	2:10	2:10
R03 Phase c	4:30	4:25	2:15	4:45	2:10	2:10
R04	3:10	3:10	3:10	3:10	3:10	3:10
2 Hour and 30 Minute Mobilization Time						
R02	3:20	3:10	3:10	4:10	3:10	3:10
R03 Phase a	3:20	3:20	3:20	3:20	3:20	3:20
R03 Phase b	5:15	5:15	5:20	5:20	5:15	5:10
R03 Phase c	5:20	5:20	5:20	5:20	5:20	5:20
R04	3:10	3:10	3:10	3:10	3:10	3:10
3 Hour and 30 Minute Mobilization Time (Base)						
R02	3:40	3:25	3:25	4:10	3:25	3:25
R03 Phase a	4:25	4:30	4:40	4:30	4:15	4:35
R03 Phase b	6:10	5:55	6:00	6:15	6:00	6:10
R03 Phase c	6:20	6:20	6:20	6:20	6:20	6:20
R04	3:40	3:25	3:25	3:40	3:25	3:25

Table 10-3. 90th Evacuation Time Estimates for Voluntary Evacuation Sensitivity Study

	Summer			Fall		
	Midweek	Weekend	Midweek Weekend	Midweek	Weekend	Midweek Weekend
Scenario:	(1)	(2)	(3)	(4)	(5)	(6)
Region	Midday	Midday	Evening	Midday	Midday	Evening
10 Percent Shadow (Demographic Survey)						
R01	3:30	3:05	2:30	4:00	2:50	2:25
R02	2:20	1:50	1:45	2:55	1:50	1:45
R04	1:40	1:35	1:35	1:40	1:35	1:40
R06	1:15	1:20	0:50	0:55	0:55	0:50
R07	2:05	2:00	1:50	2:05	2:00	1:50
20 Percent Shadow (Base)						
R01	3:40	3:10	2:30	4:00	2:55	2:30
R02	2:25	1:50	1:45	2:55	1:50	1:45
R04	1:40	1:35	1:40	1:45	1:35	1:40
R06	1:20	1:20	1:05	1:45	0:55	1:10
R07	2:15	2:10	1:50	2:15	2:05	1:50
60 Percent Shadow						
R01	4:00	3:30	2:55	4:30	3:20	2:45
R02	3:10	2:30	2:05	3:35	2:20	2:00
R04	2:00	1:40	1:45	2:50	1:45	1:45
R06	3:10	3:05	2:15	3:15	3:00	2:15
R07	3:05	2:50	2:05	3:10	2:45	2:10
100 Percent Shadow						
R01	4:25	3:55	3:15	4:55	3:45	3:05
R02	4:20	3:30	2:55	4:40	3:20	2:40
R04	3:35	3:00	2:20	4:40	2:35	2:15
R06	4:15	3:55	3:05	4:25	3:45	3:15
R07	4:15	3:55	3:20	4:25	3:45	3:15

Table 10-4. 100th Evacuation Time Estimates for Voluntary Evacuation Sensitivity Study

	Summer			Fall		
	Midweek	Weekend	Midweek Weekend	Midweek	Weekend	Midweek Weekend
Scenario:	(1)	(2)	(3)	(4)	(5)	(6)
Region	Midday	Midday	Nighttime	Midday	Midday	Nighttime
10 Percent Shadow (Demographic Survey)						
R01	5:10	4:15	3:25	5:35	3:45	3:25
R02	3:40	3:25	3:25	4:10	3:25	3:25
R04	3:40	3:25	3:25	3:40	3:25	3:25
R06	3:40	3:25	3:25	3:40	3:25	3:25
R07	3:40	3:25	3:25	3:40	3:25	3:25
20 Percent Shadow (Base)						
R01	5:10	4:25	3:25	5:35	4:00	3:25
R02	3:40	3:25	3:25	4:10	3:25	3:25
R04	3:40	3:25	3:25	3:40	3:25	3:25
R06	3:40	3:25	3:25	3:40	3:25	3:25
R07	3:40	3:25	3:25	3:40	3:25	3:25
60 Percent Shadow						
R01	5:45	5:05	3:55	6:10	4:40	3:50
R02	4:15	3:25	3:25	4:35	3:25	3:25
R04	3:40	3:25	3:25	3:40	3:25	3:25
R06	3:40	3:40	3:25	3:45	3:25	3:25
R07	3:55	3:55	3:25	4:00	3:25	3:25
100 Percent Shadow						
R01	7:20	5:55	4:35	7:35	5:40	4:30
R02	6:10	5:00	3:55	6:45	4:35	3:30
R04	3:40	3:40	3:25	5:25	3:25	3:25
R06	5:25	4:55	4:00	6:05	4:40	4:00
R07	5:45	5:15	4:15	6:10	5:05	4:10

Table 10-5. 90th Evacuation Time Estimates for Leaving Early Sensitivity Study

	Summer			Fall		
	Midweek	Weekend	Midweek Weekend	Midweek	Weekend	Midweek Weekend
Scenario:	(1)	(2)	(3)	(4)	(5)	(6)
Region	Midday	Midday	Nighttime	Midday	Midday	Nighttime
No One Leaves Early (Base)						
R02	2:25	1:50	1:45	2:55	1:50	1:45
R04	1:40	1:35	1:40	1:45	1:35	1:40
10% Leave Early						
R02	2:20	1:50	1:45	2:50	1:50	1:45
R04	1:40	1:35	1:40	1:40	1:35	1:40
50% Leave Early						
R02	2:10	1:35	1:35	2:45	1:40	1:35
R04	1:40	1:35	1:40	1:35	1:35	1:40
75% Leave Early						
R02	2:05	1:35	1:35	2:40	1:35	1:35
R04	1:35	1:35	1:40	1:35	1:35	1:40

Table 10-6. 100th Evacuation Time Estimates for Leaving Early Sensitivity Study

	Summer			Fall		
	Midweek	Weekend	Midweek Weekend	Midweek	Weekend	Midweek Weekend
Scenario:	(1)	(2)	(3)	(4)	(5)	(6)
Region	Midday	Midday	Nighttime	Midday	Midday	Nighttime
No One Leaves Early (Base)						
R02	3:40	3:25	3:25	4:10	3:25	3:25
R04	3:40	3:25	3:25	3:40	3:25	3:25
10% Leave Early						
R02	3:40	3:25	3:25	4:00	3:25	3:25
R04	3:40	3:25	3:25	3:40	3:25	3:25
50% Leave Early						
R02	3:40	3:25	3:25	3:45	3:25	3:25
R04	3:40	3:25	3:25	3:40	3:25	3:25
75% Leave Early						
R02	3:40	3:25	3:25	3:45	3:25	3:25
R04	3:40	3:25	3:25	3:40	3:25	3:25

Table 10-7. 90th Evacuation Time Estimates for Leaving Early & Urgent Mobilization Sensitivity Study

	Summer			Fall		
	Midweek	Weekend	Midweek Weekend	Midweek	Weekend	Midweek Weekend
Scenario:	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Region	**Midday**	**Midday**	**Nighttime**	**Midday**	**Midday**	**Nighttime**
No One Leaves Early (Urgent Mobilization)						
R02	2:25	1:50	1:35	3:20	1:45	1:35
R04	1:05	0:50	0:45	1:45	0:50	0:50
10% Leave Early						
R02	2:25	1:50	1:35	3:10	1:40	1:25
R04	0:55	0:50	0:45	1:45	0:50	0:40
50% Leave Early						
R02	2:15	1:35	1:25	2:55	1:30	1:20
R04	0:50	0:45	0:40	1:40	0:40	0:40
75% Leave Early						
R02	2:05	1:30	1:15	2:45	1:25	1:15
R04	0:50	0:40	0:35	1:35	0:30	0:40

Table 10-8. 100th Evacuation Time Estimates for Leaving Early & Urgent Mobilization Sensitivity Study

	Summer			Fall		
	Midweek	Weekend	Midweek Weekend	Midweek	Weekend	Midweek Weekend
Scenario:	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Region	**Midday**	**Midday**	**Nighttime**	**Midday**	**Midday**	**Nighttime**
No One Leaves Early (Urgent Mobilization)						
R02	3:25	3:10	3:10	4:10	3:10	3:10
R04	3:10	3:10	3:10	3:10	3:10	3:10
10% Leave Early						
R02	3:25	3:10	3:10	4:10	3:10	3:10
R04	3:10	3:10	3:10	3:10	3:10	3:10
50% Leave Early						
R02	3:25	3:10	3:10	4:00	3:10	3:10
R04	3:10	3:10	3:10	3:10	3:10	3:10
75% Leave Early						
R02	3:25	3:10	3:10	3:35	3:10	3:10
R04	3:10	3:10	3:10	3:10	3:10	3:10

Table 10-9. 90th Evacuation Time Estimates for Panoramic Hill Sensitivity Study

	Summer			Fall		
	Midweek	Weekend	Midweek Weekend	Midweek	Weekend	Midweek Weekend
Scenario:	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Region	**Midday**	**Midday**	**Nighttime**	**Midday**	**Midday**	**Nighttime**
Two Ways Out of Panoramic Hill (Urgent Mobilization)						
R02	0:50	0:50	0:35	1:00	0:40	0:30
R04	0:45	0:50	0:35	0:40	0:35	0:30
Two Ways Out of Panoramic Hill						
R02	1:20	1:15	1:20	1:30	1:20	1:30
R04	1:20	1:15	1:20	1:30	1:20	1:30
One Way Out of Panoramic Hill (Urgent Mobilization)						
R02	1:05	1:10	0:45	1:25	0:55	0:35
R04	1:00	1:00	0:40	1:00	0:45	0:30
One Way Out of Panoramic Hill (Base)						
R02	1:20	1:15	1:20	1:30	1:20	1:30
R04	1:20	1:15	1:20	1:30	1:20	1:30

Table 10-10. 100th Evacuation Time Estimates for Panoramic Hill Sensitivity Study

	Summer			Fall		
	Midweek	Weekend	Midweek Weekend	Midweek	Weekend	Midweek Weekend
Scenario:	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Region	**Midday**	**Midday**	**Nighttime**	**Midday**	**Midday**	**Nighttime**
Two Ways Out of Panoramic Hill (Urgent Mobilization)						
R02	1:00	1:00	0:45	1:15	0:45	0:40
R04	0:55	1:00	0:40	0:50	0:40	0:40
Two Ways Out of Panoramic Hill						
R02	3:40	3:25	3:25	3:40	3:25	3:25
R04	3:40	3:25	3:25	3:40	3:25	3:25
One Way Out of Panoramic Hill (Urgent Mobilization)						
R02	1:10	1:20	0:55	1:35	1:00	0:45
R04	1:05	1:05	0:45	1:10	0:50	0:40
One Way Out of Panoramic Hill (Base)						
R02	3:40	3:25	3:25	3:40	3:25	3:25
R04	3:40	3:25	3:25	3:40	3:25	3:25

Table 10-11. ADU/JADU/Middle Housing Units, People and Number of Evacuation Vehicles

Case	Number of Units	Number of People	Number of Vehicles	Number of Buses[5]
Future Case (City Wide)	18,205	43,146	20,754	0
Future Case (Hillside)	4,238	10,044	4,831	0
Future Build – ADU/JADUs Only	27,060	64,132	30,848	0
Future Build - Middle Housing Only	870	2,062	992	0
Future Build – ADUs/JADUs and Middle Housing	27,930	66,194	31,840	0
Future Build – ADUs/JADUs only with Transit Exemption	27,060	64,132	15,681	1,051
Future Build – ADU/JADUs and Middle Housing with Transit Exemption	27,930	66,194	16,673	1,051

Notes

Future Case (City Wide): Includes housing units that are projected to be built by the year 2031 for the City of Berkeley. Excludes any future ADU/JADU and Middle Housing developments.

Future Case (Hillside): Includes the estimated number of housing units to be built in the Hillside Overlay by the year 2031. Excludes any future ADU/JADU and Middle Housing developments.

Future Build – ADU/JADUs Only: The maximum number of ADU/JADUs that can be built within the Hillside Overlay.

Future Build – Middle Housing Only: The estimated number of Middle Housing units that will be built in the Hillside Overlay.

Future Build – ADUs/JADUs and Middle Housing: Combined number of ADU/JADUs and Middle Housing units in the Hillside Overlay.

Future Build – ADUs/JADUs only with Transit Exemption: Residents living on an ADU/JADU parcel that is not required to have off-street parking would not have a personal vehicle and would instead rely on public transit to evacuate.

Future Build – ADU/JADUs and Middle Housing with Transit Exemption: Same as "Future Build – ADUs/JADUs only with Transit Exemption" case with the addition of Middle Housing units.

[5] Represented as 2 pce's in the simulations.

Table 10-12. 90th Evacuation Time Estimates for ADU/JADU/Middle Housing Sensitivity Study

	Summer			Fall		
	Midweek	Weekend	Midweek Weekend	Midweek	Weekend	Midweek Weekend
Scenario:	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Region	**Midday**	**Midday**	**Nighttime**	**Midday**	**Midday**	**Nighttime**
Base						
R01	3:40	3:10	2:30	4:00	2:55	2:30
R02	2:25	1:50	1:45	2:55	1:50	1:45
R04	1:40	1:35	1:40	1:45	1:35	1:40
R05	2:05	1:55	1:45	2:20	1:55	1:45
Future Case						
R01	4:30	4:00	3:30	4:55	4:00	3:25
R02	2:55	2:30	2:10	3:20	2:20	2:10
R04	1:50	1:45	1:45	2:00	1:45	1:45
R05	2:30	2:30	2:10	2:45	2:15	2:10
Future ADUs and JADUs						
R01	6:40	6:15	5:55	6:25	6:05	5:45
R02	5:40	5:10	4:50	5:15	5:00	4:40
R04	2:55	2:55	2:40	2:30	2:45	2:40
R05	6:20	6:05	6:00	5:25	6:10	6:05
Future Middle Housing						
R01	4:40	4:10	3:35	5:00	4:05	3:30
R02	3:05	2:30	2:15	3:30	2:20	2:15
R04	1:50	1:45	1:45	2:00	1:45	1:45
R05	2:40	2:30	2:20	2:50	2:25	2:10
Future Combined						
R01	6:55	6:30	6:15	6:40	6:20	6:05
R02	5:40	5:10	5:00	5:20	5:05	4:45
R04	2:50	2:55	2:45	2:35	2:50	2:45
R05	6:35	6:50	6:10	5:35	6:20	6:20
Future ADU with Transit Exemption Zones						
R01	5:40	5:10	4:45	5:50	4:50	4:40
R02	4:25	4:15	4:00	4:20	4:05	3:50
R04	3:00	3:05	3:05	3:00	3:05	3:05
R05	5:55	5:40	5:30	4:30	5:50	5:05
Future Combined with Transit Exemption Zones						
R01	5:45	5:10	4:50	5:45	5:05	4:35
R02	4:30	4:20	4:05	4:30	4:10	3:50
R04	3:00	3:00	3:05	3:00	3:05	3:05
R05	5:50	5:45	5:35	5:00	5:50	5:25

Table 10-13. 100th Evacuation Time Estimates for ADU/JADU/Middle Housing Sensitivity Study

	Summer			Fall		
	Midweek	Weekend	Midweek Weekend	Midweek	Weekend	Midweek Weekend
Scenario:	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Region	**Midday**	**Midday**	**Nighttime**	**Midday**	**Midday**	**Nighttime**
Base						
R01	5:10	4:25	3:25	5:35	4:00	3:25
R02	3:40	3:25	3:25	4:10	3:25	3:25
R04	3:40	3:25	3:25	3:40	3:25	3:25
R05	3:40	3:25	3:25	3:40	3:25	3:25
Future Case						
R01	6:10	5:35	4:45	7:05	5:15	4:35
R02	4:05	3:25	3:25	4:35	3:25	3:25
R04	3:40	3:25	3:25	3:40	3:25	3:25
R05	4:00	4:05	3:30	4:15	3:30	3:25
Future ADUs and JADUs						
R01	11:25	11:15	9:50	10:10	11:05	9:35
R02	8:35	8:25	8:05	7:45	8:15	7:40
R04	3:40	3:25	3:25	3:40	3:25	3:25
R05	8:55	9:15	9:15	7:55	9:30	8:20
Future Middle Housing						
R01	6:25	5:40	5:05	7:15	5:40	4:35
R02	4:10	3:40	3:25	4:40	3:25	3:25
R04	3:40	3:25	3:25	3:40	3:25	3:25
R05	4:00	4:10	3:45	4:20	3:40	3:25
Future Combined						
R01	11:30	11:15	10:15	10:30	11:05	11:20
R02	8:50	8:30	8:10	7:50	8:25	8:00
R04	3:40	3:30	3:25	3:40	3:25	3:25
R05	9:20	9:45	10:15	7:55	9:35	8:50
Future ADU with Transit Exemption Zones						
R01	10:35	9:50	9:10	9:30	9:50	9:00
R02	8:10	7:40	7:10	7:05	7:25	6:50
R04	3:40	3:25	3:25	3:40	3:25	3:25
R05	8:10	8:30	8:10	6:50	8:15	8:05
Future Combined with Transit Exemption Zones						
R01	10:45	10:05	9:50	9:40	9:50	9:05
R02	8:10	7:40	7:15	7:20	7:35	7:00
R04	3:40	3:30	3:25	3:40	3:25	3:25
R05	8:10	8:30	8:35	6:55	8:25	8:05

Table 10-14. 90th Evacuation Time Estimates Differences Between Build and Future Cases

	Summer			Fall		
	Midweek	Weekend	Midweek Weekend	Midweek	Weekend	Midweek Weekend
Scenario:	(1)	(2)	(3)	(4)	(5)	(6)
Region	Midday	Midday	Nighttime	Midday	Midday	Nighttime
ADUs and JADUs Compared to Future Case						
R01	2:10	2:15	2:25	1:30	2:05	2:20
R02	2:45	2:40	2:40	1:55	2:40	2:30
R04	1:05	1:10	0:55	0:30	1:00	0:55
R05	3:50	3:35	3:50	2:40	3:55	3:55
Middle Housing Compared to Future Case						
R01	0:10	0:10	0:05	0:05	0:05	0:05
R02	0:10	0:00	0:05	0:10	0:00	0:05
R04	0:00	0:00	0:00	0:00	0:00	0:00
R05	0:10	0:00	0:10	0:05	0:10	0:00
Combined Compared to Future Case						
R01	2:25	2:30	2:45	1:45	2:20	2:40
R02	2:45	2:40	2:50	2:00	2:45	2:35
R04	1:00	1:10	1:00	0:35	1:05	1:00
R05	4:05	4:20	4:00	2:50	4:05	4:10
ADU with Transit Exemption Zones Compared to Future Case						
R01	1:10	1:10	1:15	0:55	0:50	1:15
R02	1:30	1:45	1:50	1:00	1:45	1:40
R04	1:10	1:20	1:20	1:00	1:20	1:20
R05	3:25	3:10	3:20	1:45	3:35	2:55
Combined with Transit Exemption Zones Compared to Future Case						
R01	1:15	1:10	1:20	0:50	1:05	1:10
R02	1:35	1:50	1:55	1:10	1:50	1:40
R04	1:10	1:15	1:20	1:00	1:20	1:20
R05	3:20	3:15	3:25	2:15	3:35	3:15

Table 10-15. 100th Evacuation Time Estimates Differences Between Build and No Build Cases

	Summer			Fall		
	Midweek	Weekend	Midweek Weekend	Midweek	Weekend	Midweek Weekend
Scenario:	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Region	**Midday**	**Midday**	**Nighttime**	**Midday**	**Midday**	**Nighttime**
ADUs and JADUs Compared to Future Case						
R01	5:15	5:40	5:05	3:05	5:50	5:00
R02	4:30	5:00	4:40	3:10	4:50	4:15
R04	0:00	0:00	0:00	0:00	0:00	0:00
R05	4:55	5:10	5:45	3:40	6:00	4:55
Middle Housing Compared to Future Case						
R01	0:15	0:05	0:20	0:10	0:25	0:00
R02	0:05	0:15	0:00	0:05	0:00	0:00
R04	0:00	0:00	0:00	0:00	0:00	0:00
R05	0:00	0:05	0:15	0:05	0:10	0:00
Combined Compared to Future Case						
R01	5:20	5:40	5:30	3:25	5:50	6:45
R02	4:45	5:05	4:45	3:15	5:00	4:35
R04	0:00	0:05	0:00	0:00	0:00	0:00
R05	5:20	5:40	6:45	3:40	6:05	5:25
ADU with Transit Exemption Zones Compared to Future Case						
R01	4:25	4:15	4:25	2:25	4:35	4:25
R02	4:05	4:15	3:45	2:30	4:00	3:25
R04	0:00	0:00	0:00	0:00	0:00	0:00
R05	4:10	4:25	4:40	2:35	4:45	4:40
Combined with Transit Exemption Zones Compared to Future Case						
R01	4:35	4:30	5:05	2:35	4:35	4:30
R02	4:05	4:15	3:50	2:45	4:10	3:35
R04	0:00	0:05	0:00	0:00	0:00	0:00
R05	4:10	4:25	5:05	2:40	4:55	4:40

Table 10-16. 90th Evacuation Time Estimates for Signal Optimization (Urgent Mobilization) Sensitivity Study

	Summer			Fall		
	Midweek	Weekend	Midweek Weekend	Midweek	Weekend	Midweek Weekend
Scenario:	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Region	**Midday**	**Midday**	**Evening**	**Midday**	**Midday**	**Evening**
City of Berkeley						
R02	2:25	1:50	1:35	3:05	1:45	1:30
R04	1:05	0:50	0:40	1:45	0:45	0:45

Table 10-17. 100th Evacuation Time Estimates for Signal Optimization (Urgent Mobilization) Sensitivity Study

	Summer			Fall		
	Midweek	Weekend	Midweek Weekend	Midweek	Weekend	Midweek Weekend
Scenario:	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Region	**Midday**	**Midday**	**Evening**	**Midday**	**Midday**	**Evening**
City of Berkeley						
R02	3:20	3:10	3:10	4:25	3:10	3:10
R04	3:10	3:10	3:10	3:10	3:10	3:10

11 RECOMMENDATIONS

This evacuation study explores how Berkeley's alerting systems, anticipated evacuee behaviors, estimated transportation resource needs, and roadway capacity and design will interact in large-scale emergencies. The results of this report can help inform Berkeley's disaster response planning, transportation and roadway planning, housing and land use development policies, and the individual evacuation plans of Berkeley households. This section uses the findings of this report to highlight recommendations for consideration by City officials.

Recommendations are summarized in Table 11-1.

11.1 Integrate Evacuation Study Concepts into City Policies and Response Planning

11.1.1 Emergency Response Strategies

It is recommended that the City consider integrating concepts from this Evacuation Study into emergency response plans and strategy development as described below.

The City can further contextualize evacuation time estimates in this report by overlaying evacuation time estimates with hazard-specific data (such as fire spread rates for fire regions, and tsunami arrival times on tsunami warning regions.) This integration of ETE and hazard data will help clarify the risk to the community from hazard events requiring large-scale evacuation.

The City can work to quantify likely resource shortfalls associated with the evacuation scenarios in this report through planning partnerships with transit providers serving Berkeley and the region, as well as emergency management and mutual aid partners at the Operational Area (County) and State. Section 8 identifies resource needs for transit-dependent evacuees. Planning partners can clarify regional and State capacity to provide support, as well as time estimates to mobilize those resources in localized and regional disaster scenarios.

The City can use congestion diagrams from this study (see Appendix F) to prioritize specific locations for Traffic Control Points (staff intersections and help improve traffic flow) during evacuations. Among the numerous competing life-safety needs associated with large-scale evacuations, responders can prioritize these locations for available traffic management resources to improve traffic flow and/or to reduce evacuation times. External traffic or pass-through traffic are vehicles with origins and destinations outside of the area being evacuated that pass through the area being evacuated during their trip. This traffic consumes the available roadway and transit capacity, reducing the available capacity to those most at risk, increasing congestion and prolonging ETE. During emergency evacuations, City responders can coordinate with partners to reduce or eliminate external/pass-through traffic. This can include use of electronic roadside signage, closure of off-ramps into Berkeley, and/or diversion of through traffic to other routes.

The City can encourage schools to develop and communicate site evacuation plans that enable parents and guardians to pick up their children at sites outside the evacuation zone. Making provisions for parents to pick up children outside the evacuation zone will reduce traffic congestion around schools in evacuation zones and will improve families' mobilization times.

11.1.2 Extreme Fire Weather Leave Early Policy

The Berkeley Fire Department should maintain its Leave Early Policy for extreme fire weather. Study results indicate population-level improvements such as the leave early policy could improve evacuation times by as much as 68% (Section 10.3). On the household level, Berkeley's Leave Early approach provides a targeted way for wildfire-exposed households to avoid fire evacuations. In a wildfire evacuation, fire may be present along the evacuation route, producing scorching radiant heat and oxygen-displacing gases. All evacuations involve potential for injury or death, if only from collisions and crashes.

In addition, the Fire Department may consider how the results of this study could be used to target Leave Early outreach efforts to residents who are most likely to have extended evacuation times. The policy is currently applied to all residents in Berkeley Fire Zones 2 & 3; staff may consider focusing on households at relatively greater risk due to extended mobilization times and/or on neighborhoods with extended driving times due to severe congestion.

11.1.3 Housing Development Policies

The City used this study to better understand how potential development in the Berkeley Hills could impact evacuation times (see Section 10.5). It is noted that these studies assessed impacts from the maximum potential levels of new residential development from ADUs/JADUs. These analyses therefore illustrate an upper bound of potential long-term impacts from ADU/JADU development in the Hillside Overlay. Based on the results of the study, it is recommended that the City institute separate, more restrictive ADU/JADU development provisions in the Hillside Overlay.

In addition, these studies identified impacts to evacuation times from a projection of likely development that could result from implementation of "Middle Housing" zoning changes. The results of this study indicated that in a repeat of the 1923 Fire (R02), Middle Housing could add between 5 and 10 minutes overall to ETEs. It is recommended that the City examine these increases in the context of fire spread scenarios. By overlaying fire spread data with evacuation time estimates, the City can better contextualize potential impacts to public health and safety from Middle Housing zoning changes.

Studies in Section 10.5 illustrate how increasing population density in an area, even when the added people do not own vehicles, can increase emergency evacuation times and create public safety impacts. More broadly, the City should consider impacts to evacuation when implementing zoning changes that could result in an increase in demand on roadways used by wildfire or tsunami evacuees. Simulation modeling could be employed to assess the impact of proposed development policies on evacuation times and congestion levels under emergency scenarios. This proactive approach can ensure that policymakers are able to consider emergency evacuation as part of the decision-making process.

11.2 Community Education and Household Evacuation Planning

Evacuation times, both for households and general populations at risk, are influenced by how quickly community members are alerted to an Evacuation Warning or Order, how quickly they can mobilize to begin their evacuation trips, and how quickly they can navigate the roadways to escape the hazard area. Reducing time in any of these three areas will speed individual and overall evacuation times and improve community safety in hazard events.

11.2.1 Community Alerting

The City of Berkeley maintains multiple emergency alerting systems for coordinated use in emergency evacuations, as described in Section 5.

It is recommended that the City consider conducting community education about Berkeley's evacuation zones, as well as the emergency alerting systems that will provide evacuation orders/warnings, and how community members can register for/opt-in to those systems. If the public is ready to receive emergency alerts, they can more quickly move into mobilization.

Additionally, the City should consider education to encourage potential evacuees to monitor evolving conditions and advisory announcements as well as maintain ongoing contact and communications with neighbors, friends, family members, support teams, and social media networks. These social connections will improve the distribution of the City's emergency alert information within the affected population. These social connections may also reduce mobilization time by connecting an evacuee to help with packing, carpooling, or ensuring they have an evacuation location ready with friends or family.

During an emergency evacuation, people outside the hazard area, who are not under evacuation order or warning, may still voluntarily evacuate. These voluntary evacuations reduce the available roadway capacity and contribute to traffic congestion. This increases evacuation times for people trying to escape the hazard area.[1] Public information and public messaging about who is at risk should be clear before and during an emergency so that community members who are not at risk are less likely to contribute to traffic congestion. The City may also consider including explicit instructions for people outside the hazard area to shelter in place, in order to reduce demand on roadways.

11.2.2 Improving Household Mobilization and Evacuation Travel Times

Mobilization is how quickly evacuees prepare to leave and enter the roadway system. Berkeley community members could take as long as 3.5 hours to mobilize. Higher mobilization times are associated with particular household decisions, such as waiting for commuters to return home, picking up children at school, or returning to the evacuation zone for any reason.

Evacuation travel time, or how long a vehicle is on the road, is increased with roadway

[1] Voluntary evacuation during an active wildfire is distinct from Berkeley Hills residents following Fire Department recommendations to leave early due to extreme fire weather, before a fire starts.

congestion. Reductions in vehicular traffic during emergency evacuations will help reduce congestion and speed evacuation travel times.

11.2.2.1 Community Education

The City should consider the results of this study when designing community education about household-level evacuation readiness. Community education may include the following concepts:

- Evacuees with vehicles should carpool (i.e., evacuate as a household in a single vehicle) to the extent possible to reduce the number of vehicles on the road, which will lessen traffic congestion and could reduce evacuation time. Evacuees with vehicle access should also be encouraged to include transit-dependent neighbors in their evacuation plans. Similarly, transit-dependent evacuees should be encouraged to improve their mobilization times by connecting with neighbors and making plans to carpool in an emergency evacuation.
- Evacuees should understand and practice using primary, secondary, and tertiary evacuation routes. An ability to react to changing conditions will improve a household's evacuation travel time and will contribute to a reduction in overall evacuation times by distributing traffic on available roadways (see Section 9).
- Parents and guardians should engage with their children's schools regarding evacuation plans, with the goal of reducing trips to pick up children from schools within an evacuation zone. Making provisions for parents to pick up children outside the evacuation zone will reduce traffic congestion around schools in evacuation zones and will improve families' mobilization times.
- Households should plan for commuters to remain outside of the evacuation zone and reunite with other household members outside the hazard area, instead of returning to the evacuation zone. This will reduce the household mobilization time.

11.2.3 Evacuating on Bicycle and Foot

The analysis in this document focuses on simulating and measuring vehicular traffic: 96.6% of Berkeley community members report that they plan to use a vehicle to evacuate. This high percentage is unsurprising, as many people will want to bring their valuable and sentimental items with them in an evacuation, and many people are not physically able and/or equipped to quickly leave on bike or foot.

However, some Berkeley community members plan to use bicycles or to walk during an evacuation. According to the demographic survey, citywide 2.2% of Berkeley residents, employees, and college students plan to evacuate on foot and 1.4% of people plan to evacuate on bicycle. In the hills specifically, these numbers decrease to 1.5% on foot and 0.5% on bicycle. This distinction could reflect the characteristics of the road network, which is winding, narrow, with significant elevation changes, versus relatively flat, wide, and gridded in the flats.

In addition to location, community members might be opting to walk or bike out for different reasons. Some households use bicycles and walking as their primary means of transportation. Others may not own or have access to a vehicle (which was the case for 7.5% of survey respondents Citywide). Still others may believe they will be able to evacuate more quickly on a bike or on foot than they could a vehicle. Past experience from the 1991 Oakland-Berkeley Hills Fire, as well as the analysis in this document, demonstrate the likelihood of significant traffic congestion in a fire, leading to the possibility that a fire could move faster than evacuating vehicles and overtake them.

From an individual evacuee perspective, the key issues to weigh in a cycling or pedestrian evacuation are speed and safety. The risks of driving out of an evacuating area are well-understood: collisions and traffic congestion can impede the evacuee's ability to escape the hazard area, creating the potential for exposure to the hazard while evacuating. Stated simply, there is an understood possibility that evacuees in vehicles could be stuck in traffic and overtaken by fire.

The assumption is that evacuating on foot or bike might be faster than evacuating in a vehicle. This analysis was not in the scope of this project.

The second key issue relates to evacuee safety. The risks present for people evacuating in vehicles (collisions and exposure to the hazard) are present for cyclists and pedestrians, and because of the lack of basic protections provided by the metal frame of a vehicle, they are heightened. Collisions are likely during evacuations, considering the high volume of people sharing the roadway under highly stressful conditions. The same collision may cause minor injuries/damage for a driver in a vehicle while a cyclist or pedestrian experiences serious injury or death. In addition, a significant injury would also divert critical emergency resources away from firefighting to attend to and transport patient(s) to the emergency room.

Secondly, exposure to the hazard at hand is also heightened for the cyclist or pedestrian. For instance, in a wildfire evacuation, fire may be present along the evacuation route, producing radiant heat and gases. Evacuees in vehicles have some protection from surrounding environmental conditions, reducing the initial impact of proximal wildfire. Evacuees on foot or bicycle will be exposed to scorching radiant heat and oxygen-displacing gases that are likely to significantly impact their ability to successfully evacuate an impacted area.

Berkeley's public safety officials recommend that biking and walking be considered as part of a household evacuation plan for a tsunami. This analysis does not assess the relative speeds of walking/biking compared to driving. Berkeley's public safety officials recommend that in some cases, for some individuals, walking or biking will provide a faster means of egress than driving. However, the circumstances under which walking or biking should be considered a primary means of egress are very specific and very limited.

Tsunami

In a tsunami, the potential area of impact has distinct geographic boundaries. If an evacuee can get outside of the inundation zone, they can reasonably assume that they will have made it to safety. In a tsunami, the arrival time and predicted location of the danger can be pre-defined.

These are advantages when evacuating on a bike or on foot – as long as the tsunami has not arrived, the fastest mode of travel that works for the individual will be the best option.

Depending on a tsunami's origin, an evacuee may be notified multiple hours in advance of its arrival onshore, allowing time with which they can safely navigate Berkeley's roadways on bike or on foot before a tsunami arrives. This means that a pedestrian or bicycling evacuation could be integrated as a primary option for a household or business tsunami evacuation plan. People who plan to bike or walk as their primary means of egress should evacuate at the earliest possible opportunity.

Wildfire

Wildfire presents a very different set of challenges from tsunami. The area of potential wildfire impact is not clearly defined and is highly dynamic due to the nature of wildfire spread. In a wildfire, the potential ignition locations are endless. A wildfire may start far away from Berkeley and grow before it impacts the community. Alternately, it may start within Berkeley. The speed of fire spread is variable depending on topography, fuel, and weather conditions. Ember cast can also ignite spot fires in advance of the main flame front.

Berkeley's public safety officials do not currently recommend biking or walking as a primary evacuation plan for wildfire. While, under some circumstances for some people, pedestrian or bicycle evacuation could potentially provide a faster means of egress than using a car, there are significant safety risks associated with this approach.

Ultimately, the decisions about when and how to evacuate belong to individuals, who will decide based on their own risk tolerance. All evacuations involve potential for injury or death, if only from collisions and crashes. The lowest-risk option is to pre-emptively leave the Berkeley Hills on days when the Berkeley Fire Department has declared extreme fire weather.

Cycling and walking: Impacts to overall evacuation times

This study does not specifically explore how overall roadway evacuation times change with a multimodal evacuation because of the 3.6% of evacuees citywide who plan to bike or walk instead of using a vehicle.

It could be posited that fewer cars on the roadway reduce vehicular congestion and could increase driving speeds. But it is beyond the scope of the study to identify how the interactions among cars, cyclists, and pedestrians leaving together sharing a roadway would change with additional cyclists/pedestrians and fewer vehicles. It is unknown whether a significant increase in people opting to evacuate via bicycle or on foot will significantly change overall evacuation times.

If it were assumed that cyclists and pedestrians could be considered removed from the roadways based on their chosen mode of egress, the sensitivity study examining the impacts to evacuation times from community members leaving the Berkeley hills early during extreme fire weather could serve as a proxy to define what kind of impacts on vehicular evacuation times would be created from more people opting to evacuate on foot or bike. (See Section 10.3 for details.)

While community members' evacuation plans may differ, it is critical that each household has a

plan that all members understand, that they practice the plan together, and that each person is able to perform their role under significant stress.

11.3 Increasing Roadway Capacity and Connectivity

These recommendations focus on how the roadway capacity (number of vehicles that can be processed in a given amount of time) and connectivity (route choice for evacuating vehicles) can be increased. The higher the roadway capacity and connectivity, the lower the evacuation time (with the same evacuating demand).

11.3.1 Traffic Calming Devices

This analysis indicates that the Traffic Calming Devices (TCDs) throughout the city are performing as designed, effectively reducing vehicular speeds and thus reducing the risk of severe injury and/or fatality traffic crashes. However, this intended function conflicts with the goal of evacuation, which is to expedite the egress of individuals from the affected area.

Appendix F identifies patterns of traffic congestion during evacuation and Appendix G highlights particular roadway constraints and traffic calming devices with notable impacts across various evacuation regions studied. It is strongly recommended that the City of Berkeley consider the following actions:

- Existing Infrastructure: Develop a citywide connectivity and evacuation capacity improvement strategy, integrating approaches such as actuated or adaptive signal timing and replacing TCDs with removable/retractable options, and other evolving technologies.
- Future infrastructure: Develop and implement a methodology to evaluate and consider evacuation efficiency and roadway capacity during the planning and implementation phases of future roadway infrastructure development, including TCD installations.
- First Responder response times: Develop and implement a methodology to assess impacts from TCDs to first responder response times in daily traffic environments.

11.3.2 Traffic Signal Improvements

Traffic signals are essential to the safe and efficient functioning of the roadway network and play a critical role during emergency evacuations. Their effectiveness in such scenarios is greatly enhanced when they remain operational during power outages and feature signal timing plans that are both optimized and adaptable to real-time traffic conditions. These capabilities help minimize the need for emergency personnel to manually direct traffic, allowing those resources to be deployed to more urgent, lifesaving duties.

To improve the resilience, coordination, and functionality of the City's traffic signal infrastructure, the following actions are recommended:

- Optimize Signal Timing Plans: Evaluate and implement improved signal timing strategies, including actuated and/or adaptive systems, to better manage traffic flow day-to-day and during emergencies. (See Section 10.6.) Many existing signals in the city are pre-timed

and lack flexibility. Adaptive signal control is particularly valuable during evacuations, as it can automatically adjust signal timings in response to real-time traffic conditions, helping to move large volumes of vehicles more efficiently and reduce congestion along key evacuation corridors.

- Install Battery Backup Systems: Upgrade all traffic signal cabinets to include battery backup systems that can operate for a minimum of 6-8 hours, ensuring continued signal operation during power outages and maintaining safe and coordinated traffic movement during evacuations.
- Enhance Emergency Vehicle Pre-emption: Evaluate potential improvements to traffic signal system to have the latest pre-emption equipment and capabilities. Pre-emption for Fire and Police Department vehicles is essential during day-to-day emergencies and evacuation events, as it allows responders to override normal signal operations, receive immediate green lights, and avoid delays. This capability ensures faster responder access to hazardous areas, supports evacuation logistics, and improves overall public safety and emergency response times.
- Strengthen Communications Infrastructure: Install a robust fiber-optic network to improve the reliability and speed of traffic signal communications. A strong communications backbone enables real-time monitoring and coordination, even if parts of the system experience disruptions.
- Deploy Smart Traffic Cameras: Install smart traffic cameras at key intersections and corridors to provide real-time detection, monitoring, and traffic data collection. These technologies support situational awareness, enable quicker response to traffic conditions, and facilitate adaptive signal control during emergencies.
- Implement Transit Signal Priority (TSP): Upgrade traffic signal system along Berkeley's highest capacity routes to ensure that public transit vehicles can move efficiently through congested corridors, reducing delays, and maximizing their ability to transport large numbers of people during day-to-day operations as well as evacuations.
- Coordinate Regionally: Work closely with surrounding jurisdictions to ensure interoperability and synchronization of traffic signal systems during emergency evacuations. Coordinated regional signal operations will help maintain consistent traffic flow, reduce delays at jurisdictional boundaries, and support broader evacuation strategies.
- Traffic Signal Software for Centralized Control: Assess the need for traffic signal software upgrades to enable full communication with external systems and centralized command through the City's envisioned Traffic Management Center (TMC). This ensures operators can remotely monitor and adjust traffic signals citywide during emergencies.

11.4 Parking Restrictions

Although temporary and permanent parking restrictions (such as red curbing) are unlikely to substantially improve evacuation flow (see Section 9), the City could consider the strategic implementation of parking restrictions along arterial roadways in the Berkeley Hills, with a focus on those roadways predominantly utilized by emergency response vehicles for ingress during

emergency response. This targeted approach would optimize maneuverability and reduce potential impedance for essential services without imposing broad restrictions that are unlikely to significantly improve overall evacuation egress flow.

The City may also evaluate and determine if temporary parking restrictions implemented on certain roadway segments only during hazardous conditions (e.g., fire weather) could improve responder ingress times during evacuation.

Table 11-1. Summary of Recommendations for Consideration by the City of Berkeley

Recommendation	Reasoning
1 Emergency Response Strategies	
1.1 Overlay evacuation time estimates with hazard-specific data (such as fire spread rates for fire regions, and tsunami arrival times on tsunami warning regions.)	This integration of ETE and hazard data will help clarify the risk to the community from hazard events requiring large-scale evacuation.
1.2 Develop regional/State planning partnerships to quantify resource shortfalls for transit-dependent evacuees.	Understanding resource shortfalls will inform approaches to address evacuation needs for transit-dependent evacuees.
1.3 Use study results to prioritize specific locations for Traffic Control Points (staffed intersections that help improve traffic flow) during evacuations.	Reduce congestion and improve traffic flow in evacuations.
1.4 During evacuations, reduce or eliminate external/pass-through traffic. This can include use of electronic roadside signage, closure of I-80 and CA-24 off-ramps into Berkeley, and/or diversion of through traffic to other routes.	Reduce roadway demand to reduce congestion and improve traffic flow in evacuations.
1.5 Encourage schools to develop and communicate site evacuation plans that enable parents and guardians to pick up their children at sites outside the evacuation zone.	Reduce traffic congestion around schools in evacuation zones and improve families' mobilization times.
2 Extreme Fire Weather Leave Early Policy	
2.1 Maintain Berkeley Fire Department Leave Early Policy for extreme fire weather. Focus on households at relatively greater risk due to extended mobilization times and/or on neighborhoods with extended driving times due to severe congestion.	Improve population-level evacuation times by reducing roadway demand. Reduce hazard exposure to evacuees by avoiding emergency evacuation altogether. Focus on populations most likely to have poor evacuation outcomes.

3	**Housing Development Policies**	
3.1	Institute separate, more restrictive ADU/JADU development provisions in the Hillside Overlay.	Mitigate potential impacts to evacuation times from ADU/JADU development in Berkeley's Hillside Overlay.
3.2	Examine ETE increases from Middle Housing zoning changes in the Hillside Overlay in the context of fire spread scenarios.	Contextualize potential impacts to public health and safety from Middle Housing zoning changes in order to mitigate potential impacts to evacuation times from Middle Housing development in Berkeley's Hillside Overlay.
3.3	Consider impacts to evacuation when implementing zoning changes that could result in an increase in demand on roadways used by wildfire or tsunami evacuees.	Provide data measuring public safety impacts from increased population density to decisionmakers. Update response plans to account for changes to evacuation time estimates.
4	**Community Alerting**	
4.1	Conduct community education about Berkeley's evacuation zones, the emergency alerting systems that will provide evacuation orders/warnings, and how community members can register for/opt-in to those systems.	If the public is ready to receive emergency alerts, they can more quickly move into mobilization.
4.2	Conduct community education to encourage potential evacuees to monitor evolving conditions and stay in contact with social networks.	Improve distribution of the City's emergency alert information within the affected population. Connecting potential evacuees to people who can help with evacuation preparedness to reduce mobilization times.
4.3	Clearly define areas at risk as well as areas not at risk in public alerts. Include explicit instructions for people outside the hazard area to shelter in place.	Reduce roadway demand.

5 Improving Household Mobilization and Evacuation Travel Times	
5.1 Encourage carpooling.	Lessen traffic congestion and reduce evacuation times. Reduce mobilization times for transit-dependent populations.
5.2 Encourage familiarity with primary, secondary, and tertiary evacuation routes.	Improve household evacuation time. Help reduce overall evacuation times by distributing traffic on available roadways.
5.3 Parents should make provisions with schools to pick up children outside the evacuation zone.	Reduce traffic congestion around schools in evacuation zones. Improve families' mobilization times.
5.4 Commuters should plan to remain outside of the evacuation zone and reunite with other household members outside the hazard area, instead of returning to the evacuation zone.	Reduce household mobilization times.
6 Evacuating on Bicycle and Foot	
6.1 Encourage community members to explore walking or cycling for household/business tsunami evacuation plans.	Walking or cycling may provide a faster escape from the tsunami inundation zone than vehicular evacuation. Tsunami areas of impact/locations of danger are clearly defined. Tsunami arrival times can be anticipated, often with multiple hours of advanced notice.
7 Traffic Calming Devices	

7.1	Existing Infrastructure: Develop a citywide connectivity and evacuation capacity improvement strategy, integrating approaches such as actuated or adaptive signal timing and replacing TCDs with removable/retractable options, and other evolving technologies.	Improve traffic flow and reduce congestion during evacuations while retaining pedestrian and cyclist protections for day-to-day use.
7.2	Future infrastructure: Develop and implement a methodology to evaluate and consider evacuation efficiency and roadway capacity during the planning and implementation phases of future roadway infrastructure development, including TCD installations.	Improve traffic flow and reduce congestion during evacuations while retaining pedestrian and cyclist protections for day-to-day use.
7.3	First Responder response times: Develop and implement a methodology to assess impacts from TCDs to first responder response times in daily traffic environments.	Provide data on public safety impacts of TCDs to decisionmakers.
8	**Traffic Signal Improvements**	
8.1	Optimize Signal Timing Plans: Evaluate and implement improved signal timing strategies, including actuated and adaptive systems.	Better manage traffic flow day-to-day and during emergencies.
8.2	Install Battery Backup Systems: Upgrade all traffic signal cabinets to include battery backup systems that can operate for a minimum of 6-8 hours.	Ensure continued signal operation during power outages and maintain safe and coordinated traffic movement during evacuations.
8.3	Enhance Emergency Vehicle Pre-emption: Evaluate potential improvements to traffic signal system to have the latest pre-emption equipment and capabilities.	Ensures faster emergency response times in both day-to-day and evacuation scenarios.

8.4	Strengthen Communications Infrastructure: Install a robust fiber-optic network to improve the reliability and speed of traffic signal communications.	Enable real-time monitoring and coordination, even if parts of the system experience disruptions.
8.5	Deploy Smart Traffic Cameras: Install smart traffic cameras at key intersections and corridors to provide real-time detection, monitoring, and traffic data collection.	Support situational awareness, enable quicker response to traffic conditions, and facilitate adaptive signal control during emergencies.
8.6	Implement Transit Signal Priority (TSP) for public transit vehicles: Upgrade traffic signal system along Berkeley's highest capacity routes.	Ensure that public transit vehicles can move efficiently through congested corridors, reducing delays, and maximizing their ability to transport large numbers of people during day-to-day operations as well as evacuations.
8.7	Coordinate Regionally: Work closely with surrounding jurisdictions to ensure interoperability and synchronization of traffic signal systems during emergency evacuations.	Help maintain consistent traffic flow, reduce delays at jurisdictional boundaries, and support broader evacuation strategies.
8.8	Traffic Signal Software for Centralized Control: Assess the need for traffic signal software upgrades to enable full communication with external systems and centralized command through the City's envisioned Traffic Management Center (TMC).	Ensure operators can remotely monitor and adjust traffic signals citywide during emergencies.
9	**Parking Restrictions**	
9.1	Explore parking restrictions along arterial roadways in the Berkeley Hills utilized by emergency response vehicles for ingress during emergency response.	Improve emergency responder ingress times during evacuations.

9.2	Explore temporary parking restrictions implemented on certain roadway segments only during hazardous conditions (e.g., fire weather).	Improve emergency responder ingress times during evacuations.

APPENDIX A

Glossary of Traffic Engineering Terms

A. GLOSSARY OF TRAFFIC ENGINEERING TERMS

This appendix provides a glossary of traffic engineering terms that are used throughout this report.

Table A-1. Glossary of Traffic Engineering Terms

Term	Definition
Analysis Network	A graphical representation of the geometric topology of a physical roadway system, which is comprised of directional links and nodes.
Link	A network link represents a specific, one-directional section of roadway. A link has both physical (length, number of lanes, topology, etc.) and operational (turn movement percentages, service rate, free-flow speed) characteristics.
Measures of Effectiveness	Statistics describing traffic operations on a roadway network.
Node	A network node generally represents an intersection of network links. A node has control characteristics, i.e., the allocation of service time to each approach link.
Origin	A location attached to a network link, within the city or Shadow Region, where trips are generated at a specified rate in vehicles per hour (vph). These trips enter the roadway system to travel to their respective destinations.
Prevailing Roadway and Traffic Conditions	Relates to the physical features of the roadway, the nature (e.g., composition) of traffic on the roadway and the ambient conditions (weather, visibility, pavement conditions, etc.).
Service Rate	Maximum rate at which vehicles, executing a specific turn maneuver, can be discharged from a section of roadway at the prevailing conditions, expressed in vehicles per second (vps) or vph.
Service Volume	Maximum number of vehicles which can pass over a section of roadway in one direction during a specified time period with operating conditions at a specified Level of Service (The Service Volume at the upper bound of Level of Service, E, equals Capacity). Service Volume is usually expressed as vph.
Signal Cycle Length	The total elapsed time to display all signal indications, in sequence. The cycle length is expressed in seconds.

Term	Definition
Signal Interval	A single combination of signal indications. The interval duration is expressed in seconds. A signal phase is comprised of a sequence of signal intervals, usually green, yellow, red.
Signal Phase	A set of signal indications (and intervals) which services a particular combination of traffic movements on selected approaches to the intersection. The phase duration is expressed in seconds.
Traffic (Trip) Assignment	A process of assigning traffic to paths of travel in such a way as to satisfy all trip objectives (i.e., the desire of each vehicle to travel from a specified origin in the network to a specified destination) and to optimize some stated objective or combination of objectives. In general, the objective is stated in terms of minimizing a generalized "cost". For example, "cost" may be expressed in terms of travel time.
Traffic Density	The number of vehicles that occupy one lane of a roadway section of specified length at a point in time, expressed as vehicles per mile (vpm).
Traffic (Trip) Distribution	A process for determining the destinations of all traffic generated at the origins. The result often takes the form of a Trip Table, which is a matrix of origin-destination traffic volumes.
Traffic Simulation	A computer model designed to replicate the real-world operation of vehicles on a roadway network, so as to provide statistics describing traffic performance. These statistics are called Measures of Effectiveness (MOE).
Traffic Volume	The number of vehicles that pass over a section of roadway in one direction, expressed in vph. Where applicable, traffic volume may be stratified by turn movement.
Travel Mode	Distinguishes between private auto, bus, rail, pedestrian and air travel modes.
Trip Table or Origin-Destination Matrix	A rectangular matrix or table, whose entries contain the number of trips generated at each specified origin, during a specified time period, that are attracted to (and travel toward) each of its specified destinations. These values are expressed in vph or in vehicles.
Turning Capacity	The capacity associated with that component of the traffic stream which executes a specified turn maneuver from an approach at an intersection.

APPENDIX B

Detailed Description of Study Procedure

B. DETAILED DESCRIPTION OF STUDY PROCEDURE

This appendix describes the activities that were performed to compute the Evacuation Time Estimates. The individual steps of this effort are represented as a flow diagram in Figure B-1. Each numbered step in the description that follows corresponds to the numbered element in the flow diagram.

Step 1

The first activity was to obtain Evacuation Zone information and create a geographic information system (GIS) base map. The study area is bounded by I-580, Piedmont Avenue, Moraga Avenue, State Route 13 and State Route 24 to the south and southeast, by the boundary of Tilden Park to the east, by Moeser Lane, San Pablo Avenue, Potrero Avenue, S 55th Street, and Bayview Avenue to the North, and by San Francisco Bay and I-580 to the West. The area that is outside of the city limits but within the study area boundary is called the Shadow Region. The base map incorporates the local roadway topology, a suitable topographic background and the Evacuation Zone boundaries.

Step 2

2020 Census block population and Census population growth (using 2023[1] population estimates published by the US Census) information was obtained in GIS format. This information was used to project the permanent resident population within the Evacuation Zones and Shadow Region to the year 2024 and to define the spatial distribution and demographic characteristics of the population within the study area.

Employee data were provided by the city and supplemented by the U.S. Census Longitudinal Employer-Household Dynamics from the OnTheMap Census analysis tool[2].

Visitor information is based on parking lot capacities within the city and the average annual tourists that visit the City of Berkeley.

Schools, medical facilities and juvenile homes data were provided by the City of Berkeley supplemented with internet searches.

Step 3

A kickoff meeting was conducted with major stakeholders. The purpose of the kickoff meeting was to present an overview of the work effort, identify key agency personnel, and indicate the data requirements for the study. Specific requests for information were presented to the city. Unique features of the study area were discussed to identify the local concerns that should be addressed by the ETE study.

[1] The annual population estimates prepared by the Census Bureau for the entire U.S. involves an extensive data gathering process. As such, population estimates are a year behind – 2024 data will be released in 2025. Thus, this 2024 update uses the 2023 census population estimates. The schedule for release of Census data is provided on the Census website: https://www.census.gov/programs-surveys/popest/about/schedule.html

[2] https://onthemap.ces.census.gov/

Step 4

Next, a physical survey of the roadway system in the study area was conducted to determine the geometric properties of the roadway sections, the channelization of lanes on each section of roadway, whether there are any turn restrictions or special treatment of traffic at intersections, the type and location of traffic calming devices, the type and functioning of traffic control devices, gathering signal timings for pre-timed traffic signals, and to make the necessary observations needed to estimate realistic values of roadway capacity.

Step 5

A demographic survey of households within the City of Berkeley was conducted to identify household dynamics, trip generation characteristics, and evacuation-related demographic information of the city population. This information was used to determine important study factors including the average number of evacuating vehicles used by each household, and the time required to perform pre-evacuation mobilization activities.

Step 6

A computerized representation of the physical roadway system, called a link-node analysis network, was developed using the UNITES software developed by KLD (See Section 1.3). Once the geometry of the network was completed, the network was calibrated using the information gathered during the road survey (Step 4). Estimates of roadway capacity for each link and other link-specific characteristics were introduced to the network description. Traffic signal timings were input accordingly. The link-node analysis network was imported into a GIS map. Census data was overlaid in the map, and origin centroids where trips would be generated during the evacuation process were assigned to appropriate links.

Step 7

The study area includes 106 Evacuation Zones. Regions (groupings of Evacuation Zones) that may be ordered to evacuate, were developed.

The need for evacuation can occur over a range of times, or variations of time-of-day, day-of-week, and season. Scenarios were developed to capture the variation in evacuation demand, roadway capacity and mobilization time, for different times of day, days of the week, and times of year.

Step 8

The input stream for the DYNEV II model, which integrates the dynamic traffic assignment and distribution model, DTRAD, with the evacuation simulation model, was created for a prototype evacuation case – the evacuation of all Evacuation Zones for a representative scenario.

Step 9

After creating this input stream, the DYNEV II System was executed on the prototype evacuation case to compute evacuating traffic routing patterns. DYNEV II contains an extensive suite of data diagnostics which check the completeness and consistency of the input data

specified. The analyst reviews all warning and error messages produced by the model and then corrects the database to create an input stream that properly executes to completion.

The model assigns destinations to all origin centroids consistent with a (general) outbound evacuation of the Evacuation Zones and Shadow Region, away from the hazard. The analyst may optionally supplement and/or replace these model-assigned destinations, based on professional judgment, after studying the topology of the analysis roadway network. The model produces link and network-wide measures of effectiveness as well as estimates of evacuation time.

Step 10

The results generated by the prototype evacuation case are critically examined. The examination includes observing the animated graphics (using the Evacuation Animator (EVAN) software which operates on data produced by DYNEV II) and reviewing the statistics output by the model. This is a labor-intensive activity, requiring the direct participation of skilled engineers who possess the necessary practical experience to interpret the results and to determine the causes of any problems reflected in the results.

Essentially, the approach is to identify those bottlenecks in the network that represent locations where congested conditions are pronounced and to identify the cause of this congestion. This cause can take many forms, either as excess demand due to high rates of trip generation, improper routing, a shortfall of capacity (as in a traffic calming device), or as a quantitative flaw in the way the physical system was represented in the input stream. This examination leads to one of two conclusions:

- The results are satisfactory; or
- The input stream must be modified accordingly.

This decision requires, of course, the application of the user's judgment and experience based upon the results obtained in previous applications of the model and a comparison of the results of the latest prototype evacuation case iteration with the previous ones. If the results are satisfactory in the opinion of the user, then the process continues with Step 13. Otherwise, proceed to Step 11.

Step 11

There are many "treatments" available to the user in resolving apparent problems. These treatments range from decisions to reroute the traffic by assigning additional evacuation destinations for one or more sources, imposing turn restrictions where they can produce significant improvements in capacity, changing the control treatment at critical intersections so as to provide improved service for one or more movements, or in prescribing specific treatments for channelizing the flow so as to expedite the movement of traffic along major roadway systems. Such "treatments" take the form of modifications to the original prototype evacuation case input stream. All treatments are designed to improve the representation of evacuation behavior.

Step 12

As noted above, the changes to the input stream must be implemented to reflect the modifications undertaken in Step 11. At the completion of this activity, the process returns to Step 9 where the DYNEV II System is again executed.

Step 13

The prototype evacuation case was used as the basis for generating all region and scenario-specific evacuation cases to be simulated. This process was automated through the UNITES user interface. For each specific case, the population to be evacuated, the trip generation distributions, the roadway capacity and speeds, and other factors are adjusted to produce a customized case-specific data set.

Step 14

All evacuation cases are executed using the DYNEV II System to compute ETE. Once results were available, quality control procedures were used to assure the results were consistent, dynamic routing was reasonable, and traffic congestion/bottlenecks were addressed properly.

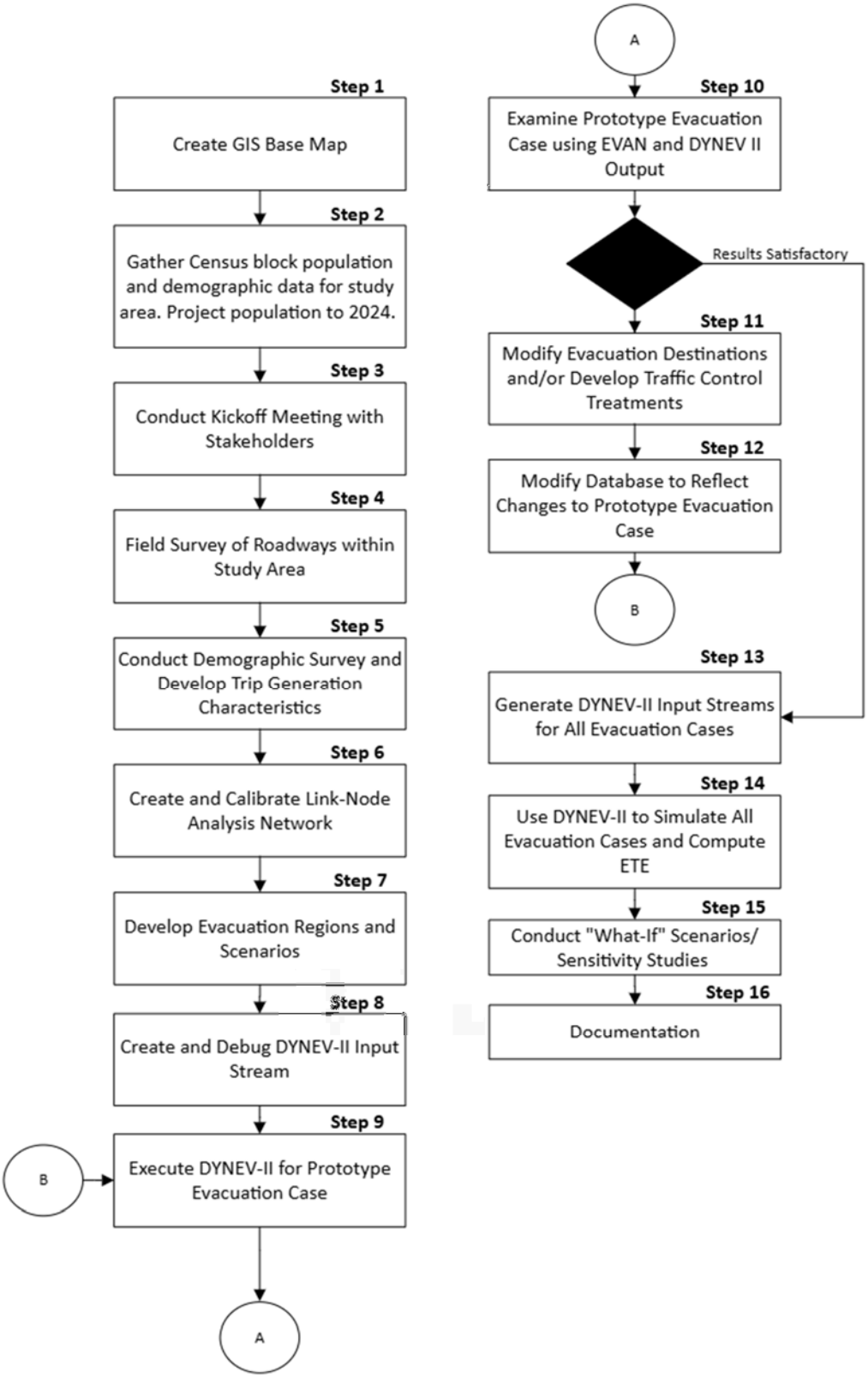
Step 15

Several ETE sensitivity studies were conducted to consider the impact on ETE based on "what if" scenarios. These scenarios were then compared to the baseline ETE (if possible) to test if certain tactics could be used to reduce evacuation time or to see the impact of changes in evacuating demand or roadway supply.

Step 16

The simulation results are analyzed, tabulated and graphed. The results were then documented.

Figure B-1. Flow Diagram of Activities



APPENDIX C

Facility Data

C. FACILITY DATA

This appendix lists population information, as of December 2024, for special facilities that were used in this study. Special facilities are defined as schools, preschools/day care centers, medical facilities, and juvenile homes. Maps of each school, preschool/day care center, medical facility, and juvenile home are provided. The estimates of tourist and employee population (see Section 3, Sub-sections 3.3 and 3.4, respectively) are summarized in the tables below.

Table C-1. K-12 Schools and Higher Education Sites within the City of Berkeley

Area(s)	Evacuation Zone	School Name	Street Address	Municipality	Enroll-ment
Berkeley Flats	BER-E014	Berkeley Rose Waldorf School	2515 Hillegass Ave	Berkeley	97
Berkeley Flats	BER-E014	Berkeley School of Theology	2606 Dwight Way	Berkeley	65
Berkeley Flats	BER-E025	Ruth Acty Elementary School	1400 Ada St	Berkeley	433
Berkeley Flats	BER-E025	The Crowden School	1475 Rose St	Berkeley	75
Berkeley Flats	BER-E026	Martin Luther King Middle School	1781 Rose St	Berkeley	1,007
Berkeley Flats	BER-E027	School of the Madeleine	1225 Milvia St	Berkeley	337
Berkeley Flats	BER-E038	Bayhill High School	1940 Virginia St	Berkeley	73
Berkeley Flats	BER-E038	Berkeley Arts Magnet at Whittier School	1645 Milvia St	Berkeley	407
Berkeley Flats	BER-E044	Berkeley City College	2050 Center St	Berkeley	6,519
Berkeley Flats	BER-E044	Berkeley High School	1980 Allston Way	Berkeley	3,427
Berkeley Flats	BER-E044	California Jazz Conservatory	2087 Addison St	Berkeley	88
Berkeley Flats	BER-E044	Pacific Boychoir Academy	215 Ridgeway Ave	Berkeley	30
Berkeley Flats	BER-E045	Berkwood Hedge School	1809 Bancroft Way	Berkeley	128
Berkeley Flats	BER-E046	Oxford Elementary at West Campus	1222 Univ Ave	Berkeley	256
Berkeley Flats	BER-E046	The Berkeley School	1310 University Ave	Berkeley	236
Berkeley Flats	BER-E052	Longfellow Arts and Technology Middle School	1500 Derby St	Berkeley	504
Berkeley Flats	BER-E053	Acupuncture and Integrative Medicine College-Berkeley	2550 Shattuck Ave	Berkeley	153
Berkeley Flats	BER-E053	Berkeley Technology Academy	2701 Mlk Jr. Way	Berkeley	36
Berkeley Flats	BER-E053	Walden Center & School	2446 Mckinley Ave	Berkeley	84
Berkeley Flats	BER-E053	Washington Elementary School	2300 Mlk Jr. Way	Berkeley	416
Berkeley Flats	BER-E054	East Bay School for Boys	2340 Durant Ave	Berkeley	105
Berkeley Flats	BER-E054	Institute of Buddhist Studies	2140 Durant Ave	Berkeley	53
Berkeley Flats	BER-E064	Sylvia Mendez Elementary School	2840 Ellsworth St	Berkeley	409
Berkeley Flats	BER-E065	The Elmwood Academy	2722 Benvenue Ave	Berkeley	100
Berkeley Flats	BER-E065	Willard Middle School	2425 Stuart St	Berkeley	669
Berkeley Flats	BER-E070	Malcolm X Elementary School	1731 Prince St	Berkeley	552

Area(s)	Evacuation Zone	School Name	Street Address	Municipality	Enroll-ment
Berkeley Flats	BER-E071	Escuela Bilingue Internacional School	410 Alcatraz Ave	Berkeley	324
Berkeley Flats	BER-E073	Emerson Elementary School	2800 Forest Ave	Berkeley	323
Berkeley Flats	BER-E073	Maybeck High School	2727 College Ave	Berkeley	121
North Berkeley Hills	BER-E001	Thousand Oaks Elementary School	840 Colusa Ave	Berkeley	382
North Berkeley Hills	BER-E009	Cragmont Elementary School	830 Regal Rd	Berkeley	331
North Berkeley Hills	BER-E016	Pacific Lutheran Theological Seminary	2770 Marin Ave	Berkeley	50
North Berkeley Hills	BER-E028	Dominican School of Philosophy & Theology	2301 Vine St	Berkeley	100
North Berkeley Hills	BER-E040	Church Divinity School of the Pacific	2451 Ridge Rd	Berkeley	122
North Berkeley Hills	BER-E040	Graduate Theological Union	2400 Ridge Rd	Berkeley	275
North Berkeley Hills	BER-E040	Jesuit School of Theology	1735 LeRoy Ave	Berkeley	112
North Berkeley Hills	BER-E040	Pacific School of Religion	1798 Scenic Ave	Berkeley	139
North Berkeley Hills	BER-E040	Zaytuna College	1712 Euclid Ave	Berkeley	43
South Berkeley Hills	BER-E055	The Wright Institute	2728 Durant Ave	Berkeley	638
South Berkeley Hills	BER-E076	John Muir Elementary School	2955 Claremont Ave	Berkeley	306
UC Berkeley	BER-E042	University of California - Berkeley	Oxford St	Berkeley	44,075
West Berkeley	BER-E047 East	Black Pine Circle School	2027 7th St	Berkeley	347
West Berkeley	BER-E047 East	Rosa Parks Environmental Science School	920 Allston Way	Berkeley	442
West Berkeley	BER-E047 West	VIA Center	2126 6th St	Berkeley	20
				TOTAL:	**64,409**

Table C-2. Preschools and Day Care Centers within the City of Berkeley

Area(s)	Evacuation Zone	Facility Name	Street Address	Municipality	Enroll-ment
Berkeley Flats	BER-E014	Berkeley Rose Waldorf School	2515 Hillegass Ave	Berkeley	24
Berkeley Flats	BER-E014	Hearts Leap Beginnings	2640 College Ave	Berkeley	40
Berkeley Flats	BER-E014	Hearts Leap ICRI Preschool	2638 College Ave	Berkeley	70
Berkeley Flats	BER-E022	Berkeley Little School	1611 Hopkins St	Berkeley	42
Berkeley Flats	BER-E024	Ala Costa Center for the Developmentally Disabled	1300 Rose St	Berkeley	58
Berkeley Flats	BER-E026	BUSD - Hopkins Street	1810 Hopkins St	Berkeley	140
Berkeley Flats	BER-E026	Mustard Seed Preschool	1640 Hopkins St	Berkeley	66
Berkeley Flats	BER-E027	Jewish Community Ctr of The East Bay-Berkeley	1414 Walnut St	Berkeley	75
Berkeley Flats	BER-E036	Cedar Creek Montessori School	1600 Sacramento St	Berkeley	40
Berkeley Flats	BER-E036	Woolly Mammoth Childcare & Preschool	1333 University Ave	Berkeley	69
Berkeley Flats	BER-E038	Berkeley Montessori School	2030 Francisco St	Berkeley	119
Berkeley Flats	BER-E038	The New School of Berkeley	1606 Bonita	Berkeley	48
Berkeley Flats	BER-E038	The New School of Berkeley-Schoolage	1924 Cedar St	Berkeley	45
Berkeley Flats	BER-E039	Hearts Leap North	2220 Cedar St	Berkeley	45
Berkeley Flats	BER-E045	Berkeley Special Education Preschool	2134 Mlk Jr. Way	Berkeley	90
Berkeley Flats	BER-E045	Berkeley YMCA EHS - Vera Casey	2246 Martin Luther King Jr Way	Berkeley	26
Berkeley Flats	BER-E045	Congregation Beth Israel-Gan Shalom	2230-32 Jefferson St	Berkeley	32
Berkeley Flats	BER-E045	Little Elephant Montessori, Inc.	2008 McGee Ave	Berkeley	24
Berkeley Flats	BER-E045	Shu Ren International School	2125 Jefferson Ave	Berkeley	179
Berkeley Flats	BER-E046	Berkeley International Montessori School	1227 Bancroft Way	Berkeley	21
Berkeley Flats	BER-E046	Child Education Center	2112 Browning St	Berkeley	107
Berkeley Flats	BER-E046	Congregation Netivot Shalom	1316 University Ave	Berkeley	30
Berkeley Flats	BER-E046	Little Beans Preschool	2117 Acton St	Berkeley	40
Berkeley Flats	BER-E046	Rosemarie's Motivational Preschool	1141 Bancroft Way	Berkeley	22
Berkeley Flats	BER-E053	BUSD - King Child Development Center	1939 Ward St	Berkeley	108
Berkeley Flats	BER-E054	Cornerstone Children's Center	2407 Dana St	Berkeley	112

Area(s)	Evacuation Zone	Facility Name	Street Address	Municipality	Enroll-ment
Berkeley Flats	BER-E054	UCB - Dwight Way Center	2427 Dwight Way	Berkeley	42
Berkeley Flats	BER-E054	UCB - Harold E. Jones Child Study Ctr/Childcare	2425 Atherton St	Berkeley	56
Berkeley Flats	BER-E054	UCB - Haste Street Child Development Center	2339 Haste St	Berkeley	92
Berkeley Flats	BER-E063	Berkeley YMCA Head Start - South YMCA	2901 California St	Berkeley	94
Berkeley Flats	BER-E068	Model School Comprehensive Humanistic Learning Ctr	2330 Prince St	Berkeley	63
Berkeley Flats	BER-E068	Through the Looking Glass Early Head Start	3075 Adeline Ave	Berkeley	24
Berkeley Flats	BER-E069	American International Montessori School	3339 Martin Luther King Jr Way	Berkeley	117
Berkeley Flats	BER-E069	Ephesian Children's Center	1907 Harmon Ave	Berkeley	36
Berkeley Flats	BER-E069	Mi Mundo Preschool	1866 Alcatraz Ave	Berkeley	29
Berkeley Flats	BER-E070	VIA Nova Children's School	3032 Martin Luther King Jr Way	Berkeley	45
Berkeley Flats	BER-E073	The Monteverde School	2727 College	Berkeley	30
Berkeley Flats	BER-E073	St. John's Child Care Center	2717 Garber St	Berkeley	45
North Berkeley Hills	BER-E006	Step One School	499 Spruce St	Berkeley	108
North Berkeley Hills	BER-E017	Berkeley Hills Nursery School	1161 Sterling Ave	Berkeley	40
North Berkeley Hills	BER-E020	Childrens Community Center	1140 Walnut St	Berkeley	52
North Berkeley Hills	BER-E021	Dandelion Nursery School, Inc	941 The Alameda	Berkeley	24
North Berkeley Hills	BER-E028	Beth El Nursery School	1301 Oxford St	Berkeley	74
UC Berkeley/South Berkley Hills	BER-E059	UCB - Clark Kerr Campus Children's Center	2900 Dwight Way, Bldg. #5	Berkeley	29
UC Berkeley/South Berkley Hills	BER-E059	UCB - Clark Kerr Preschool	2601 Warring St, Bldg. 15	Berkeley	29
South Berkeley Hills	BER-E076	Kids In Motion	2955 Claremont Ave	Berkeley	70
South Berkeley Hills	OKL-E008	Arbor Preschool East	207 Alvarado St	Berkeley	22
West Berkeley	BER-E023 East	BUSD - Franklin Preschool	1460 - 8th St	Berkeley	192
West Berkeley	BER-E023 East	Centro Vida Bilingual Childcare Center	1000 Camelia St	Berkeley	64
West Berkeley	BER-E023 West	Duck's Nest - Berkeley	1411 - 4th St	Berkeley	91
West Berkeley	BER-E023 West	Golden Gate Learning Center	1450 Sixth St	Berkeley	57

Area(s)	Evacuation Zone	Facility Name	Street Address	Municipality	Enroll-ment
West Berkeley	BER-E035 East	Bahia School Age Program	1718 - 8th St	Berkeley	65
West Berkeley	BER-E035 East	Dolma Child Care Center	1700 - 7th St	Berkeley	14
West Berkeley	BER-E047 East	Berkeley YMCA Head Start - West	2009 10th St	Berkeley	86
West Berkeley	BER-E047 East	Nia House Learning Center	2234 - 9th St	Berkeley	94
West Berkeley	BER-E050 East	Ecole Bilingue De Berkeley	1009 Heinz Ave	Berkeley	426
West Berkeley	BER-E050 East	Global Montessori International School	2830 - 9th St	Berkeley	90
West Berkeley	BER-E050 East	Pixar Child Development Center	2600 10th St	Berkeley	108
West Berkeley	BER-E050 East	Sunshine Preschool (CEID)	1035 Grayson St, Rm #8	Berkeley	45
West Berkeley	BER-E050 West	Aquatic Park School	830 Heinz Ave	Berkeley	77
				TOTAL:	**4,202**

Table C-3. Medical Facilities within the City of Berkeley

Area(s)	Evacuation Zone	Facility Name	Street Address	Municipality	Current Census	Ambu-latory Patients	Wheel-chair Patients	Bed-ridden Patients
Berkeley Flats	BER-E045	Silverado Memory Care Center	2235 Sacramento St	Berkeley	87	37	22	28
Berkeley Flats	BER-E046	Chaparral House	1309 Allston Way	Berkeley	42	6	18	18
Berkeley Flats	BER-E047 East	Elegance Berkeley	2100 San Pablo Ave	Berkeley	47	20	12	15
Berkeley Flats	BER-E053	Alta Bates Summit Medical Center - Herrick Campus	2001 Dwight Way	Berkeley	58	58	0	0
Berkeley Flats	BER-E061	Kyakameena Care Center	2131 Carleton St	Berkeley	60	26	15	19
Berkeley Flats	BER-E064	Berkeley Pines Care Center	2223 Ashby Ave	Berkeley	32	4	18	10
Berkeley Flats	BER-E064	Elmwood Care Center	2829 Shattuck Ave	Berkeley	77	33	19	25
Berkeley Flats	BER-E067	Alta Bates Summit Medical Center - Alta Bates Campus	2450 Ashby Ave	Berkeley	183	73	37	73
Berkeley Flats	BER-E068	Ashby Care Center	2270 Ashby Ave	Berkeley	29	5	14	10
North Berkeley Hills	BER-E012	New Bridge Foundation	2325 Hearst Ave & 1816 Scenic Ave	Berkeley	45	20	14	11
UC Berkeley/South Berkley Hills	BER-E059	Redwood Gardens Apartments	2951 Derby St	Berkeley	168	76	50	42
Berkeley Flats	BER-E061	Other medical facilities within the city[1]		Berkeley	10	10	-	-
Berkeley Flats	BER-E068			Berkeley	23	23	-	-
				TOTAL:	**861**	**391**	**219**	**251**

[1] In addition to the medical facilities identified by the City of Berkely, this table also includes data obtained from the 2020 Census, which gathered population data for skilled nursing facilities at the census block level. See Section 3, Sub-section 3.5.1 for additional information.

Table C-4. Juvenile Homes[2] within the City of Berkeley

Area	Evacuation Zone	Facility Name	Street Address	Municipality	Current Census
Berkeley Flats	BER-E070	Juvenile homes within the city		Berkeley	2
West Berkeley	BER-E047 West			Berkeley	3
West Berkeley	BER-E047 East			Berkeley	4
				TOTAL:	**9**

Table C-5. Major Employers[3] within the City of Berkeley

Area(s)	Evacuation Zone	Facility Name	Street Address	Municipality	Employees Commuting into the City	Employees Commuting into the City by Public Transit	Employees Commuting into the City by Private Vehicles
Berkeley Flats	BER-E026	Various Locations throughout the city			111	40	71
Berkeley Flats	BER-E027				92	33	59
Berkeley Flats	BER-E036				271	97	174
Berkeley Flats	BER-E037				107	38	69
Berkeley Flats	BER-E038				578	206	372
Berkeley Flats	BER-E044				246	88	158
Berkeley Flats	BER-E044				157	56	101
Berkeley Flats	BER-E044				144	51	93
Berkeley Flats	BER-E044				124	44	80
Berkeley Flats	BER-E044				116	41	75
Berkeley Flats	BER-E044				90	32	58
Berkeley Flats	BER-E045				146	52	94
Berkeley Flats	BER-E053				261	93	168

[2] The 2020 Census data indicates that 9 people live at juvenile homes within the City of Berkeley. See Section 3, Sub-section 3.5.2 for additional information.

[3] The major employer locations identified by the City of Berkeley are shown in Figure C-12. The locations are represented by circles which increase in size proportional to the number of employees commuting into the city. See Section 3, Sub-section 3.4 for detailed information.

Area(s)	Evacuation Zone	Facility Name	Street Address	Municipality	Employees Commuting into the City	Employees Commuting into the City by Public Transit	Employees Commuting into the City by Private Vehicles
Berkeley Flats	BER-E053				87	31	56
Berkeley Flats	BER-E053				87	31	56
Berkeley Flats	BER-E061				89	32	57
Berkeley Flats	BER-E064				179	64	115
Berkeley Flats	BER-E065				288	103	185
Berkeley Flats	BER-E065				116	41	75
Berkeley Flats	BER-E067				1,289	460	829
Berkeley Flats	BER-E067				301	107	194
Berkeley Flats	BER-E067				119	42	77
Berkeley Flats	BER-E067				97	35	62
Berkeley Flats	BER-E068				130	46	84
Berkeley Flats	BER-E069				119	42	77
Berkeley Flats	BER-E069				115	41	74
Berkeley Flats	BER-E069				94	34	60
Lawrence Berkeley National Lab	LBL Zones				3,028	1,081	1,947
South Berkeley Hills	BER-E055				172	61	111
UC Berkeley	BER-E043				11,435	4,082	7,353
UC Berkeley	BER-E043				118	42	76
West Berkeley	BER-E023 East				249	89	160
West Berkeley	BER-E023 East				100	36	64
West Berkeley	BER-E023 East				102	36	66
West Berkeley	BER-E023 West				358	128	230
West Berkeley	BER-E023 West				168	60	108
West Berkeley	BER-E023 West				180	64	116
West Berkeley	BER-E023 West				159	57	102

Area(s)	Evacuation Zone	Facility Name	Street Address	Municipality	Employees Commuting into the City	Employees Commuting into the City by Public Transit	Employees Commuting into the City by Private Vehicles
West Berkeley	BER-E034				126	45	81
West Berkeley	BER-E035 West				728	260	468
West Berkeley	BER-E035 West				142	51	91
West Berkeley	BER-E047 East				341	122	219
West Berkeley	BER-E047 West				837	299	538
West Berkeley	BER-E047 West				209	75	134
West Berkeley	BER-E047 West				158	56	102
West Berkeley	BER-E047 West				89	32	57
West Berkeley	BER-E050 East				279	100	179
West Berkeley	BER-E050 East				129	46	83
West Berkeley	BER-E050 East				106	38	68
West Berkeley	BER-E050 East				95	34	61
West Berkeley	BER-E050 East				87	31	56
West Berkeley	BER-E050 West				164	59	105
West Berkeley	BER-E050 West				139	50	89
West Berkeley	BER-E050 West				90	32	58
				TOTAL:	**25,341**	**9,046**	**16,295**

Table C-6. Tourists[4] within the Study Area

Area(s)	Evacuation Zone	Facility Name	Street Address	Municipality	Tourists
Berkeley Flats	ALB-E006	Various Locations throughout the city			151

[4] The locations of the tourists are unavailable. It is assumed that tourists can visit any tourist attractions within the City of Berkeley and their vehicles are located along streets where street parking is allowed as well as in the parking garages available. See Section 3, Sub-section 3.3 for more details.

Area(s)	Evacuation Zone	Facility Name	Street Address	Municipality	Tourists
Berkeley Flats	ALB-E007				1
Berkeley Flats	ALB-E008				130
Berkeley Flats	BER-E014				207
Berkeley Flats	BER-E022				549
Berkeley Flats	BER-E024				395
Berkeley Flats	BER-E025				271
Berkeley Flats	BER-E026				600
Berkeley Flats	BER-E027				445
Berkeley Flats	BER-E036				751
Berkeley Flats	BER-E037				624
Berkeley Flats	BER-E038				362
Berkeley Flats	BER-E039				180
Berkeley Flats	BER-E044				351
Berkeley Flats	BER-E045				467
Berkeley Flats	BER-E046				500
Berkeley Flats	BER-E051				765
Berkeley Flats	BER-E052				609
Berkeley Flats	BER-E053				612
Berkeley Flats	BER-E054				357
Berkeley Flats	BER-E056				184
Berkeley Flats	BER-E060				119
Berkeley Flats	BER-E061				344
Berkeley Flats	BER-E062				408
Berkeley Flats	BER-E063				569
Berkeley Flats	BER-E064				497
Berkeley Flats	BER-E065				331
Berkeley Flats	BER-E067				246
Berkeley Flats	BER-E068				322

Area(s)	Evacuation Zone	Facility Name	Street Address	Municipality	Tourists
Berkeley Flats	BER-E069				142
Berkeley Flats	BER-E070				568
Berkeley Flats	BER-E071				315
Berkeley Flats	BER-E072				330
Berkeley Flats	BER-E073				397
Berkeley Flats	BER-E074				13
Berkeley Flats	BER-E075				19
Berkeley Flats	OKL-E020				2
Berkeley Flats	OKL-E021				3
Berkeley Flats	OKL-E022				9
Berkeley Flats	OKL-E241				85
Lawrence Berkeley National Lab	LBL-E001				0
Lawrence Berkeley National Lab	LBL-E002				0
Lawrence Berkeley National Lab	LBL-E003				0
Lawrence Berkeley National Lab	LBL-E004				0
Lawrence Berkeley National Lab	LBL-E005				0
Lawrence Berkeley National Lab	LBL-E006				0
North Berkeley Hills	BER-E001				341
North Berkeley Hills	BER-E002				446
North Berkeley Hills	BER-E003				200
North Berkeley Hills	BER-E004				256
North Berkeley Hills	BER-E005				145
North Berkeley Hills	BER-E006				164
North Berkeley Hills	BER-E007				199
North Berkeley Hills	BER-E008				268
North Berkeley Hills	BER-E009				264
North Berkeley Hills	BER-E010				270
North Berkeley Hills	BER-E011				345

Area(s)	Evacuation Zone	Facility Name	Street Address	Municipality	Tourists
North Berkeley Hills	BER-E012				138
North Berkeley Hills	BER-E015				351
North Berkeley Hills	BER-E016				422
North Berkeley Hills	BER-E017				271
North Berkeley Hills	BER-E018				250
North Berkeley Hills	BER-E019				327
North Berkeley Hills	BER-E020				358
North Berkeley Hills	BER-E021				232
North Berkeley Hills	BER-E028				544
North Berkeley Hills	BER-E029				316
North Berkeley Hills	BER-E030				203
North Berkeley Hills	BER-E031				353
North Berkeley Hills	BER-E032				327
North Berkeley Hills	BER-E033				133
North Berkeley Hills	BER-E040				369
South Berkeley Hills	BER-E013				245
South Berkeley Hills	BER-E055				106
South Berkeley Hills	BER-E057				95
South Berkeley Hills	BER-E058				266
UC Berkeley/South Berkley Hills	BER-E059				220
South Berkeley Hills	BER-E066				38
South Berkeley Hills	BER-E076				193
South Berkeley Hills	BER-E077				10
South Berkeley Hills	BER-E078				178
South Berkeley Hills	OKL-E004				11
South Berkeley Hills	OKL-E007				13
South Berkeley Hills	OKL-E008				115
South Berkeley Hills	OKL-E009				28

Area(s)	Evacuation Zone	Facility Name	Street Address	Municipality	Tourists
South Berkeley Hills	OKL-E010				51
South Berkeley Hills	OKL-E015				22
South Berkeley Hills	OKL-E017				13
South Berkeley Hills	OKL-E018				180
South Berkeley Hills	OKL-E019				82
UC Berkeley	BER-E041				354
UC Berkeley	BER-E042				404
UC Berkeley	BER-E043				439
UC Berkeley	OKL-E001				239
UC Berkeley	OKL-E002				483
West Berkeley	BER-E023 East				427
West Berkeley	BER-E023 West				680
West Berkeley	BER-E034				1,920
West Berkeley	BER-E035 East				316
West Berkeley	BER-E035 West				492
West Berkeley	BER-E047 East				418
West Berkeley	BER-E047 West				512
West Berkeley	BER-E048				537
West Berkeley	BER-E049				85
West Berkeley	BER-E050 East				527
West Berkeley	BER-E050 West				513
Shadow Region		Tilden Park Golf Course[5]	10 Golf Course Dr	Berkeley	260
Shadow Region		Tilden Regional Park[5]	2501 Grizzly Peak Blvd	Orinda	993
				TOTAL:	**32,187**

[5] Tilden Park Golf Course and Tilden Regional Park are located in the Shadow Region and considered in this study due to the close proximity to the city.

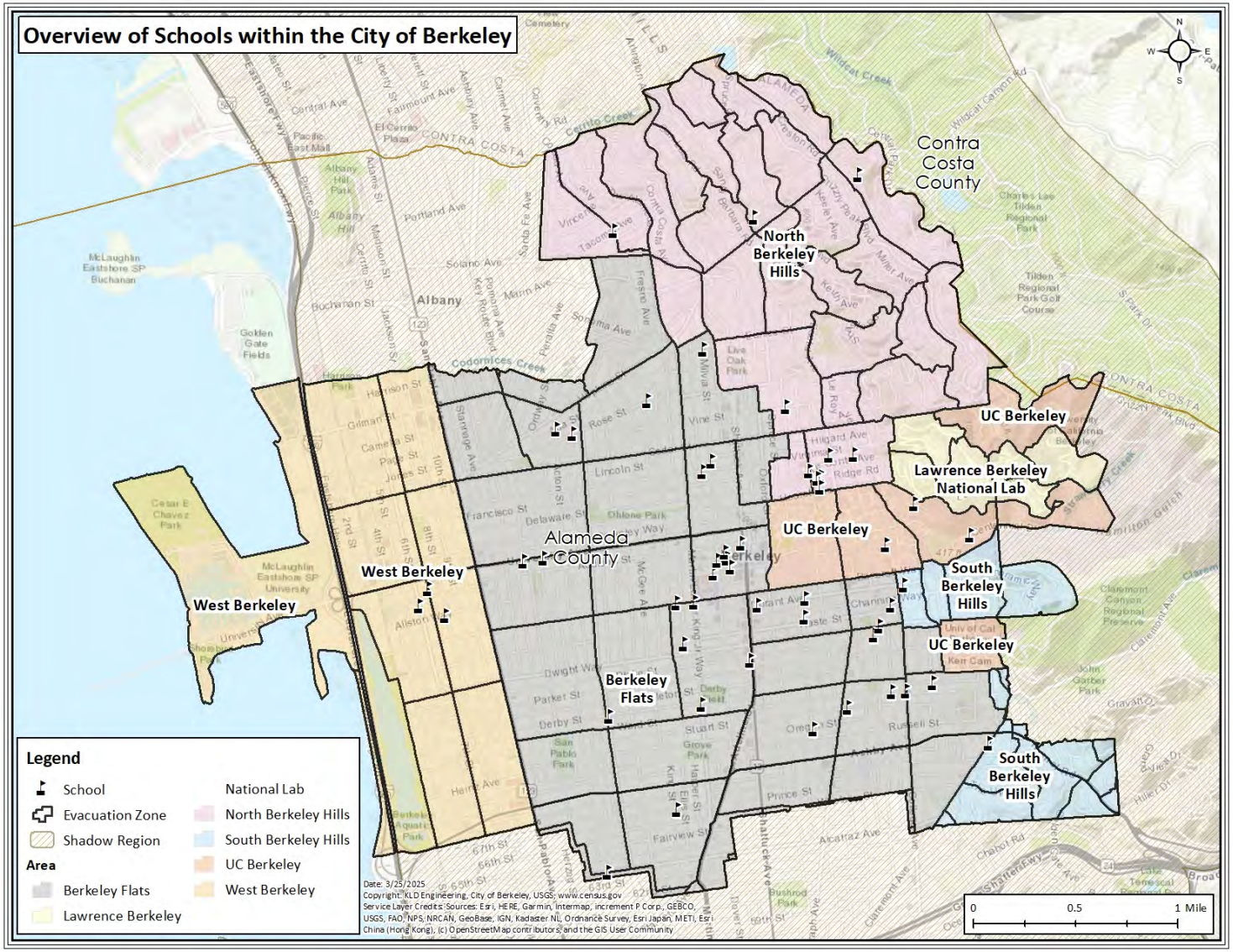


Figure C-1. Overview of K-12 Schools and Higher Education Sites within the City of Berkeley

Map No.	Facility Name
1	Acupuncture and Integrative Medicine College-Berkeley
2	Bayhill High School
3	Berkeley Arts Magnet at Whittier School
4	Berkeley City College
5	Berkeley High School
6	Berkeley Rose Waldorf School
7	Berkeley School of Theology
8	Berkeley Technology Academy
9	Berkwood Hedge School
10	California Jazz Conservatory
11	East Bay School for Boys
12	Emerson Elementary School
13	Escuela Bilingue Internacional School
14	Institute of Buddhist Studies
15	Longfellow Arts and Technology Middle School
16	Malcolm X Elementary School
17	Martin Luther King Middle School
18	Maybeck High School
19	Oxford Elementary at West Campus
20	Pacific Boychoir Academy
21	Ruth Acty Elementary School
22	School of the Madeleine
23	Sylvia Mendez Elementary School
24	The Berkeley School
25	The Crowden School
26	The Elmwood Academy
27	Walden Center & School
28	Washington Elementary School
29	Willard Middle School

Schools in Berkeley Flats Area

Legend

School | Evacuation Zone | Shadow Region

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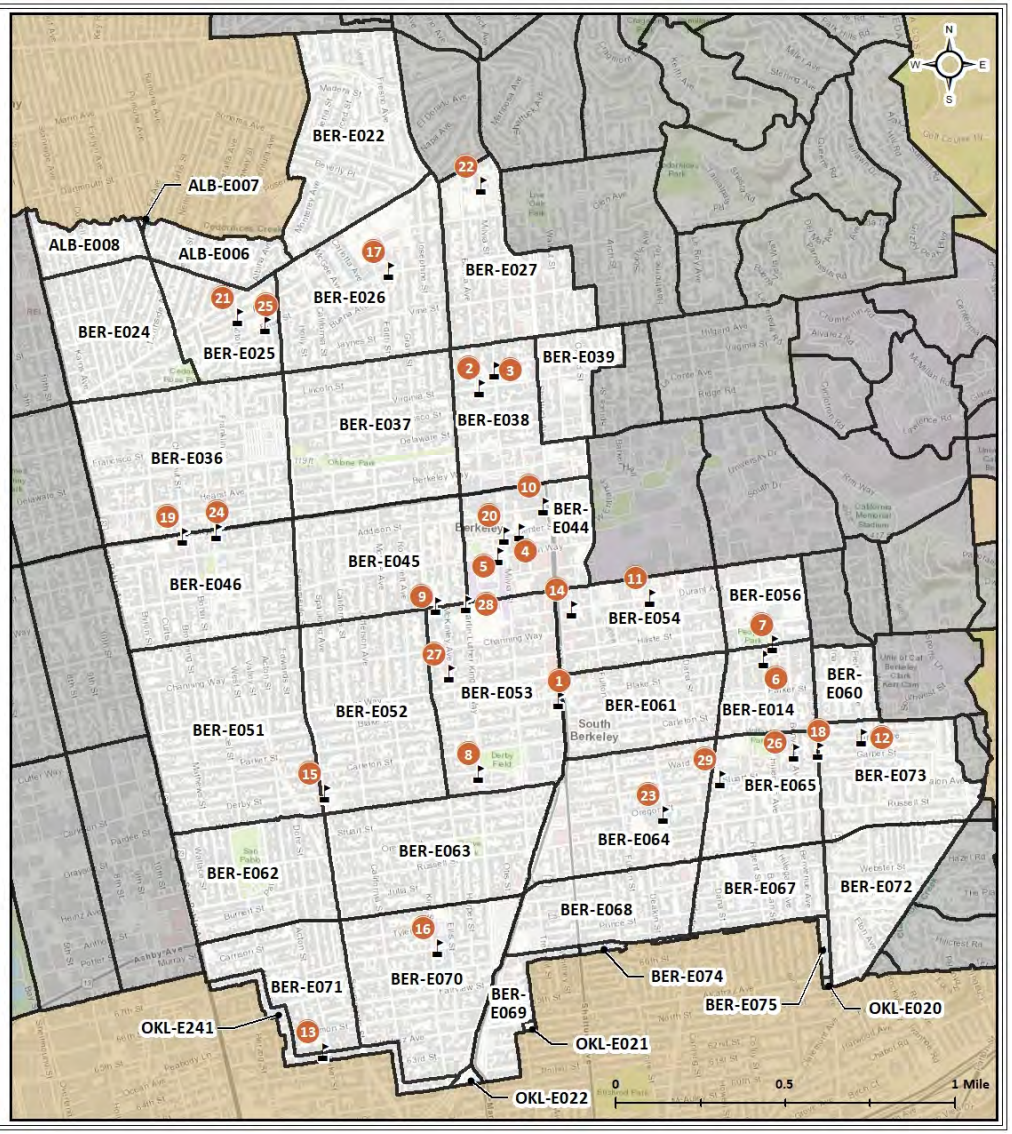


Figure C-2. K-12 Schools and Higher Education Sites in Berkeley Flats Area

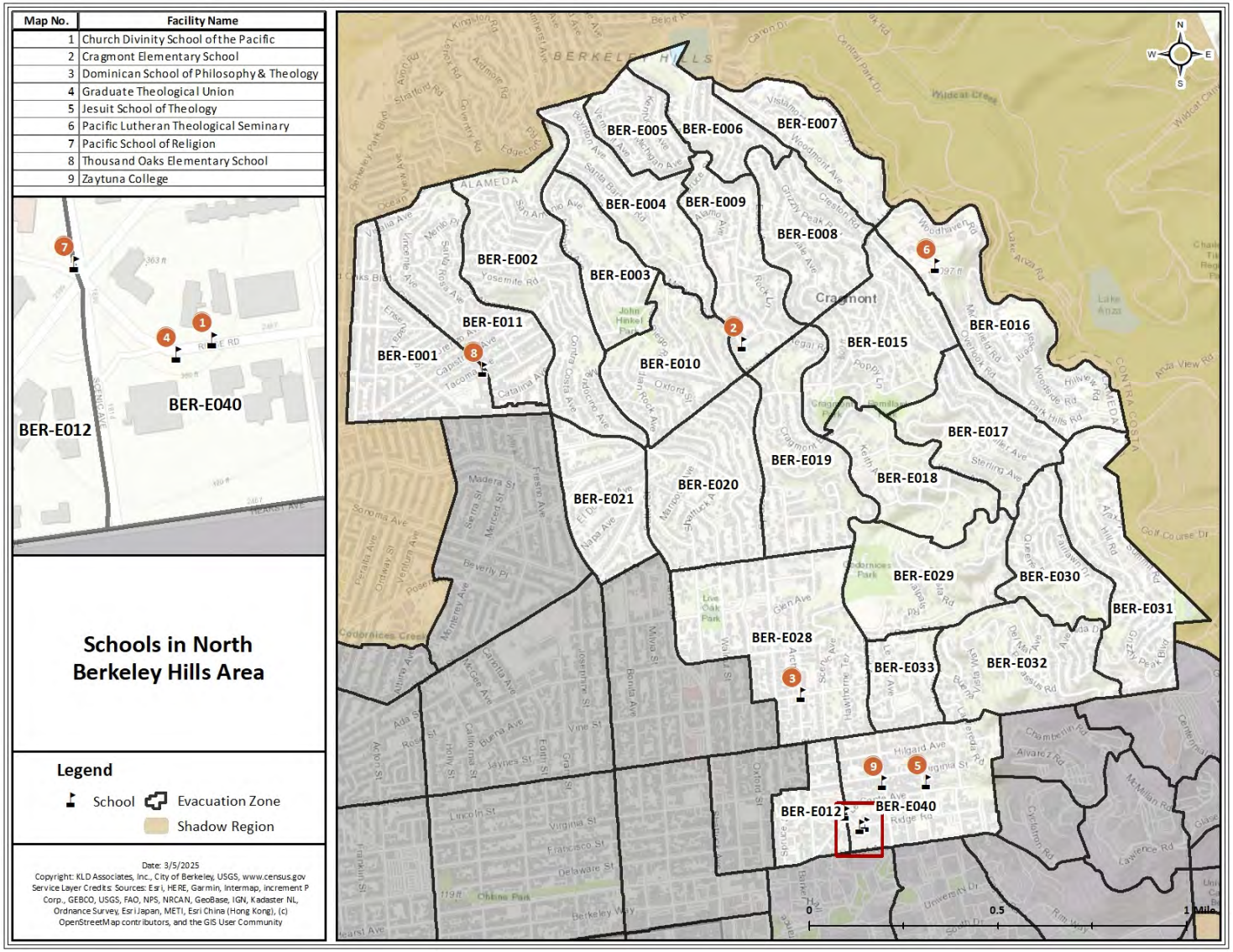


Figure C-3. K-12 Schools and Higher Education Sites in North Berkeley Hills Area

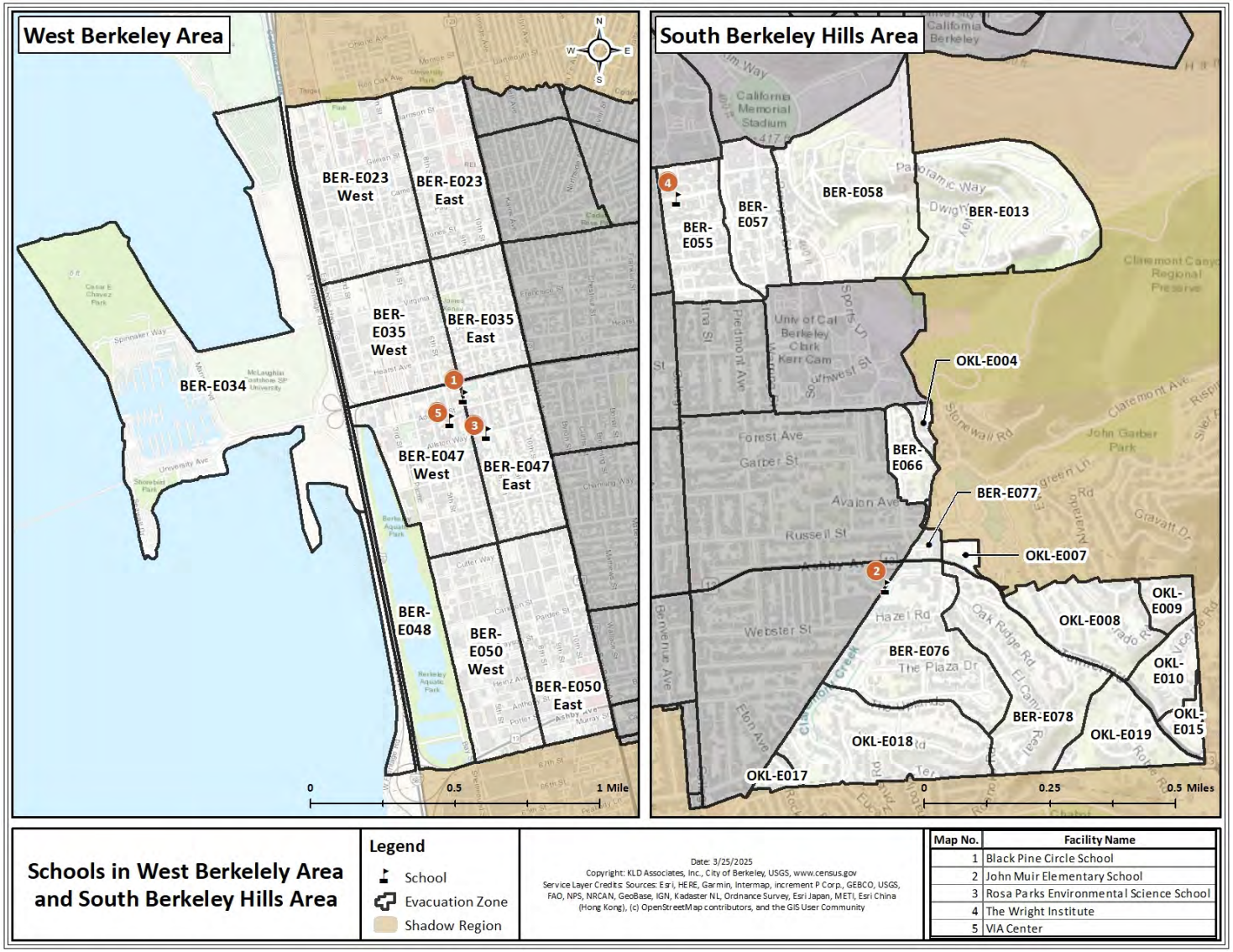


Figure C-4. K-12 Schools and Higher Education Sites in West Berkeley and South Berkeley Hills Areas

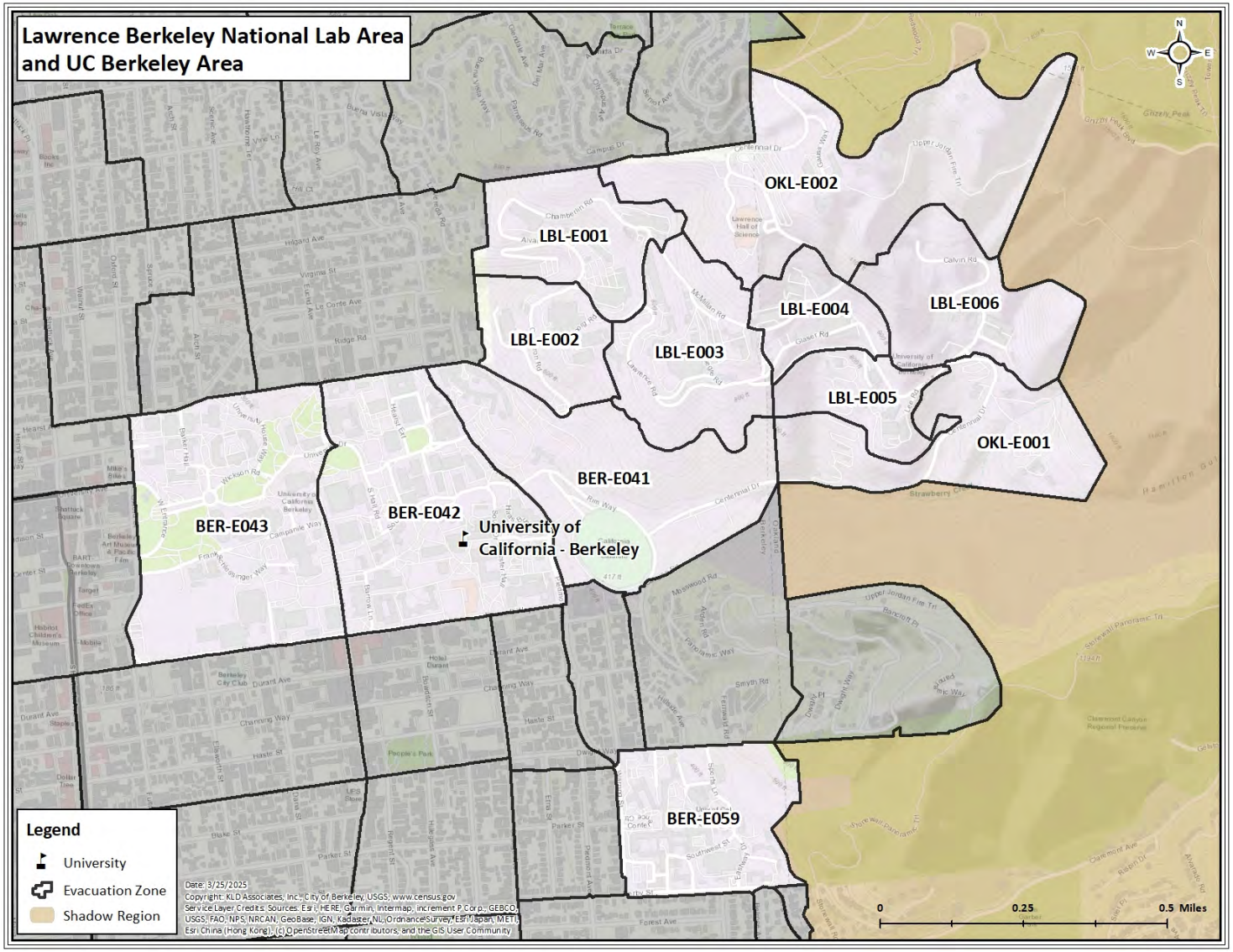


Figure C-5. S K-12 Schools and Higher Education Sites in Lawrence Berkeley National and UC Berkeley Areas

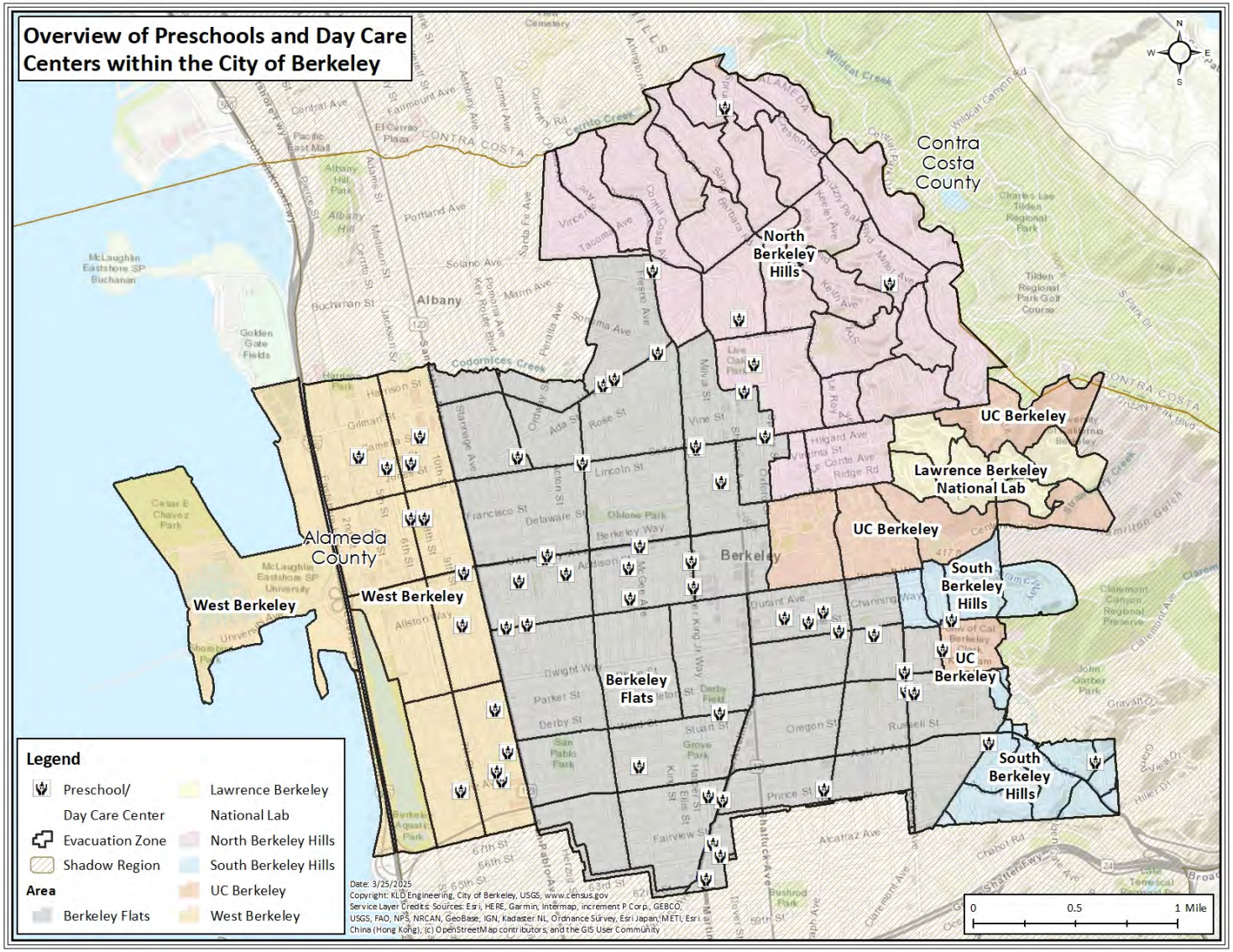


Figure C-6. Overview of Preschools and Day Care Centers within the City of Berkeley

Map No.	Facility Name
1	Ala Costa Ctr. For The Developmentally Disabled
2	American International Montessori School
3	Berkeley International Montessori School
4	Berkeley Little School
5	Berkeley Montessori School
6	Berkeley Rose Waldorf School
7	Berkeley Special Education Preschool
8	Berkeley YMCA EHS - Vera Casey
9	Berkeley YMCA Head Start - South YMCA
10	BUSD - Hopkins Street
11	BUSD - King Child Development Center
12	Cedar Creek Montessori School
13	Child Education Center
14	Congregation Beth Israel-Gan Shalom
15	Congregation Netivot Shalom
16	Cornerstone Children's Center
17	Ephesian Children's Center
18	Hearts Leap Beginnings
19	Hearts Leap ICRI Preschool
20	Hearts Leap North
21	Jewish Community Ctr of The East Bay-Berkeley
22	Little Beans Preschool
23	Little Elephant Montessori, Inc.
24	Mi Mundo Preschool
25	Model School Comprehensive Humanistic Learning Ctr
26	Mustard Seed Preschool
27	Rosemarie's Motivational Preschool
28	Shu Ren International School
29	St. John's Child Care Center
30	The Monteverde School
31	The New School of Berkeley
32	The New School Of Berkeley-Schoolage
33	Through the Looking Glass Early Head Start
34	UCB - Dwight Way Center
35	UCB - Harold E. Jones Child Study Ctr/Childcare
36	UCB - Haste Street Child Development Center
37	VIA Nova Children's School
38	Woolly Mammoth Childcare & Preschool

Preschools and Day Care Centers in Berkeley Flats Area

Legend

Preschool/ Day Care Center

Evacuation Zone

Shadow Region

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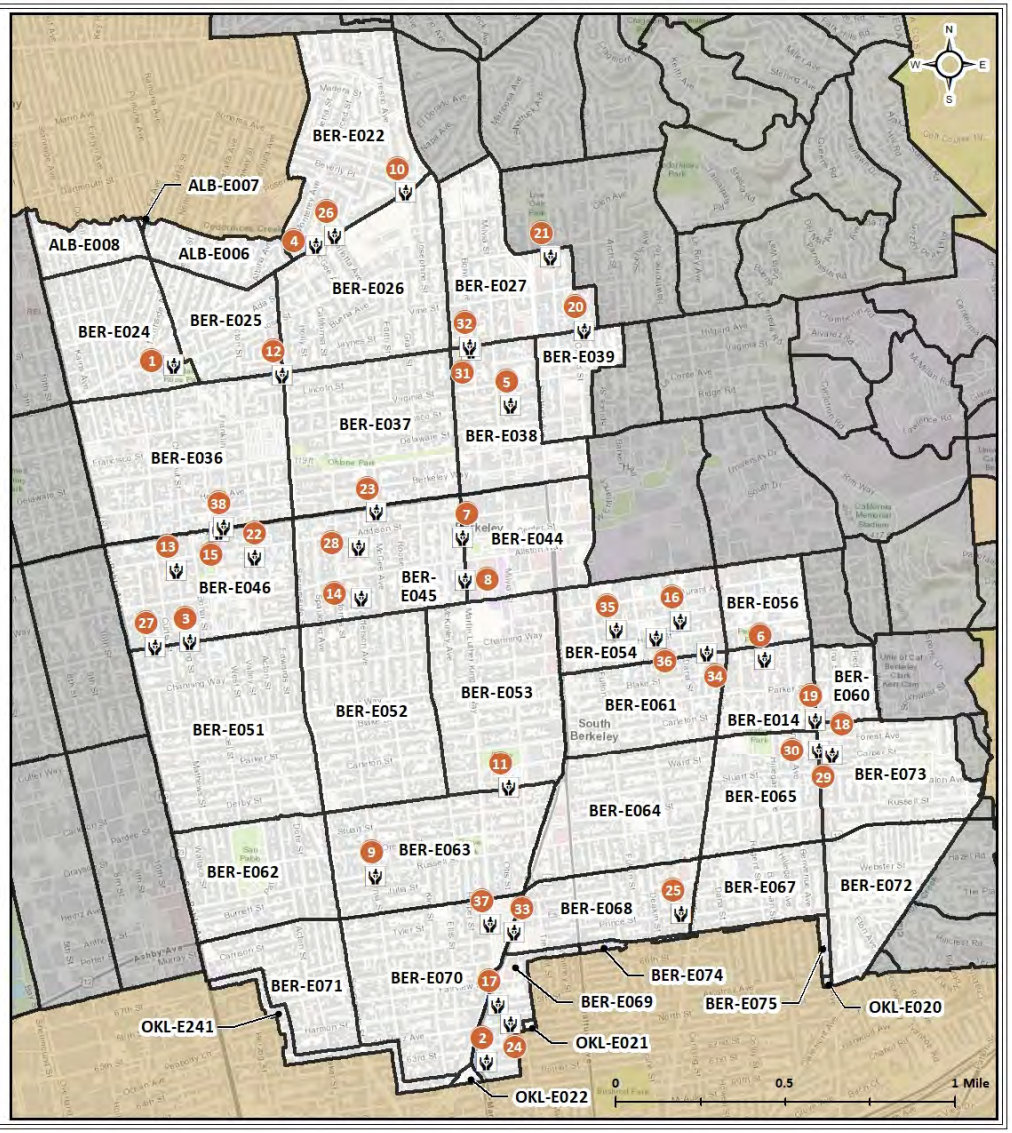


Figure C-7. Preschools and Day Care Centers in Berkeley Flats Area

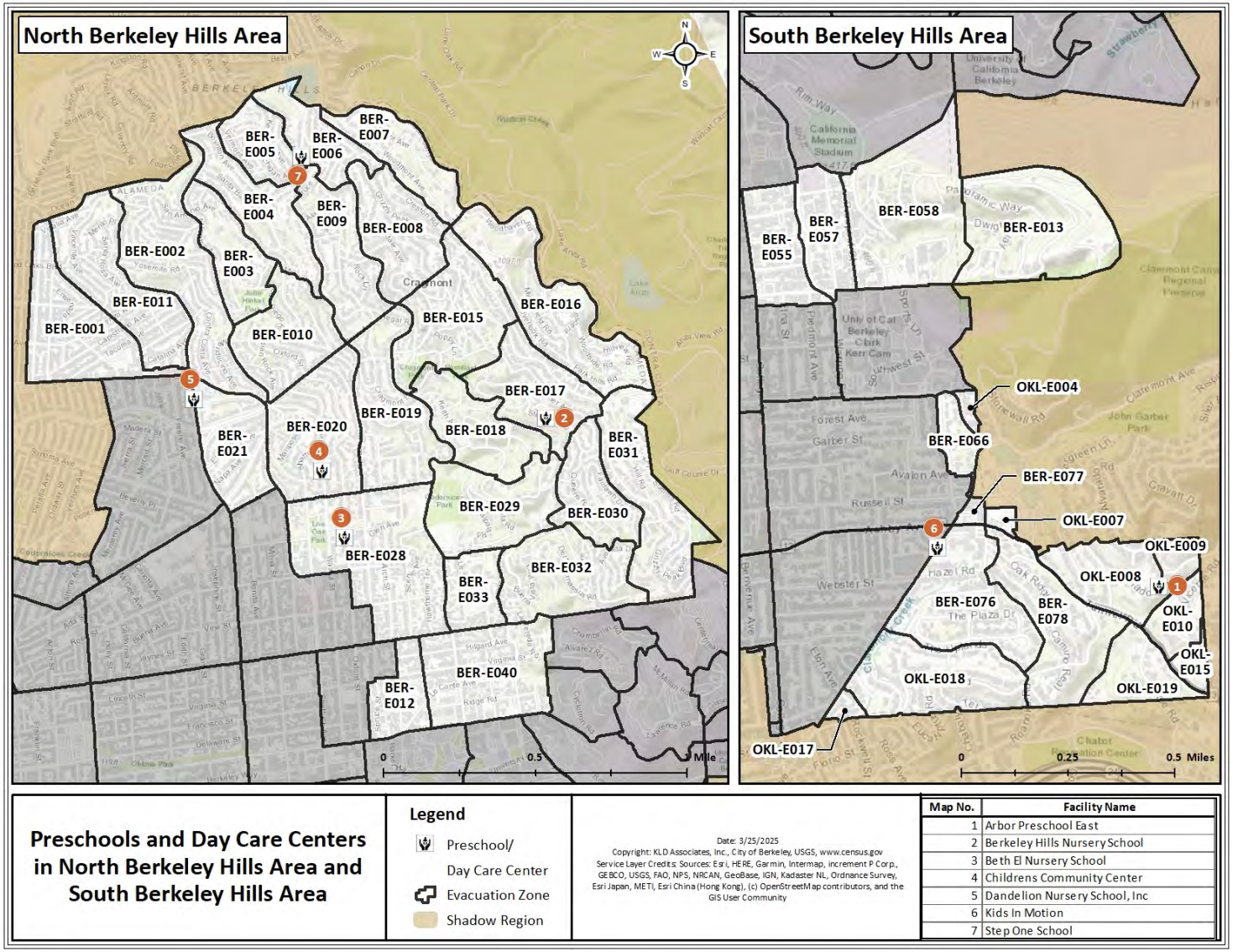
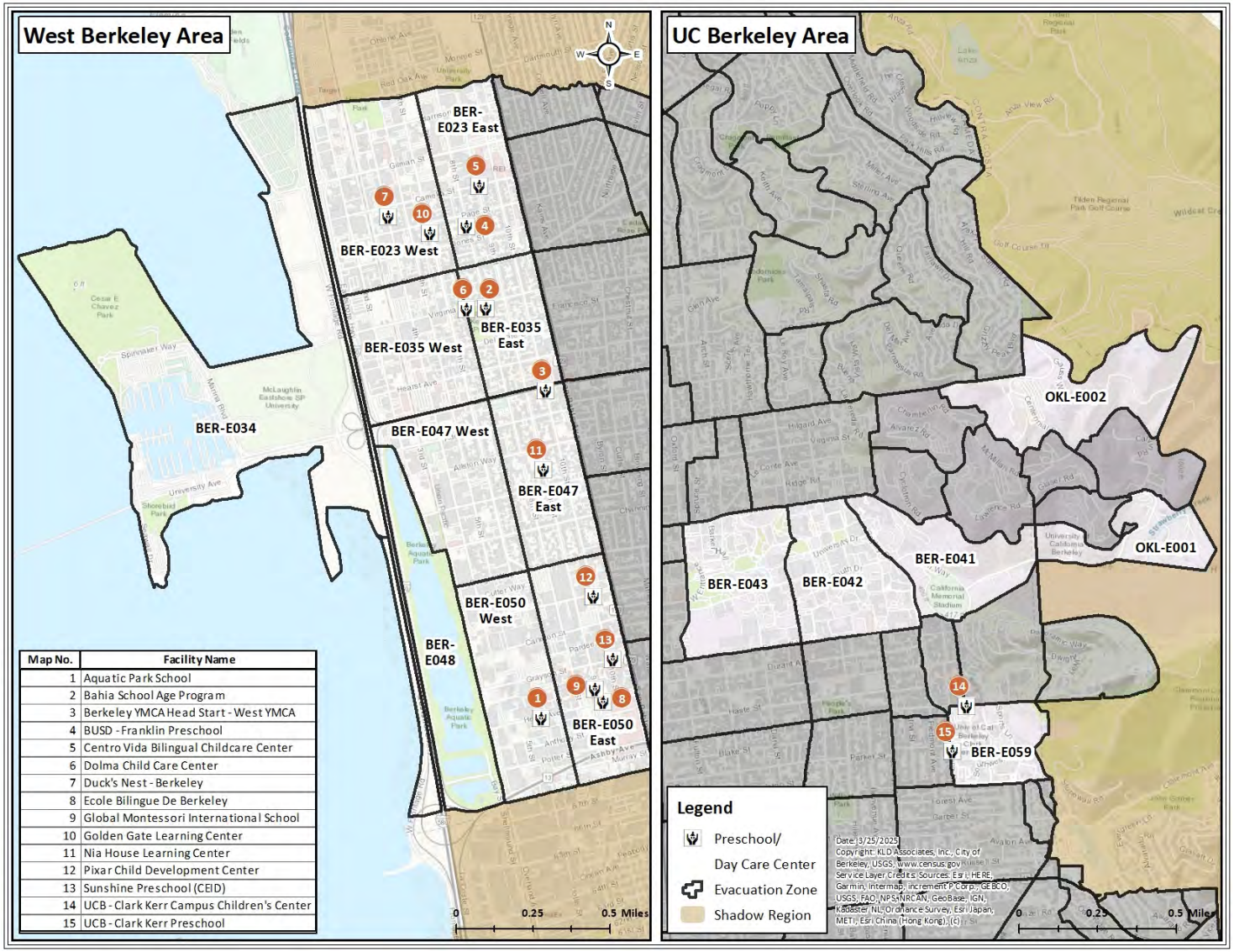


Figure C-8. Preschools and Day Care Centers in North Berkeley Hills and South Berkeley Hills Areas



Map No.	Facility Name
1	Aquatic Park School
2	Bahia School Age Program
3	Berkeley YMCA Head Start - West YMCA
4	BUSD - Franklin Preschool
5	Centro Vida Bilingual Childcare Center
6	Dolma Child Care Center
7	Duck's Nest - Berkeley
8	Ecole Bilingue De Berkeley
9	Global Montessori International School
10	Golden Gate Learning Center
11	Nia House Learning Center
12	Pixar Child Development Center
13	Sunshine Preschool (CEID)
14	UCB - Clark Kerr Campus Children's Center
15	UCB - Clark Kerr Preschool

Figure C-9. Preschools and Day Care Centers in West Berkeley and UC Berkeley Areas

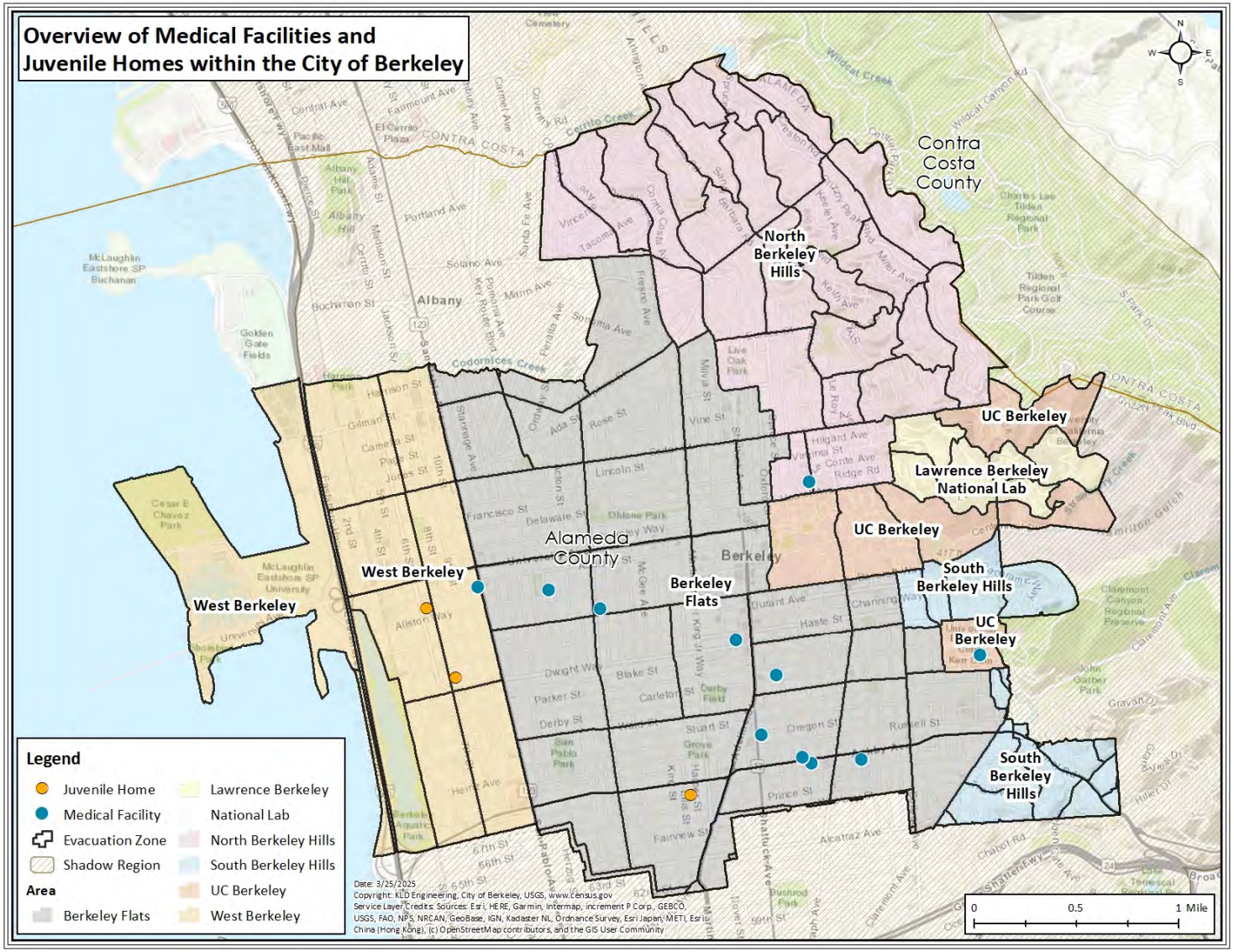


Figure C-10. Overview of Medical Facilities and Juvenile Homes within the City of Berkeley

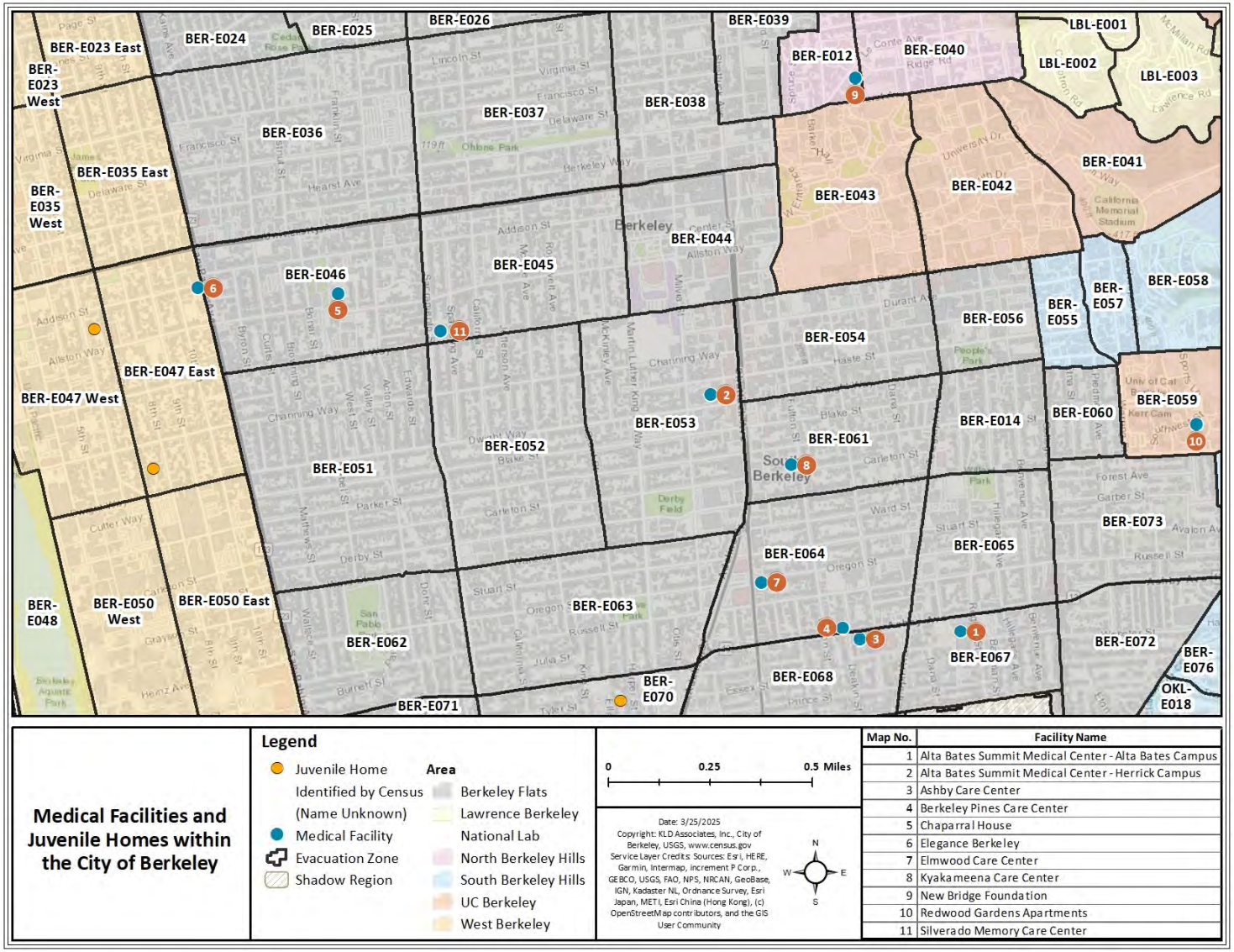


Figure C-11. Medical Facilities and Juvenile Homes within the City of Berkeley

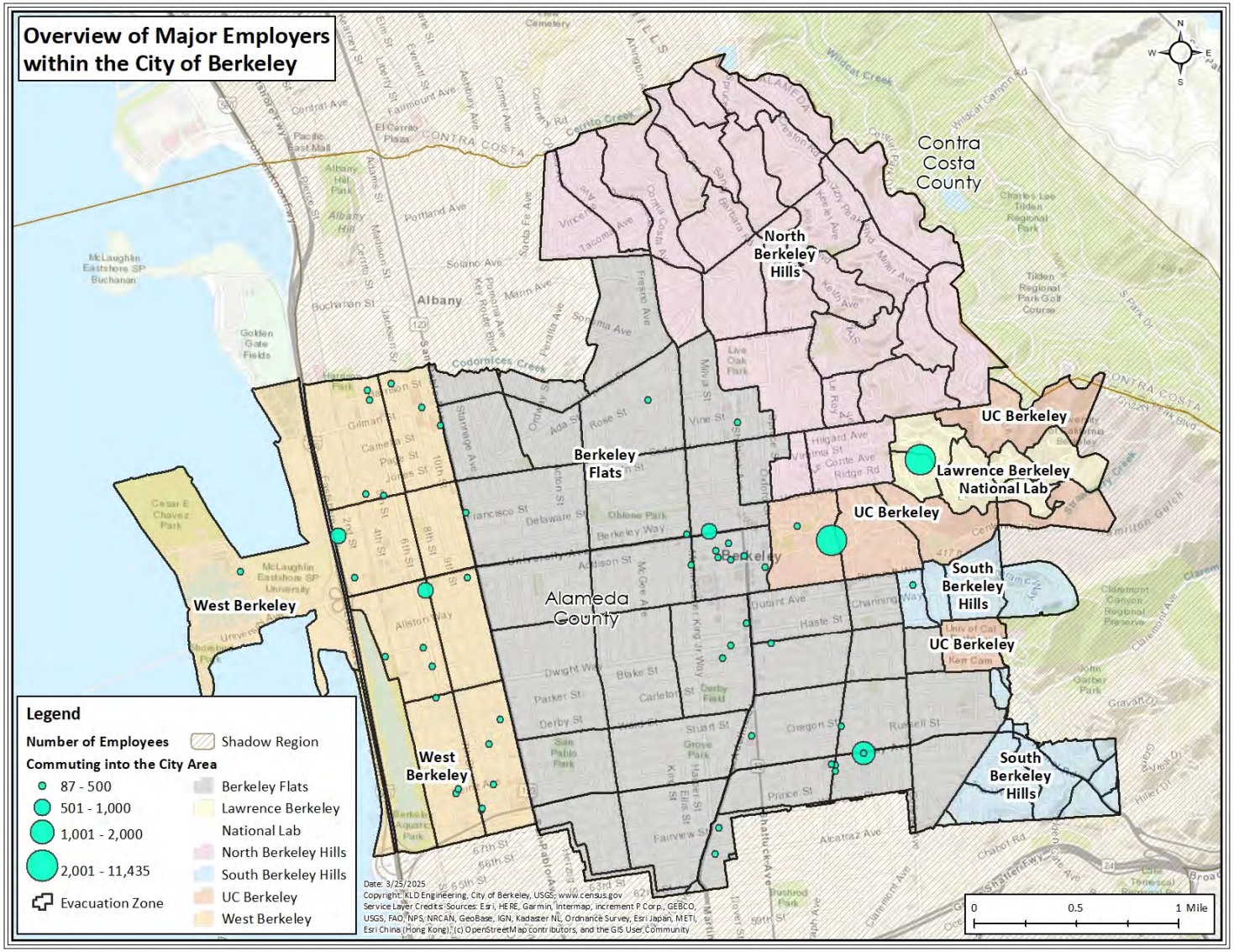


Figure C-12. Overview of Major Employers within the City of Berkeley

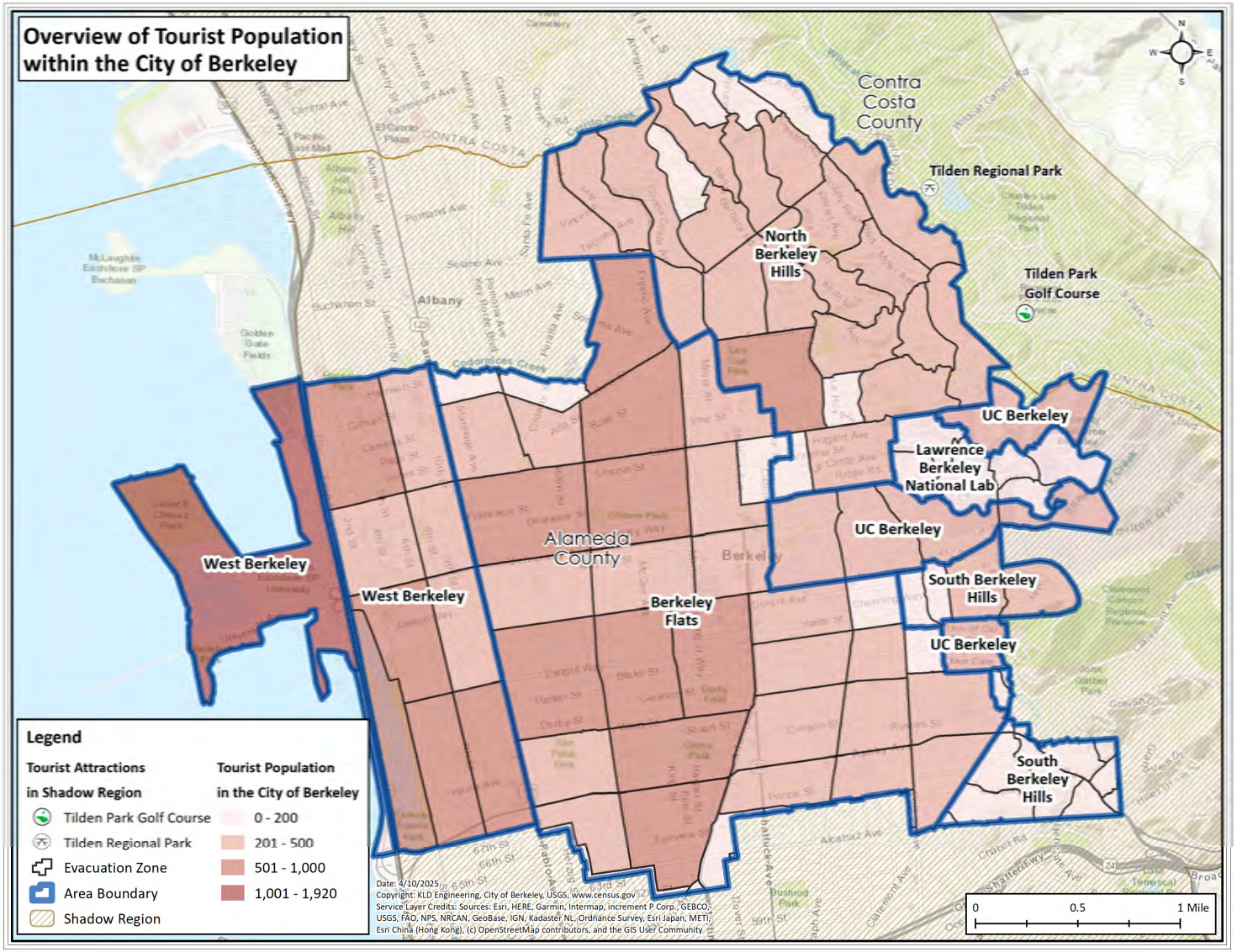


Figure C-13. Overview of Tourist Population within the City of Berkeley

APPENDIX D

Demographic Survey

D. DEMOGRAPHIC SURVEY

This appendix presents the results obtained from a Demographic Survey that was conducted from August 10 – October 8, 2023 in support of this study. Outlined below is the survey sampling plan, results obtained, and survey instrument (See Attachment A).

D.1 Introduction

The analyses conducted in this study require the identification of travel patterns, car ownership and household size of the population. Demographic information can be obtained from Census data; however, the use of this data has several limitations when applied to emergency planning. First, the Census data do not encompass the range of information needed to identify the time required for preliminary activities (mobilization) that must be undertaken prior to evacuating the area. Secondly, Census data do not contain attitudinal responses needed from the population within the city and consequently may not accurately represent the anticipated behavioral characteristics of the evacuating populace.

These concerns are addressed by conducting a demographic survey of a representative sample of the study area population. The survey is designed to elicit information from the public concerning family demographics and estimates of response times to well defined events. The design of the survey includes a limited number of questions of the form "What would you do if …?" and other questions regarding activities with which the respondent is familiar ("How long does it take you to…?").

D.2 Survey Instrument and Sampling Plan

Attachment A presents the final survey instrument used in this study for the demographic survey. A draft of the instrument was submitted to stakeholders for comment. Comments were received and the survey instrument was modified accordingly, prior to conducting the survey.

The survey results were drawn from the various subdivisions within the city and a statistically reliable sample was obtained Citywide, for residents of the Berkeley Flats, and for residents of the Berkeley hills. A total of 1,453 completed surveys were obtained within the city, which corresponds to a sampling error of ±2.5% at the 95% confidence level based on the 2020 Census household data.

D.3 Survey Results

The results of the survey fall into three categories. The first category is household demographic results. Household demographic information includes such factors as household size, automobile ownership, automobile availability, and commuters. The second category of survey results is about evacuation responses. This section contains results regarding how residents in the study area would respond to an evacuation. The third category of results contains time distributions for performing certain pre-evacuation activities. These data are processed to develop the trip generation distributions used in the evacuation modeling effort, as discussed in Section 5.

A review of the survey instrument reveals that several questions have a "Don't Know" (DK) or "Prefer Not to Say" option for a response. It is accepted practice in conducting surveys of this type to accept the answers of a respondent who offers a DK or "Prefer Not to Say" response for a few questions. To address the issue of occasional DK responses from a large sample, the practice is to assume that the distribution of these responses is the same as the underlying distribution of the positive responses. In effect, the DK responses are ignored, and the distributions are based upon the positive data that is acquired.

D.3.1 Household Demographic Results

Household Size

Figure D-1 presents the distribution of household size within each Area, based on the responses to the demographic survey. The average household contains 2.39[1] people according to the survey results.

Automobile Ownership

The average number of automobiles available per household in the study area is 1.55. The distribution of automobile ownership is presented in Figure D-2. It should be noted that only 7.5% responded that they do not have access to a vehicle. Figure D-3 and Figure D-4 present the automobile availability by household size. As expected, the majority (approximately 97%) of households of 2 or more people have access to at least one vehicle.

Ridesharing

Approximately 87% of the households surveyed responded that they would share a ride with a neighbor, relative, or a friend, if a car was not available to them when advised to evacuate in the event of an emergency (49.1% specified that they would only be able to rideshare if their neighbor/friend were home). Approximately 13% of the households would not rideshare with a neighbor, relative, or friend. Figure D-5 displays these results.

Evacuation Assistance and Specialized Transportation Needs

Six percent of households indicated that someone in the household would need help from someone outside the household (caretaker, personal attendant) to prepare to evacuate or to get to a vehicle.

Figure D-6 presents the percentage of people citywide who will need outside help as described above, along with specialized transportation assistance. Approximately 1.6% require a wheelchair accessible van, 0.2% require an ambulance and 0.4% require other modes of transportation. The remaining 3.8% do not require a specialized vehicle to evacuate.

Note that when compared to the emPOWER data described in Section 3.8 the survey results show lower estimates for people requiring an ambulance to evacuate and higher estimates for people requiring a wheelchair accessible van to evacuate.

[1] The average household size of 2.39 is only reported for informational purposes and was not used in the study. The average household size of 2.61 was used instead, which was taken from the 2020 U.S., as stated in Section 3.1.

Commuters

Figure D-7 presents the distribution of the number of commuters in each household. Commuters are defined as household members who travel to work or college on a daily basis. The data shows the majority of households (58%) do not have commuters who travel to work or college on a daily basis. There is an average of 0.64 commuters per household in the study area, and approximately 42% of households have at least one commuter who travels to work or college on a daily basis.

Berkeley Marina & UC Berkeley

A question was asked to estimate the respondents who lived in the Berkeley Marina, and/or if they were a UC Berkeley undergraduate student, graduate student, visiting scholar, student researcher, or postdoctoral. 10 respondents live at Berkeley Marina, 31 are UC Berkeley undergraduate students, and 24 are graduate students at UC Berkeley. See Figure D-10.

Commuter Travel Modes

Figure D-8 presents the mode of travel that commuters use on a daily basis. The majority (44.3%) of commuters use their private automobiles to travel to work. 25.3% of commuters walk/bicycle, 6.8% of commuters take a bus, 11.2% of commuters utilize BART, 8.7% use a combination of public transit, and 3.7% of commuters carpool to travel to work. The data shows an average of 1.08 employees per vehicle, assuming 2 people per vehicle – on average – for carpools.

Commuter Work Location

Approximately 51% of households with commuters responded that they work within Zip Codes that belong to the Areas. The other 49% commute outside of the Areas to work.

Number of Days Commuting to Work/College

Figure D-9 presents the distribution of the number of days each commuter travels to work or college. Approximately, 64% of commuters travel to work at least 4 days or more a week, 21% of commuters travel 3 times a week and the remaining 15% travel once or twice a week.

D.3.2 Evacuation Response

Several questions were asked to gauge the population's response to an emergency. These are now discussed:

"Do you have any children attending K-12 school/childcare? If an evacuation is ordered for my home area during the school day, I would:" Approximately 22% of households have children within Areas. Of the 22% of households, as shown in Figure D-10, 83.4% of them will pick up their children at the school during an emergency, 2.5% would wait for buses to bring their children home if there is an early dismissal, 4.8% would not be home and would have a trusted guardian pick up their children from school/childcare, 0.6% would not be home and would have a trusted guardian pick up their children after they get off if the bus if there is an early dismissal, 4.5% would not pick up their children or send a guardian to pick up their children, 2.9% would wait for their children to walk/bike home, and the remaining 1.3% have other plans for reuniting with their children.

"How many cars would your household use during an evacuation?" The response is shown in Figure D-11. On average, evacuating households would use 1.14 vehicles.

"Would your family await the return of other family members prior to evacuating the area?" Of the survey participants who responded, approximately 30% said they would await the return of other family members before evacuating and the remaining 70% indicated that they would not await the return of other family members before evacuating.

"An evacuation is occurring in parts of Berkeley and you are worried. Emergency officials say that your area is not in danger. People in your area are told to stay off the roads to help the evacuation of areas in danger. Would you evacuate/not evacuate?" This question is designed to elicit information regarding compliance with instructions to shelter-in-place (not evacuate). The results indicate that approximately 90% of households who are advised to shelter at home would do so; the remaining 10% would choose to evacuate the area.

"Emergency officials advise you to evacuate due to an emergency. Where would you evacuate to?" Based on the responses, approximately 61% would evacuate to a friend/relative's home. Approximately 6% would evacuate to an evacuation shelter, 23% would evacuate to a hotel, motel, short-term rental (ex. AirBnB/VRBO), or campground, about 5% would evacuate to a second/seasonal home, about 2% responded that it depends on the emergency, and about 2% answered the question as other (work/office, vehicle, UC Berkeley campus, Berkeley marina, etc.). The remaining 1% of households would not evacuate. See Figure D-12 for complete results.

"If emergency officials told your area to evacuate, would you also tell a neighbor or friend in your area to evacuate?" This question is designed to elicit information regarding notification between residents in the study area. Approximately 95% of respondents said they would notify a neighbor or a friend. The remaining 5% said they would not.

"How would you tell your neighbor or friend to evacuate?" This question is designed to see how respondents in the study area would notify neighbors or friends during an evacuation, if they chose to do so. From the respondents who elected to notify a neighbor or friend during an evacuation (approximately 95% of respondents), 33.1% would notify using text message, 20.6% would make a phone call, 2.6% would use social media outlets, 42.6% of respondents would notify their neighbors in person, 0.8% of respondents would notify using a neighborhood email group, and 0.3% indicated they would use other methods. Figure D-13 displays these results.

"How would you rate your cell phone coverage near your home?" Figure D-14 presents how the respondents rated the cell phone coverage within their area. The purpose of this question was to gain insight into how well a cell phone-based alert and/or notification would be received. This question was added for informational purposes only and was not used in this study. As shown in the figure, the data is more heavily weighted towards good or better with 75% of respondents rating their cell phone reception in their area as good, very good, or excellent. Approximately 24% rated cell phone coverage as fair, poor or very poor in their area and the remaining 1% indicated that they do not have a cell phone.

"Do you have an AT&T landline?" Approximately 27% of the households have an AT&T landline, and 73% do not have an AT&T landline.

"Do you have any pet(s) and/or animal(s)? What type(s) of pet and/or animal do you have?" Approximately 50% of households have pets. Approximately 38.4% of households have small pets/animals and 11.3% have large pets/animals, and less than 0.1% report having large livestock. Figure D-15 displays these results.

"What would you do with your pet(s) and/or animal(s) if you had to evacuate?" Due to an error in the questionnaire, the responses to this question are omitted from the report.

D.3.3 Time Distribution Results

The survey asked several questions about the amount of time it takes to perform certain pre-evacuation activities. These activities involve actions taken by residents during the course of their day-to-day lives. Thus, the answers fall within the realm of the responder's experience.

The mobilization distributions provided below are the result of having applied the analysis described in Section 5.4.1 on the component activities of the mobilization.

"How long would it take you to notify a neighbor or friend to evacuate?" This question is designed to see how long it would take respondents to notify a neighbor or friend should they choose to do so. This distribution is displayed in Figure D-16 from the respondents who elected to notify a neighbor or friend during an evacuation. Approximately 85% of respondents can notify a neighbor or friend within 10 minutes; 100% within 20 minutes.

"How long would it take you to pick up your children from school?" This question is designed to see how long it would take respondents to pick up their children from school. This distribution is displayed in Figure D-17 from the respondents have school children, approximately 64% can pick up their school children within 20 minutes and all (100%) children are pick up within 45 minutes.

"How long does it take the commuter to complete preparation for leaving work/college?" Figure D-18 presents the cumulative distribution; in all cases, the activity is completed by 35 minutes. Approximately 90% can leave in less than 25 minutes.

"How long would it take the commuter to travel home?" Figure D-19 presents the work to home travel time for the Areas. Approximately 80% of commuters can arrive home within 40 minutes of leaving work; all within 90 minutes.

"If an emergency evacuation was ordered for your area, how long would it take your household to get ready to leave? Think about time to pack clothing, medications, other critical items, to prepare your pets, secure your home, and pack the car?" Figure D-20 presents the time required to prepare for leaving on an evacuation trip. In many ways this activity mimics a family's preparation for a short holiday or weekend away from home. Hence, the responses represent the experience of the responder in performing similar activities. The distribution shown in Figure D-20 has a long "tail." Approximately 90% of households can be ready to leave home within 75 minutes; the remaining 10% of households require up to an additional 60 minutes.

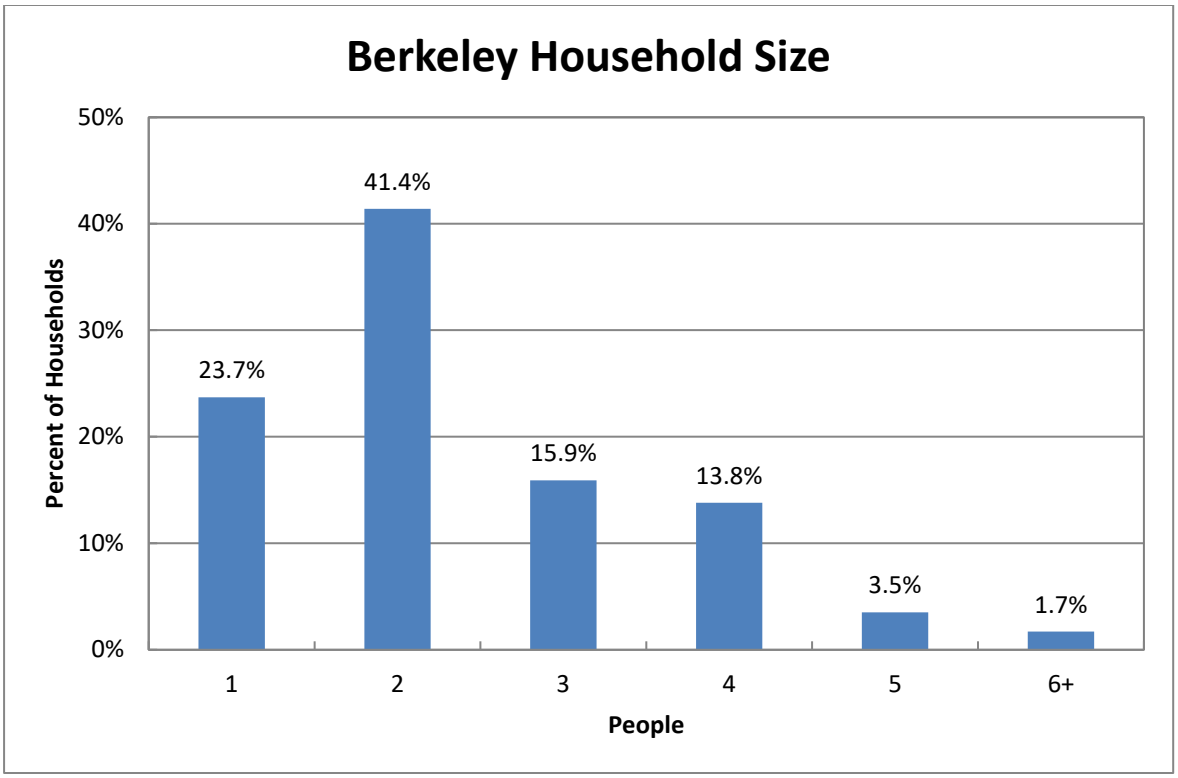


Figure D-1. Household Size in the Study Area

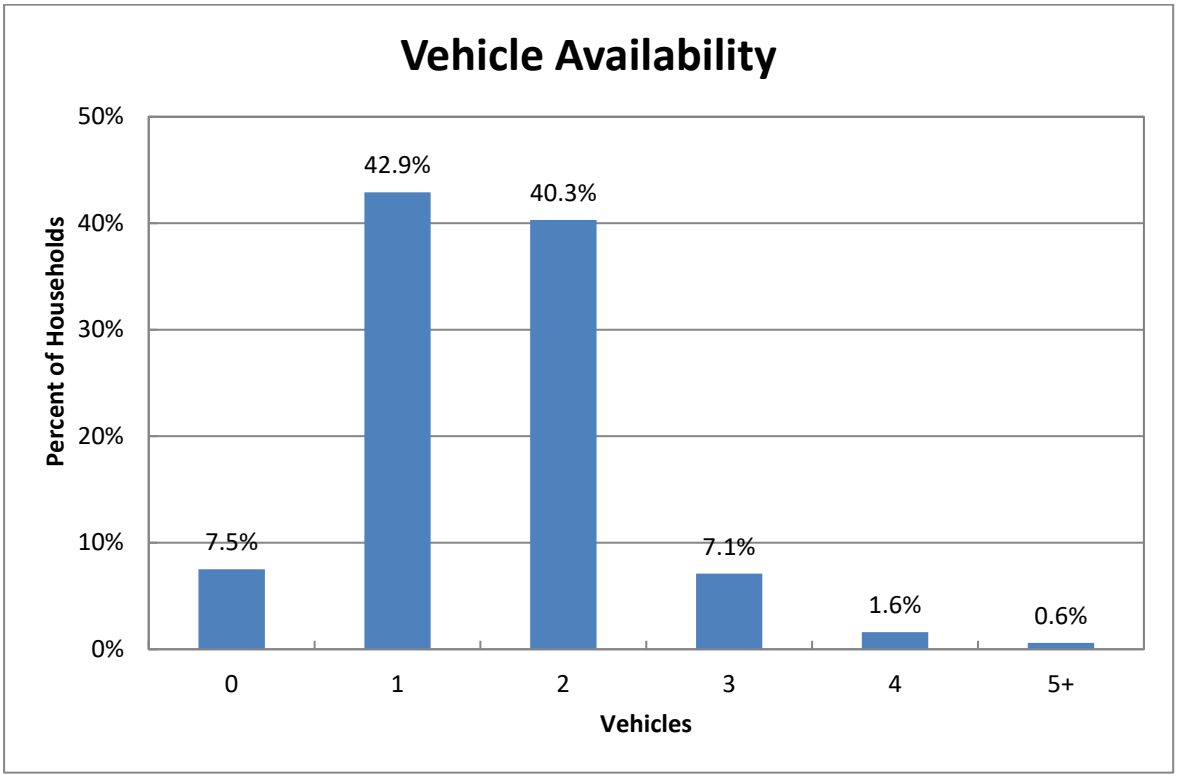


Figure D-2. Vehicle Availability

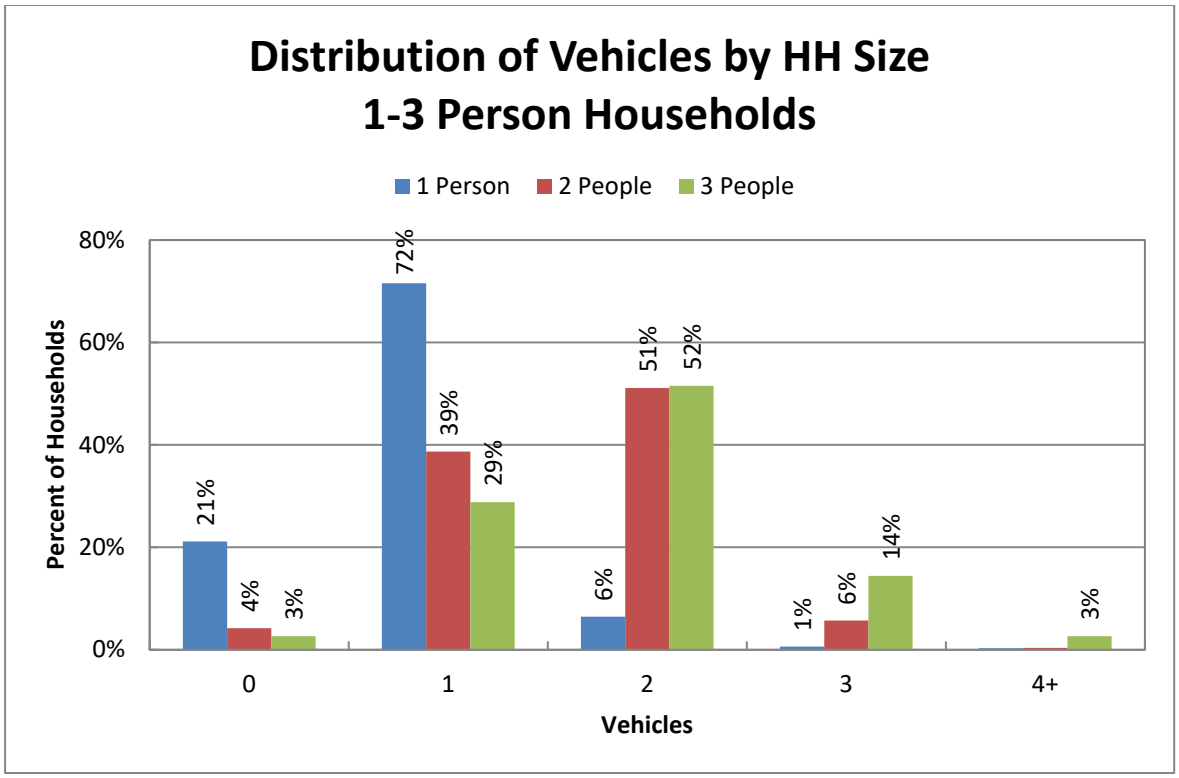


Figure D-3. Vehicle Availability - 1 to 3 Person Households

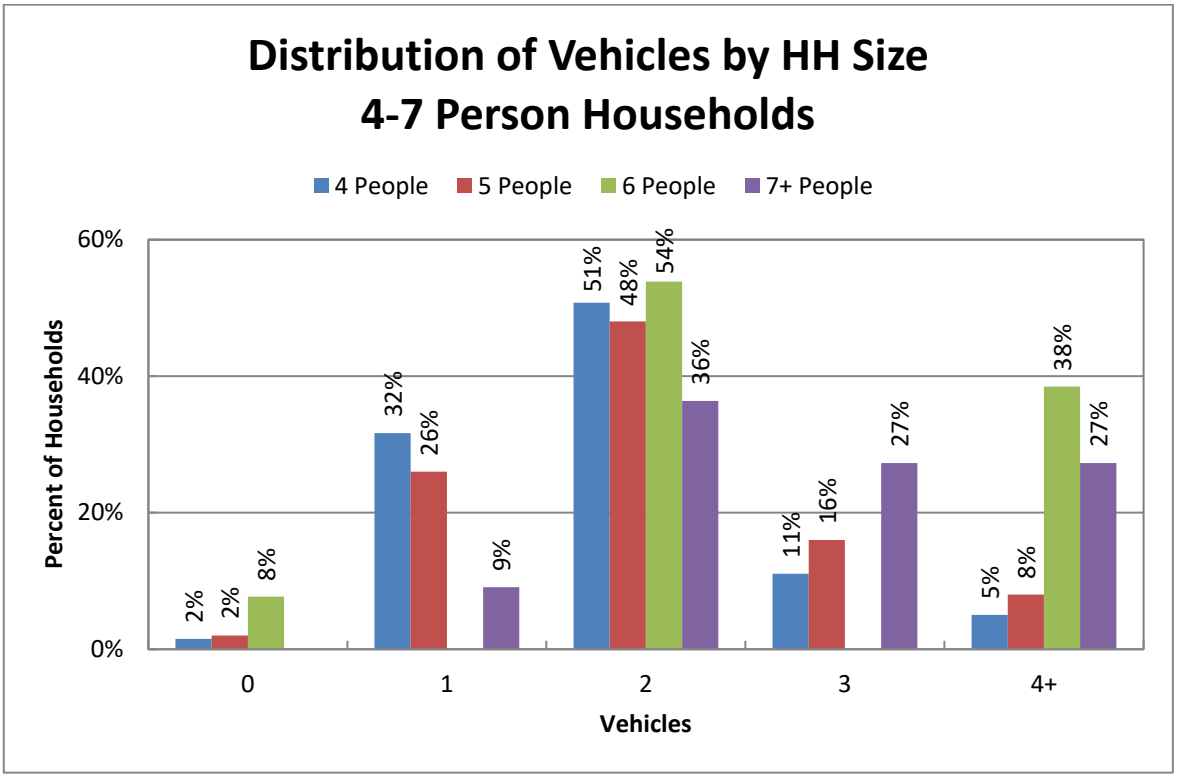


Figure D-4. Vehicle Availability – 4 to 7 Person Households

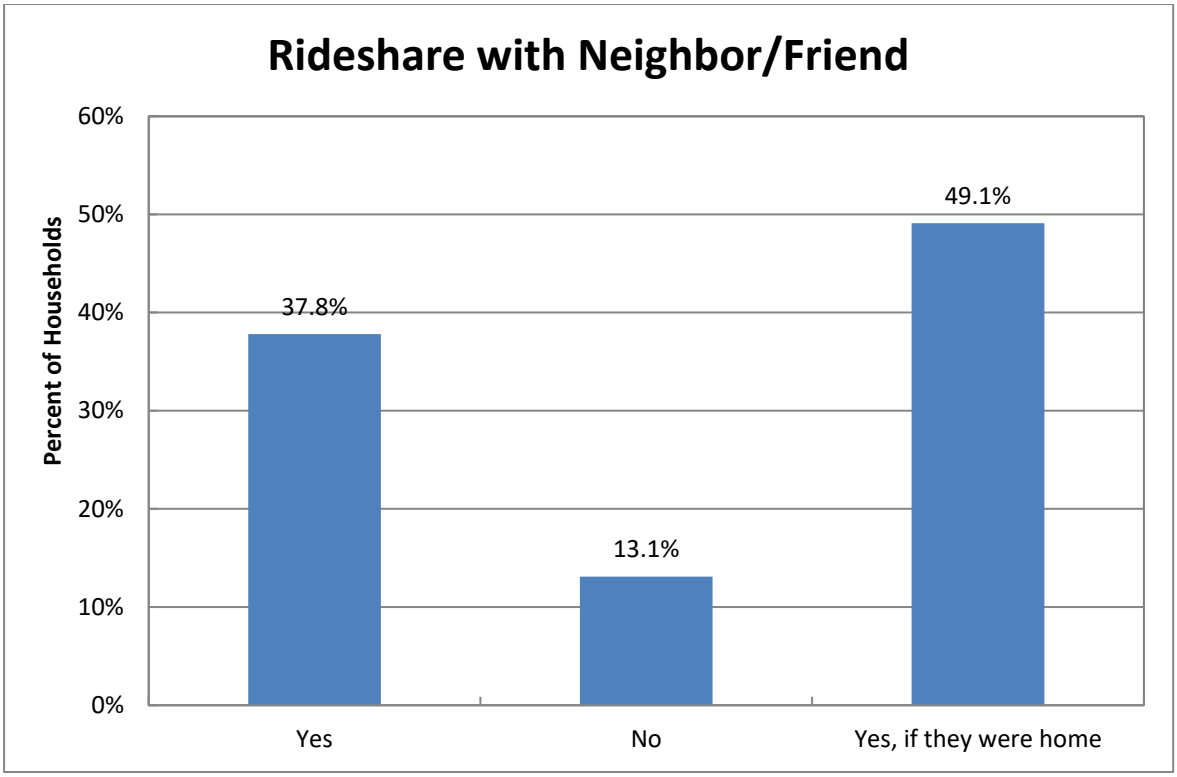


Figure D-5. Rideshare with Neighbor/Friend

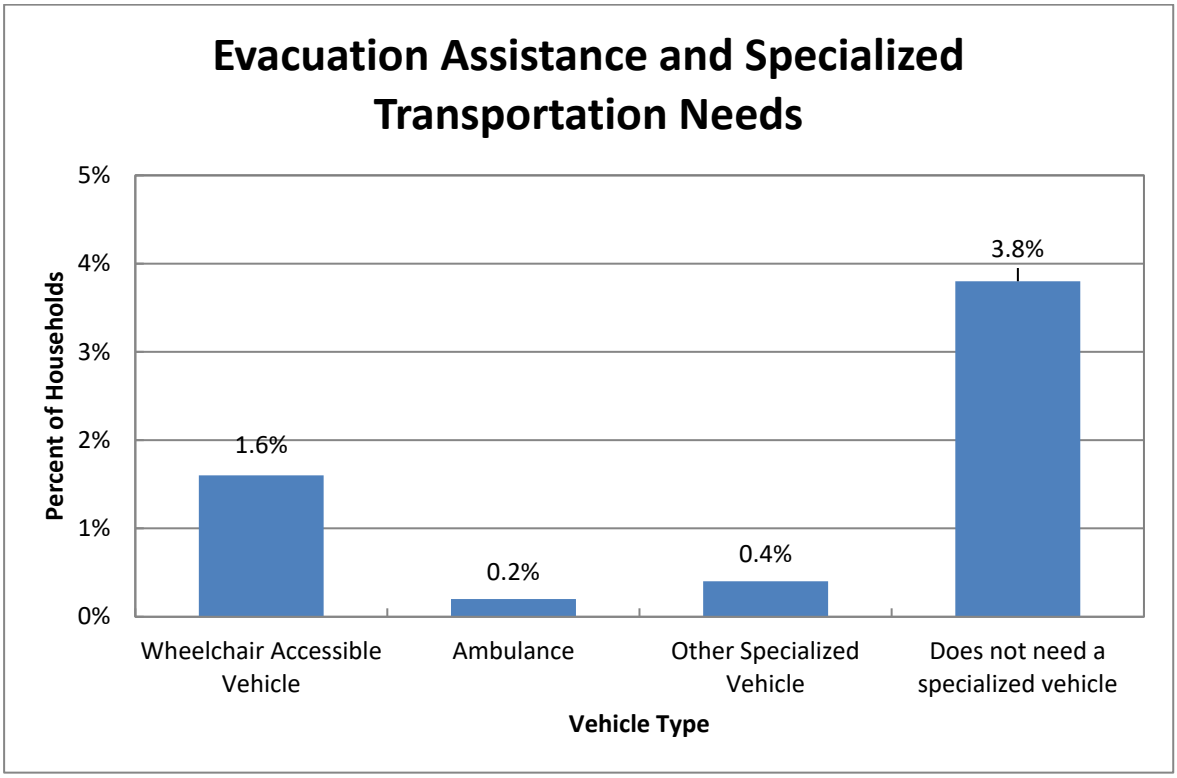


Figure D-6. Specialized Transportation Needs for Households Requiring Evacuation Assistance

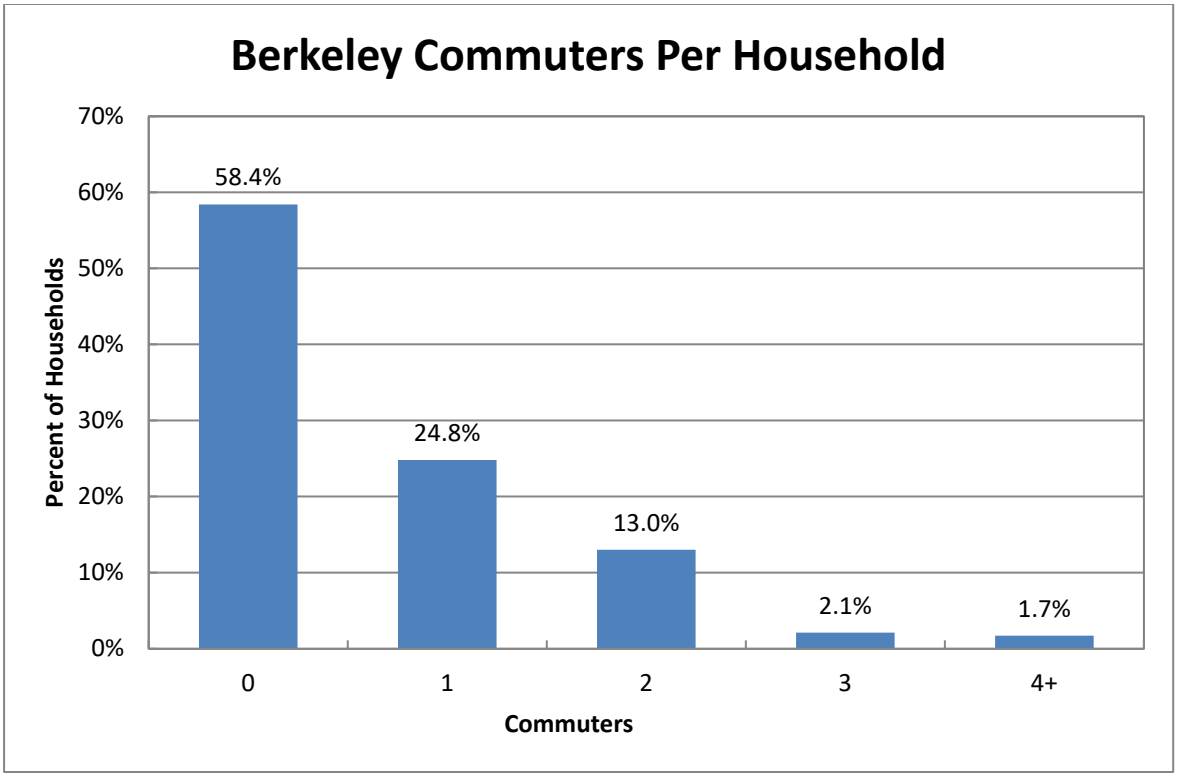


Figure D-7. 5-Day-per-Week Commuters in Households in the Study Area

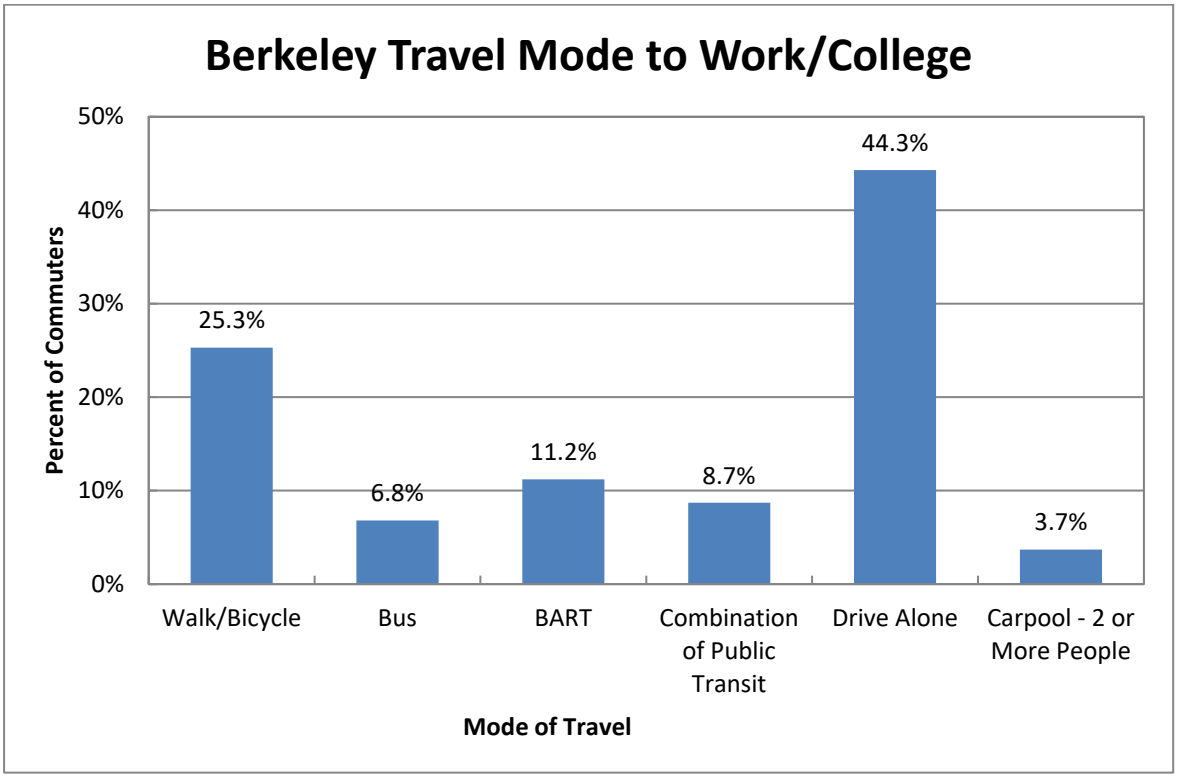


Figure D-8. Travel Modes to Work/College in the Study Area

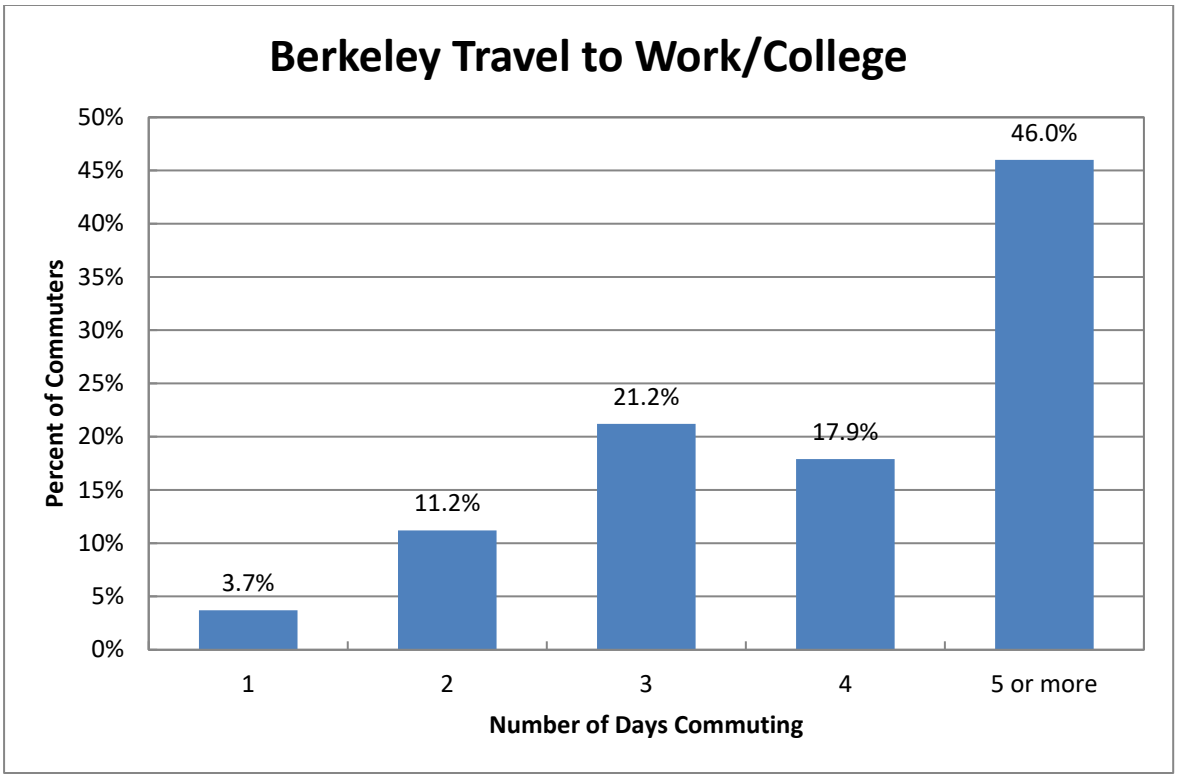


Figure D-9. Number of Days Commuting to Work/College

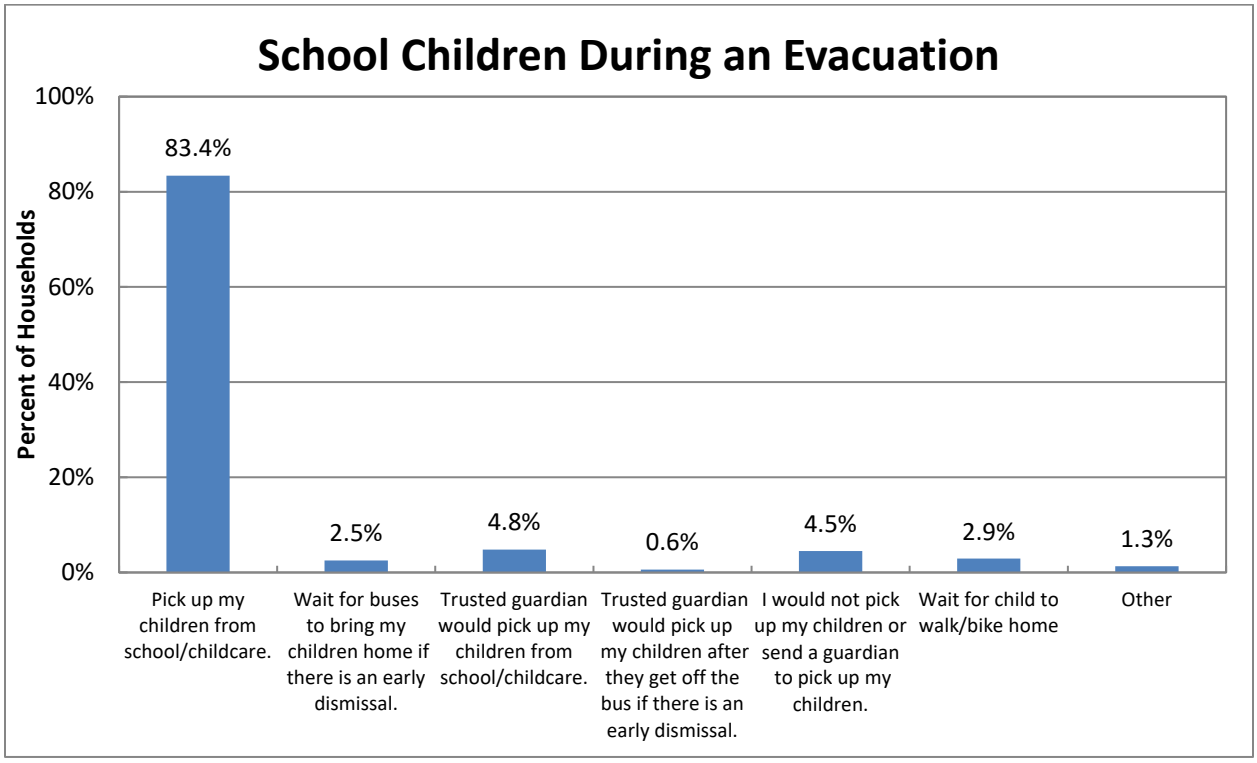


Figure D-10. School Children During an Evacuation

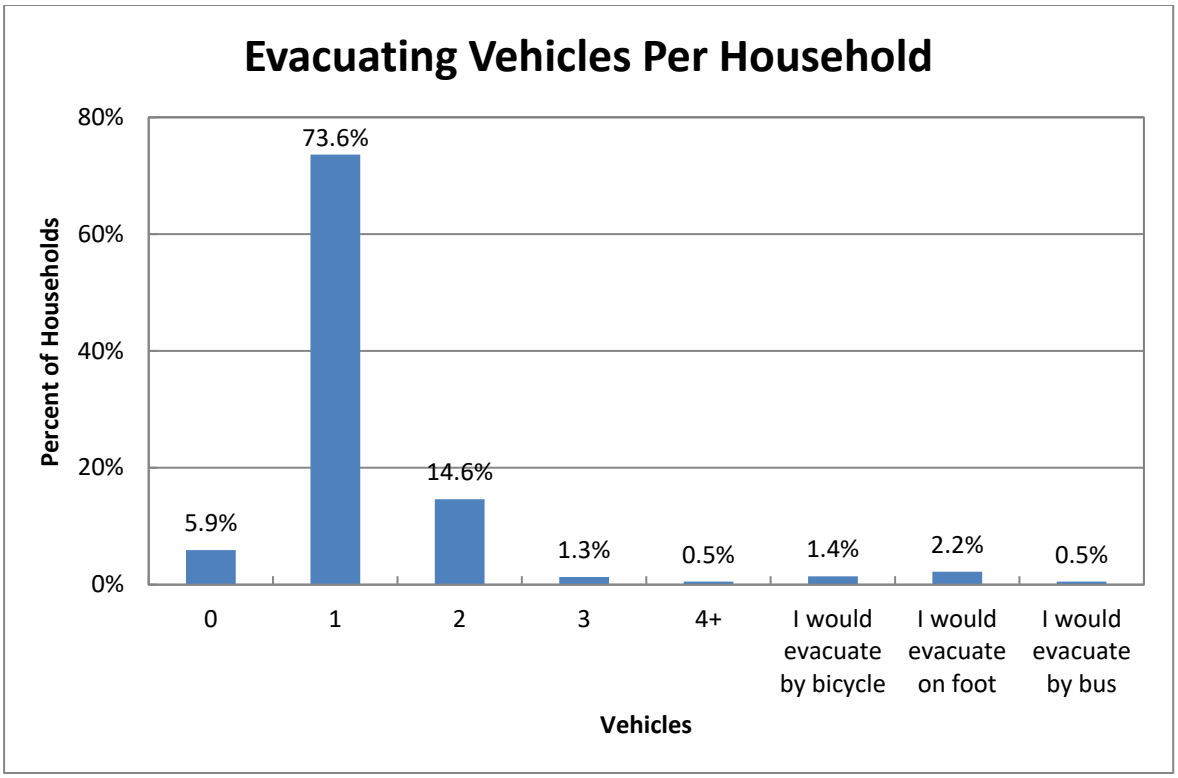


Figure D-11. Number of Vehicles Used for Evacuation

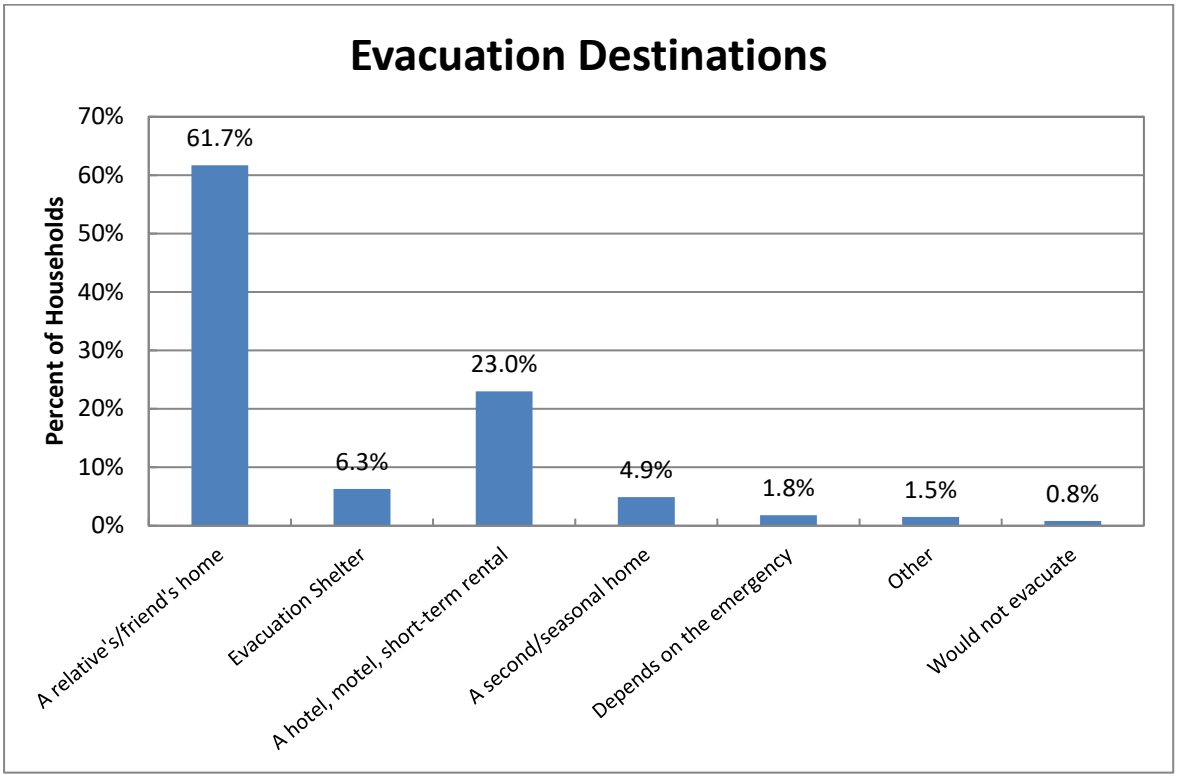


Figure D-12. Study Area Evacuation Destinations

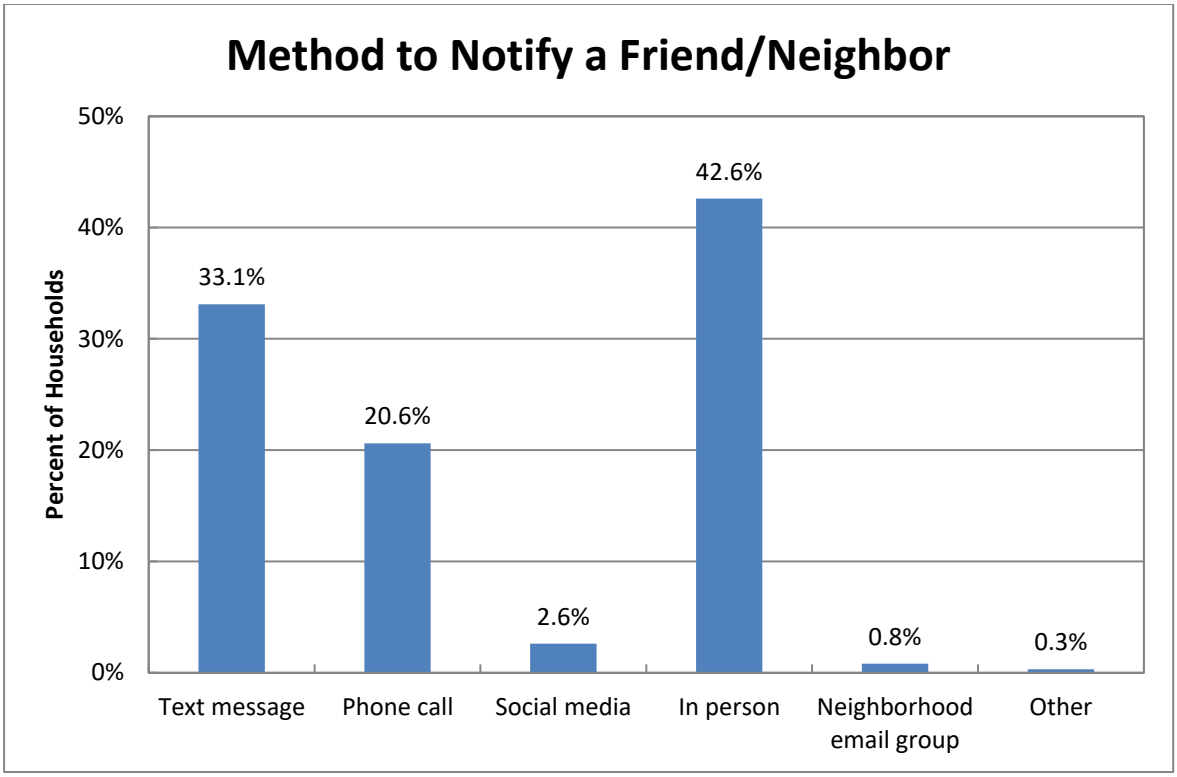


Figure D-13. Method to Notify a Friend/Neighbor

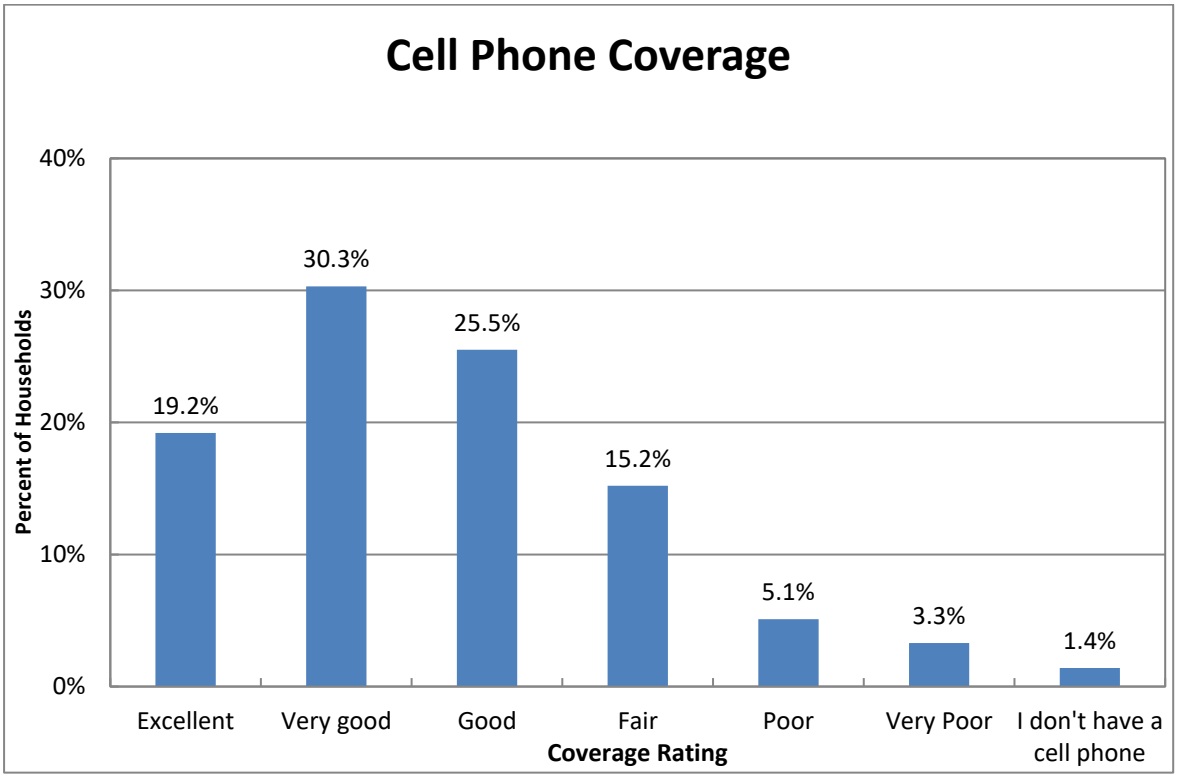


Figure D-14. Cell Phone Coverage

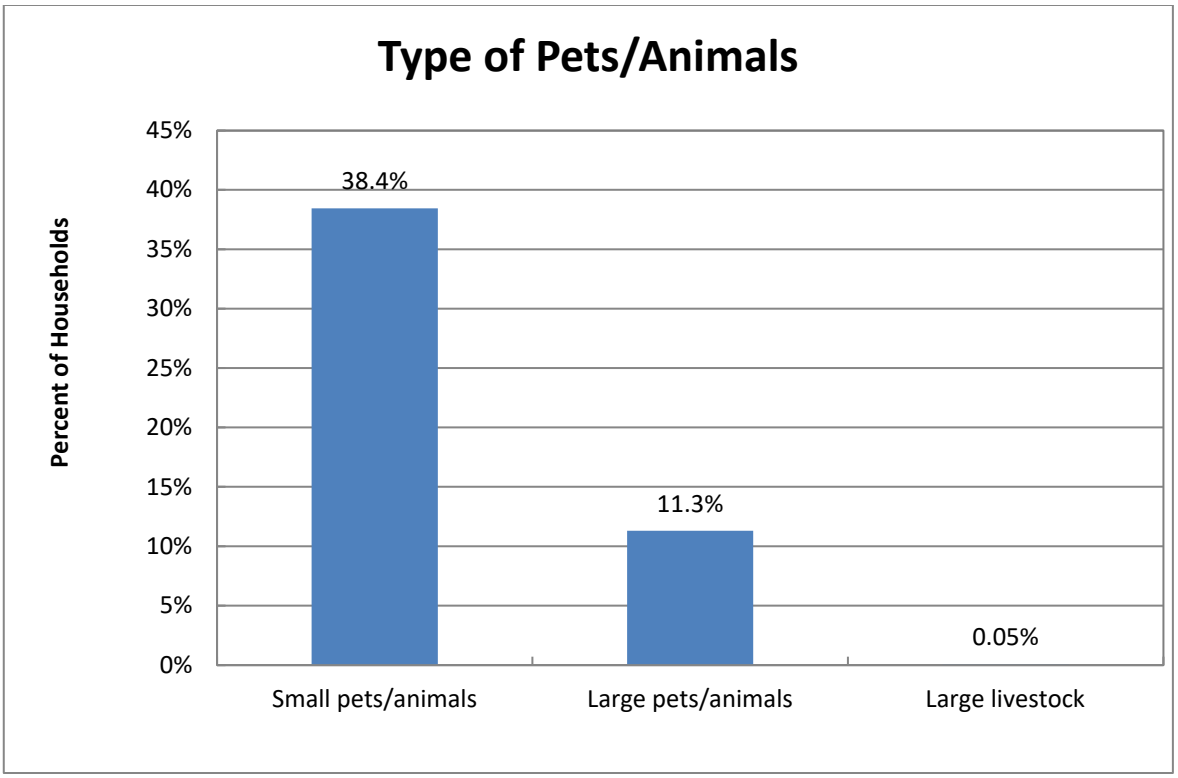


Figure D-15. Pet Ownership in Study Area

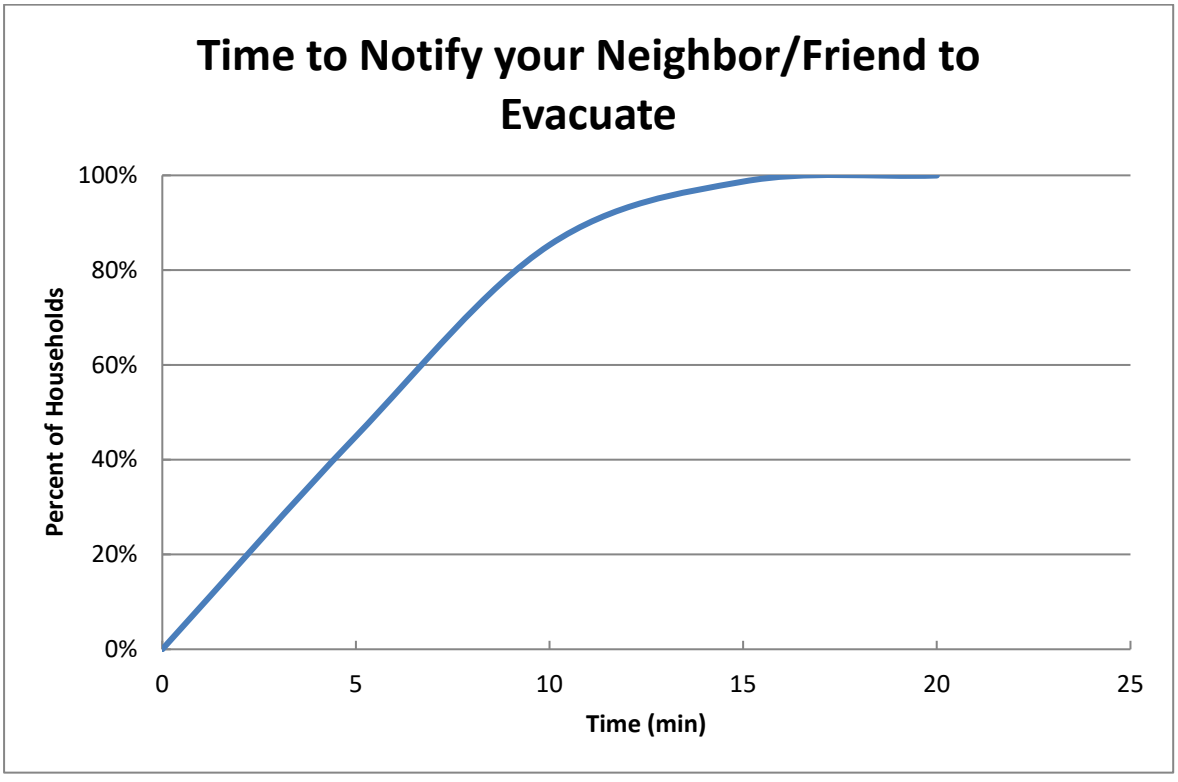


Figure D-16. Time to Take to Notify a Neighbor/Friend to Evacuate

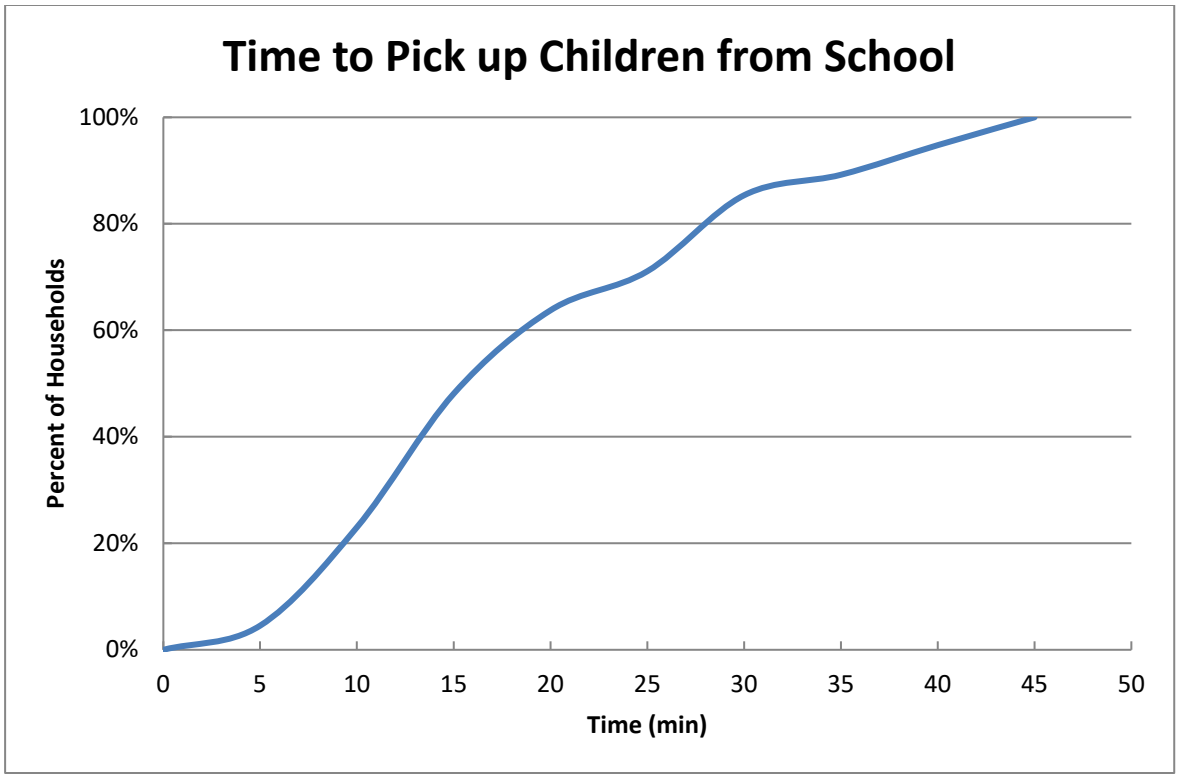


Figure D-17. Time to Pick Up Children from School

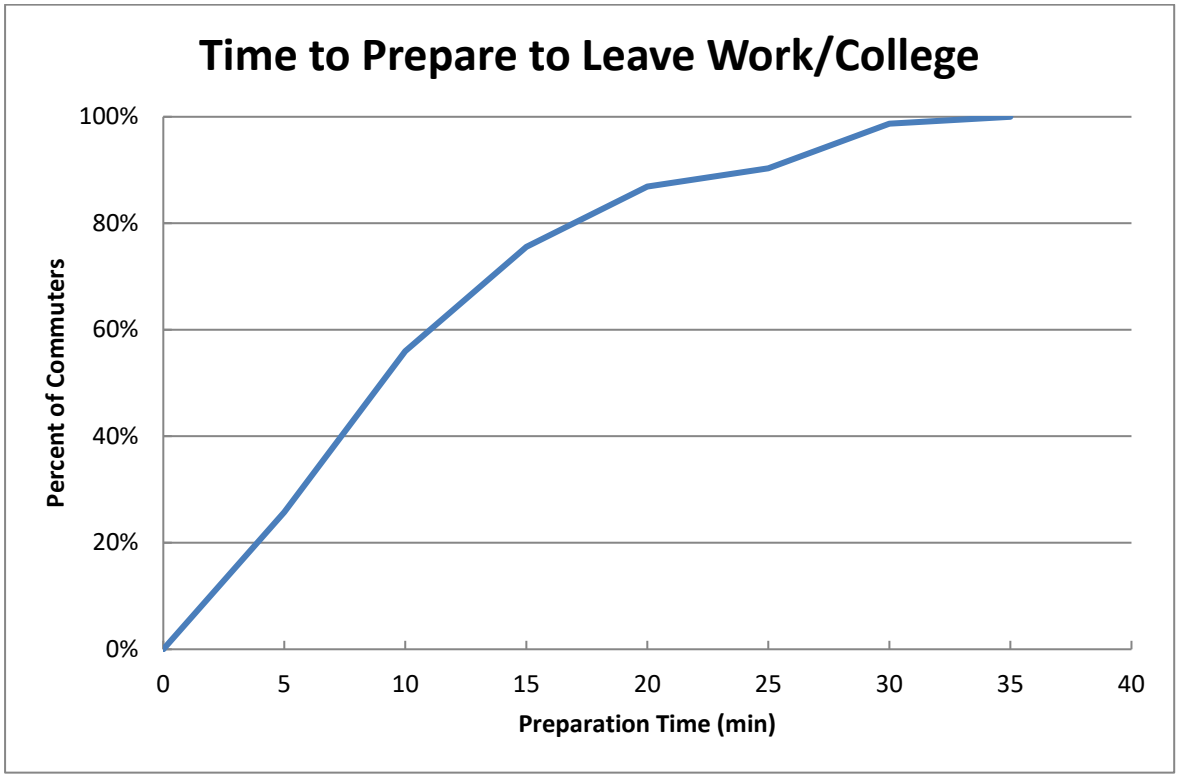


Figure D-18. Time Required to Prepare to Leave Work/College

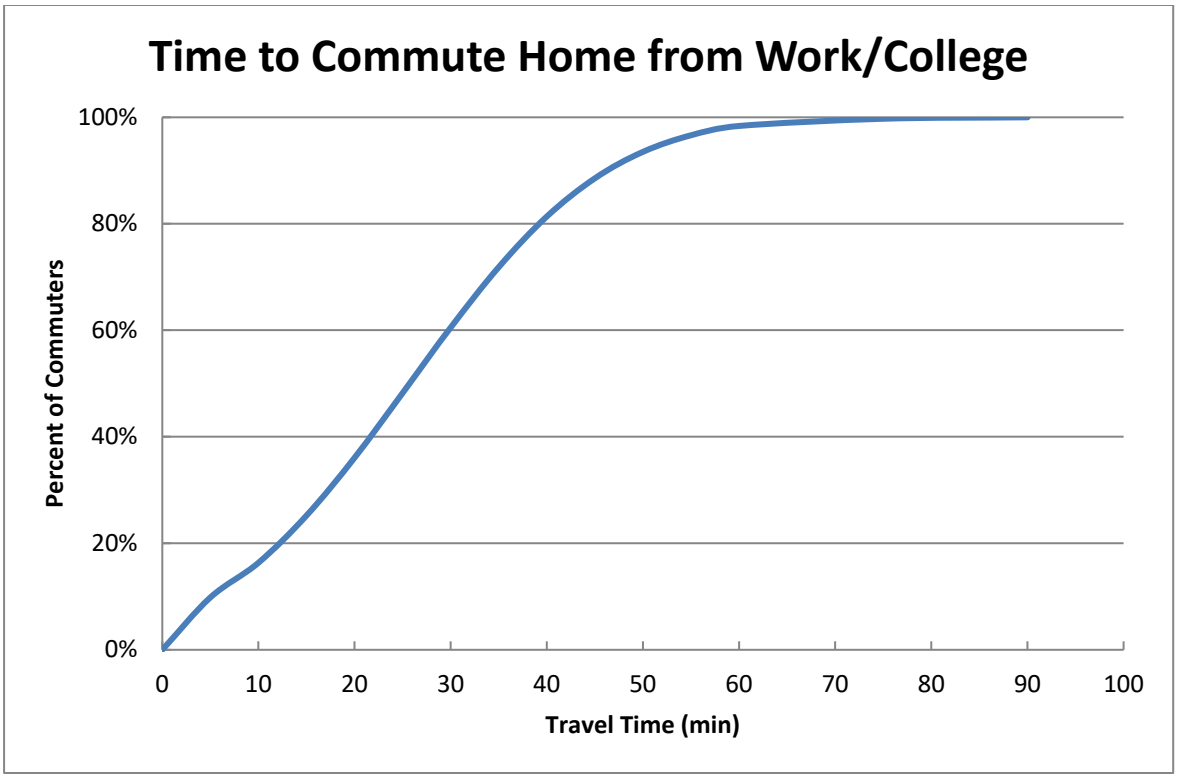


Figure D-19. Time to Travel Home from Work/College



Figure D-20. Time to Prepare Home for Evacuation

ATTACHMENT A

Demographic Survey Instrument



City of Berkeley Community Evacuation Survey

Welcome!

Please help us improve Berkeley's emergency evacuation plans by completing this 10-minute survey. Your responses will help us predict how long it will take people in Berkeley to get out of the path of a fire, tsunami, or other hazard. With this information, we can provide better instructions on how to stay safe in emergencies.
This survey includes prize giveaways to 7 (seven) randomly chosen respondents! There will be 3 (three) first prize winners with a $100 Visa gift card and 4 (four) second prize winners with a $50 Visa gift card. In order to win a prize, please provide your address, phone number and/or email address at the end of the survey. If you wish to not participate, you may opt to not provide your personal information but still complete to survey to help improve our local emergency planning. PLEASE PROVIDE ONLY ONE RESPONSE PER HOUSEHOLD. MULTIPLE ENTRIES WILL BE DISQUALIFIED FOR THE PRIZE GIVEAWAY.
Thank you for taking the time to do this survey. If you have questions please reach out to the Berkeley Fire Department's Office of Emergency Services: oes@berkeleyca.gov.
All your answers will be kept strictly confidential. City of Berkeley staff, its consulting team for this project, and their families are not eligible for the prize giveaways.

1A. What is your home zip code? *

1B: Check off any boxes that describe you. (Leave blank if none of these options describe you):

- ☐ I am a UC Berkeley undergraduate student.
- ☐ I am a UC Berkeley graduate student, visiting scholar, student researcher, or postdoc.
- ☐ I live in the Berkeley Marina.

2. How many people usually live in your household (including roommates)?

Please Select

3A. How many running cars does your household have?

Please Select

3B. How many cars would your household use during an evacuation?

Please Select

4. If you didn't have your own transportation, could you get a ride out of the area with a neighbor or friend in an emergency?

- ◯ Yes
- ◯ No
- ◯ Yes, if they were home
- ◯ Not sure/prefer not to say

5A. Does anyone in your household need help from someone outside the household (caretaker, personal attendant) to prepare to evacuate or to get to a vehicle?

- ◯ Yes
- ◯ No
- ◯ Don't Know/Prefer not to say

If you would like to provide more details on your answer to Question 5A, please describe below:

5B. How many people in your household require a specialized vehicle to evacuate? For each person, choose the vehicle that they would need to evacuate.

	0	1	2	3	4	More than 4
Wheelchair Accessible Vehicle	○	○	○	○	○	○
Ambulance	○	○	○	○	○	○
Other Specialized Vehicle	○	○	○	○	○	○

If you chose "Other Specialized Vehicle" for Question 5B, please describe the vehicle:

6. How many adults in your household commute to work or college on a daily basis? *

Please Select

Travel to Work or College

7. How many days a week does each commuter travel to work?

	1	2	3	4	5 or more
Commuter 1	○	○	○	○	○
Commuter 2	○	○	○	○	○
Commuter 3	○	○	○	○	○
Commuter 4	○	○	○	○	○

8. How does each commuter usually travel to work or college on those days?

	Walk/Bicycle	Bus	BART	Combination of Public Transit	Drive Alone	Carpool - 2 or More People	Don't Know
Commuter 1	○	○	○	○	○	○	○
Commuter 2	○	○	○	○	○	○	○
Commuter 3	○	○	○	○	○	○	○
Commuter 4	○	○	○	○	○	○	○

9-1. What zip code does Commuter #1 commute to for work or college?

9-2. What zip code does Commuter #2 commute to for work or college?

9-2. What zip code does Commuter #2 commute to for work or college?

9-4. What zip code does Commuter #4 commute to for work or college?

Getting Ready to Leave Work or College

10-1. On a normal day, how long does it take Commuter #1 to pack up and leave their worksite or college?

Please Select

If you answered "Over 2 Hours" for Question 10-1, please tell us how many hours:

10-2. On a normal day, how long does it take Commuter #2 to pack up and leave their worksite or college?

Please Select

If you answered "Over 2 Hours" for Question 10-2, please tell us how many hours:

10-3. On a normal day, how long does it take Commuter #3 to pack up and leave their worksite or college?

Please Select

If you answered "Over 2 Hours" for Question 10-3, please tell us how many hours:

10-4. On a normal day, how long does it take Commuter #4 to pack up and leave their worksite or college?

Please Select

If you answered "Over 2 Hours" for Question 10-4, please tell us how many hours:

Travel Home From Work or College

11-1. How long does it usually take Commuter #1 to travel home from work or college?

Please Select

If you answered "Over 2 Hours" for Question 11-1, please tell us how many hours:

11-2. How long does it usually take Commuter #2 to travel home from work or college?

Please Select

If Over 2 Hours for Question 11-2, please tell us how many hours:

11-3. How long does it usually take Commuter #3 to travel home from work or college?

Please Select

If Over 2 Hours for Question 11-3, please tell us how many hours:

11-4. How long does it usually take Commuter #4 to travel home from work or college?

Please Select

If Over 2 Hours for Question 11-4, please tell us how many hours:

Household Evacuation Plan

12. If an emergency evacuation was ordered for your area, how long would it take your household to get ready to leave? Think about time to pack clothing, medications, other critical items, to prepare your pets, secure your home, and pack the car.

Please Select

13. Please choose one of the following:

- ◯ During an emergency, I would await the return of household members to evacuate together.
- ◯ During an emergency, I would evacuate independently and meet other household members later.
- ◯ Don't know

14A. Emergency officials advise you to evacuate due to an emergency. Where would you evacuate to?

- ◯ A relative's or friend's home
- ◯ Wait for an evacuation shelter to be set up, then go there
- ◯ A hotel, motel, short-term rental (ex: AirBnB/VRBO), or campground
- ◯ A second/seasonal home
- ◯ Would not evacuate
- ◯ Don't know
- ◯ Prefer not to say
- ◯ Other

If you answered "Other" for Question 14A, please tell us more:

14B. An evacuation is occurring in parts of Berkeley and you are worried. Emergency officials say that your area is not in danger. People in your area are told to stay off the roads to help the evacuation of areas in danger. Would you:

- ◯ Not evacuate
- ◯ Evacuate
- ◯ Don't know/prefer not to say

Children in School/Childcare

15A. Do you have any children attending K-12 school/childcare?

- ◯ Yes
- ◯ No
- ◯ Prefer not to say

15B. If an evacuation is ordered for my home area during the school day, I would:

- ◯ Pick up my children from school/childcare.
- ◯ Wait for buses to bring my children home if there is an early dismissal.
- ◯ I will not be home - I would have a trusted guardian pick up my children from school/childcare.
- ◯ I will not be home - I would have a trusted guardian pick up my children after they get off the bus if there is an early dismissal.
- ◯ I would not pick up my children or send a guardian to pick up my children.
- ◯ Other ____

15C. How long would it take you or a guardian to pick up your children from school?

Please Select

If you answered "Other" to Question 15B and this question does not apply, please leave it blank.

Pet Questions

16A. Do you have any pet(s) and/or animal(s)? *

- ◯ Yes
- ◯ No
- ◯ Prefer not to say

16B. What type(s) of pet and/or animal do you have?

- ☐ Small pets/animals
- ☐ Large pets/animals
- ☐ Large livestock
- ☐ Prefer not to say

16C. What would you do with your pet(s) and/or animal(s) if you had to evacuate?

- ◯ Leave pet at home
- ◯ Take pet with me
- ◯ Take pet/animal to a different place than I will go
- ◯ I have different plans for each pet/animal
- ◯ Don't know/Prefer not to say

Emergency Alerting Systems

17. How would you rate the cell phone coverage near your home?

- ◯ Excellent
- ◯ Very Good
- ◯ Good
- ◯ Fair
- ◯ Poor
- ◯ Very Poor
- ◯ I don't have a cell phone
- ◯ Prefer not to say

18. Do you have an AT&T landline?

- ◯ Yes
- ◯ No
- ◯ Prefer not to say

Sharing Evacuation Instructions

19A. If emergency officials told your area to evacuate, would you also tell a neighbor or friend in your area to evacuate?

- ◯ Yes
- ◯ No
- ◯ Prefer not to say

19B. How would you tell your neighbor or friend to evacuate?

- ☐ Text message
- ☐ Phone call
- ☐ Social media
- ☐ In person

- [ ] Neighborhood email group
- [ ] Don't know/prefer not to say
- [ ] Other

19C. How long would it take you to tell your neighbor or friend to evacuate?

Please Select

Prize Giveaway Information

Please only fill this out if you wish to be eligible for the prize giveaways. Please provide an email, mailing address, and/or a phone number to be contacted.

Name

First Name Last Name

Email

example@example.com

Address

Street Address

Street Address Line 2

City State / Province

Postal / Zip Code

Phone Number

Please enter a valid phone number.

Please press "Submit" below to complete the survey!

Submit

Thank you for taking the time to complete this survey.

If you would like to learn more about Fire Weather and Evacuations, please visit our website at https://berkeleyca.gov/safety-health/fire/fire-weather-evacuation.

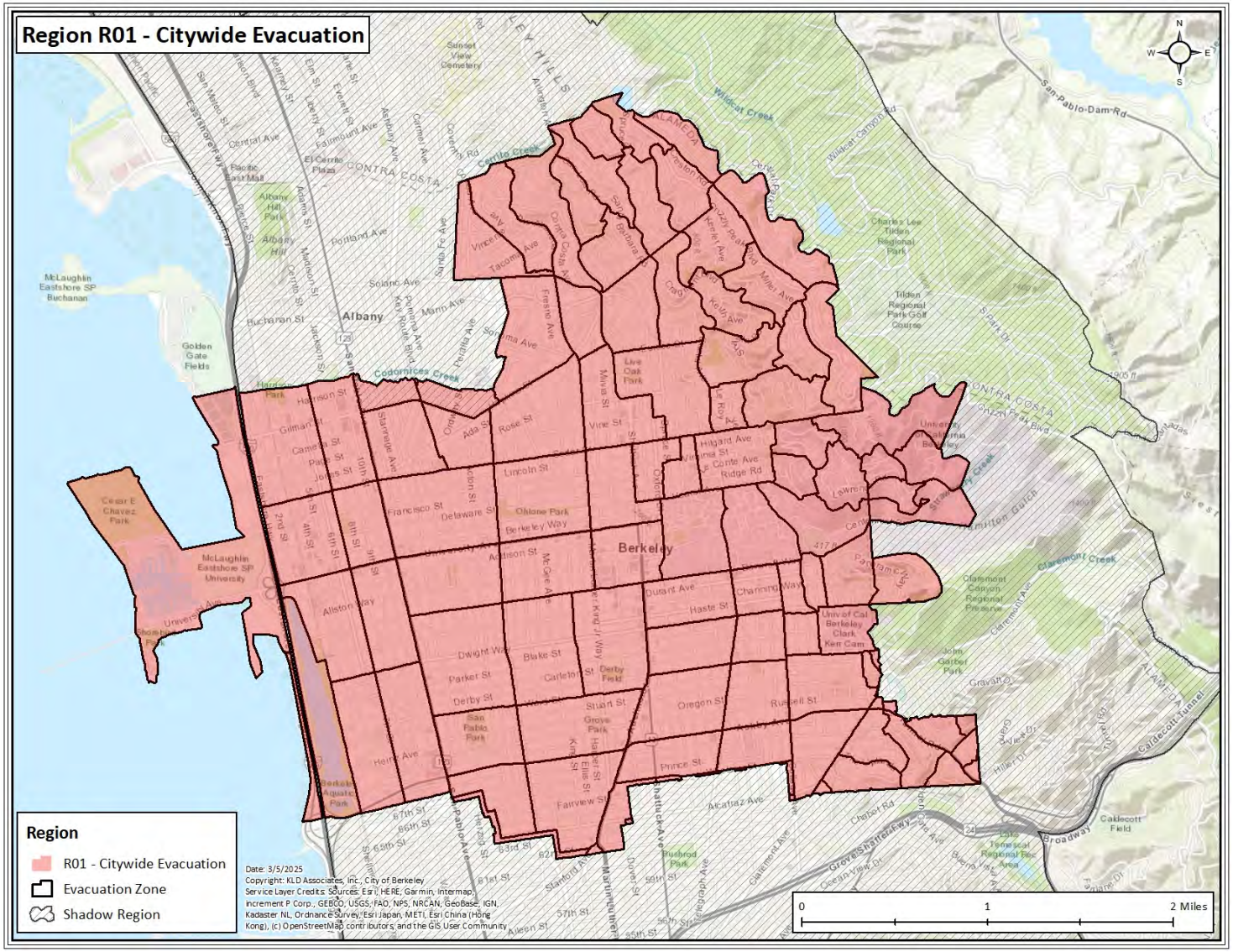
If you have questions or concerns, please email the City of Berkeley Fire Department - Office of Emergency Services: oes@berkeleyca.gov.

APPENDIX E

Evacuation Regions

E EVACUATION REGIONS

This appendix presents maps of all of the Evacuation Regions (groupings of Genasys Zones) considered for this study. These evacuation regions were developed in consultation with the City of Berkeley. They are based on historical evacuation data and represent areas expected to evacuate together in response to a given hazard or emergency.


Region R01 - Citywide Evacuation
Region
R01 - Citywide Evacuation
Evacuation Zone
Shadow Region
Date: 3/5/2025
Copyright: KLD Associates, Inc., City of Berkeley
Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community
0
1
2 Miles
Albany
Berkeley
Emeryville
CONTRA COSTA
ALAMEDA
Codornices Creek
Cerrito Creek
Wildcat Creek
Strawberry Creek
Claremont Creek
Hamilton Gulch
San Pablo Dam Rd
Central Ave
Solano Ave
Marin Ave
Gilman St
Hearst Ave
Ashby Ave
Dwight Way
Durant Ave
Haste St
Bancroft Way
Oregon St
Russell St
Prince St
Ridge Rd
Lincoln St
Delaware St
Francisco St
Addison St
Allston Way
Parker St
Derby St
Stuart St
Grove Park
Ohlone Park
Berkeley Way
Live Oak Park
San Pablo Park
Cesar E Chavez Park
McLaughlin Eastshore SP University
McLaughlin Eastshore SP Buchanan
Golden Gate Fields
Albany Hill Park
Pacific East Mall
El Cerrito Plaza
Sunset View Cemetery
Charles Lee Tilden Regional Park
Tilden Regional Park Golf Course
Claremont Canyon Regional Preserve
John Garber Park
Caldecott Tunnel
Caldecott Field
Berkeley Aquatic Park
Bushrod Park
Ohlone Greenway
Cesar Chavez Park
Broadway
Grove-Shafter Freeway
Eastshore Freeway
Buchanan St
Portland Ave
Fairview St
Aleatraz Ave
Ashby Ave
Alcatraz Ave
Telegraph Ave
Shattuck Ave
Martin Luther King Jr Way
Sacramento St
Adeline St
Fresno Ave
Sonoma Ave
Virginia St
Rose St
Vine St
Hearst Ave
Channing Way
Haste St
Durant Ave
Addison St
Allston Way
Dwight Way
Parker St
Derby St
Stuart St
Oregon St
Russell St
Prince St

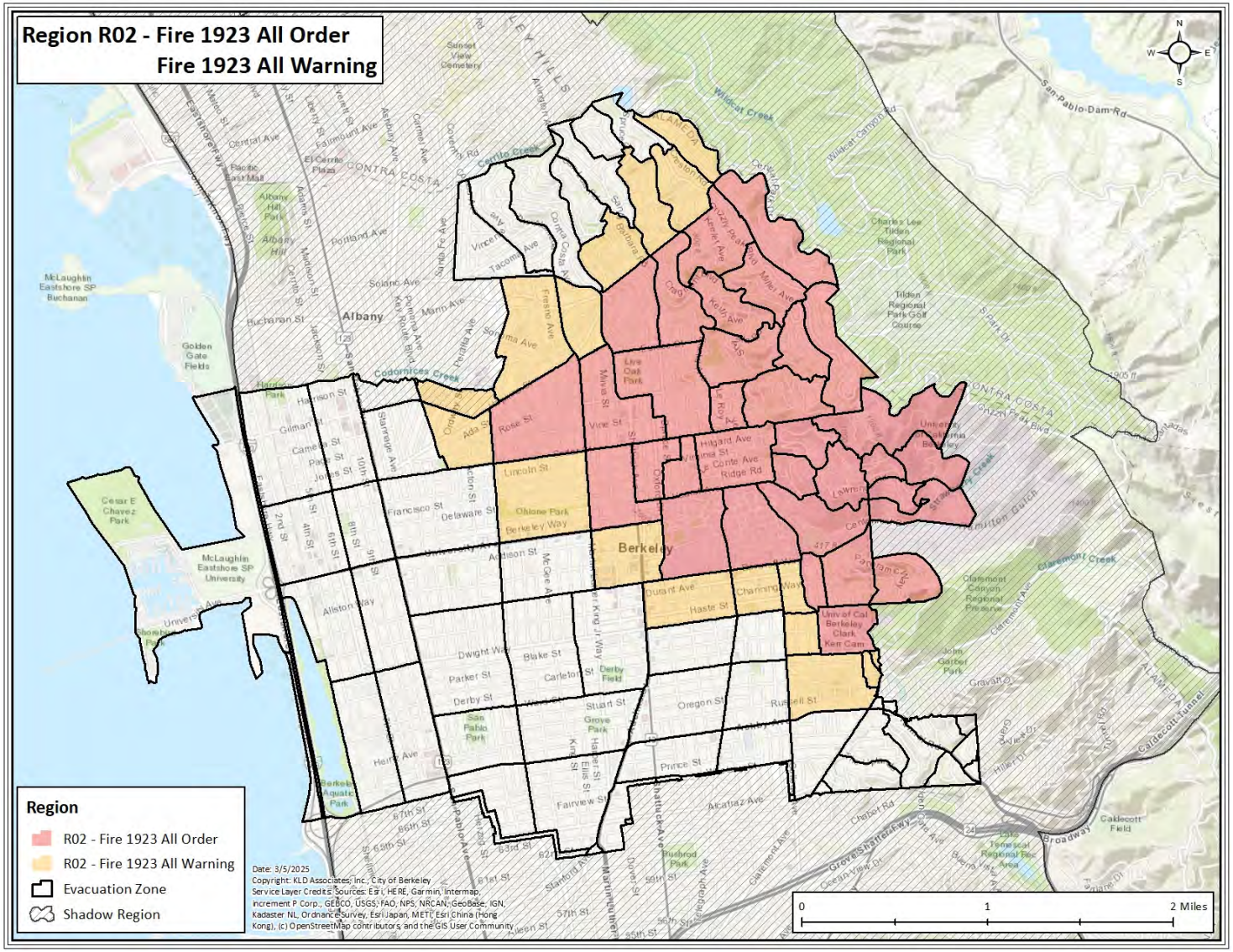


Figure E-2. Fire 1923

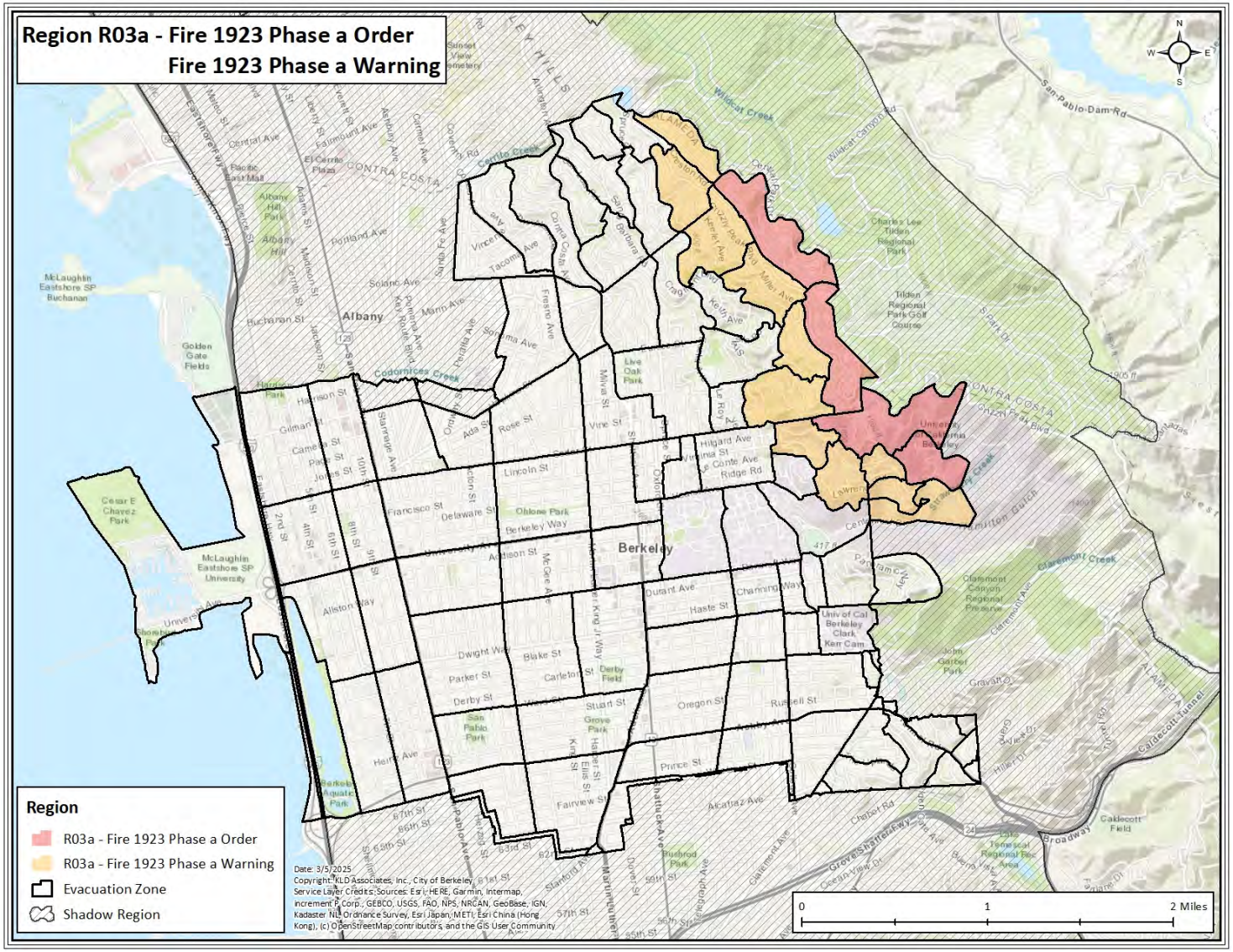


Figure E-3. Fire 1923 Phase a

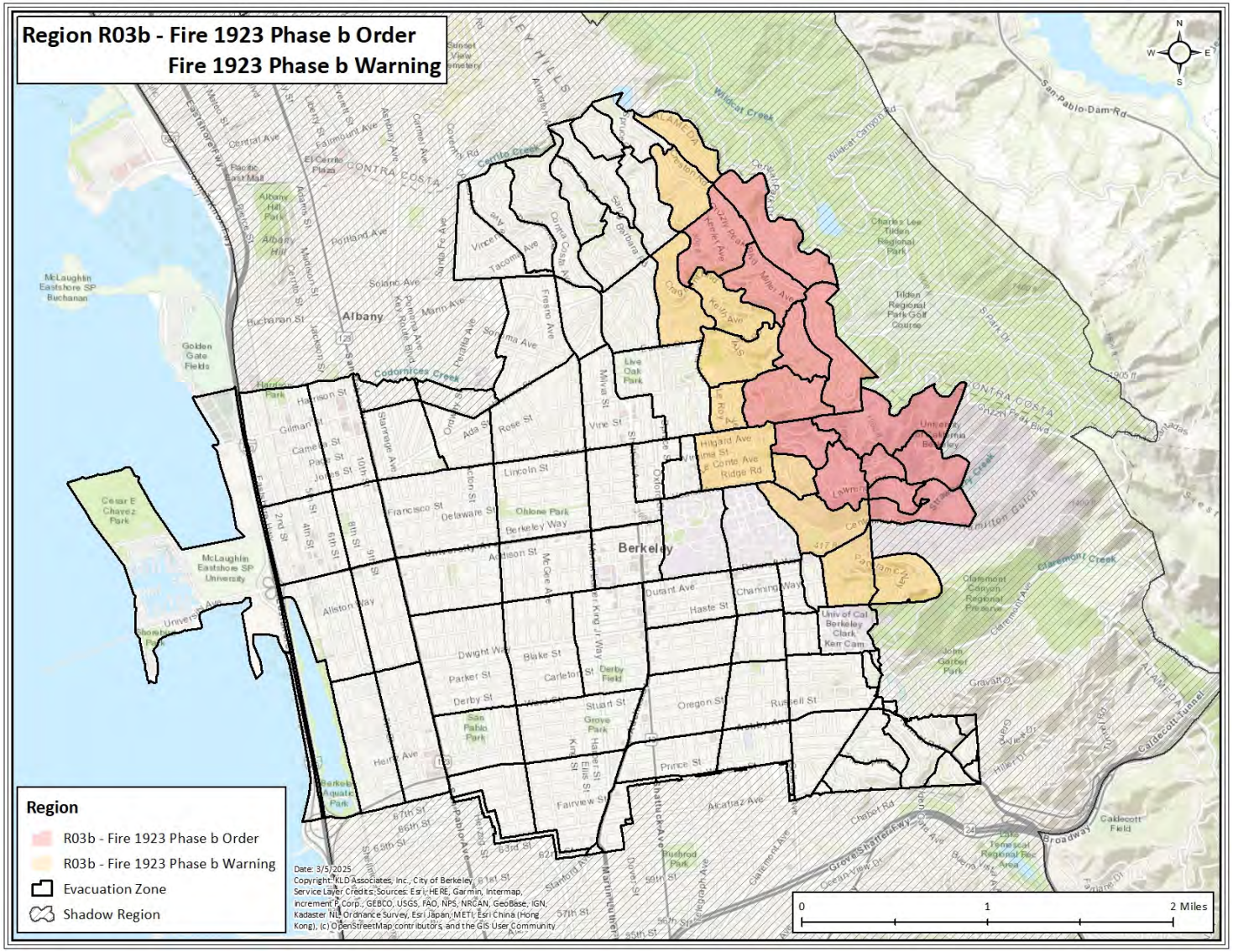


Figure E-4. Fire 1923 Phase b

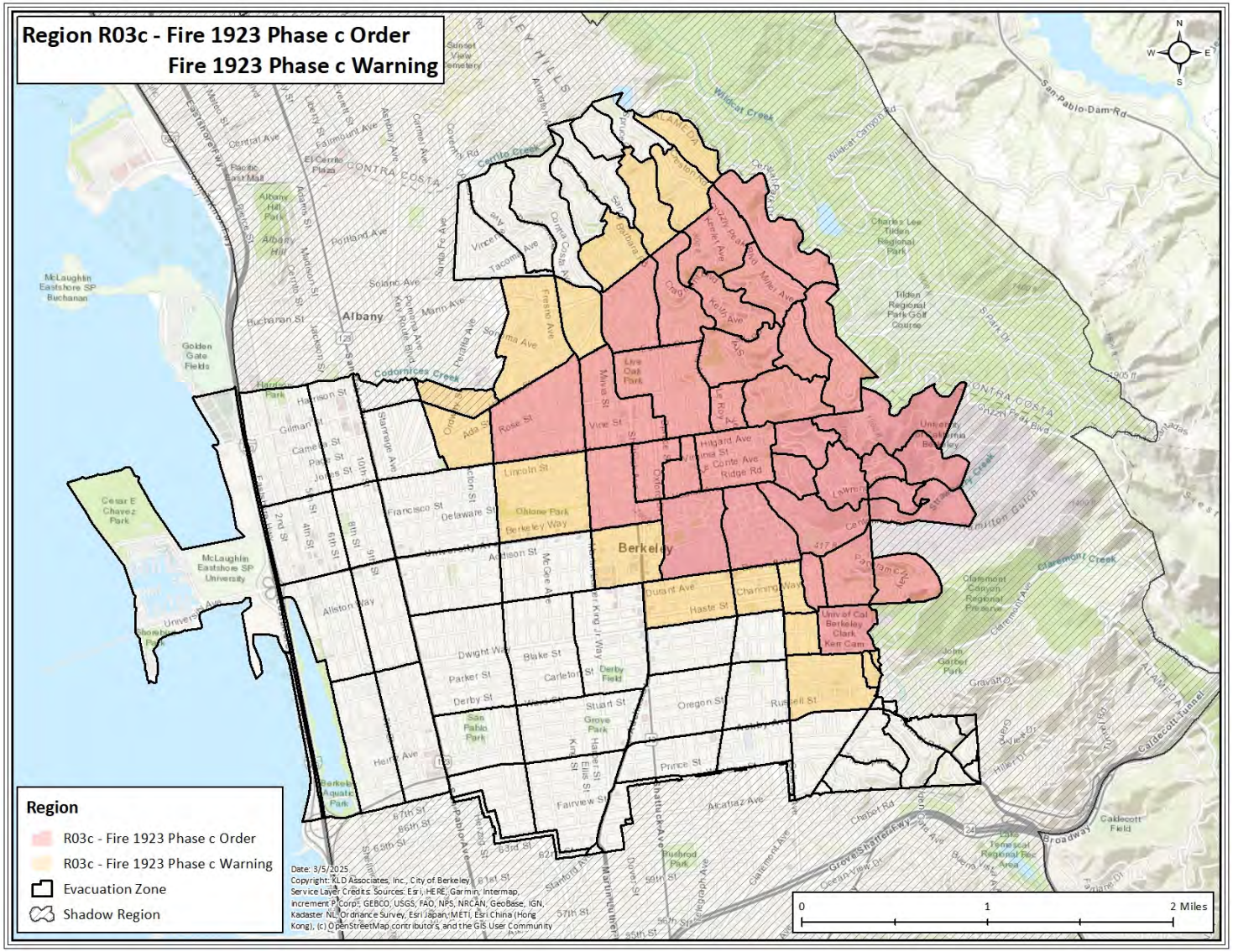


Figure E-5. Fire 1923 Phase c

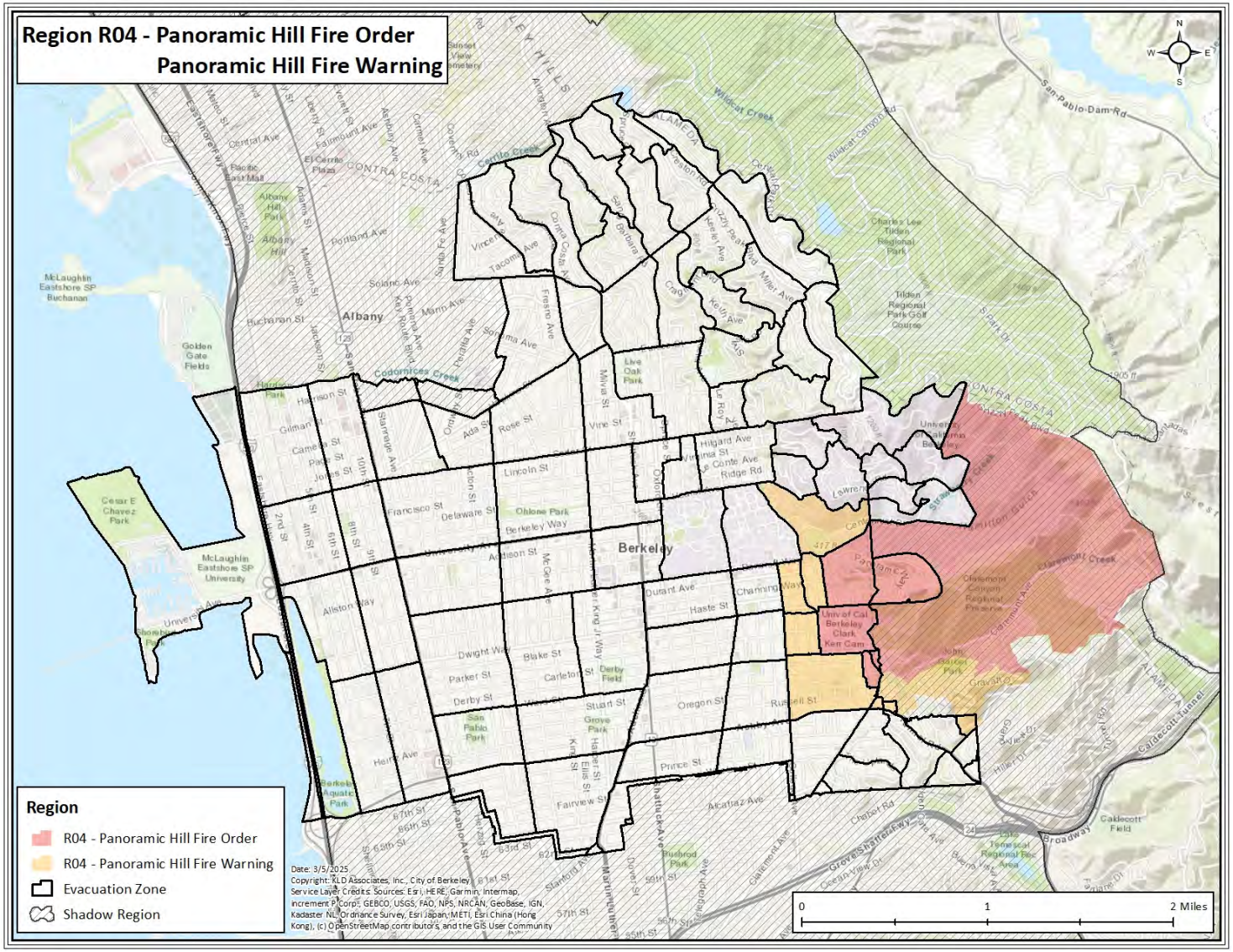


Figure E-6. Panoramic Hill Fire

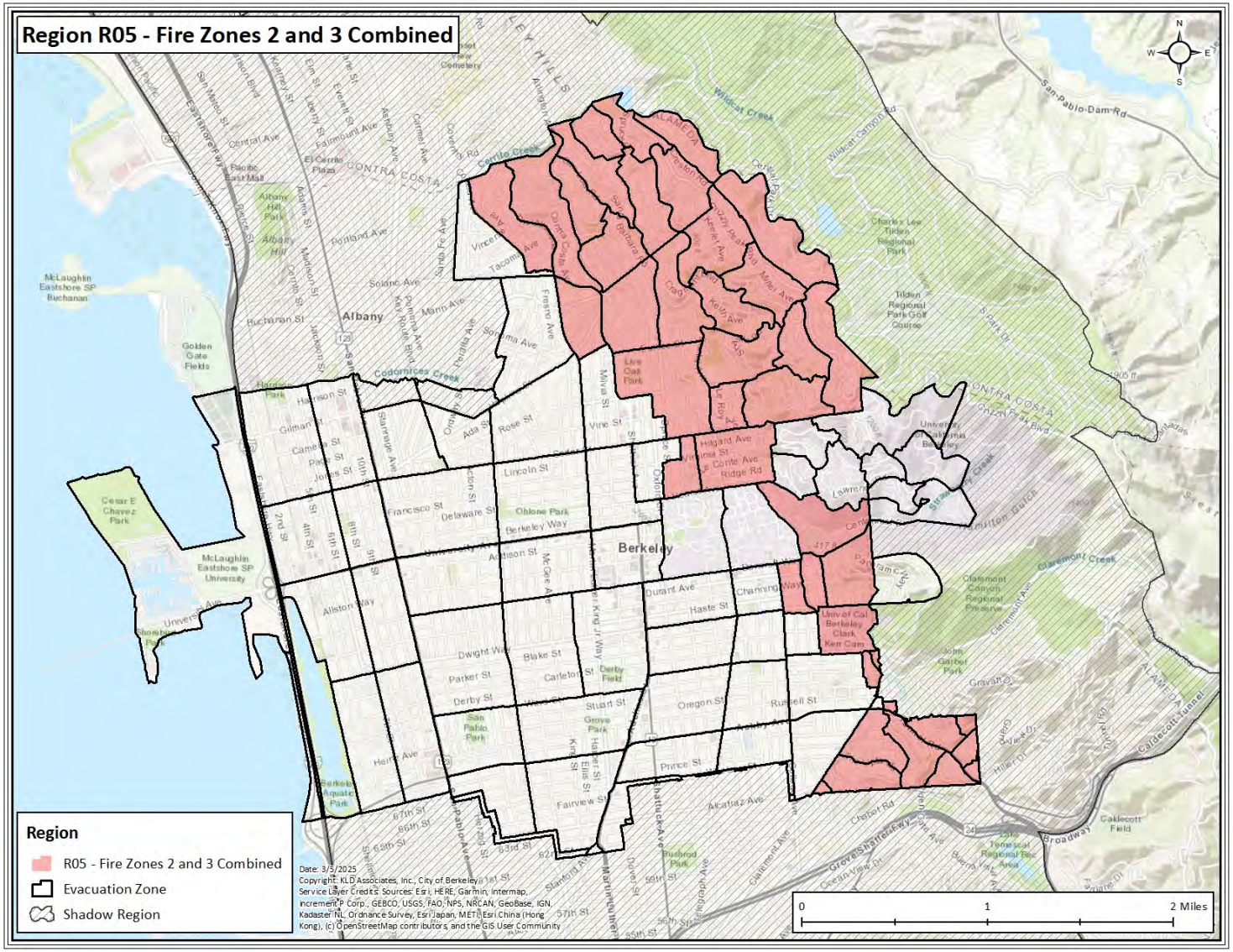


Figure E-7. Fire Zone 2 and 3 Combined

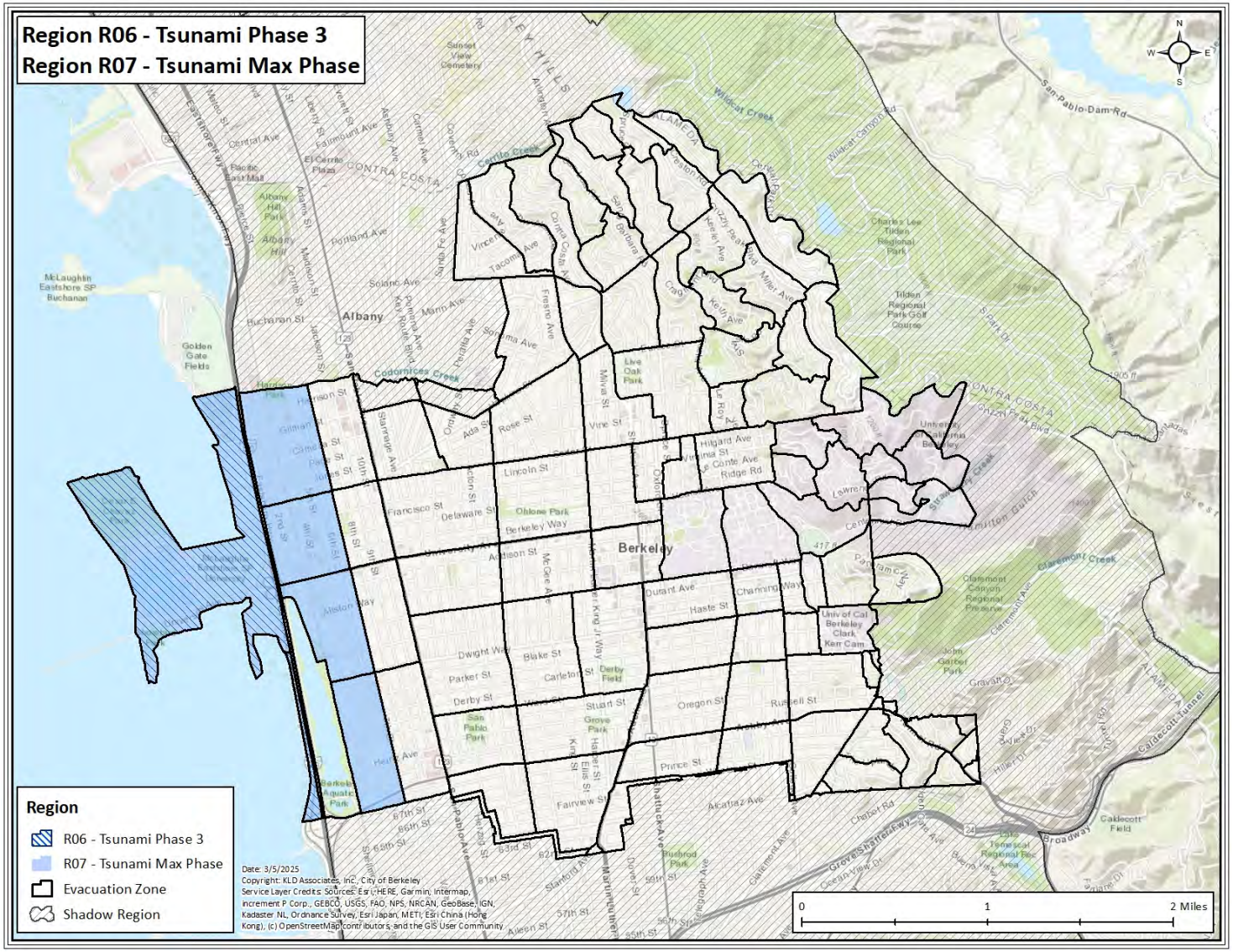


Figure E-8. Tsunami Phase 3 and Tsunami Max Phase

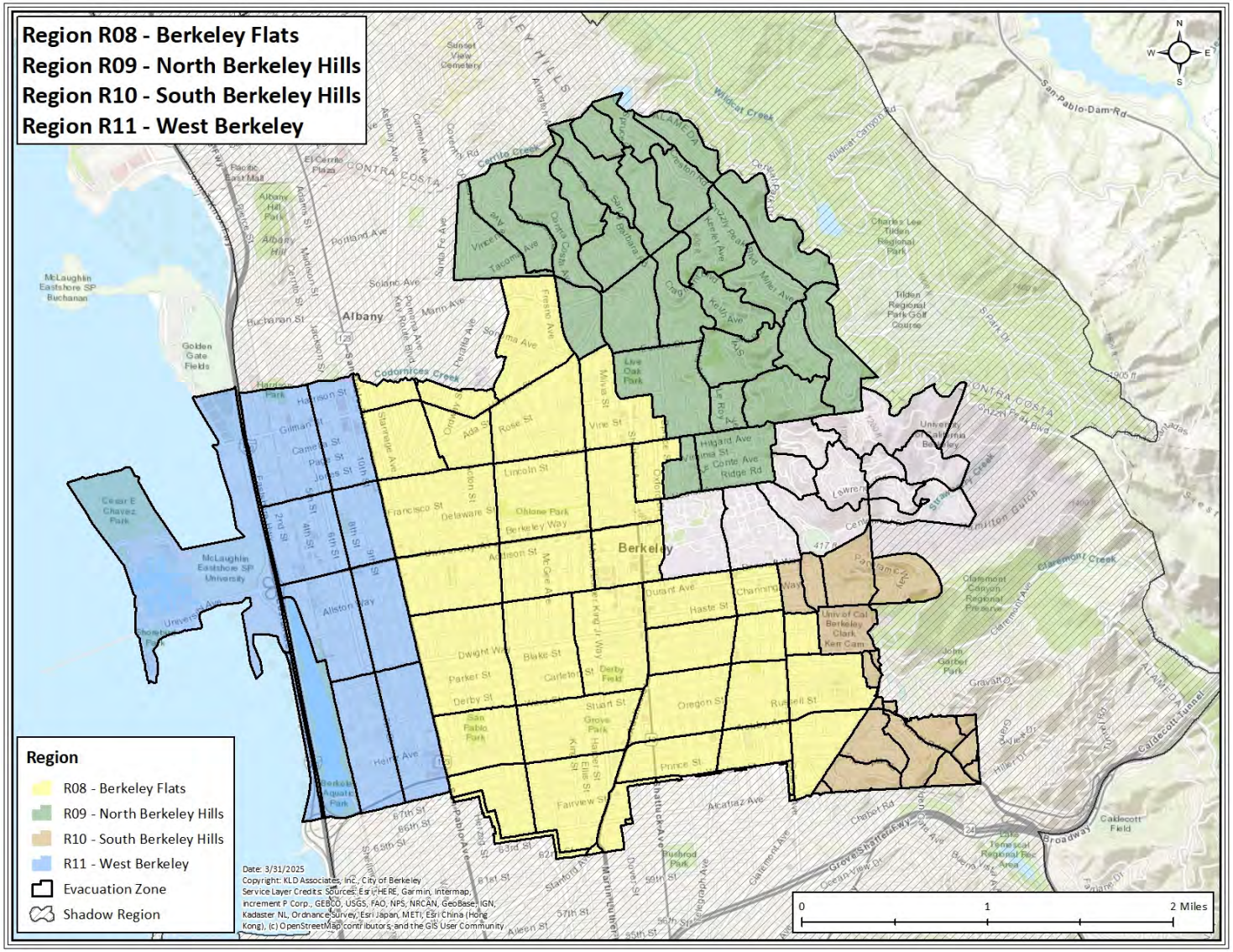


Figure E-9. Berkeley Flats, North Berkeley, South Berkeley and West Berkeley

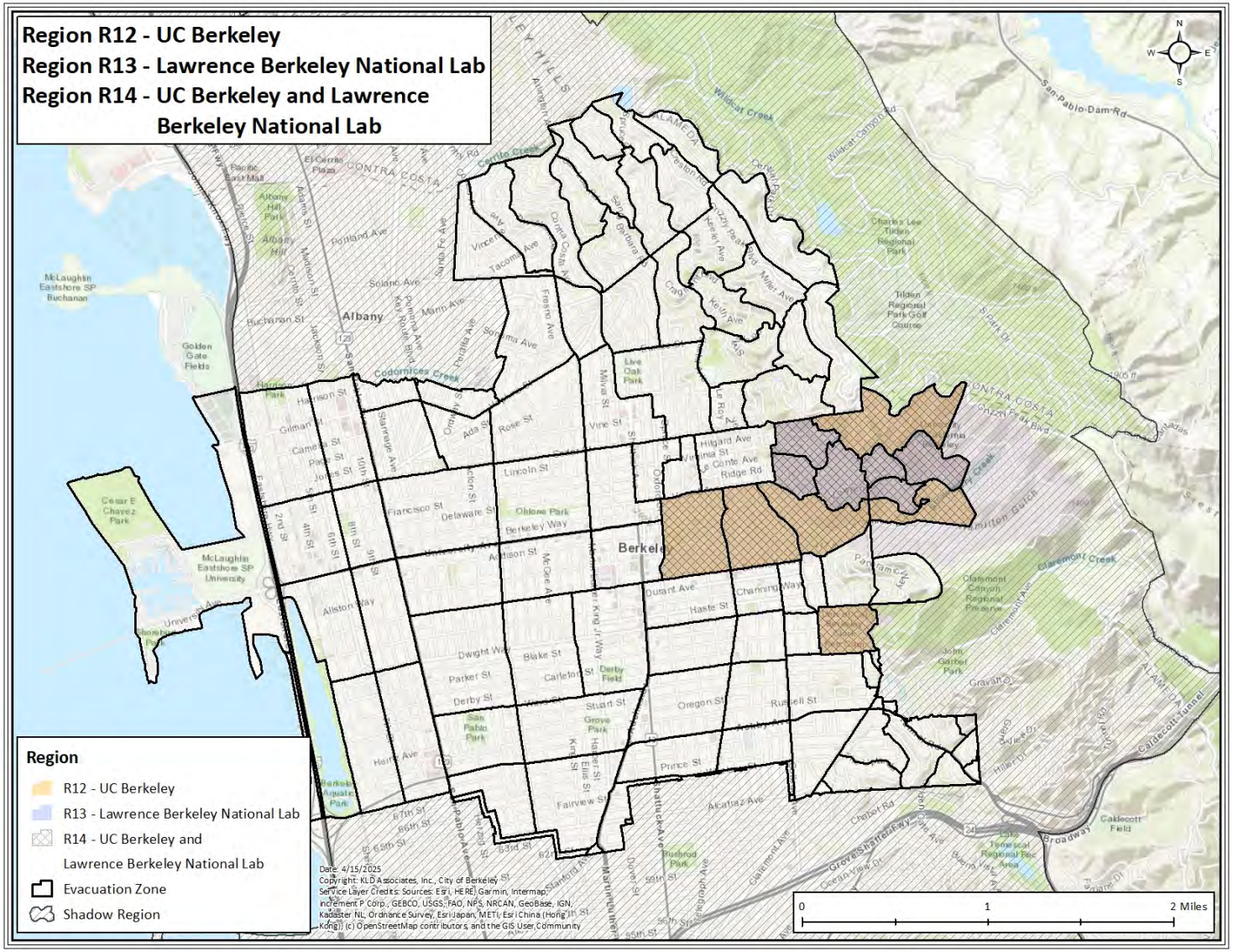


Figure E-10. UC Berkeley and Lawrence Berkeley National Lab

APPENDIX F

Patterns of Traffic Congestion During Evacuation

F. PATTERNS OF TRAFFIC CONGESTION DURING EVACUATION

This appendix provides patterns of traffic congestion during an evacuation. Traffic congestion, as the term is used here, is defined as Level of Service (LOS) F. LOS F is defined as follows (HCM 2022, page 5-5):

> The HCM uses LOS F to define operations that have either broken down (i.e., demand exceeds capacity) or have reached a point that most users would consider unsatisfactory, as described by a specified service measure value (or combination of service measure values). However, analysts may be interested in knowing just how bad the LOS F condition is, particularly for planning applications where different alternatives may be compared. Several measures are available for describing individually, or in combination, the severity of a LOS F condition:
>
> • *Demand-to-capacity ratios* describe the extent to which demand exceeds capacity during the analysis period (e.g., by 1%, 15%).
>
> • *Duration of LOS F* describes how long the condition persists (e.g., 15 min, 1 h, 3 h).
>
> • *Spatial extent measures* describe the areas affected by LOS F conditions. They include measures such as the back of queue and the identification of the specific intersection approaches or system elements experiencing LOS F conditions.

All highway "links" which experience LOS F are delineated in these figures by a thick red line; all others are lightly indicated. Congestion develops around concentration of population and traffic bottlenecks. The congestion patterns are presented for the regions specified below for Scenario 4 (fall midweek midday) as it's the scenario with highest vehicular demand and therefore greatest levels of congestion.

F.1 Citywide Evacuation (Region R01)

As is noted in Section 7, **Region R01 does not reflect a realistic emergency or disaster**. An event requiring simultaneous evacuation of all of Berkeley would have regional impacts to roadway and transportation systems that are far beyond the scope of this analysis.

Rather, Citywide evacuation was included in this document in order to stress Berkeley's roadway network to identify areas of potential traffic congestion that may not have been apparent from other evacuation cases.

Figure F-1 displays congestion patterns just 15 minutes after the Evacuation Order. At this time, 8.1% of vehicles have begun their evacuation trip and 6% of evacuating vehicles have successfully evacuated Berkeley. Initial congestion patterns are developing, particularly in the eastern portion of the Berkeley Flats and surrounding the UC Berkeley campus. As vehicles begin to mobilize, the increased traffic volume is already exceeding the capacity of key roadways in this area. This localized congestion is potentially due to the convergence of

multiple evacuation routes, clustered pre-timed signals and traffic calming devices, a series of one-way pairs, and the high density of residential areas adjacent to the university.

1 hour after the initial Evacuation Order, 54.6% of vehicles have begun their evacuation trip and 26.7% of evacuating vehicles have successfully evacuated Berkeley. As shown in Figure F-2, congestion has become fully developed, with near-gridlock conditions prevailing. The Berkeley Flats are now experiencing LOS F on virtually every major street, indicating severely congested flow. This widespread congestion extends into the Berkeley Hills area, impacting key thoroughfares such as Spruce Street, Grizzly Peak Boulevard, Boynton Avenue, and Marin Avenue, all of which are also operating at LOS F. The confluence of evacuating traffic from both the flats and the hills has resulted in a critical bottleneck, effectively impeding movement and significantly reducing the overall evacuation efficiency.

Two hours after the Evacuation Order, 96.7% of vehicles have begun their evacuation trip and 50.1% of evacuating vehicles have successfully evacuated Berkeley. Severe congestion persists, although a slight improvement is observed in the Berkeley Hills area, as shown in Figure F-3. However, the situation has escalated elsewhere, with Interstate 580 (I-580) and its associated ramps now operating at LOS F, effectively creating a major bottleneck for evacuees attempting to leave the area along this freeway. As drivers seek alternative routes, arterial streets such as San Pablo Avenue, Sacramento Street, and Shattuck Avenue are experiencing increased traffic volume. The inherent configuration of Berkeley's road network, characterized by predominantly north-south routes and limited east-west connectivity, exacerbates the congestion, restricting evacuation options and further hindering traffic flow. This constrained network design contributes significantly to the persistent gridlock and poses a considerable challenge to efficient evacuation.

Three hours after the Evacuation Order, nearly all (99.6%) vehicles have begun their evacuation trip and 72.7% of evacuating vehicles have successfully evacuated Berkeley. As shown in Figure F-4, the congestion begins to show some signs of differentiation. While the Berkeley Flats area continues to experience heavy congestion, particularly in the northern sections, conditions in the southeast are starting to improve. In the Berkeley Hills area, the dissipation of congestion continues, though several key arteries, including Woodmont Avenue, Grizzly Peak Boulevard, Spruce Street, Marin Avenue and Boynton Avenue, remain at LOS F, indicating persistent bottlenecks. On I-580, some sections are now operating at LOS C, a significant improvement. However, the ramps connecting to the interstate remain heavily congested and continue to function as the primary bottleneck, impeding the overall flow of evacuating traffic onto the interstate. This persistent ramp congestion suggests that access to and from one of the primary evacuation routes remains a critical bottleneck.

Four hours after the initial Evacuation Order, all evacuating vehicles have begun their evacuation trip and 89.7% of evacuating vehicles have successfully evacuated Berkeley. As shown in Figure F-5, a noticeable reduction in citywide congestion can be observed. LOS F conditions are now primarily concentrated within a defined area bounded by Dwight Way and Hopkins Street to the south and north, and Sacramento Street and Piedmont Avenue to the west and east. The presence of traffic calming devices, such as those on Fulton St, reduces the

efficiency of the evacuation by slowing traffic down. In the Berkeley Hills, while general improvement is evident, Spruce Street continues to experience LOS E, indicating localized congestion. West of San Pablo Ave, roadways show significant improvement as all roadways in the area are operating at LOS C or better, particularly those providing access to I-580.

Four hours and 45 minutes after the Evacuation Order, 96.7% of evacuating vehicles have successfully evacuated Berkeley. Shattuck Avenue and Martin Luther King Jr Way continue to experience significant congestion between Ashby Avenue and Hopkins Street, as shown in Figure F-6. This persistent bottleneck is likely attributable to the pre-timed signal system present throughout these sections of the roadway. The fixed timing of these signals may not be adequately responding to the fluctuating traffic demands of the evacuation, creating inefficiencies and hindering traffic flow.

As shown in Figure F-7, 5 hours and 15 minutes after the Evacuation Order, the final pockets of congestion (LOS F) are on Cedar Street, Hearst Avenue and Shattuck Avenue while all other roads are operating at LOS D or better. The city is clear of congestion approximately 20 minutes later at 5 hours and 35 minutes after the Evacuation Order. This projected clearance time aligns with the overall evacuation time estimate.

F.2 1923 Fire Repeat (Region R02)

Figure F-8 shows the patterns of traffic congestion for a 1923 Fire Repeat at 1 hour and 2 hours after the Evacuation Order. One hour into the evacuation, the majority of the roads within the evacuated area are operating at LOS F conditions, especially surrounding UC Berkeley. Congested conditions develop between Dwight Way and Hopkins Ave and between Sacramento St and Grizzly Peak Blvd. All employees, visitors and college students who evacuate using personal vehicles mobilize within 1 hour after the Evacuation Order. Hence, the congestion that is present at 1 hour into the evacuation is largely caused by these vehicles. Only 20% of the population west of Sacramento St is evacuating for this Region, and for that reason the congestion within the Berkeley Flats is less significant.

Two hours after the Evacuation Order, the congestion near UC Berkeley lessens as the students and employees from the college have mobilized and evacuated. Congestion is present in other parts of the evacuated zones, which are still operating at LOS F conditions, specifically between Bancroft Way and Hopkins Ave and between Martin Luther King Jr Way and Gayley Rd. Congestion along Grizzly Peak Drive and Woodmont Ave has worsened as more residents are mobilizing within Berkeley Hills.

Figure F-9 shows the patterns of traffic congestion for 1923 Fire Repeat at 3 hours and 4 hours after the Evacuation Order. At 3 hours, Gayley Road and Hearst Ave near UC Berkeley are still operating at LOS F conditions within the Evacuation Zones. Both roads are clear of congestion 4 hours after the Evacuation Order. At 3 hours, Marin Ave, Hopkins St, Arlington Ave and Cedar St, which serve the majority of evacuating population leaving the area at risk are also still congested. One hour later at 4 hours after the Evacuation Order, the only road that is operating at LOS F conditions is Cedar St at the pretimed signalized intersection with Martin Luther King Jr Way, which clears of congestion 10 minutes later at 4 hours and 10 minutes.

F.3 1923 Fire Repeat Phased (Region R03)

Figure F-10 displays the patterns of traffic congestion for 1923 Fire Repeat (Phased) at 1 hour and 2 hours after the Evacuation Order. As discussed in Section 6, the residents that live closer to the proximity of the fire are ordered to evacuate first while other areas within the 1923 Fire Repeat Region are ordered to evacuate 90 (Phase b) and 180 minutes (Phase c) after. Since only the evacuations of residents are phased, but employees, college students and visitors in the entire area (including phase b and c) leave when evacuations are initially ordered, the congestion patterns near UC Berkeley are comparable between Figure F-10 and Figure F-8. However, congestion that is closer in proximity to the eastern boundary of Berkeley (closer to Tilden Park) is more pronounced in the phased region due evacuees from outside of Phase a entering Phase a, as is discussed in Section 7.

As shown in Figure F-11Figure F-11, since phase c does not start until 3 hours after the Evacuation Order, the congestion patterns at 3 hours are significantly improved as the demand is distributed over a long period of time, allowing the roadway network to process the demand more effectively. LOS F still exists near UC Berkeley. However, Berkeley Hills roadways are operating at LOS D or better as shown in Figure F-11Figure F-11. Even though residents from phase c are still mobilizing 4 hours after the Evacuation Order, they face little to no congestion leaving the area as all roads within the zones ordered to evacuate are operating at LOS C or better. All phase c evacuees are fully mobilized at 6 hours and 15 minutes after the Evacuation Order. All congestion clears 5 hours and 20 minutes. Because phase c is delayed by 180 minutes, the initial evacuation congestion has cleared by the time phase c is fully mobilized.

F.4 Panoramic Hill Fire (Region R04)

Figure F-12 displays the patterns of traffic congestion for a Panoramic Hill Fire 30 minutes and 1 hour after the Evacuation Order. Congestion within Panoramic Hill is minimal, operating at LOS C or better. As discussed in Section 10, even though Panoramic Hill only has one egress route, evacuees are mobilizing over a long period of time (over 3 hours), hence, the roadway network within the area being ordered to evacuate does not get overwhelmed trying to process the demand. Outside of Panoramic Hill and the evacuated area, near the Channing Way traffic circle, roadways operate at LOS F. The diverter on Derby St between Warring St and College Ave, is problematic for this area as evacuees can't travel westbound on Derby St to reach College Ave. At this point, vehicles on Derby St southbound are essentially forced to continue on Derby St to the congested intersection with Claremont Ave. Thirty minutes later, at 1 hour after the Evacuation Order, congestion persists near the traffic circle on Piedmont Ave and Channing Way. It should be noted that since the fire origin, travel direction and rate of spread is not modeled, Claremont Avenue was modeled as a viable evacuation route. At 1 hour after the evacuation order, this roadway experiences congested conditions due to the low-capacity geometric bends (i.e., hairpin turns) along this path.

Figure F-13 displays the patterns of traffic congestion for Panoramic Hill Fire 1 hour and 30 minutes and 2 hours after the Evacuation Order. Piedmont Ave to Warring St, to Derby St to Belrose Ave to Claremont Blvd is operating at LOS F conditions at 1 hour and 30 minutes after

the Evacuation Order. This congestion is caused by the limited connections in this area. Once evacuees pass the intersection with Dwight Ave on Piedmont Ave, they are essentially forced to stay on Warring St/Derby St/Belrose Ave/Claremont Blvd, as there is only one connection (Forest Ave) to College Ave and other roadways leaving this area. Congestion along these roads clears 30 minutes later, 2 hours after the Evacuation Order.

F.5 Fire Zones 2 & 3 (Region R05)

As is discussed in Section 7, it is unlikely that there would be a simultaneous evacuation of Fire Zones 2 and 3 (the Berkeley hills) in association with a particular emergency or disaster. This region is included to help analyze impacts of the Berkeley Hills from administrative changes that could affect development in the area.

Figure F-14 displays the patterns of traffic congestion for Fire Zones 2 & 3 at 1 hour and 2 hours after the Evacuation Order. One hour into the evacuation, the majority of the roads within the Evacuation Zones are operating at LOS F conditions including Grizzly Peak Blvd, Euclid Ave, Spruce St, Marin Ave, La Loma Ave, Gayley Rd, and Arlington Ave. Outside of the evacuated area, roadways in proximity to UC Berkeley are also congested. Even though the UC Berkeley campus is not ordered to evacuate, 20% of evacuees are assumed to voluntary evacuate, so the demand exceeds the capacity causing LOS F conditions within this area. To the south, Ashby Rd/Tunnel Rd is heavily congested as it is the highest capacity roadway within the South Berkeley Hills. Two hours into the evacuation, congestion in South Berkeley Hills and UC Berkeley have dissipated somewhat. However, the North Berkeley Hills is still heavily congested. Roads within this area are windy and narrow, resulting in slower speeds and lower capacities. The roundabout that is along Channing Way and Piedmont Ave is slowing down traffic, causing congestion southbound along Piedmont Ave in this area. The five-legged roundabout on Marin Ave is also proving to be a bottleneck as traffic along competing movements attempt to merge into the roundabout at the same time.

Figure F-15 displays the patterns of traffic congestion for Fire Zones 2 & 3 at 2 hours and 30 minutes and 3 hours after the Evacuation Order. The last remnants of congestion within the evacuated area are present along Piedmont Ave/Warring Ave, Euclid Ave, Hearst Ave, Henry St, Spruce St, Grizzly Peak Blvd, and Woodmont Ave. Thirty minutes later, at 3 hours after the Evacuation Order, most of this congestion has cleared. Piedmont Ave is operating at LOS D or better at this time, and all congestion clears 15 minutes later (3 hours and 15 minutes after the Evacuation Order).

F.6 Tsunami Warning Phase 3 (Region R06)

Figure F-16 displays the patterns of traffic congestion for Tsunami Warning Phase 3 at 30 minutes and 1 hour after the Evacuation Order. Just 30 minutes after the Evacuation Order, University Ave and I-580 are already operating at LOS F conditions. University Ave and Frontage Rd are the only two egress routes for this region. Even though Frontage Road is operating at LOS D or better, the traffic circle that gives access to I-580 (near Gilman St) is operating at LOS F at this time. Thirty minutes later, one hour after the Evacuation Order, University Ave is clear of

congestion within the region. However, congestion along Frontage Rd (near Gilman St and Ashby Ave) worsens due to low capacity on the traffic circle to the north and the merge between Ashby Ave and Frontage Rd to the south. Traffic along I-580 has also worsened as evacuees utilize this roadway as their primary evacuation route out of the area.

Figure F-17 displays the patterns of traffic congestion for Tsunami Warning Phase 3 at 1 hour and 30 minutes and 2 hours and 30 minutes after the Evacuation Order. I-580 is still heavily congested at 1 hour and 30 minutes into the evacuation, operating at LOS F, but this congestion clears 2 hours and 30 minutes after the Evacuation Order. At both times, Frontage Road is clear of congestion. Even though there are still evacuees mobilizing until 3 hours and 30 minutes after the Evacuation Order, all congestion clears by 2 hours and 30 minutes from the Evacuation Order.

F.7 Tsunami Warning Max Phase (Region R07)

Figure F-18 displays the patterns of traffic congestion for Tsunami Warning Max Phase at 30 minutes and 1 hour after the Evacuation Order. Evacuees in Region R07 can use I-580, University Ave, Gilman St, Ashby Ave and Seventh/Sixth St to leave the evacuated area. All of these roads experience some level of congestion (LOS F conditions) at 30 minutes after the Evacuation Order. Thirty minutes later, at 1 hour after the Evacuation Order, congestion along University Ave and Seventh/Sixth St worsens while congestion along Gilman St dissipates.

Figure F-19 displays the patterns of traffic congestion for Tsunami Warning Max Phase at 1 hour 30 minutes and 2 hours after the Evacuation Order. Congestion has significantly dissipated at 1 hour and 30 minutes after the Evacuation Order. The Ashby Rd on-ramp to I-580 is operating at LOS F conditions. The on-ramp is a capacity restriction in this area as Ashby Ave merges down to a single lane from 2-lanes. The speeds are also lower as the on-ramp is a cloverleaf-style ramp. Frontage Rd northbound experiences congestion as well due to the yield control and right turn movement at the traffic circle at Gilman St. I-580, and many of its on-ramps, experience LOS F conditions as well. An hour later, at 2 hours and 30 minutes after the Evacuation Order, congestion within the region has almost entirely dissipated, except along I-580 southbound, which clears 5 minutes later at 2 hours and 35 minutes. Even though there are still evacuees mobilizing until 3 hours and 30 minutes after the Evacuation Order, all congestion is clear within 2 hours and 35 minutes after the Evacuation Order.

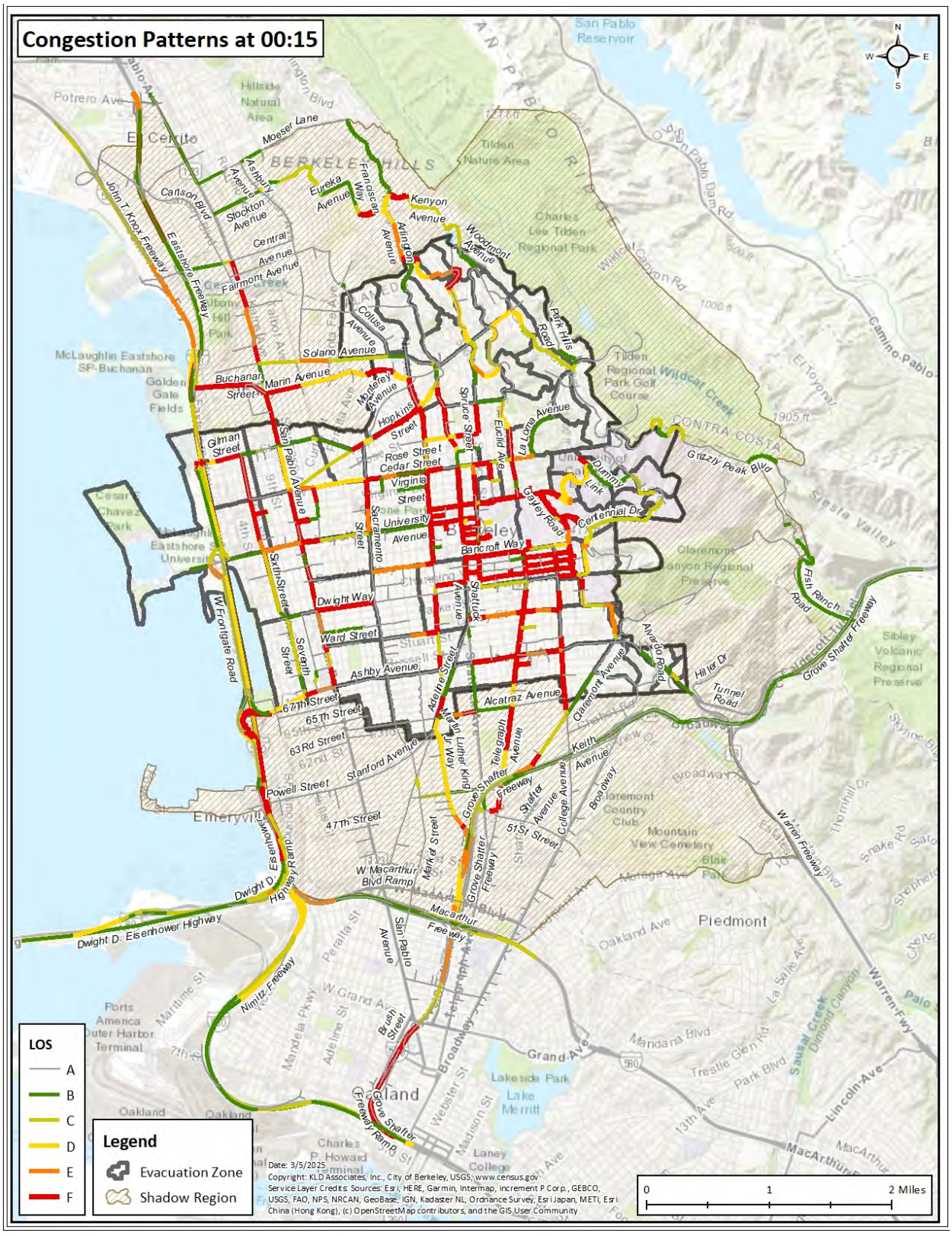


Figure F-1. Region R01 Congestion Patterns 15 Minutes after the Evacuation Order

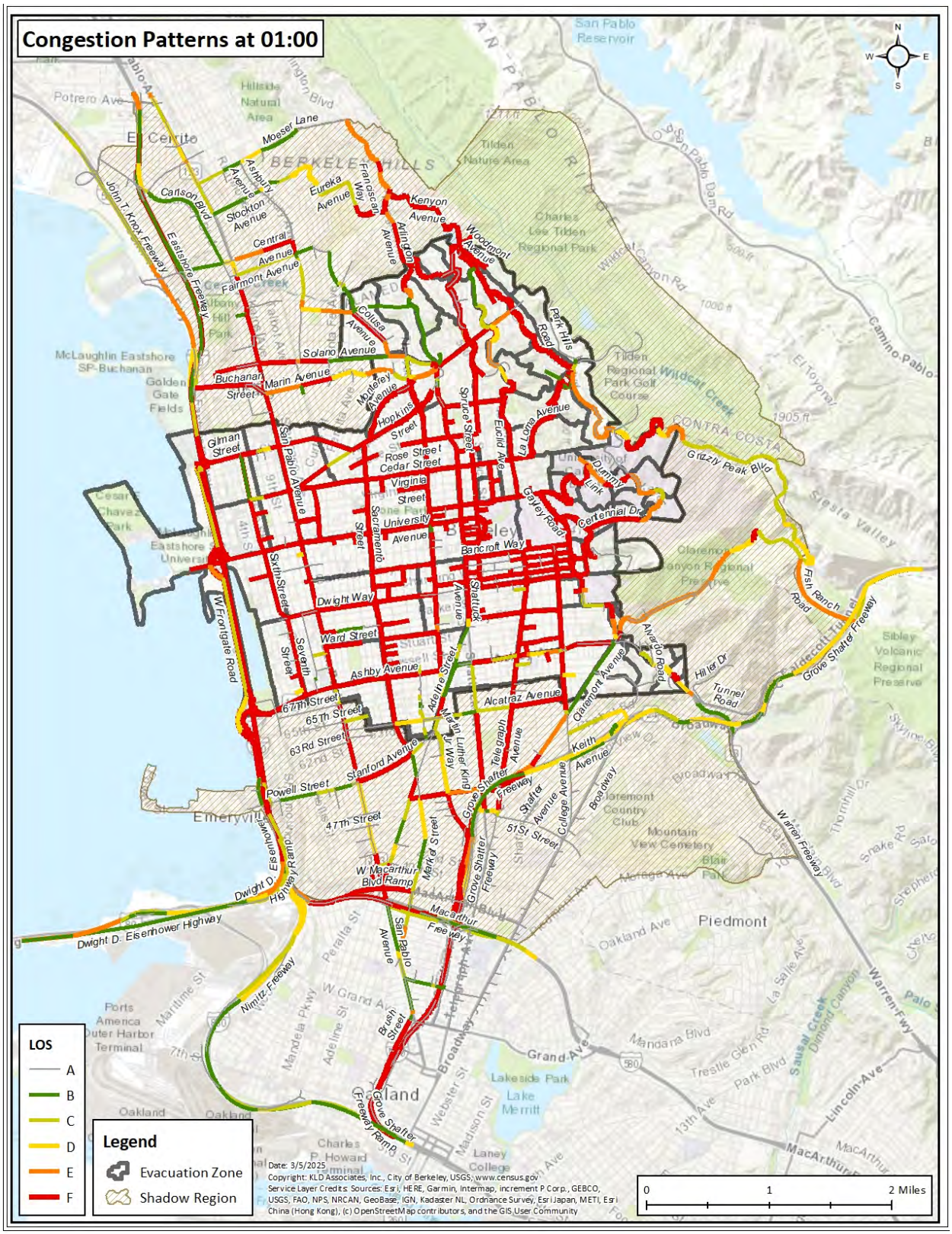


Figure F-2. Region R01 Congestion Patterns 1 Hour after the Evacuation Order

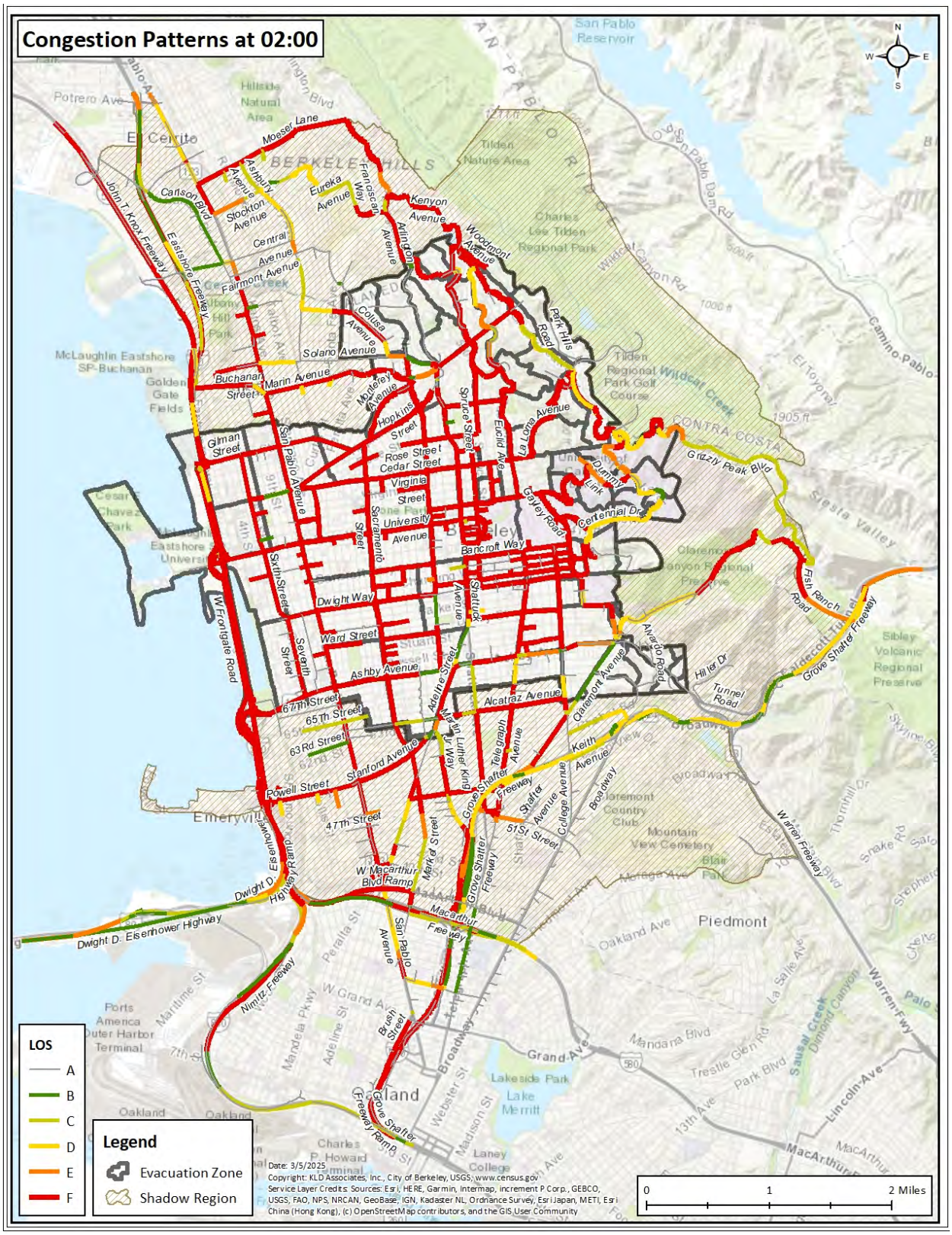


Figure F-3. Region R01 Congestion Patterns 2 Hours after the Evacuation Order

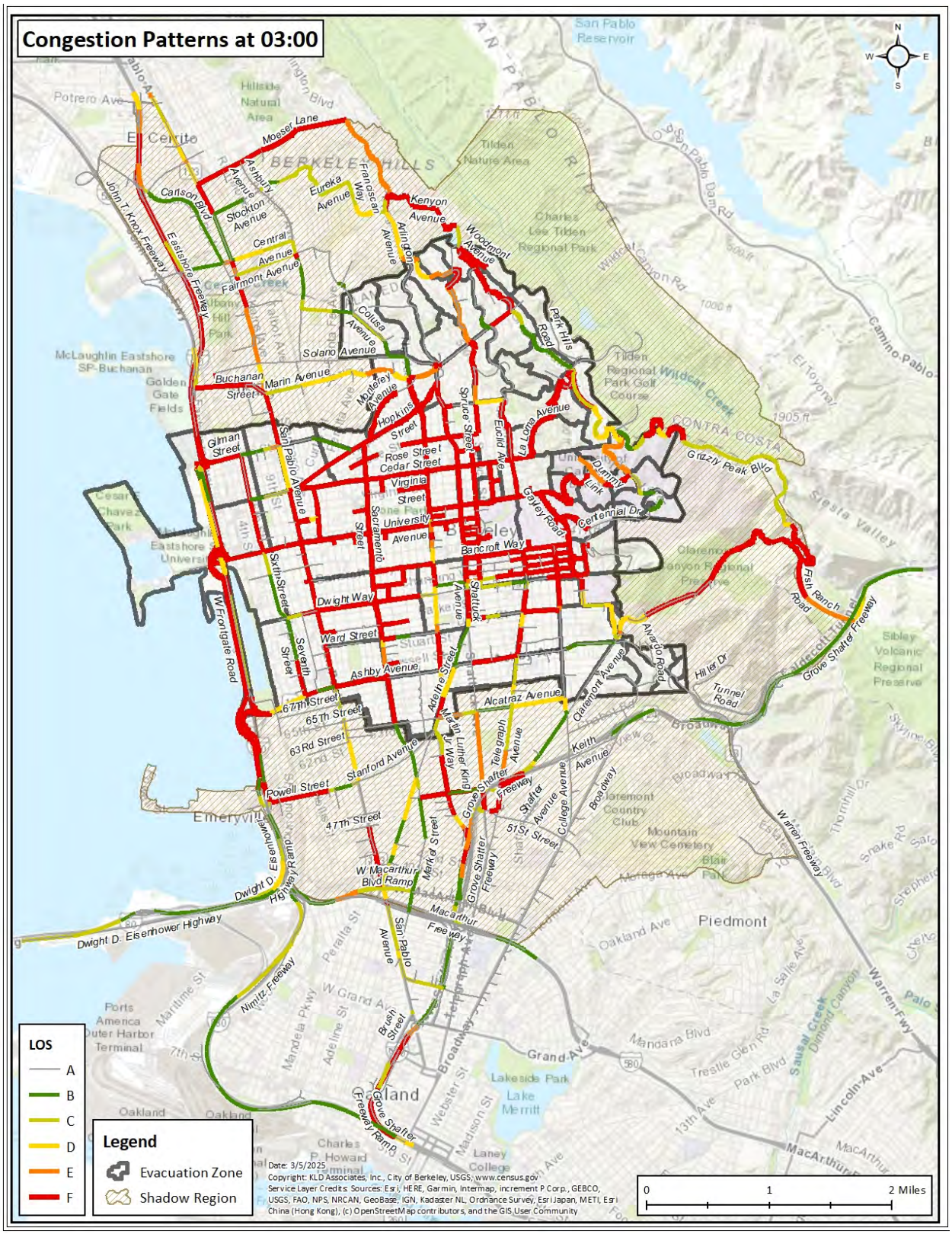


Figure F-4. Region R01 Congestion Patterns 3 Hours after the Evacuation Order

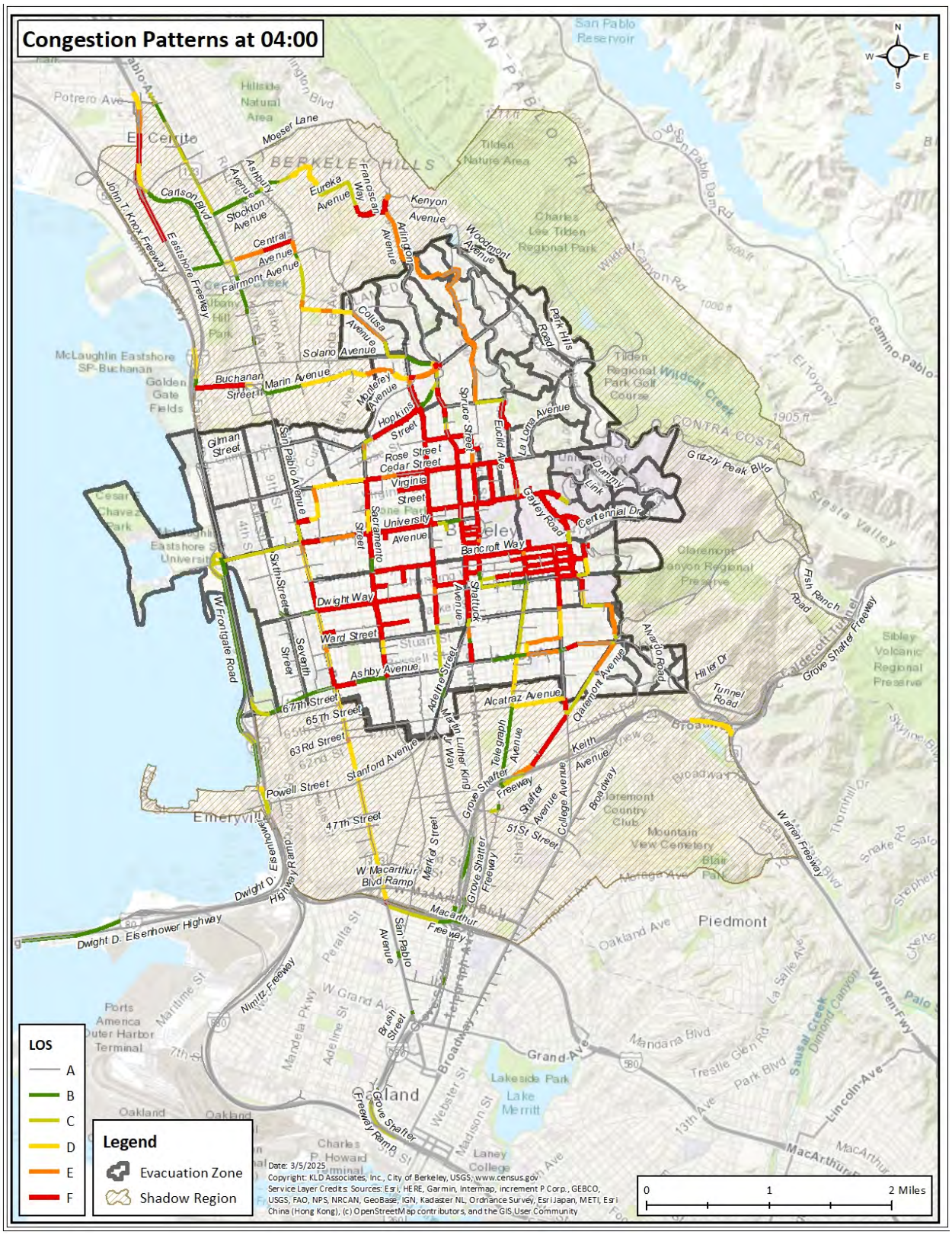


Figure F-5. Region R01 Congestion Patterns 4 Hours after the Evacuation Order

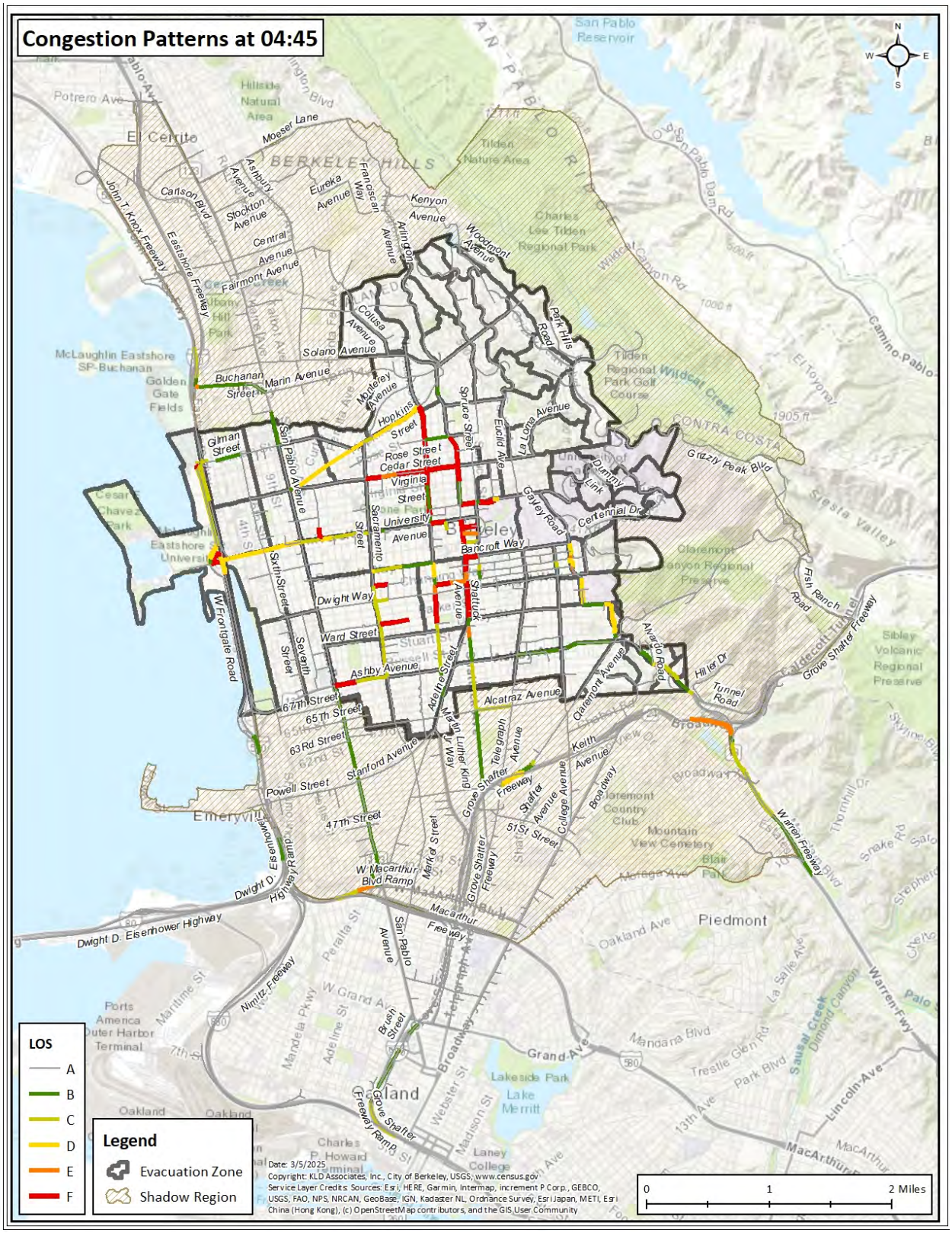
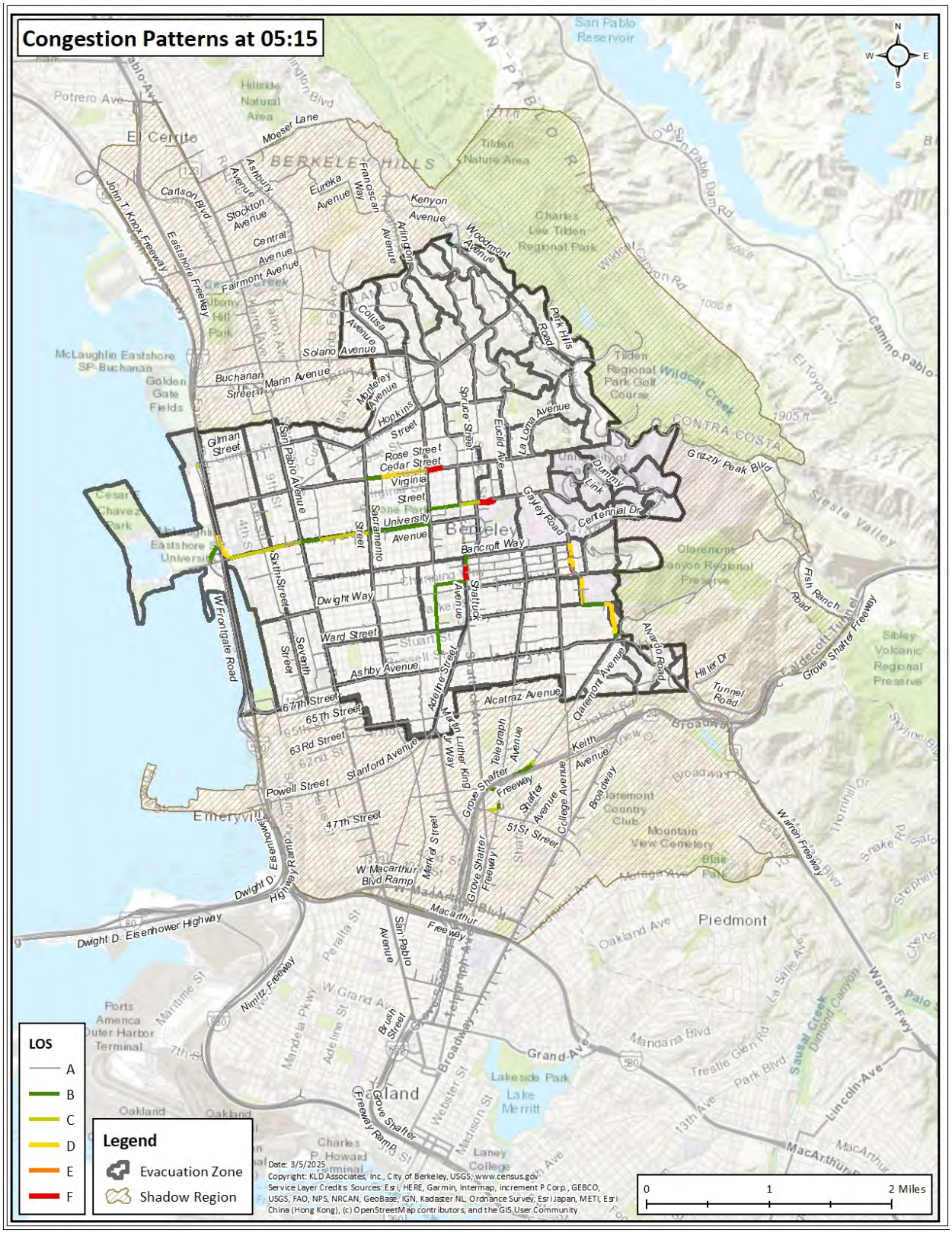


Figure F-6. Region R01 Congestion Patterns 4 Hours and 45 Minutes after the Evacuation Order


Congestion Patterns at 05:15
LOS
A
B
C
D
E
F
Legend
Evacuation Zone
Shadow Region
Date: 3/5/2025
Copyright: KLD Associates, Inc., City of Berkeley, USGS, www.census.gov
Service Layer Credits: Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community
0
1
2 Miles
Berkeley
Emeryville
Oakland
Piedmont
San Pablo Reservoir
Tilden Nature Area
Charles Lee Tilden Regional Park
Claremont Canyon Regional Preserve
Sibley Volcanic Regional Preserve
Lake Merritt
Lakeside Park
Mountain View Cemetery
Claremont Country Club
Golden Gate Fields
Ports America Outer Harbor Terminal
Dwight D. Eisenhower Highway
Grove Shafter Freeway
Macarthur Freeway
Nimitz Freeway
Eastshore Freeway
Warren Freeway
Grizzly Peak Blvd
Gayley Road
Centennial Dr
Bancroft Way
University Avenue
Dwight Way
Ashby Avenue
Alcatraz Avenue
Stanford Avenue
Powell Street
47th Street
51st Street
Broadway
College Avenue
Claremont Avenue
Telegraph Avenue
Shattuck Avenue
Sacramento Street
San Pablo Avenue
Solano Avenue
Marin Avenue
Gilman Street
Hopkins Street
Rose Street
Cedar Street
Virginia Street
Euclid Ave
La Loma Avenue
Park Hills Road
Woodmont Avenue
Kenyon Avenue
Arlington Avenue
Fairmont Avenue
Central Avenue
Stockton Avenue
Ashbury Avenue
Eureka Avenue
Franciscan Way
Carlson Blvd
John T Knox Freeway
Potrero Ave
Moeser Lane
Hillside Natural Area
El Cerrito
Buchanan Street
Monterey Avenue
Colusa Avenue
Cesar Chavez Park
Eastshore University
Seventh Street
Sixth Street
W Frontage Road
Adeline Street
Martin Luther King Jr Way
Market Street
Peralta St
San Pablo Avenue
Broadway
Webster St
Madison St
Grand Ave
Lakeshore Ave
Mandana Blvd
Trestle Glen Rd
Park Blvd
13th Ave
Lincoln Ave
MacArthur
Oakland Ave
Keith Avenue
Broadway
Thornhill Dr
Snake Rd
Skyline Blvd
Fish Ranch Road
Tunnel Road
Hiller Dr
Alvarado Road
Caldecott Tunnel
Wildcat Canyon Rd
San Pablo Dam Rd
Camino Pablo
El Toyonal
Wildcat Creek
Sobrante Ridge
Sugsta Valley
Dummy Link
Maritime St
W Grand Ave
Brush Street
Mandela Pkwy
Adeline St
Oakland
Laney College
Charles P. Howard Terminal
Ohlone Greenway
Dimond Canyon
Sausal Creek
La Salle Ave
Palo
Warren Fwy
Shepherd
Morraga Ave
Blair Park
W Macarthur Blvd Ramp
Dwight D
Highway Ramp
Grove Shafter Freeway Ramp
Eastshore Freeway
Alcatraz Avenue
Ward Street
Virginia Street
Rose Street
Cedar Street
Hopkins Street
Gilman Street
Buchanan Street
Marin Avenue
Solano Avenue
Colusa Avenue
Arlington Avenue
Woodmont Avenue
Kenyon Avenue
Park Hills Road
Euclid Ave
La Loma Avenue
Spruce Street
Monterey Avenue
Sacramento Street
University Avenue
Gayley Road
Centennial Dr
Dummy Link
Grizzly Peak Blvd
Bancroft Way
Dwight Way
Ward Street
Ashby Avenue
Alcatraz Avenue
Claremont Avenue
Hiller Dr
Alvarado Road
Tunnel Road
Caldecott Tunnel
Grove Shafter Freeway
Fish Ranch Road
Keith Avenue
Broadway
College Avenue
Shafter Avenue
Telegraph Avenue
Martin Luther King Jr Way
Adeline Street
Shattuck Avenue
Sacramento Street
San Pablo Avenue
Seventh Street
Sixth Street
W Frontage Road
67th Street
65th Street
63rd Street
47th Street
51st Street
Powell Street
Stanford Avenue
Dwight D. Eisenhower Highway
Macarthur Freeway
Nimitz Freeway
Eastshore Freeway
Warren Freeway
Grove Shafter Freeway
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MacArthur
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Charles P. Howard Terminal
Ohlone Greenway
Dimond Canyon
Sausal Creek
La Salle Ave
Palo
Warren Fwy
Shepherd
Morraga Ave
Blair Park
Claremont Country Club
Mountain View Cemetery
Lakeside Park
Lake Merritt
Ports America Outer Harbor Terminal
Golden Gate Fields
McLaughlin Eastshore SP-Buchanan
Cesar Chavez Park
Eastshore University
El Cerrito
Potrero Ave
Moeser Lane
Hillside Natural Area
Carlson Blvd
John T Knox Freeway
Eastshore Freeway
Ashbury Avenue
Stockton Avenue
Eureka Avenue
Franciscan Way
Central Avenue
Fairmont Avenue
Albany Hill Park
Cerrito Creek
Gilman Street
Buchanan Street
Marin Avenue
Solano Avenue
Colusa Avenue
Monterey Avenue
Hopkins Street
Spruce Street
Euclid Ave
La Loma Avenue
Park Hills Road
Woodmont Avenue
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Arlington Avenue
Rose Street
Cedar Street
Virginia Street
Dummy Link
Grizzly Peak Blvd
Gayley Road
Centennial Dr
University Avenue

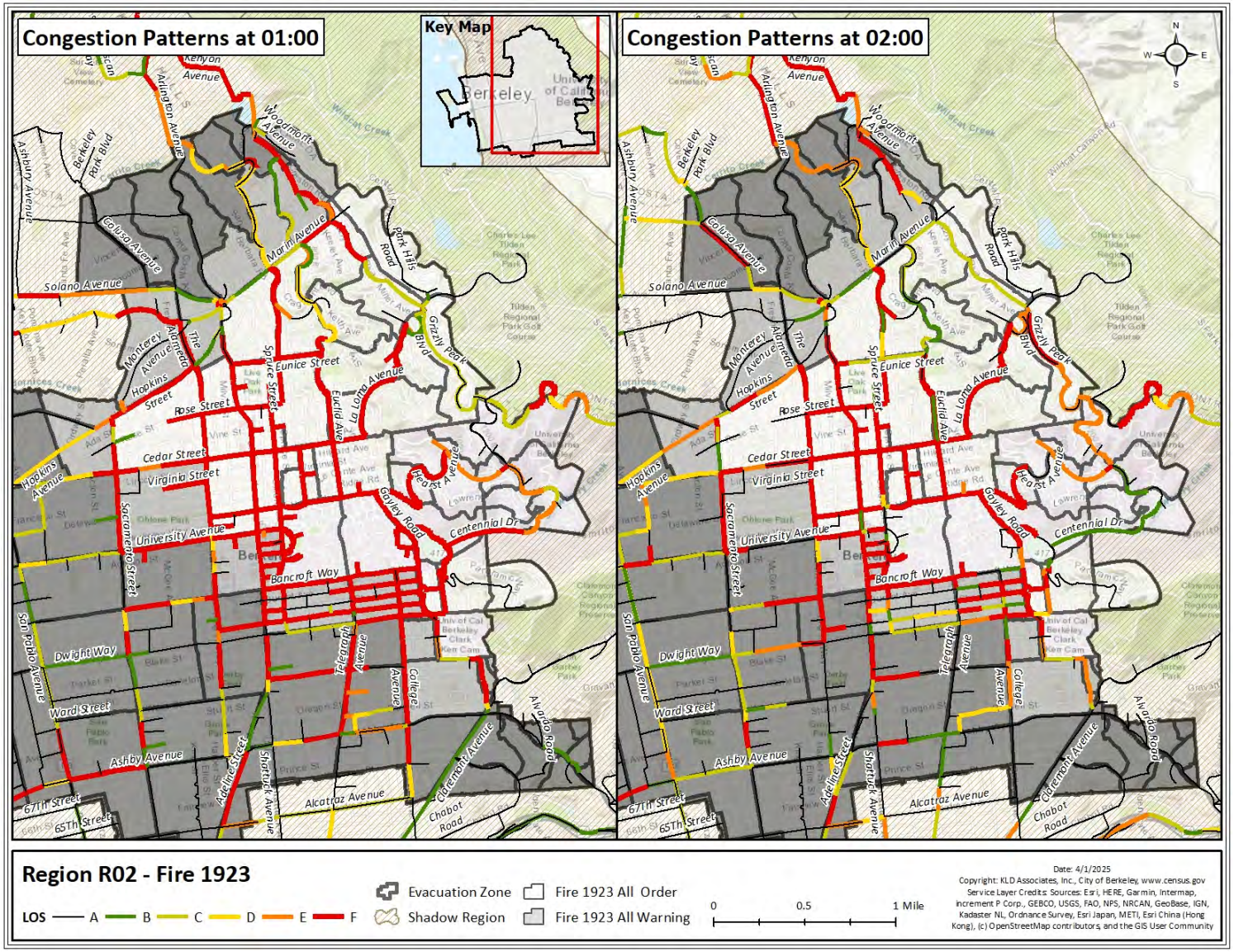


Figure F-8. Region R02 Congestion Patterns 1 Hour and 2 Hours after the Evacuation Order

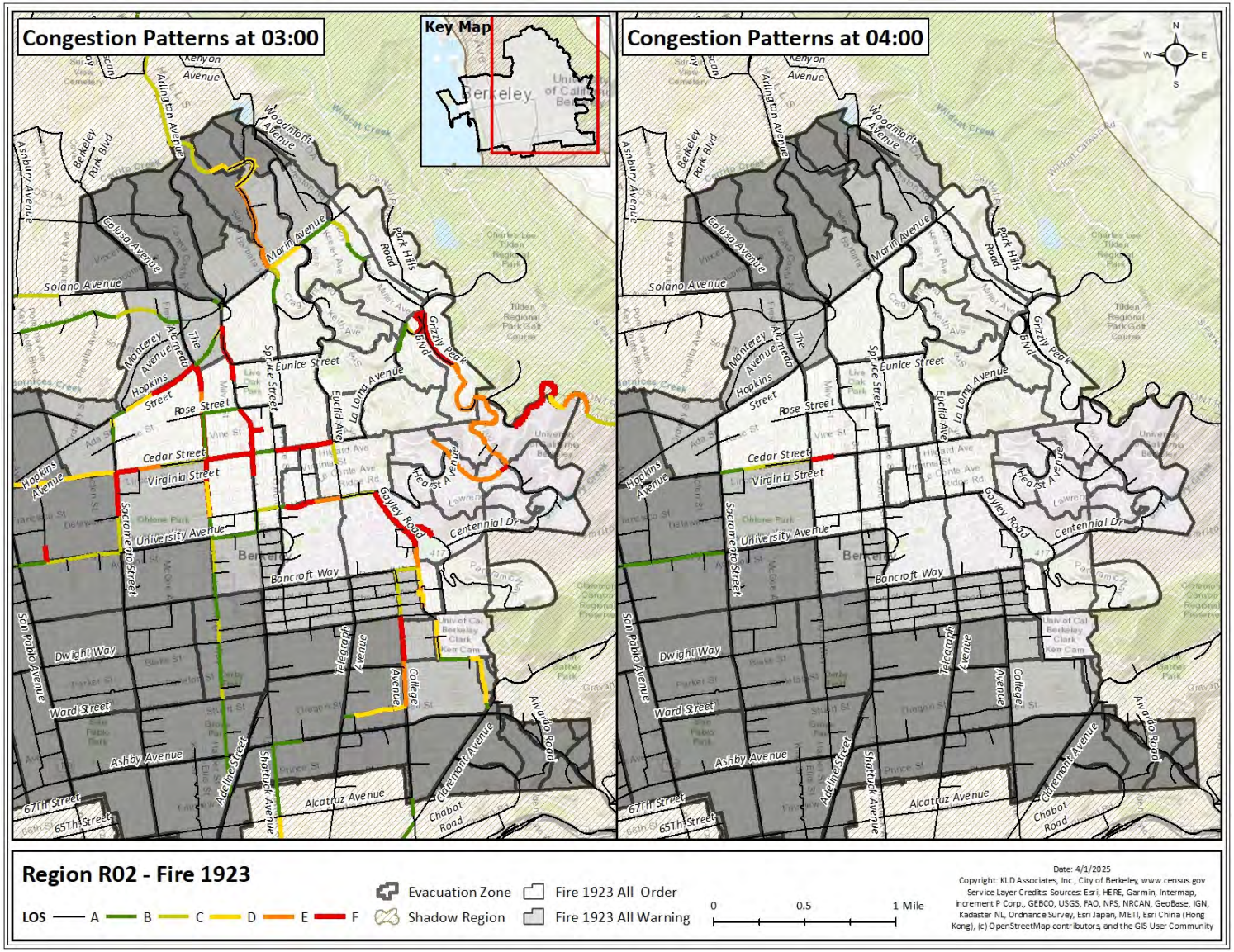


Figure F-9. Region R02 Congestion Patterns 3 Hours and 4 Hours after the Evacuation Order

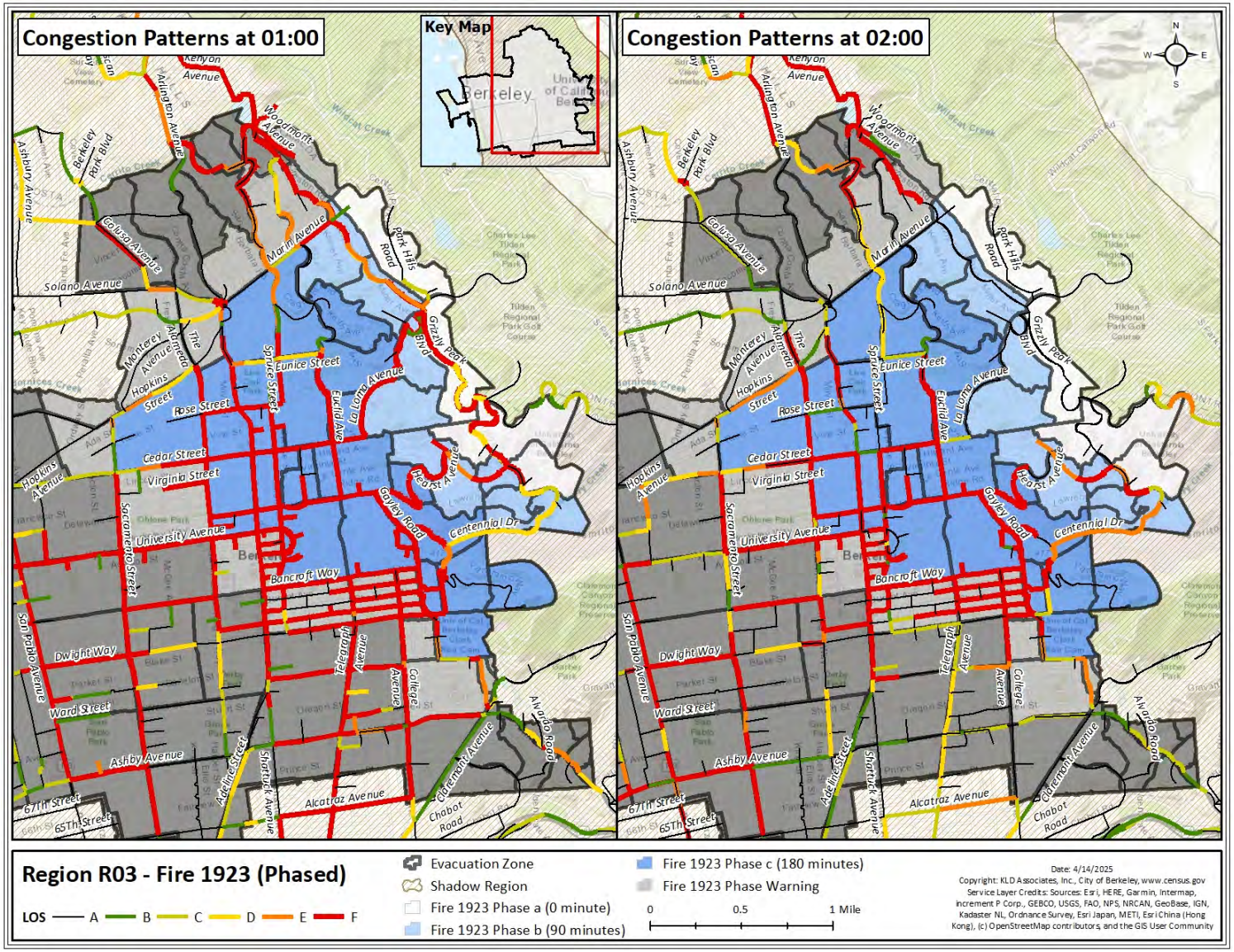


Figure F-10. Region R03 Congestion Patterns 1 Hour and 2 Hours after the Evacuation Order

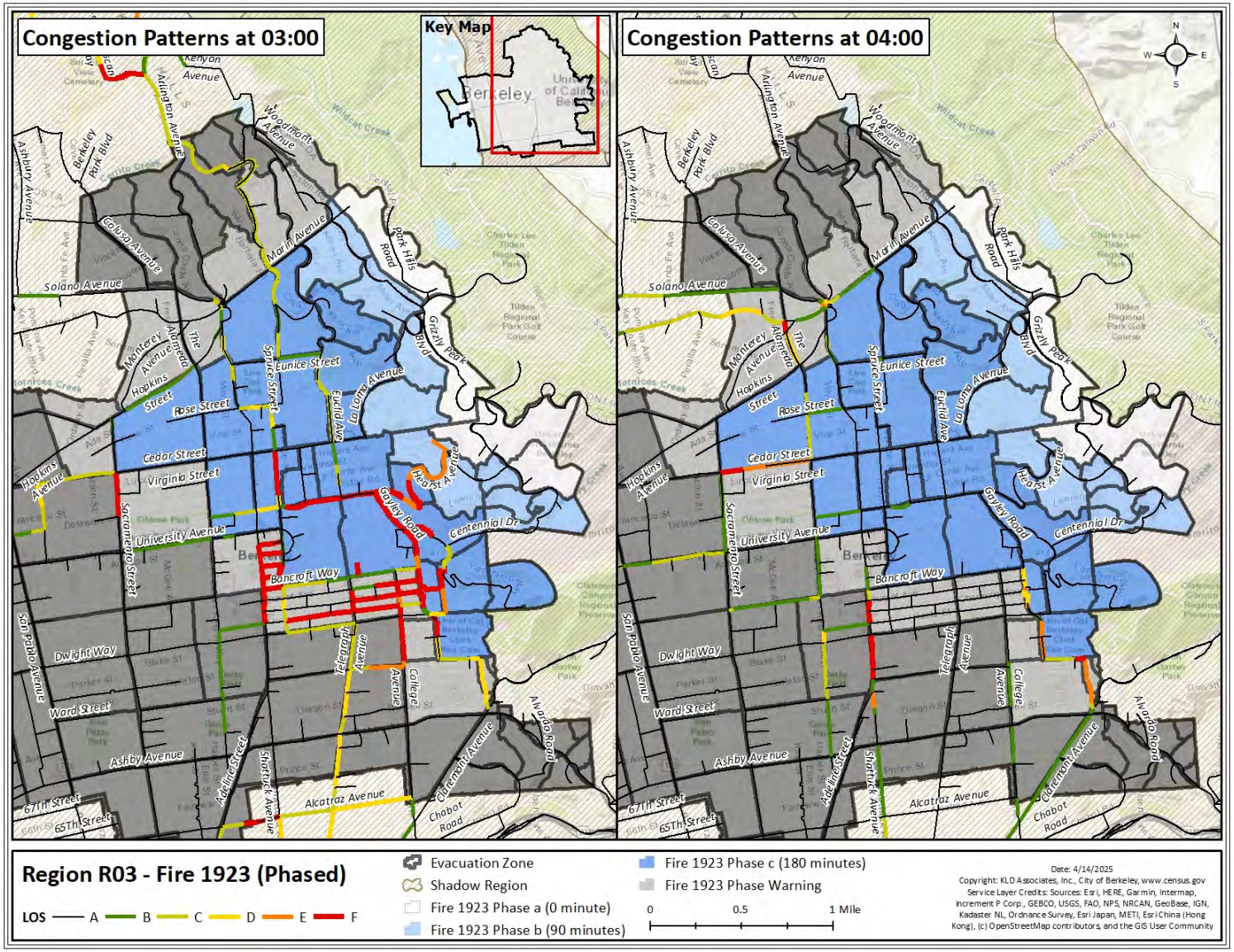


Figure F-11. Region R03 Congestion Patterns 3 Hours and 4 Hours after the Evacuation Order

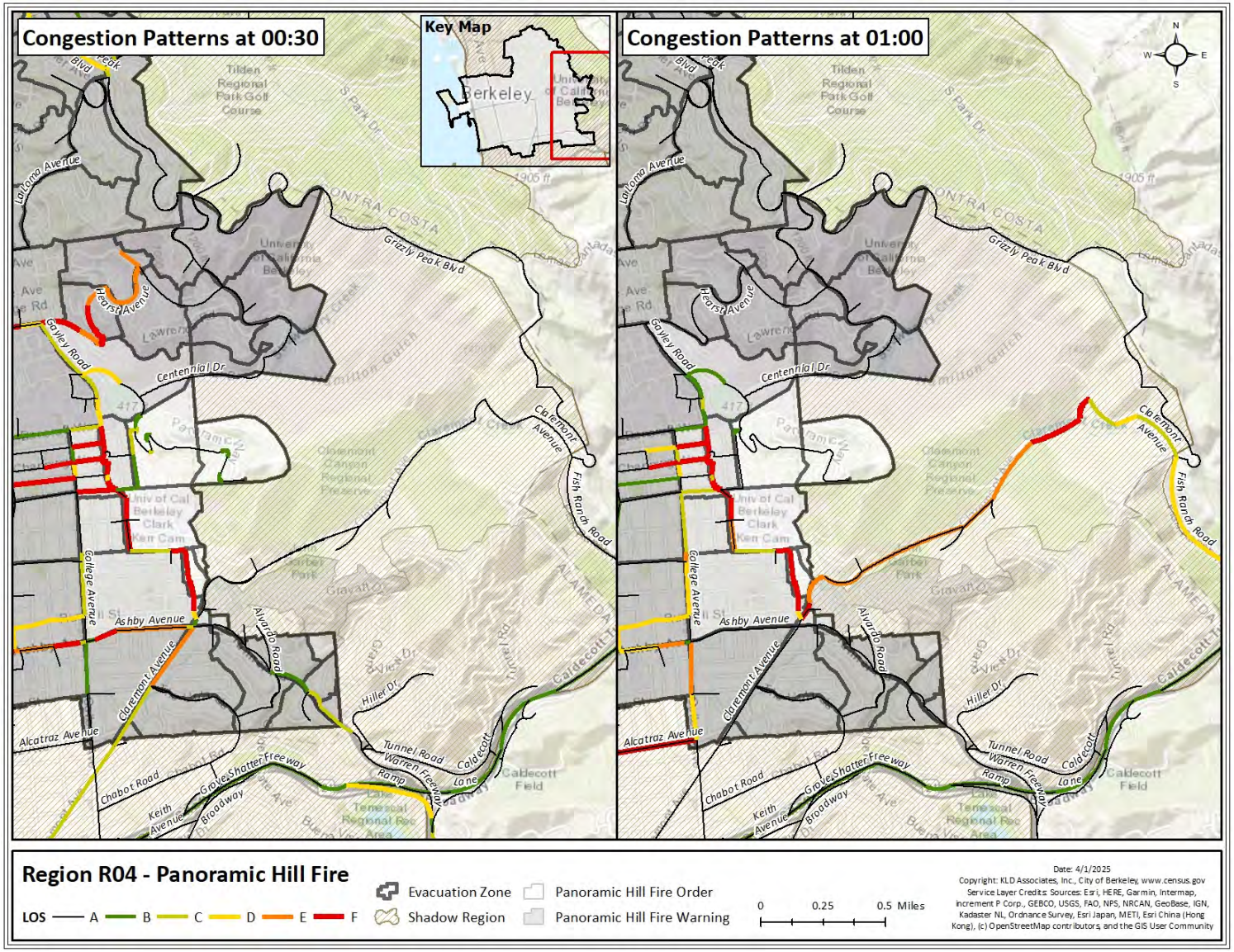


Figure F-12. Region R04 Congestion Patterns 30 Minutes and 1 Hour after the Evacuation Order

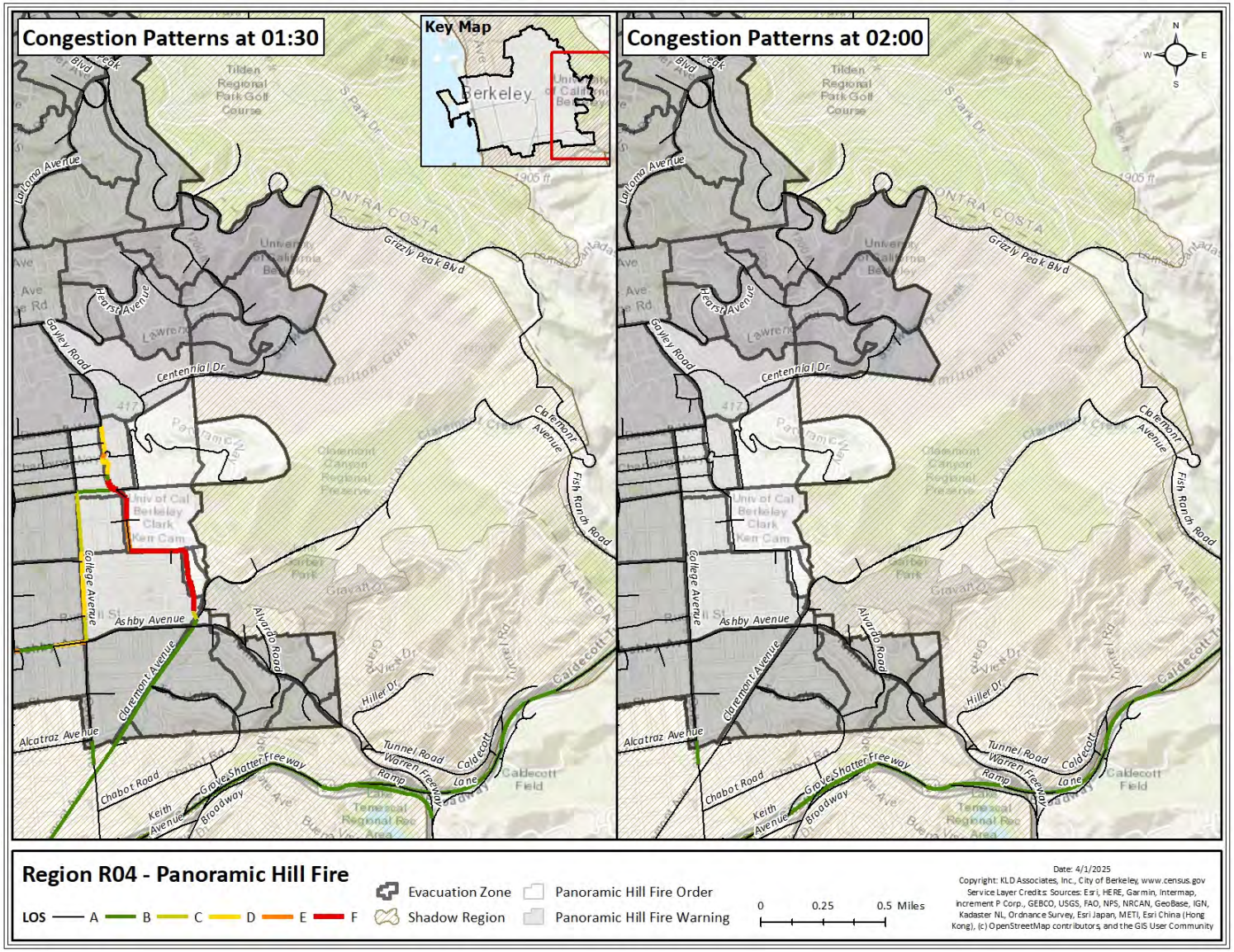


Figure F-13. Region R04 Congestion Patterns 1 Hour and 30 Minutes and 2 Hours after the Evacuation Order

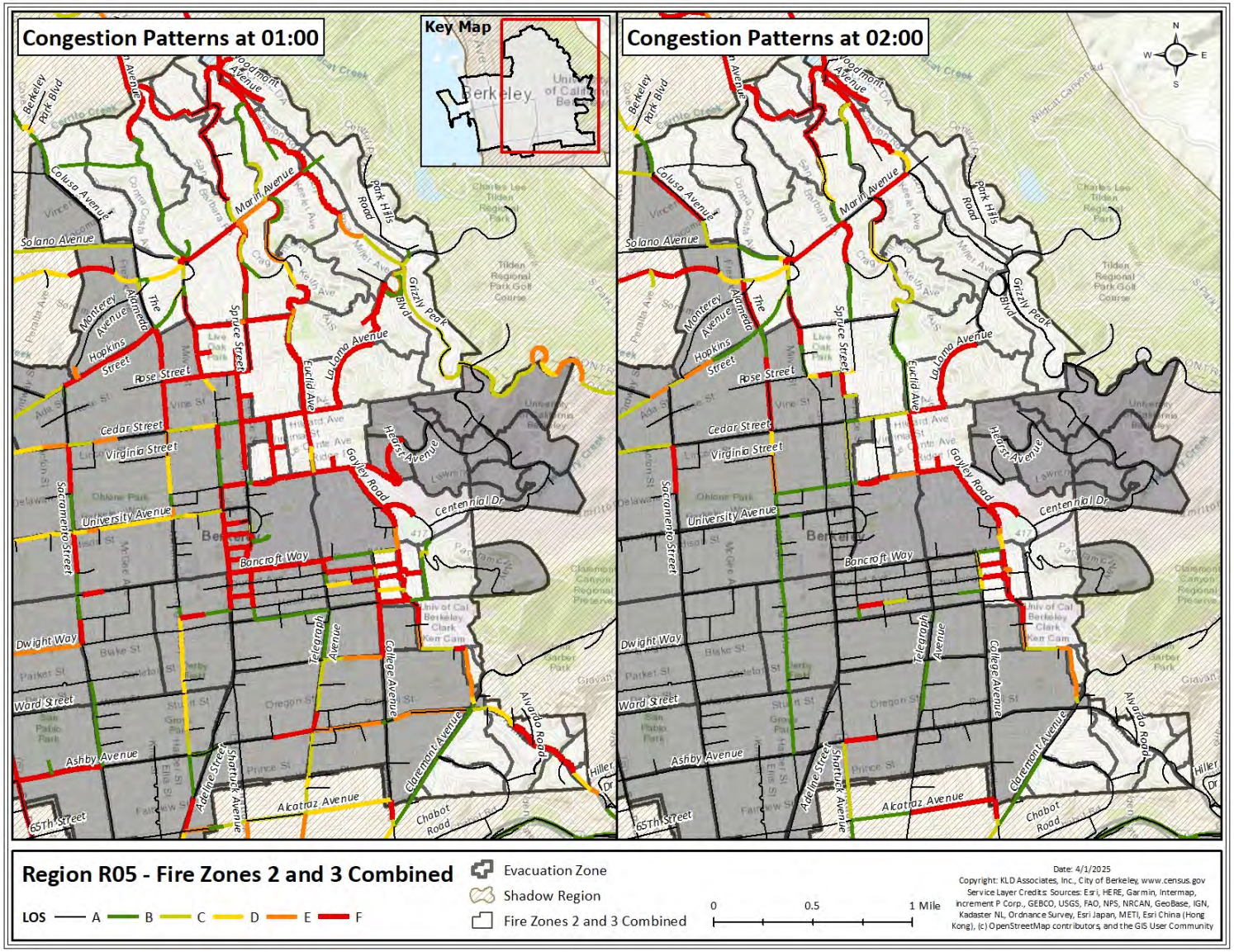


Figure F-14. Region R05 Congestion Patterns 1 Hour and 2 Hours after the Evacuation Order

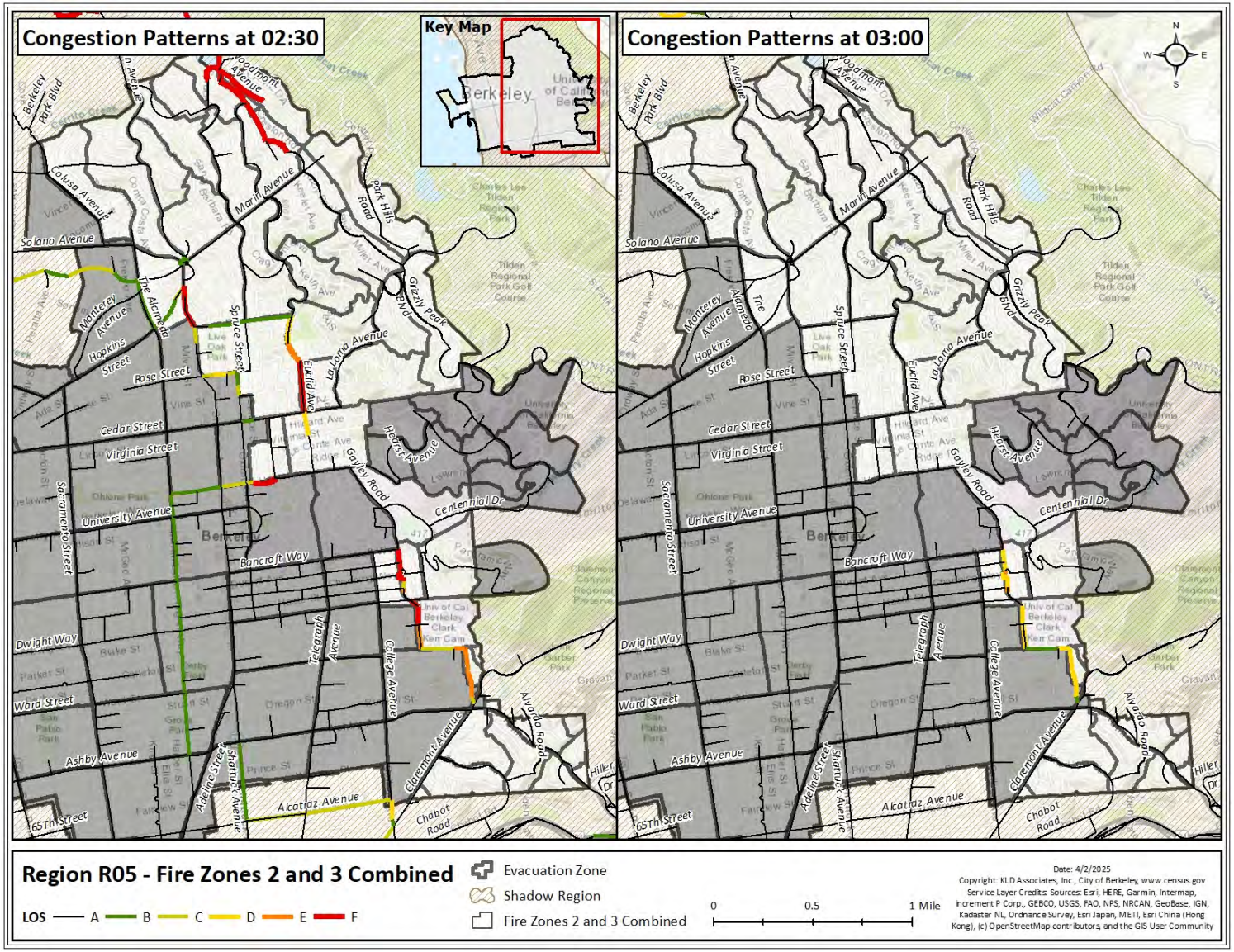


Figure F-15. Region R05 Congestion Patterns 2 Hours and 30 minutes and 3 Hours after the Evacuation Order

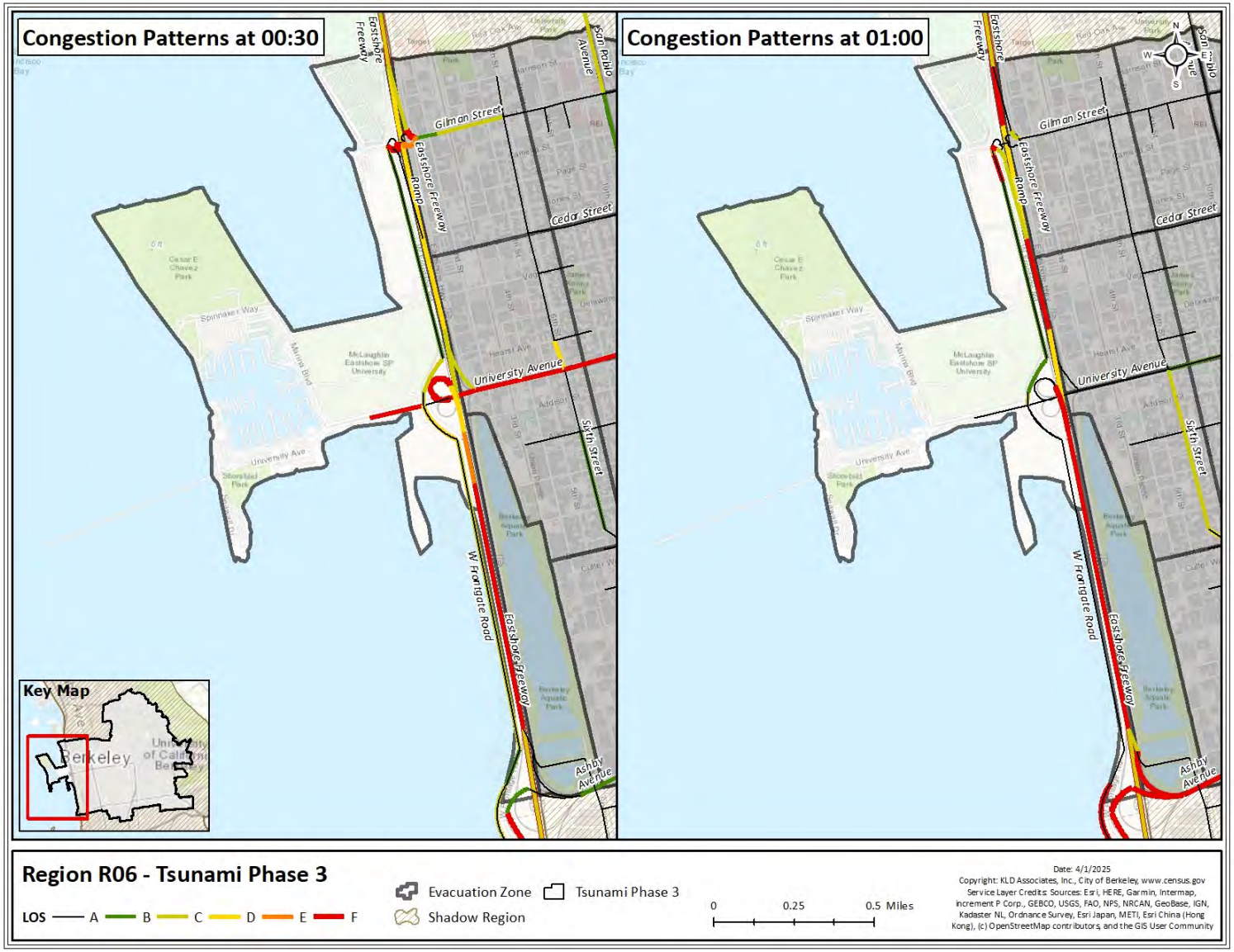


Figure F-16. Region R06 Congestion Patterns 30 Minutes and 1 Hour after the Evacuation Order

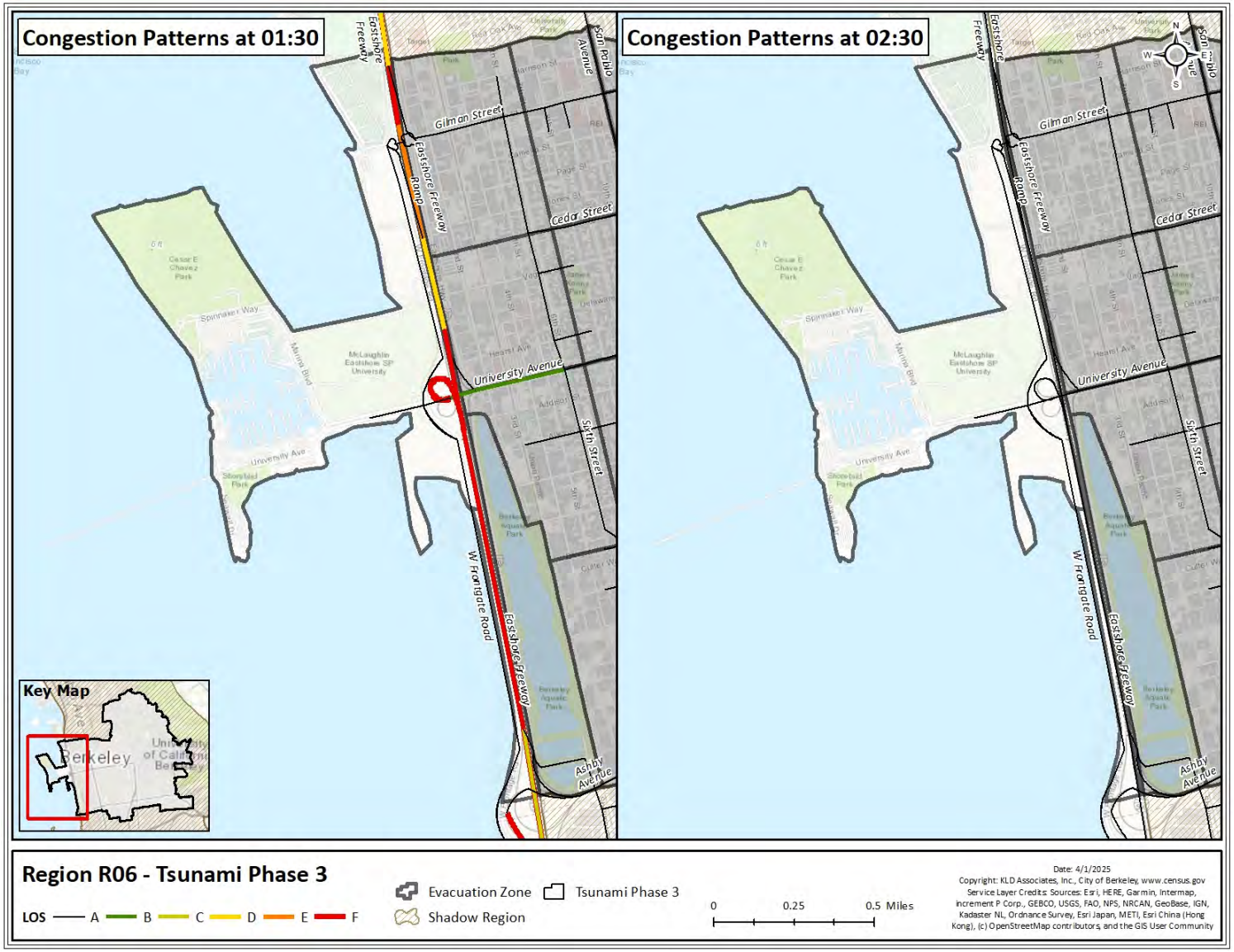


Figure F-17. Region R06 Congestion Patterns 1 Hour and 30 Minutes and 2 Hours and 30 Minutes after the Evacuation Order

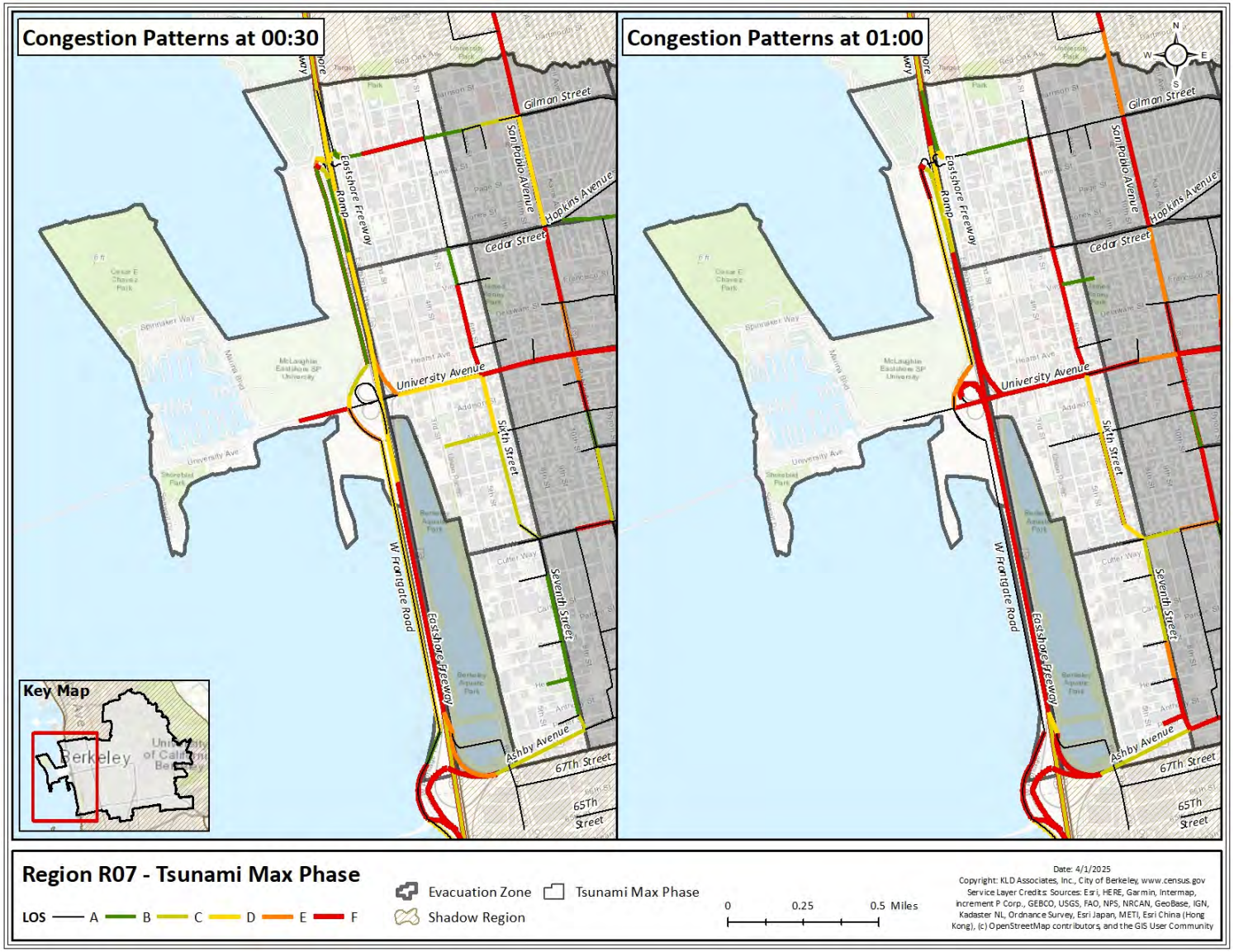


Figure F-18. Region R07 Congestion Patterns 30 Minutes and 1 Hour after the Evacuation Order

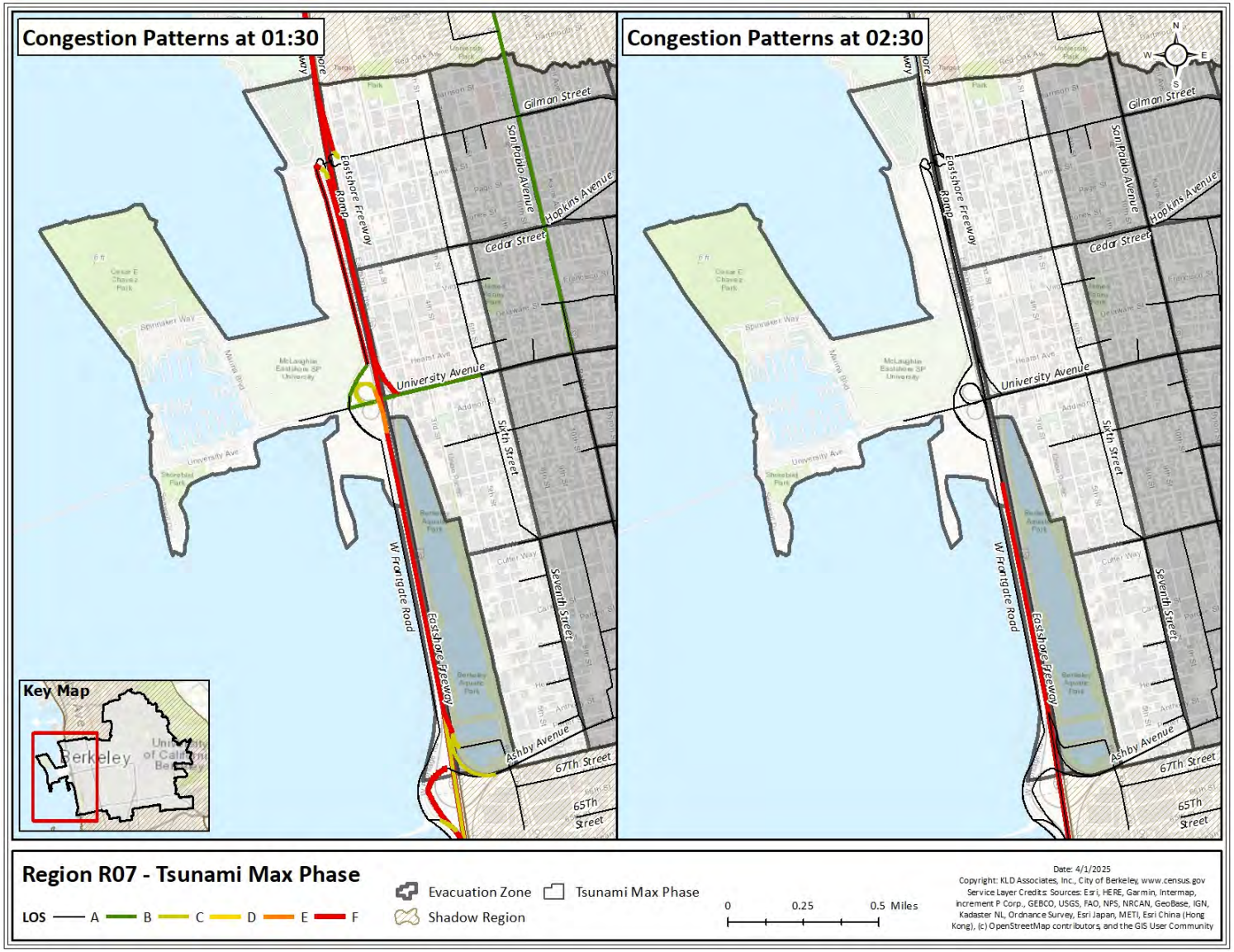


Figure F-19. Region R07 Congestion Patterns 1 Hour and 30 Minutes and 2 Hours and 30 Minutes after the Evacuation Order

APPENDIX G

Traffic Calming Devices, Traffic Signals, and Existing Street Network Characteristics Posing Challenges to Evacuation

G. TRAFFIC CALMING DEVICES (TCDS), TRAFFIC SIGNALS AND EXISTING STREET NETWORK CHARACTERISTICS POSING CHALLENGES TO EVACUATION

Appendix F provides patterns of traffic congestion during various evacuation cases. The figures in Appendix F were analyzed to identify problem areas, which are explored here in additional detail. This Appendix specifically identifies the impacts to evacuation traffic flow from traffic calming devices (TCDs), pre-timed traffic signals, and other attributes of Berkeley's roadway network or built and natural environment within the identified problem areas.

G.1 TCDs in DYNEV

Figure G-1 shows the TCDs within the City of Berkeley as of January 14, 2025. As discussed in Section 1.3, the traffic simulation model was developed based on the data collected during the field survey which was conducted in May 2023. The existing traffic calming devices (TCDs) were modeled within the network based on their impact to speed and capacity. Below is a summary of how each TCD broadly impacts the simulation of evacuating vehicles:

- Diverters are represented as disconnected links and nodes, effectively blocking routing paths and reflecting their function in preventing through traffic. (This is also applicable for sections of roadway that are for cyclists only.)
- Traffic circles, often functioning as all-way stops within the city, are assigned low capacities (approximately 900 vehicles per hour per lane) due to the inherent delays associated with stopping or yielding.
- Vertical deflection, like speed humps or bumps, are modeled by reducing link speeds as the driver safely navigates them, thereby lowering the effective capacity of those road segments.
- Rectangular rapid flashing beacons (RRFB) and pedestrian hybrid beacons (PHB) only influence vehicle behavior if the surveyor cautiously reduced speed at these locations, otherwise, they are disregarded.[1]
- Horizontal deflection affecting only the shoulder or parking lane, such as bulb outs, dedicated bike lanes, and median crossings are also excluded from the model, unless they encroach on travel lanes.

It should be noted that the impact of TCDs on fire apparatus and emergency vehicle response times is being conducted as a separate work effort. The scope of this study is limited to evacuating vehicles and the impacts of these TCDs on evacuation is discussed herein.

[1] Note that RRFB and PHB are not technically traffic calming devices but are described here because in Berkeley RRFB have been used as part of the City's draft traffic calming toolbox.

G.2 Traffic Calming Devices, Traffic Signals, and Other Street Network Characteristics Posing Challenges to Evacuation

Appendix F identifies patterns of traffic congestion expected for various evacuation regions and cases. This Appendix highlights particular roadway constraints and traffic calming devices with notable impacts across various evacuation cases studied.

This section identifies the specific traffic calming devices, traffic signals, and other street network characteristics posing challenges to evacuation, with the goal of identifying opportunities to improve traffic flow in evacuations. Traffic calming devices, by design, reduce vehicle speeds for pedestrian safety, reduce vehicle volumes on residential streets, and/or disrupt network connectivity for vehicles. Consequently, simulation results indicate drivers will have a strong preference for routes devoid of TCDs, which allow for higher speeds, have greater capacities, and have greater route choice availability. This preference, coupled with limited evacuation directions (in order to leave the city, drivers are essentially limited to an evacuation northbound or southbound), concentrates demand onto a reduced set of roadways. This concentrated demand results in congestion with both macroscopic impacts, increasing the overall time to clear the hazard area, as well as impacts to individual evacuees, whose time on the roadway increases.

Section 10 identifies improvements to evacuation traffic flow from a widescale transition to actuated/adaptive traffic signals. This section highlights pre-timed signals with notable impacts across various evacuation cases studied, so that they may be considered for prioritization in a shift to actuated/adaptive signals.

The existing characteristics of the road network are noted to provide a comprehensive analysis of the challenges to evacuation traffic flow. Some are assumed to be fixed, such as preexisting facilities and parks; others are noted as traffic design elements that could be improved for evacuation traffic flow.

Affected Area: South and West of UC Berkeley Campus

As shown in Figure F-2 through Figure F-5, Figure F-8, Figure F-10, and somewhat in Figure F-14, congestion is pronounced in areas of the city to the south and immediate west of the UC Berkeley campus. The area is bounded as follows: Piedmont Ave (east), Dwight Way (south), Shattuck Avenue (west), and University Ave-Oxford St-Bancroft Way (north). This is a result of the following:

<u>Traffic Calming</u>

- Between University and Dwight, there are only two roadways (Addison St and Allston Way) that provide a direct westbound connection for vehicles to access Sacramento St.
    - The diverter at Channing Way and Roosevelt Ave breaks the connection along Channing Way between the two arterials.
    - Addison St and Allston Way are the only roadways that provide the direct westbound connection to Sacramento Street, and they have numerous traffic circles with low capacities (that operate as all way stop intersections) between

Shattuck Ave and Sacramento Ave.

- Fulton St is not a viable southbound option for traffic in Downtown Berkeley and Southside due to diverters that block traffic from traveling southbound.
- Ellsworth St is not a desirable southbound option for traffic in Downtown Berkeley and Southside due to numerous traffic circles that lower the capacity of these roadways.

Traffic Signals

- Pretimed signals along Shattuck Ave exacerbate traffic in this area as vehicles are not efficiently processed through the signals in the north-south direction. This can be seen in Figure F-1 through Figure F-6, Figure F-8, Figure F-10, Figure F-11, and Figure F-14.
- Pretimed signals along Cedar St at the intersections with Sacramento St, Martin Luther King Jr Way, Shattuck Ave and Oxford St and the pretimed signals along Haste St westbound at Dana St, Ellsworth St and Fulton St also prevent efficient traffic flow westbound. This congestion resulting from the pretimed signals along Cedar St can be visually seen in Figure F-5 though Figure F-11.

Existing Street Network Characteristics

- Between University and Dwight, there are only two roadways that provide a direct westbound connection (Addison St and Allston Way) for vehicles to access Sacramento St.
    - Berkeley High School breaks Bancroft Way between Milvia St and Martin Luther King Jr Way.
    - Haste St intersects Martin Luther King Jr Way at a T-intersection and does not continue westbound to connect into Sacramento St.
- The limited desirable westbound connections force traffic south from Downtown Berkeley and Southside to funnel either northbound along Arlington Ave or Oxford St or southbound along Shattuck Ave, Telegraph Ave, College Ave, and Warring St/Derby St/Belrose Ave/Claremont Blvd to evacuate the area.

Affected Area: North of Ohlone Park

The portion of the city that lies between Sacramento St, Cedar St, Martin Luther King Jr Way, and Ohlone Park are in a unique situation for evacuation. This area is limited in the number of outbound paths to choose from.

Traffic Calming

- Between Sacramento Street and Martin Luther King Jr Way, only one street (California St) connects Ohlone Park with Cedar Street.
    - Diverters along Virginia St/McGee Ave and Grant St make northbound evacuation difficult for parts of this area.

Existing Street Network Characteristics

- Roadway design forces westbound traffic to go northbound on Sacramento St at every intersection except Lincoln, which is stop controlled.

- Ohlone Park blocks southbound egress out of this area.
- All eastbound routes meet with Martin Luther King Jr Way at stop signs.
- Southbound traffic must first go northbound to Cedar or go eastbound to Martin Luther King Jr Way (and wait for a break in traffic).
- Between Sacramento Street and Martin Luther King Jr Way, only one street (California St) connects Ohlone Park with Cedar Street. Edith St and Josephine St both stop at Virginia St and do not continue south.

This area is one of the last to clear in an evacuation of the entire city as shown in Figure F-6.

Affected Area: South and West of Clark Kerr Campus

As shown for the Panoramic Fire case (Figure F-12 and Figure F-13), the portion of the city that lies between Ashby Ave (south), College Ave (west), Dwight Way (north), and Warring St/Derby St/Bellrose Ave/Claremont Blvd (east) is also limited in the number of outbound paths to choose from.

Traffic Calming

- The diverter at Piedmont Ave and Parker St prevents traffic from traveling westbound.
- The diverter at Piedmont Ave and Derby St prevents traffic from traveling westbound.
- The diverter at the intersection with Derby St/Tanglewood Rd prohibits traffic from utilizing Tanglewood Rd to access Claremont Ave.
- The diverter at Avalon Ave and Claremont Ave prohibits vehicles from Avalon Ave from accessing Claremont Ave. As such, traveling further south on Bellrose Ave, Claremont Blvd/Garber St and Avalon Ave do not provide westbound or eastbound connections.
- Due to the diverter at Piedmont Ave/Russell St, traffic cannot access College Ave via Russell St.
- Traffic could travel on Claremont Blvd to Forest Ave. The speed table along Forest Ave has a low capacity of this roadway.

Existing Street Network Characteristics

- Evacuees traveling southbound along Piedmont Ave are limited in options once they pass the intersection with Dwight Way.
- Traveling eastbound on any road does not provide a way out of the area.

Affected Area: Lawrence Berkeley National Lab (LBNL)

As discussed in Section 7.3.9, during the midweek during the day, the heavy flow of traffic leaving LBNL combined with the daily background and shadow evacuating traffic in areas just west of LBNL overwhelms the intersection of Gayley Rd/LaLoma Ave and Hearst Ave.

Traffic Signals

- The intersection of Gayley Rd/LaLoma Ave and Hearst Ave is a pretimed traffic signal. Conversion to an actuated signal may provide better throughput at this intersection for an evacuation of LBNL.

G.3 Recommendations

This analysis highlights the TCDs, traffic signals, and existing street network characteristics with potential to reduce overall network capacity and to locally impede flow of evacuees in large-scale evacuations.

TCDs in particular are vital for pedestrian safety, as well as reduction of speed and traffic volume on neighborhood streets.

For existing infrastructure, the City should develop and implement a citywide connectivity and capacity strategy, potentially integrating approaches such as actuated or adaptive signal timing and replacing TCDs with removable/retractable options. As part of proposed infrastructure changes, City should develop and implement a methodology to conduct a comprehensive capacity analysis, considering peak evacuation demand (as is presented in Appendix F and G of this document), should be conducted. This analysis will attempt to ensure that infrastructure changes will not result in new evacuation bottlenecks, as increased traffic volume of diverting vehicles is redistributed in the roadway network. This proactive approach will attempt to ensure that strategies to improve connectivity and increase roadway capacity do not create downstream impacts.

For future infrastructure, it is strongly recommended that the City develop and implement a methodology to evaluate and consider evacuation efficiency and roadway capacity during the planning and implementation phases of future roadway infrastructure development, including TCD installations. Simulation modeling could be employed to assess the impact of proposed roadway infrastructure development, including TCDs, on evacuation times and congestion levels under emergency scenarios.

In addition to exploring these impacts for evacuation contexts, impacts to first responder response times should also be assessed in daily traffic environments to better understand the full impact of TCDs and other traffic calming measures. This effort is currently underway.

Section 11.3.2 identifies traffic signal improvements that could improve evacuation flow.

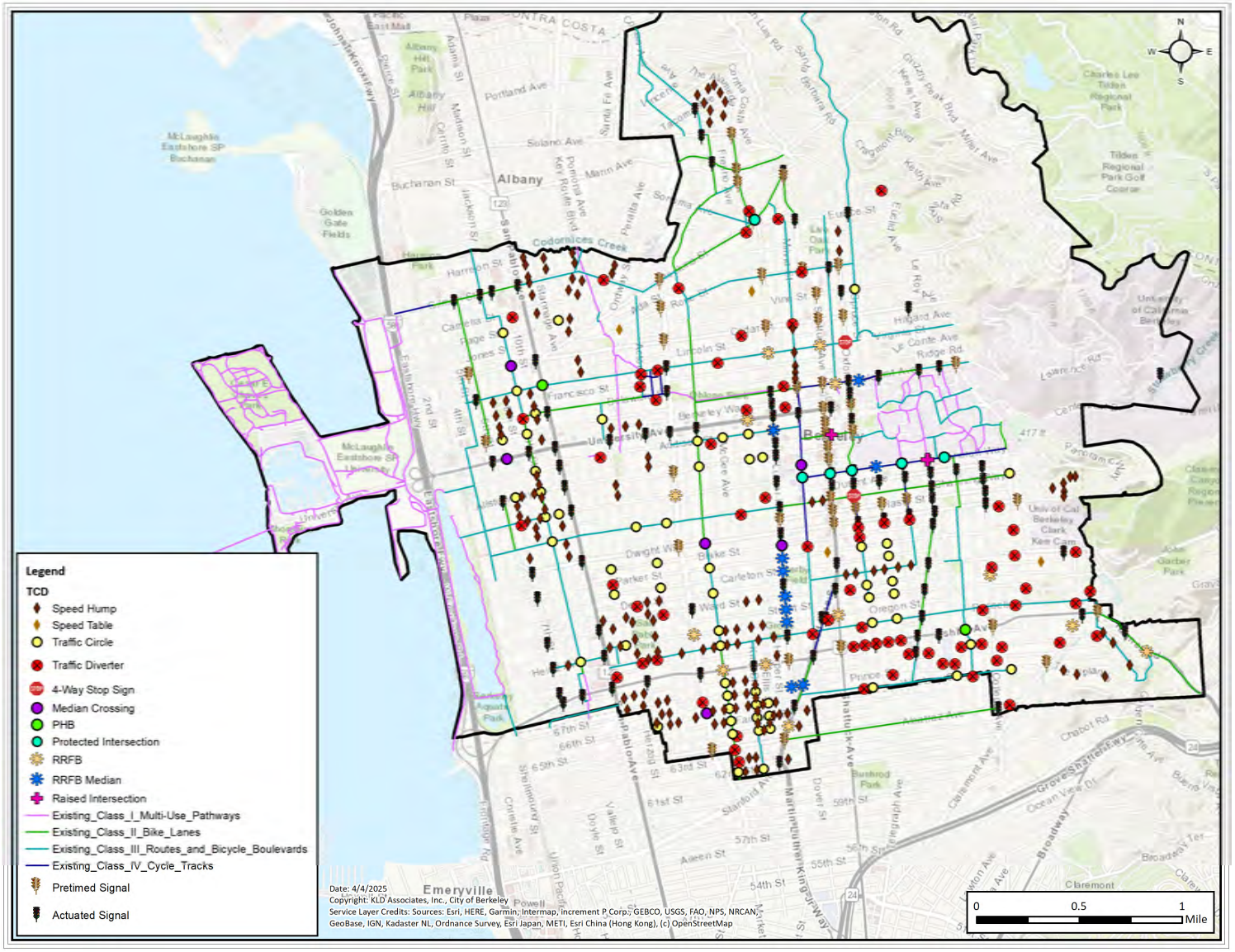


Figure G-1. Traffic Calming Devices, Traffic Signals, and Existing Street Network Characteristics

APPENDIX H

Region Specific Facility and Transit Dependent Population Data

H. REGION SPECIFIC FACILITY AND TRANSIT DEPENDENT POPULATION DATA

This appendix provides a list of special facility and transit dependent population data for Region R01 through Region R07. The following Sections explain how these numbers are derived for each population group that could be transit dependent:

- Visitors – Section 3.3
- Employees – Section 3.4
- Medical Facilities – Section 3.5.1
- Schools/Preschools/Day Care Centers – Section 3.6.1
- Colleges – Section 3.6.2
- Transit Dependent Residents – Section 3.7
- People Requiring Specialized Transportation Assistance – Section 3.8

Table H-1. Facility and Transit Dependent Population by Region

Region Number	Region Name	Facility Name	Facility Type	Total Population	Transit Dependent Population
R01	Citywide Evacuation	Various locations throughout the region	Transient Attractions	44,192	13,258
		Various locations throughout the region	Major Employers	25,341	9,046
		Various locations throughout the region	Transit Dependent Residents	1,686	1,686
		Various locations throughout the region	People Requiring Specialized Transportation Assistance	348	348
		Alta Bates Summit Medical Center - Alta Bates Campus	Medical Facility	183	183
		Alta Bates Summit Medical Center - Herrick Campus	Medical Facility	58	58
		Ashby Care Center	Medical Facility	29	29
		Berkeley Pines Care Center	Medical Facility	32	32
		Chaparral House	Medical Facility	42	42
		Elegance Berkeley	Medical Facility	47	47
		Elmwood Care Center	Medical Facility	77	77
		Kyakameena Care Center	Medical Facility	60	60
		New Bridge Foundation	Medical Facility	45	45
		Redwood Gardens Apartments	Medical Facility	168	168
		Silverado Memory Care Center	Medical Facility	87	87
		Ala Costa Ctr. For The Developmentally Disabled	Preschool/Day Care Center	58	10
		American International Montessori School	Preschool/Day Care Center	117	20
		Aquatic Park School	Preschool/Day Care Center	77	13
		Arbor Preschool East	Preschool/Day Care Center	22	4
		Bahia School Age Program	Preschool/Day Care Center	65	11
		Berkeley Hills Nursery School	Preschool/Day Care Center	40	7
		Berkeley International Montessori School	Preschool/Day Care Center	21	4
		Berkeley Little School	Preschool/Day Care Center	42	7
		Berkeley Montessori School	Preschool/Day Care Center	119	20
		Berkeley Rose Waldorf School	Preschool/Day Care Center	24	4
		Berkeley Special Education Preschool	Preschool/Day Care Center	90	15
		Berkeley YMCA EHS - Vera Casey	Preschool/Day Care Center	26	4
		Berkeley YMCA Head Start - South YMCA	Preschool/Day Care Center	94	16

Region Number	Region Name	Facility Name	Facility Type	Total Population	Transit Dependent Population
R01	Citywide Evacuation	Berkeley YMCA Head Start - West YMCA	Preschool/Day Care Center	86	15
		Beth El Nursery School	Preschool/Day Care Center	74	13
		BUSD - Franklin Preschool	Preschool/Day Care Center	192	33
		BUSD - Hopkins Street	Preschool/Day Care Center	140	24
		BUSD - King Child Development Center	Preschool/Day Care Center	108	18
		Cedar Creek Montessori School	Preschool/Day Care Center	40	7
		Centro Vida Bilingual Childcare Center	Preschool/Day Care Center	64	11
		Child Education Center	Preschool/Day Care Center	107	18
		Childrens Community Center	Preschool/Day Care Center	52	9
		Congregation Beth Israel-Gan Shalom	Preschool/Day Care Center	32	5
		Congregation Netivot Shalom	Preschool/Day Care Center	30	5
		Cornerstone Children's Center	Preschool/Day Care Center	112	19
		Dandelion Nursery School, Inc	Preschool/Day Care Center	24	4
		Dolma Child Care Center	Preschool/Day Care Center	14	2
		Duck's Nest - Berkeley	Preschool/Day Care Center	91	15
		Ecole Bilingue De Berkeley	Preschool/Day Care Center	426	72
		Ephesian Children's Center	Preschool/Day Care Center	36	6
		Global Montessori International School	Preschool/Day Care Center	90	15
		Golden Gate Learning Center	Preschool/Day Care Center	57	10
		Hearts Leap Beginnings	Preschool/Day Care Center	40	7
		Hearts Leap ICRI Preschool	Preschool/Day Care Center	70	12
		Hearts Leap North	Preschool/Day Care Center	45	8
		Jewish Community Ctr of The East Bay-Berkeley	Preschool/Day Care Center	75	13
		Kids In Motion	Preschool/Day Care Center	70	12
		Little Beans Preschool	Preschool/Day Care Center	40	7
		Little Elephant Montessori, Inc.	Preschool/Day Care Center	24	4
		Mi Mundo Preschool	Preschool/Day Care Center	29	5
		Model School Comprehensive Humanistic Learning Ctr	Preschool/Day Care Center	63	11
		Mustard Seed Preschool	Preschool/Day Care Center	66	11
		Nia House Learning Center	Preschool/Day Care Center	94	16
		Pixar Child Development Center	Preschool/Day Care Center	108	18
		Rosemarie's Motivational Preschool	Preschool/Day Care Center	22	4

Region Number	Region Name	Facility Name	Facility Type	Total Population	Transit Dependent Population
R01	Citywide Evacuation	Shu Ren International School	Preschool/Day Care Center	179	30
		St. John's Child Care Center	Preschool/Day Care Center	45	8
		Step One School	Preschool/Day Care Center	108	18
		Sunshine Preschool (CEID)	Preschool/Day Care Center	45	8
		The Monteverde School	Preschool/Day Care Center	30	5
		The New School of Berkeley	Preschool/Day Care Center	48	8
		The New School Of Berkeley-Schoolage	Preschool/Day Care Center	45	8
		Through the Looking Glass Early Head Start	Preschool/Day Care Center	24	4
		UCB - Clark Kerr Campus Children's Center	Preschool/Day Care Center	29	5
		UCB - Clark Kerr Preschool	Preschool/Day Care Center	29	5
		UCB - Dwight Way Center	Preschool/Day Care Center	42	7
		UCB - Harold E. Jones Child Study Ctr/Childcare	Preschool/Day Care Center	56	10
		UCB - Haste Street Child Development Center	Preschool/Day Care Center	92	16
		VIA Nova Children's School	Preschool/Day Care Center	45	8
		Woolly Mammoth Childcare & Preschool	Preschool/Day Care Center	69	12
		Acupuncture and Integrative Medicine College-Berkeley	School	153	0
		Bayhill High School	School	73	12
		Berkeley Arts Magnet at Whittier School	School	407	69
		Berkeley City College	School	6,519	174
		Berkeley High School	School	3,427	583
		Berkeley Rose Waldorf School	School	97	16
		Berkeley School of Theology	School	65	0
		Berkeley Technology Academy	School	36	6
		Berkwood Hedge School	School	128	22
		Black Pine Circle School	School	347	59
		California Jazz Conservatory	School	88	0
		Church Divinity School of the Pacific	School	122	0
		Cragmont Elementary School	School	331	56
		Dominican School of Philosophy & Theology	School	100	0
		East Bay School for Boys	School	105	18
		Emerson Elementary School	School	323	55
		Escuela Bilingue Internacional School	School	324	55

Region Number	Region Name	Facility Name	Facility Type	Total Population	Transit Dependent Population
R01	Citywide Evacuation	Graduate Theological Union	School	275	0
		Institute of Buddhist Studies	School	53	0
		Jesuit School of Theology	School	112	0
		John Muir Elementary School	School	306	52
		Longfellow Arts and Technology Middle School	School	504	86
		Malcolm X Elementary School	School	552	94
		Martin Luther King Middle School	School	1,007	171
		Maybeck High School	School	121	21
		Oxford Elementary at West Campus	School	256	44
		Pacific Boychoir Academy	School	30	5
		Pacific Lutheran Theological Seminary	School	50	0
		Pacific School of Religion	School	139	0
		Rosa Parks Environmental Science School	School	442	75
		Ruth Acty Elementary School	School	433	74
		School of the Madeleine	School	337	57
		Sylvia Mendez Elementary School	School	409	70
		The Berkeley School	School	236	40
		The Crowden School	School	75	13
		The Elmwood Academy	School	100	17
		The Wright Institute	School	638	0
		Thousand Oaks Elementary School	School	382	65
		University of California - Berkeley	School	44,075	2,289
		VIA Center	School	20	3
		Walden Center & School	School	84	14
		Washington Elementary School	School	416	71
		Willard Middle School	School	669	114
		Zaytuna College	School	43	0
			REGION TOTAL:	**141,006**	**30,382**

Region Number	Region Name	Facility Name	Facility Type	Total Population	Transit Dependent Population
R02	Fire 1923 Evacuation Order	Various locations throughout the region	Transient Attractions	9,342	2,803
		Various locations throughout the region	Major Employers	15,362	5,484
		Various locations throughout the region	Transit Dependent Residents	525	525
		Various locations throughout the region	People Requiring Specialized Transportation Assistance	108	108
		New Bridge Foundation	Medical Facility	45	45
		Redwood Gardens Apartments	Medical Facility	168	168
		Berkeley Hills Nursery School	Preschool/Day Care Center	40	7
		Berkeley Montessori School	Preschool/Day Care Center	119	20
		Beth El Nursery School	Preschool/Day Care Center	74	13
		BUSD - Hopkins Street	Preschool/Day Care Center	140	24
		Childrens Community Center	Preschool/Day Care Center	52	9
		Hearts Leap North	Preschool/Day Care Center	45	8
		Jewish Community Ctr of The East Bay-Berkeley	Preschool/Day Care Center	75	13
		Mustard Seed Preschool	Preschool/Day Care Center	66	11
		The New School of Berkeley	Preschool/Day Care Center	48	8
		The New School of Berkeley-Schoolage	Preschool/Day Care Center	45	8
		UCB - Clark Kerr Campus Children's Center	Preschool/Day Care Center	29	5
		UCB - Clark Kerr Preschool	Preschool/Day Care Center	29	5
		Bayhill High School	School	73	12
		Berkeley Arts Magnet at Whittier School	School	407	69
		Church Divinity School of the Pacific	School	122	0
		Dominican School of Philosophy & Theology	School	100	0
		Graduate Theological Union	School	275	0
		Jesuit School of Theology	School	112	0
		Martin Luther King Middle School	School	1,007	171
		Pacific Lutheran Theological Seminary	School	50	0
		Pacific School of Religion	School	139	0
		School of the Madeleine	School	337	57
		University of California - Berkeley	School	44,075	2,289
		Zaytuna College	School	43	0

Region Number	Region Name	Facility Name	Facility Type	Total Population	Transit Dependent Population
R02	Fire 1923 Evacuation Warning	Various locations throughout the region	Transient Attractions	4,265	1,280
		Various locations throughout the region	Major Employers	1,156	413
		Various locations throughout the region	Transit Dependent Residents	270	270
		Various locations throughout the region	People Requiring Specialized Transportation Assistance	56	56
		Berkeley Little School	Preschool/Day Care Center	42	7
		Cornerstone Children's Center	Preschool/Day Care Center	112	19
		Dandelion Nursery School, Inc	Preschool/Day Care Center	24	4
		St. John's Child Care Center	Preschool/Day Care Center	45	8
		The Monteverde School	Preschool/Day Care Center	30	5
		UCB - Dwight Way Center	Preschool/Day Care Center	42	7
		UCB - Harold E. Jones Child Study Ctr/Childcare	Preschool/Day Care Center	56	10
		UCB - Haste Street Child Development Center	Preschool/Day Care Center	92	16
		Berkeley City College	School	6,519	174
		Berkeley High School	School	3,427	583
		California Jazz Conservatory	School	88	0
		Cragmont Elementary School	School	331	56
		East Bay School for Boys	School	105	18
		Emerson Elementary School	School	323	55
		Institute of Buddhist Studies	School	53	0
		Maybeck High School	School	121	21
		Pacific Boychoir Academy	School	30	5
		Ruth Acty Elementary School	School	433	74
		The Crowden School	School	75	13
		The Wright Institute	School	638	0
			REGION TOTAL:	**66,681**	**6,669**

Region Number	Region Name	Facility Name	Facility Type	Total Population	Transit Dependent Population
R03a	Fire 1923 Phase a Evacuation Order	Various locations throughout the region	Transient Attractions	1,423	427
		Various locations throughout the region	Transit Dependent Residents	64	64
		Various locations throughout the region	People Requiring Specialized Transportation Assistance	13	13
		Pacific Lutheran Theological Seminary	School	50	0
R03a	Fire 1923 Phase a Evacuation Warning	Various locations throughout the region	Transient Attractions	2,377	713
		Various locations throughout the region	Transit Dependent Residents	175	175
		Various locations throughout the region	People Requiring Specialized Transportation Assistance	36	36
		Berkeley Hills Nursery School	Preschool/Day Care Center	40	7
			REGION TOTAL:	**4,178**	**1,435**
R03b	Fire 1923 Phase b Evacuation Order	Various locations throughout the region	Transient Attractions	3,347	1,004
		Various locations throughout the region	Transit Dependent Residents	207	207
		Various locations throughout the region	People Requiring Specialized Transportation Assistance	43	43
		Berkeley Hills Nursery School	Preschool/Day Care Center	40	7
		Pacific Lutheran Theological Seminary	School	50	0
R03b	Fire 1923 Phase b Evacuation Warning	Various locations throughout the region	Transient Attractions	2,772	832
		Various locations throughout the region	Major Employers	3,028	1,081
		Various locations throughout the region	Transit Dependent Residents	175	175
		Various locations throughout the region	People Requiring Specialized Transportation Assistance	36	36
		Church Divinity School of the Pacific	School	122	0
		Graduate Theological Union	School	275	0
		Jesuit School of Theology	School	112	0
		Pacific School of Religion	School	139	0
		Zaytuna College	School	43	0
			REGION TOTAL:	**10,389**	**3,385**
R03c	Fire 1923 Phase c Evacuation Order	Various locations throughout the region	Transient Attractions	9,342	2,803
		Various locations throughout the region	Major Employers	15,362	5,484
		Various locations throughout the region	Transit Dependent Residents	525	525
		Various locations throughout the region	People Requiring Specialized Transportation Assistance	108	108

Region Number	Region Name	Facility Name	Facility Type	Total Population	Transit Dependent Population
R03c	Fire 1923 Phase c Evacuation Order	New Bridge Foundation	Medical Facility	45	45
		Redwood Gardens Apartments	Medical Facility	168	168
		Berkeley Hills Nursery School	Preschool/Day Care Center	40	7
		Berkeley Montessori School	Preschool/Day Care Center	119	20
		Beth El Nursery School	Preschool/Day Care Center	74	13
		BUSD - Hopkins Street	Preschool/Day Care Center	140	24
		Childrens Community Center	Preschool/Day Care Center	52	9
		Hearts Leap North	Preschool/Day Care Center	45	8
		Jewish Community Ctr of The East Bay-Berkeley	Preschool/Day Care Center	75	13
		Mustard Seed Preschool	Preschool/Day Care Center	66	11
		The New School of Berkeley	Preschool/Day Care Center	48	8
		The New School of Berkeley-Schoolage	Preschool/Day Care Center	45	8
		UCB - Clark Kerr Campus Children's Center	Preschool/Day Care Center	29	5
		UCB - Clark Kerr Preschool	Preschool/Day Care Center	29	5
		Bayhill High School	School	73	12
		Berkeley Arts Magnet at Whittier School	School	407	69
		Church Divinity School of the Pacific	School	122	0
		Dominican School of Philosophy & Theology	School	100	0
		Graduate Theological Union	School	275	0
		Jesuit School of Theology	School	112	0
		Martin Luther King Middle School	School	1,007	171
		Pacific Lutheran Theological Seminary	School	50	0
		Pacific School of Religion	School	139	0
		School of the Madeleine	School	337	57
		University of California - Berkeley	School	44,075	2,289
		Zaytuna College	School	43	0
R03c	Fire 1923 Phase c Evacuation Warning	Various locations throughout the region	Transient Attractions	4,265	1,280
		Various locations throughout the region	Major Employers	1,156	413
		Various locations throughout the region	Transit Dependent Residents	270	270
		Various locations throughout the region	People Requiring Specialized Transportation Assistance	56	56
		Berkeley Little School	Preschool/Day Care Center	42	7
		Cornerstone Children's Center	Preschool/Day Care Center	112	19

Region Number	Region Name	Facility Name	Facility Type	Total Population	Transit Dependent Population
R03c	Fire 1923 Phase c Evacuation Warning	Dandelion Nursery School, Inc	Preschool/Day Care Center	24	4
		St. John's Child Care Center	Preschool/Day Care Center	45	8
		The Monteverde School	Preschool/Day Care Center	30	5
		UCB - Dwight Way Center	Preschool/Day Care Center	42	7
		UCB - Harold E. Jones Child Study Ctr/Childcare	Preschool/Day Care Center	56	10
		UCB - Haste Street Child Development Center	Preschool/Day Care Center	92	16
		Berkeley City College	School	6,519	174
		Berkeley High School	School	3,427	583
		California Jazz Conservatory	School	88	0
		Cragmont Elementary School	School	331	56
		East Bay School for Boys	School	105	18
		Emerson Elementary School	School	323	55
		Institute of Buddhist Studies	School	53	0
		Maybeck High School	School	121	21
		Pacific Boychoir Academy	School	30	5
		Ruth Acty Elementary School	School	433	74
		The Crowden School	School	75	13
		The Wright Institute	School	638	0
			REGION TOTAL:	**91,385**	**14,956**

Region Number	Region Name	Facility Name	Facility Type	Total Population	Transit Dependent Population
R04	Panoramic Hill Fire Evacuation Order	Various locations throughout the region	Transient Attractions	757	227
		Various locations throughout the region	Transit Dependent Residents	80	80
		Various locations throughout the region	People Requiring Specialized Transportation Assistance	16	16
		Redwood Gardens Apartments	Medical Facility	168	168
		UCB - Clark Kerr Campus Children's Center	Preschool/Day Care Center	29	5
		UCB - Clark Kerr Preschool	Preschool/Day Care Center	29	5
R04	Panoramic Hill Fire Evacuation Warning	Various locations throughout the region	Transient Attractions	1,090	327
		Various locations throughout the region	Major Employers	172	61
		Various locations throughout the region	Transit Dependent Residents	127	127
		Various locations throughout the region	People Requiring Specialized Transportation Assistance	26	26
		St. John's Child Care Center	Preschool/Day Care Center	45	8
		The Monteverde School	Preschool/Day Care Center	30	5
		Emerson Elementary School	School	323	55
		Maybeck High School	School	121	21
		The Wright Institute	School	638	0
			REGION TOTAL:	**3,651**	**1,131**

Region Number	Region Name	Facility Name	Facility Type	Total Population	Transit Dependent Population
R05	Fire Zones Fire Zones 2 and 3 Combined	Various locations throughout the region	Transient Attractions	8,851	2,655
		Various locations throughout the region	Major Employers	172	61
		Various locations throughout the region	Transit Dependent Residents	668	668
		Various locations throughout the region	People Requiring Specialized Transportation Assistance	138	138
		New Bridge Foundation	Medical Facility	45	45
		Redwood Gardens Apartments	Medical Facility	168	168
		Arbor Preschool East	Preschool/Day Care Center	22	4
		Berkeley Hills Nursery School	Preschool/Day Care Center	40	7
		Beth El Nursery School	Preschool/Day Care Center	74	13
		Childrens Community Center	Preschool/Day Care Center	52	9
		Dandelion Nursery School, Inc	Preschool/Day Care Center	24	4
		Kids In Motion	Preschool/Day Care Center	70	12
		Step One School	Preschool/Day Care Center	108	18
		UCB - Clark Kerr Campus Children's Center	Preschool/Day Care Center	29	5
		UCB - Clark Kerr Preschool	Preschool/Day Care Center	29	5
		Church Divinity School of the Pacific	School	122	0
		Cragmont Elementary School	School	331	56
		Dominican School of Philosophy & Theology	School	100	0
		Graduate Theological Union	School	275	0
		Jesuit School of Theology	School	112	0
		John Muir Elementary School	School	306	52
		Pacific Lutheran Theological Seminary	School	50	0
		Pacific School of Religion	School	139	0
		The Wright Institute	School	638	0
		Zaytuna College	School	43	0
			REGION TOTAL:	**12,606**	**3,920**

Region Number	Region Name	Facility Name	Facility Type	Total Population	Transit Dependent Population
R06	**Tsunami Phase 3**	Various locations throughout the region	Transient Attractions	1,944	583
		Various locations throughout the region	Major Employers	126	45
		Various locations throughout the region	Transit Dependent Residents	32	32
		Various locations throughout the region	People Requiring Specialized Transportation Assistance	7	7
			REGION TOTAL:	**2,109**	**667**
R07	**Tsunami Max Phase**	Various locations throughout the region	Transient Attractions	4,077	1,223
		Various locations throughout the region	Major Employers	3,547	1,266
		Various locations throughout the region	Transit Dependent Residents	111	111
		Various locations throughout the region	People Requiring Specialized Transportation Assistance	23	23
		Aquatic Park School	Preschool/Day Care Center	77	13
		Duck's Nest - Berkeley	Preschool/Day Care Center	91	15
		Golden Gate Learning Center	Preschool/Day Care Center	57	10
		VIA Center	School	20	3
			REGION TOTAL:	**8,003**	**2,664**

0. City of Berkeley Evacuation StoryMaps: Text-Only Version

July 2025

This document provides a text-only version of analysis from the City of Berkeley's Evacuation StoryMaps.

This document has six parts:

1. **The Evacuation Time Study Project:** Explains why the Study was conducted and highlights key evacuation time estimates for different hazard scenarios.

2. **Household Evacuation Planning:** Offers useful takeaways from the Study to help residents create their own evacuation plans.

3. **Evacuation and Fire Spread:** Compares wildfire spread rates in the Berkeley Hills with evacuation timelines to assess risk to the community.

4. **Improving Evacuation Times:** Evaluates proposed ideas—such as parking restrictions or road design change—to see whether they would meaningfully improve evacuation safety or speed.

5. **Access Impaired Neighborhoods Analysis:** Addresses the requirements of Senate Bill 99, which mandates identification of residential developments in hazard areas that lack at least two emergency evacuation routes.

6. **Evacuation Route Safety, Capacity and Viability Analysis:** Addresses the requirements of Assembly Bill 747, which requires local governments to assess the capacity, safety, and viability of evacuation routes under various emergency conditions.

7. **Learn More:** Contains links to access more information and download referenced reports.

1. The Evacuation Time Study Project

0. About the Study

Berkeley faces risks like wildfire, tsunami, and other emergencies that could require large evacuations. These rare but dangerous events can have very different outcomes depending on the time, season, and how the community responds.

The Evacuation Time Study uses simulations to model a wide array of large-scale evacuations that would be too risky or impractical to conduct in real life. It tests different conditions—like time, location, and evacuee behaviors—and is built on a solid understanding of Berkeley's hazards, streets, and community. The Study is a useful tool to help responders, residents, and elected leaders better prepare for emergencies.

1. Evacuation Time Study Methodology

Berkeley's Evacuation Time Study was developed over two years by experts in evacuation, transportation, and emergency planning.
In 2023, the City hired KLD, a firm experienced in evacuation modeling, including for nuclear sites.
KLD drove every street in Berkeley, gathered detailed information, and surveyed the community. They used all of this to build a detailed evacuation model for Berkeley.

Using this model, KLD estimated evacuation times for different parts of the city.
KLD also ran "what-if" scenarios to see how evacuation times might change under different conditions.

2. Evacuation Areas

The Study estimates how long it would take to evacuate different parts of Berkeley. These areas are based on past disasters, known risks, and geography.

Each evacuation area has several evacuation time estimates, depending on the time of day, day of the week, and season.
Evacuations take longer when more people are in Berkeley—this means more people need to leave and there is more traffic on the roadways, both in and outside the evacuating area.

Evacuation times are longer when school is in session, on weekdays, and during daytime hours. They are shorter at night and on weekends.

3. How long will it take to evacuate different areas of Berkeley?

1923 Berkeley Fire Repeat

This evacuation area is based on the 1923 Berkeley Fire, the worst fire in the city's history.

Evacuation orders would stretch from Berkeley's eastern edge and extend as far west as Sacramento Street, involving residents from Marin Avenue stretching as far south as the UC Berkeley campus.
Estimated evacuation times range from 1 hour and 35 minutes to 4 hours and 10 minutes.

Panoramic Hill Fire

This evacuation area is based on a fire affecting Panoramic Hill, an area of Berkeley's Wildland-Urban Interface with only one road in and out.

Estimated evacuation times range from 45 minutes to 1 hour and 45 minutes.

Tsunami Warning

Two evacuation areas were analyzed for a Tsunami Warning.

A Max Phase Tsunami Warning would affect areas of Berkeley extending from the San Francisco Bay to as far east as 7th Street. Evacuating this area would take between 1 hour and 50 minutes and 2 hours and 15 minutes.

A Phase 3 Tsunami Warning would affect only the area west of I-80. Evacuating this area would take between 55 minutes and 1 hour and 45 minutes.

2. Household Evacuation Planning

0. Some Background

The Evacuation Time Study is a high-level model to support emergency planning. It also gives useful insights for community members making their own household evacuation plans.

1. Evacuation Process

Evacuation doesn’t start on the road. It happens in three steps:

1. **Notification** – Knowing there's an evacuation order is the first step. Signing up for emergency alerts helps people get this information faster.
2. **Mobilization** – This is the time spent getting ready to leave, like packing, preparing the home, or waiting for family members.
3. **Roadway Time** – This is the time spent driving out of the hazard area.

Each household's total evacuation time will be different, depending on how quickly they get notified, how long they take to get ready, and how fast they can travel to safety.

The evacuation times in this report combine the estimated times for all people within a given evacuating area.

2. Evacuate Faster

Here are key tips from the Study to help you reduce your own evacuation time:

Tip 1: Sign up for emergency alerts.

Knowing you need to evacuate is the first step.

- Download the Genasys Protect App to be first to know when evacuations are ordered.
- Sign up for AC Alert to get detailed instructions to your phone and email.

Tip 2: Leave as Early as Possible

The Study shows that people who leave sooner have shorter travel times. They start driving before roadways become heavily congested.
In simulating household evacuation times during a repeat of the 1923 Fire, the Study shows that taking longer to get ready rapidly increases your total evacuation time. For example:

- A household that leaves in 30 minutes may reach safety in 1 hour and 10 minutes.
- A household that leaves in 1 hour may reach safety in 2 hours and 15 minutes.
- A household that leaves in 1.5 hours may reach safety in 3 hours and 10 minutes.
- A household that leaves in 2.5 hours minutes may reach safety in 3 hours and 50 minutes.

In this example, waiting an extra 30 minutes can add over an hour to the total evacuation time.
These delays are caused by growing traffic. In the 1923 Fire Repeat example:

- At the start, roads are mostly clear.
- After 30-45 minutes, they become 50% full.
- After 120 minutes, the roads are completely jammed.

This example shows that if you get on the road earlier, when traffic is light, you'll get out faster.

3. Plan Where You'll Go

Most people will choose to stay with friends, family, or at a hotel.

Make your plan before an emergency. Think about options outside of Berkeley—or even outside the Bay Area.

If there is a fire or tsunami, emergency shelters will also be opened in safe areas. They may be outside of Berkeley.

Know Multiple Ways Out

Being ready to use different roads will help you – and all evacuees— get to safety faster.

This map highlights Berkeley's highest-capacity roadways that can move the most people. They include:

- University Ave
- Adeline St
- Ashby Ave (SR 13)
- Cedar St
- Interstate 80 (I-80)
- San Pablo Ave (SR 123)
- Sacramento St
- Claremont Ave
- Marin Ave

But during a major evacuation, they won't be enough on their own. Evacuees will need to use all available streets to get out. Spreading out traffic helps everyone escape more quickly.

"What's my evacuation route?"

1. Be ready to use any available roadways.
2. Know the roads around your home and plan at least 2 routes out.

4. Evacuees Without Cars

The Evacuation Time Study predicts times for people leaving in vehicles, but many people in Berkeley do not own cars.

Here are key tips from the Study for people without cars:

1. **Plan to carpool:**
    - Carpooling helps reduce the number of vehicles on the road during an evacuation.
    - Everyone should plan ahead to carpool with neighbors.
    - If you don’t own a car, make arrangements with neighbors who do.
    - If you have a car, plan to help neighbors who may need a ride.
    - Working together makes evacuation faster and safer for everyone.
2. **“Should I walk or bike out?”**
    - Walking or biking during an evacuation can be risky, especially if the hazard is close or traffic is heavy.
    - Cars provide some protection against the hazard and in traffic collisions.
3. No matter how you evacuate, your chances of staying safe are much better if you leave as early as possible.

Here are a few key tips from Berkeley public safety officials to help you plan ahead and choose the safest option for your situation:

1. **In the case of a tsunami,**
    - Walking and cycling can be good options for your tsunami evacuation plan.

    - Berkeley's tsunami zone is west of 7th Street.
    - Walking or biking out of the tsunami zone might be quicker than driving.

2. **In the case of a wildfire:**
    - Berkeley public safety officials do not recommend walking and cycling as your first choice to evacuate from the Berkeley Hills. Fires can spread quickly and unpredictably, and there's no way to know how much time you have.
    - On foot or bike, you're directly exposed to heat, smoke, and dangerous gases. In a car, you have some protection.
    - Drivers evacuating during wildfires make dangerous choices. If you're walking or biking, you're exposed—not just to the fire, but to the traffic around you.

The safest choice is to leave the Berkeley Hills early on days when the Berkeley Fire Department has declared Extreme Fire Weather. Visit the Fire Weather and Evacuation page to learn more.

5. Emergency Transportation

Don't count on government transportation as your main evacuation plan.

In a major emergency, Berkeley will ask for help from nearby agencies to send buses, ambulances, and wheelchair vans. They may not get to you in time because:

- There may not be enough vehicles available quickly.
- Roads may be blocked or too crowded.
- Conditions may be too dangerous—buses can't drive through fire, and bus drivers aren't trained like firefighters.

Plan ahead:

- Leave the Berkeley Hills early on Extreme Fire Weather Days.

- Get to know your neighbors. Make a plan to help each other evacuate.
- Plan to carpool.
- For tsunami evacuations, consider walking or biking.

3. Evacuation and Fire Spread

1. Evacuation and Fire Spread: Impacts of the 1923 Berkeley Fire in the Present Day

Evacuation time estimates are an important tool for planning.

To understand their impact on community safety, we need to compare them to how fast a hazard, like a fire, could reach the evacuating area.

This section compares how fast a fire could spread in the Berkeley Hills with how long it might take to evacuate.

- **First**, we use data from the 1923 Berkeley Fire—the city's worst fire—to model how a fire might spread today.
- **Then**, we use evacuation modeling to show traffic and congestion if that same area had to evacuate now.

By combining fire spread and traffic patterns, we can see the risks the community would face in a modern-day repeat of the 1923 Berkeley Fire.

2. 1923 Berkeley Fire

Archival maps show key details of the 1923 Berkeley Fire.

The archival maps extend as far east as today's Rose Garden and Glendale La Loma Park, about halfway up the present-day Berkeley Hills.

In 1923, areas east of this point were mostly grasslands.

The fast-moving grass fire entered this point around 2:00 PM.

It was pushed by strong Diablo winds blowing 25 to 40 mph.

The fire spread southwest until around 4:20 PM, when moist westerly winds took over.

It reached as far as Shattuck Avenue and Berkeley Way and moved through about 1.3 km of buildings in 2.5 hours.

Shifting to the Present Day

More buildings have been added to the Berkeley hills.

Areas that were grasslands in 1923 are now neighborhoods.

The current border of Berkeley neighborhoods has moved 1.3 km uphill.

To model the spread of the 1923 Fire in today's Berkeley, we also shift the point where it enters built neighborhoods 1.3 km farther uphill.

Today, if the same fire entered Berkeley at the current eastern edge, it would take about 2.5 hours to reach Codornices Park and the Rose Garden.

It would take another 2.5 hours to reach Shattuck Avenue.

In total, the fire would take about 5 hours to move from Berkeley's eastern edge to Shattuck Avenue.

3. Evacuation for a 1923 Berkeley Fire Repeat

Now, let's look at what this fire spread could mean for people trying to evacuate.
If the 1923 Berkeley Fire happened today, evacuation orders (lawful orders to leave now) would stretch from Berkeley's eastern edge and extend as far west as Sacramento Street, involving residents from Marin Avenue stretching as far south as the UC Berkeley campus. Evacuation warnings (instructions to prepare to evacuate or leave immediately if you need extra time), would be issued for areas surrounding the Evacuation Order zones.

Evacuation Time Estimates

This Evacuation Time Study predicts how long it would take to clear the evacuation order area.

The evacuation clock starts when evacuations are ordered.

The times differ depending on time of day, season, and day of week.

In the Spring, Fall, and Winter:

- Midweek daytime evacuation takes 4 hours and 10 minutes.
- Weekend daytime evacuation takes 1 hour and 45 minutes.
- Evening evacuation takes 1 hour and 35 minutes.

In the Summer:

- Midweek daytime evacuation takes 2 hours and 25 minutes.
- Weekend daytime evacuation takes 1 hour and 50 minutes.
- Evening evacuation takes 1 hour and 35 minutes.

Combining Evacuation Traffic and Fire Spread

Now we will combine our 1923 Fire spread model with an associated traffic simulation from the Evacuation Time Study. We will use a midweek daytime evacuation in the fall, because fall is the season that carries the highest risk for a wind-driven wildfire.

The estimated evacuation time is 4 hours and 10 minutes.

How to use this model

This model shows what a repeat of a past fire might look like today. It was built using one set of possibilities – like where a fire starts, how it spreads, and which roads are open. It is meant to show general ideas about fire spread and evacuation, not exact outcomes. **Do not use this model to choose your evacuation routes or make your household evacuation plan.**

What the model shows

Many evacuees will encounter gridlock.

This model doesn’t predict how many people get out safely.

It shows that some evacuees will be overtaken by fire on the roads as they try to escape.

1 Hour after Evacuation Order

The fire has reached Berkeley’s eastern border.

Severe roadway congestion is extending into the Berkeley flats.

Many streets are gridlocked.

2 Hours after Evacuation Order

Fire is spreading through Berkeley buildings.

Fire is also spreading over roadways in use by evacuees.

Berkeley's highest-capacity roadways nearest to the fire are gridlocked.

3 Hours after Evacuation Order

Fire continues to spread through Berkeley neighborhoods.

Overall, there is less gridlock as more evacuees escape.

Fire is spreading over roadways in use by evacuees.

4 Hours after Evacuation Order

Fire continues to spread through Berkeley neighborhoods.

Some traffic congestion is still present in the evacuation order area.

5 Hours after Evacuation Order

Fire continues to spread through Berkeley neighborhoods.

The evacuation is complete.

6 Hours after Evacuation Order

Fire reaches Shattuck Avenue.

We've experienced this before

The model shows traffic gridlock in areas where fire is spreading.

In a fast-moving, wind-driven fire, flames could outpace evacuation efforts—reaching people before they can escape.

This threat is not unique to Berkeley. Some similar situations have occurred most recently in Los Angeles, Lahaina, and Paradise, and locally in the 1991 Oakland-Berkeley Hills Fire.

This modeling reinforces the urgent need for new approaches to fire evacuation—starting with individual households and reaching through the highest levels of government.

Taking Control

Fires are unpredictable once they ignite.

The model makes clear that Berkeley's road network cannot support a quick, large-scale evacuation.

In Berkeley, both residents and responders have the most control over fire safety before a fire starts.

Our approach to fire evacuation must be built on a foundation of:

- Preventing fire spread through home hardening and defensible space
- Leaving the Berkeley Hills early on Extreme Fire Weather days—before a fire begins.

4. Improving evacuation times

The Evacuation Time Study looked at many ideas from the community and first responders to find ways to improve evacuation times and keep people safer.

1. Will parking restrictions in the Berkeley hills help in evacuations?

Yes and no.

Parking restrictions won't get evacuees out faster.

On typical residential street in the Berkeley Hills, cars park along the sides of the street. At some points, the street is too narrow for two cars to pass each other.

Removing parked cars reduces side-to-side crowding.

Without parked cars, evacuating vehicles can drive faster on the street.

But, there is a bigger problem.

When there are too many cars going the same way, intersections turn into chokepoints.

When parked cars are removed, evacuating vehicles will use the extra roadway width to try to get out faster.

But there are still too many cars going the same way.

Even without parked cars, intersections are still chokepoints.

And there is another problem.

When the road narrows, cars must still go 1 by 1 to get through.

The primary limitation is too many cars trying to leave at once.

Removing parked cars won't address this main problem.

However, selective parking restrictions may help emergency responders get in.

On wider streets, parking restrictions may help fire engines and other emergency responders get through while people are evacuating.

Response apparatus may use wider Berkeley Hills roadways to access emergencies.

Removing parked cars reduces side-to-side crowding.

This added road width could help fire engines get in.

Fire engines may still be slowed down at intersections.

But they will not be caught in the same gridlock as evacuees, because most traffic is headed out.

2. Roadway Design and Infrastructure

The Study found that evacuation traffic is likely made worse by pre-timed traffic signals and roadway designs intended to slow vehicles and restrict their movement.

Traffic Calming

On normal days, traffic calming devices (like diverters, traffic circles, and speed humps) make roads safer by slowing down cars, reducing traffic on residential streets, and limiting how cars move through neighborhoods.

But during evacuations, the safety goal is to move traffic quickly. Traffic calming slows down evacuees and adds to traffic jams.

Traffic Signals

Traffic signals can impact evacuation times.

Pre-timed traffic signals follow a fixed schedule to control which direction of traffic gets to go. During an evacuation, these fixed signals **can slow things down.**

Actuated or adaptive signals adjust their timing based on real-time traffic. These signals can **help traffic move** more smoothly during evacuations and in everyday use.

Existing Infrastructure

Traffic calming devices and traffic signals are positioned throughout Berkeley.

The Study found four parts of Berkeley where traffic backups during evacuations are likely made worse by pre-timed traffic signals, as well as street designs focused on slowing vehicles and limiting how they travel:

- South and West of the UC Berkeley Campus
- South and West of Clark Kerr Campus
- North of Ohlone Park
- Lawrence Berkeley National Lab

5. Access Impaired Neighborhood Analysis

California Senate Bill 99 (SB99) requires cities to identify residential developments in hazard areas that do not have at least two emergency evacuation routes.

The Access Impaired Neighborhood analysis identifies:

- Primary Access Impaired Neighborhoods, which have only one way in and out
- Secondary Access Impaired Neighborhoods, which have only one viable way out

Residents with only one way out are at greater risk during evacuations. If their one route is cut off because of the emergency, or blocked by vehicles evacuating, they will be forced to flee on foot or bicycle.

Primary Access Impaired Neighborhoods (SB99)

This analysis identifies parcels with one way in and out as Berkeley's "Primary Access Impaired Neighborhoods."

In total, there are 139 Primary Access Impaired Neighborhoods with 1,547 residential parcels. These neighborhoods are distributed throughout the Berkeley flats and hills. Only one primary AIN is west of San Pablo Ave.

There are different reasons that each of these neighborhoods has one way in and out. Some have a natural dead end, such as a cul-de-sac. Others have manmade blockages from bollards or islands.

Primary Access Impaired Neighborhoods exist throughout Berkeley. The Panoramic Hill neighborhood contains the most Primary Access Impaired Neighborhood parcels, with only one exit route for the entire neighborhood at a stop-controlled intersection at Panoramic Way and Prospect St/Canyon Rd.

Primary Access Impaired Neighborhoods created by manmade blockages are mostly in the Berkeley flats. Some are on Panoramic Hill, and some are in southeast Berkeley between College Ave and Claremont Ave.

Additional Analysis:

Secondary Access Impaired Neighborhoods (AIN)

The analysis next identifies Berkeley's "Secondary Access Impaired Neighborhoods." These parcels have multiple evacuation routes available but only one viable exit, due to narrow roadways and hairpin turns.

In total, there are 195 Secondary Access Impaired Neighborhoods with 3,715 residential parcels. They primarily sit in the North Berkeley Hills with a few scattered in southeast Berkeley, east of Claremont Ave.

The northern Berkeley Hills contain the majority of secondary Access Impaired Neighborhoods. Residents in these neighborhoods will need more time for safe evacuation compared to those in other parts of the city.

Narrow Roads

There are different reasons for narrow roadways and tight turns. In some cases, topography dictates the challenging roadway. In others, on-street parking narrows the available pavement width.

When responders must use narrow, winding roads to access an emergency, they cannot drive quickly. They are likely to encounter traffic delays as they try to pass outgoing traffic. These ingress challenges will be exacerbated in an evacuation.

Berkeley's narrow roads are classified as constrained, moderately constrained, and severely constrained.

The narrow roadways are almost exclusively in the north Berkeley Hills in the area north of Codornices Park. Narrow roadways are also present on Panoramic Hill.

Tight turns exist throughout the North and South Berkeley Hills.

6. Evacuation Route Safety, Capacity, and Viability Analysis

0. Introduction

California Assembly Bill 747 (AB747) requires cities to identify evacuation routes and their capacity, safety, and viability under a range of emergency scenarios.

The analysis discusses the capacity, safety, and viability of Berkeley's roadways for different evacuations.

1. Capacity

The capacity of each roadway segment within the City of Berkeley is based on field observations collected in May 2023, including the number of moving lanes on each roadway.

The analysis identified assigned measured the capacity of each roadway segment and assigned a capacity from one of these four levels:

- red: 225-900 passenger cars per hour,
- yellow: 901-1700 passenger cars per hour,
- light green: 1701-5700 passenger cars per hour,
- dark green: 5701-15750 passenger cars per hour.

In the Berkeley Hills, most roadways are red. In the rest of the city, roadways are a mixture of red, yellow and light green. The only dark green roadway is the I-80 freeway.

I-80 has the highest capacity, followed by multilane major arterials like San Pablo Ave, University Ave, Shattuck Ave/Adeline St, Sacramento St, Telegraph Ave, and Claremont Ave.

The vast majority of roadways within the city are single-lane collectors with a free flow speed of 45mph or less and a capacity of approximately 1,700 passenger cars per hour

or less. In the hills, free flow speeds are 20 mph or less and capacities are 900 passenger cars per hour or less.

2. Max Demand

When under maximum evacuation demand, most of Berkeley's roadways will experience significant congestion.

Major arterials like San Pablo Avenue, Sacramento Street, University Avenue, Adeline Street, Ashby Avenue, and Claremont Avenue can better service the evacuating demand than the smaller, local streets within the heart of the city. Under maximum demand, these roadways show less congestion.

However, to most quickly evacuate an area, traffic should be distributed across all available routes.

3. Safety Risk

Each Berkeley roadway is given a safety rating. Lower scores are safer.

Roadways with the highest scores have the highest exposure to traffic fatalities, narrowest width, tightest turns, steepest slopes, poorest pavement condition and/or are located above or below a bridge or tunnel. Safety ratings do not consider the roadways' exposure to natural hazards. Hazard rating, described below, addresses this risk.

Berkeley's least safe roadways are within the hills and along Panoramic Way. These roadways are extremely narrow, winding, and steep.

Many of the roadways within the flats, including San Pablo Ave, have poor or very poor pavement conditions, giving them a higher unsafe rating.

The safest roadways are Frontage Road, University Avenue, and Adeline Street.

4. Hazard Rating

In addition to the roadway characteristics, roadway safety can be described based on hazard exposure.

Roadways receive hazard ratings based on their exposure to hazards such as landslide and tsunami.

It should be noted that routes with hazard exposure may still need to be used by evacuees. As such, the hazard factors are presented separately from the safety factors and were excluded in the overall safety rating in the Safety Risk section previously discussed.

5. Demographic Vulnerability

Although not specifically a consideration of a roadway's safety, capacity or viability, neighborhood demographics can indicate areas that may face greater challenges when evacuating.

For example, areas with less vehicle availability will face greater challenges when evacuating, as compared to areas where households have more personal vehicles to drive themselves out.

Higher vulnerability ratings indicate greater vulnerabilities of the population living along a roadway segment. Demographic vulnerability factors were considered separately from the safety, capacity or viability factors described above.
The analysis identified four different demographic vulnerability levels:

- blue: 0.5-1.14,
- light green: 1.5-1.9,
- orange: 2.0-2.7,
- red: 2.8-3.8.

The map shows blue level vulnerability in the following areas:

- North Berkeley Hills.
- Claremont neighborhood.
- Area north of University Ave bounded by San Pablo Ave to the west and Sacramento St to the east.

- Panoramic Hill (City of Oakland portion).

The map shows light green level vulnerability in the following areas:

- Area bounded by 6th St to the west, University Ave to the south San Pablo Ave to the east and Camelia St to the north.
- Area bounded by Sacramento St to the west, Martin Luther King Jr Way to the east, Dwight Way to the south and Cedar St to the north.
- Area bounded by Hearst Ave to the south, Spruce St to the west, Cedar St to the north and Lawrence Berkeley National Laboratory (LBNL) to the east.
- Area bounded by Fulton St to the west, College Ave to the east, Derby St to the north and city boundary to the south.
- Area bounded by College Ave to the west, Ashby Ave to the south, city boundary to the east and Dwight Way to the north.

The map shows orange level vulnerability in the following areas:

- Everything west of San Pablo Ave with the exception of the area bounded by 6th St to the west, University Ave to the south, San Pablo Ave to the east and Camelia St to the north.
- Area bounded by Eunice St to the north, Spruce St to the east, University Ave to the south and Martin Luther King Jr Way to the west.
- Area bounded by San Pablo Ave to the west, Fulton St to the east, Dwight Way to the north, and city boundary to the south. The orange area extends north on Shattuck and Milvia St to Bancroft Ave. It extends east to College Ave on Dwight Way, Blake St, Parker St and Carleton St.

The map shows red level vulnerability in the following areas:

- Area bounded by San Pablo Ave to the west, University Ave to the north, Sacramento St to the east and Dwight to the south.
- The UC Berkeley main campus.
- Southside neighborhood extending east to Fulton St and south to Dwight Way.
- Berkeley High extending south to Dwight Way.
- Streets surrounding Downtown Berkeley Bart Station.
- Panoramic Hill (City of Berkeley portion).

6. Results

While the safety, capacity, viability, and vulnerability varies somewhat within individual street segments on a particular roadway, the following roadways have the highest capacity, are relatively safe, and are the most viable across their entire length.

- University Ave
- Adeline St
- Ashby Ave (SR 13)
- Cedar St
- Interstate 80 (I-80)
- San Pablo Ave (SR 123)
- Sacramento St
- Claremont Ave
- Marin Ave

7. Learn More

Berkeley's evacuation instructions use findings from the 2025 Evacuation Time Study. Download the Evacuation Time Study.

Berkeley also performed analysis to comply with State evacuation planning requirements. Download the Access Impaired Neighborhoods Analysis and the Evacuation Route Safety, Capacity, and Viability Analysis to learn more.

To learn more about Berkeley's Extreme Fire Weather leave early approach and to make your own household fire weather plan, visit the Fire Weather and Evacuation page.

To learn more about protecting your property and preventing fire spread, visit FireSafe Berkeley.

RESOLUTION NO. 70,712-N.S.

CONTRACT: KLD ENGINEERING, P.C. FOR EVACUATION AND RESPONSE TIME MODELING

WHEREAS, due to climate and land use changes, wildfires are occurring more frequently along the West Coast. The fuel, topography, transportation network, housing density, and narrow structure separation make a large portion of the City a CalFIRE Very High Fire Danger Severity Zone (VHFDSZ). This means the area presents significant wildfire risk to the people living in, working in and visiting these areas and the adjacent areas of the City; and

WHEREAS, with an estimated population of 30,000 in the VHFDSZ even a partial evacuation will place a substantial number of people and vehicles on the road network. Given the geography of the City with wildland areas to the east, evacuees must predominately travel west to evacuate the VHFDSZ using mostly narrow evacuation routes. Evacuating a large number of people with such a challenging transportation network presents a significant risk. If flames or smoke from a wildfire, or down power lines from an earthquake block one or more of these evacuation routes, the risk is exacerbated; and

WHEREAS, according to the Standards of Coverage analysis provided to City Council on April 19, 2022, the City's response to fire and medical emergencies is 1 minute, 53 seconds slower than the nationally recommended travel time of four-minutes. Today the Department only has only experiential data to quantify the impacts proposed roadway treatments would have to response times; and

WHEREAS, the City requires professional assistance to meet the unfunded state mandates outlined in SB 99, AB 747, and AB 1409, and requires related professional services in the areas of traffic and evacuation modeling and planning; and

WHEREAS, funds are available for this contract in the Fire Department Measure FF (Budget code 164-72-745-000-0000-000-612990) and UC Settlement Funds (Budget code 147-72-743-000-0000-000-612990).

NOW THEREFORE, BE IT RESOLVED by the Council of the City of Berkeley that the City Manager is authorized to piggyback on the County of Santa Barbara contract and execute a contract and any amendments with KLD Engineering, P.C., for Evacuation and Response Time Modeling from April 1, 2023 through June 30, 2024 in the amount not to exceed $400,000 with an option to extend for an additional two years not to exceed an additional $100,000 if the piggyback contract is extended.

The foregoing Resolution was adopted by the Berkeley City Council on March 14, 2023 by the following vote:

Ayes: Bartlett, Hahn, Harrison, Humbert, Kesarwani, Robinson, Taplin, Wengraf, and Arreguin.

Noes: None.

Absent: None.

Jesse Arreguin, Mayor

Attest:

Rose Thomsen, Deputy City Clerk

RESOLUTION NO. 71,368-N.S.

CONTRACT NO. 32300165 AMENDMENT: KLD ENGINEERING, P.C. FOR EVACUATION AND RESPONSE ANALYSIS

WHEREAS, on May 18, 2023, the City executed Contract No. 32300165 with KLD Engineering, P.E. for traffic evacuation and evacuation modeling services; and

WHEREAS, this contract piggybacked on a County of Santa Barbara contract which expires on June 30, 2024; and

WHEREAS, the County of Santa Barbara is not extending its contract (on which the City of Berkeley piggybacked) with KLD Engineering, P.E.; and

WHEREAS, this work is required by the State of California within SB 99, AB 747, and AB 1409; and

WHEREAS, in July 2023, KLD Engineering, P.C. reached a strategic agreement to transfer its evacuation and emergency planning business line to KLD Associates; and

WHEREAS, Staff from KLD Associates has already developed a detailed traffic model that will underly any evacuation time studies, has collected and begun analysis on voluminous data from response apparatus, and has developed deep familiarity with the Berkeley community, key sites, hazards, and other data that will inform evacuation and response times; and

WHEREAS, due to this and the specific experience with the City of Berkeley listed above, competing for this service is not amenable performed this work for the first year of the contract with KLD Engineering, P.E.; and

WHEREAS, staff determined that ongoing as-needed analysis would be required beyond the contract's original extended expiration date.

NOW THEREFORE, BE IT RESOLVED by the Council of the City of Berkeley that the City Manager is authorized to amend to Contract No. 32300165 with KLD Engineering, P.C. for evacuation and response time modeling to reassign to KLD Associates through June 30, 2026, and to provide an option to extend for an additional five (5) years and add $200,000, making initial term plus extension NTE $600,000 through June 30, 2031.

The foregoing Resolution was adopted by the Berkeley City Council on June 4, 2024 by the following vote:

Ayes: Bartlett, Hahn, Humbert, Kesarwani, Lunaparra, Taplin, Wengraf, and Arreguin.

Noes: None.

Absent: None.

Jesse Arreguin, Mayor

Attest:
Mark Numainville, City Clerk

Date Completed

Household name

Home Address

HOUSEHOLD FIRE WEATHER PLANNING TOOL

CITY OF BERKELEY FIRE DEPARTMENT

CITY OF BERKELEY
FIRE DEPARTMENT



Dear Berkeley community,

This Household Fire Weather Planning Tool will guide you through important decisions to stay safe during “Extreme Fire Weather” and evacuations. By taking time to think through these issues now, ahead of an emergency, you will have more power when the time comes to act.

Our fire challenge

Fire has always been a natural part of our ecosystem, maintaining forest health, controlling invasive species, and providing a rich habitat for wildlife. In Berkeley, densely-built homes and vegetation have been introduced to hillside areas that required burning to maintain ecological balance. For many years people have tried to prevent fire in forests and developed areas, disrupting this balance. As a result, catastrophic fires are now occurring throughout the Bay Area and the world. We must respect that in Berkeley, we built densely on a place that nature wants to periodically burn, and we must be ready to act when this natural process occurs.

History has shown that evacuations out of the Berkeley hills will be challenging. In the 1991 Tunnel Fire, cars backed up on narrow roadways. Many people had to abandon their vehicles and run. Twenty-five people lost their lives. We have seen similar situations play out in wildfires across the West including the Camp Fire in Paradise (85 deaths), the Tubbs Fire in Santa Rosa (29), and the Maui fires in Lahaina (101).

When the Berkeley Fire Department examined wildfire history, it became clear to us that the most catastrophic fires started under extreme fire weather conditions. During extreme fire weather, low humidity and strong winds spread fires with breathtaking speed. Normal firefighting is hampered, and firefighters shift their focus to moving people out of harm’s way. With climate change, fire weather is becoming more frequent. Berkeley’s roadways are still constrained, and do not have capacity to quickly move large populations out of the way of a fast-moving fire. **For these reasons, we recommend that you leave the hills during extreme fire weather, even before a fire starts.**

Make the right decisions for your household

Ultimately, you are responsible for choosing when to leave. In this document we share key decisions you'll need to make about your safety during extreme fire weather or an evacuation. We designed this tool so you can complete it with everyone in your household, giving you a shared plan before you are put into a crisis situation.

Planning together

Especially here in our city, we live in community with one another. Every day we rely on people around us for help. As you make your plans for fire weather and evacuation, think about the friends, family, and caretakers you rely on every day – will you need their help to pack up and leave? If so, create this plan with them.

The people we rely on the most don't always live nearby. Once you have used this planning tool to understand the help you will need, create your second line of defense – say hello to your neighbors. Ask them for the help you will need to safely evacuate. These conversations can feel uncomfortable. Many of us have lost touch with the people living next to us. There is good news: time after time disasters bring communities together. Don't wait for a disaster to make a connection. We hope this document will help facilitate conversations with the people who are closest to you and can help in an emergency. Once your plan is ready, share copies with anyone who will help you, and keep a copy readily accessible so you can review it in the event an emergency occurs.

In service,

David Sprague

Fire Chief

City of Berkeley

DAVID SPRAGUE / FIRE CHIEF

2100 MARTIN LUTHER KING JR. WAY, SECOND FLOOR, BERKELEY, CA 94704 510.981.3473

DSPRAGUE@BERKELEYCA.GOV

Members of our household

☐ Everyone in our household knows their role in our plan.

List Household members (humans and pets):

_____

_____

Our household has decided to leave…

Before a fire

☐ Red Flag Warning conditions

☐ Extreme fire weather conditions

After a fire starts

☐ Evacuation warning for our zone

☐ Evacuation order for our zone

Definitions and details:

Will you wait to evacuate until after a fire starts, or will you leave during periods of heightened threat?

Fire weather: heightened threat

- Red Flag Warning: Indicates elevated fire risk. Declared by National Weather Service.
- Extreme fire weather: Rare conditions of extremely elevated fire risk. Declared by Berkeley Fire Department.

The Berkeley Fire Department recommends that residents in Fire Zones 2 and 3 (the Berkeley Hills) leave during extreme fire weather, before a fire starts. A fire that starts during extreme fire weather will spread quickly, and you may not have enough time to evacuate. See www.berkeleyca.gov/wildfire to learn about fire weather in Berkeley.

Evacuation warning/order: a fire has ignited

- Evacuation Warning: Prepare to evacuate. Evacuate now if you will need extra time to evacuate (children, pets, elders, people with mobility challenges).

- Evacuation Order: Evacuate now.

Even if you have not received an evacuation warning or order, you should leave immediately if you experience any of the following:

- Fire in a home adjacent to yours, or
- Fire in a home close to yours and the wind is strong, or
- Strong winds are carrying smoke or embers through or over your neighborhood, or
- You feel threatened.

Our household is ready to receive emergency alerts.

Berkeley's emergency alerting systems will be used to share Red Flag Warnings, extreme fire weather, and evacuation instructions.

All members of my household:

- ☐ Have signed up for AC Alert
- ☐ Have listened to the fire evacuation alert from the Outdoor Warning System sirens
- ☐ Have visited Berkeley's Emergency Map and learned our evacuation zone.
- ☐ Have downloaded the Genasys Protect app to our smartphones to get alerts about emergencies in the areas of Berkeley we care about.
    - We have also added addresses we care about (ex: home, work, school) as "My Saved Locations."

Our Household's Evacuation Zone: BER-E____

- ☐ Know what to do if they hear an emergency siren tone: Find more information!
    1. Check their phones
    2. Check Berkeley's Emergency Map

Definitions and details:

- **AC Alert** is Berkeley's primary emergency alerting system. Sign up for AC Alert before a fire to make sure you get messages. Officials will use it to send alerts about fire weather and evacuations.
- During a fire, responders will post real-time evacuation information on **Berkeley's Emergency Map**. You can bookmark the site on your phones and computers.
- The **Outdoor Warning System** is a network of emergency sirens designed to alert people outdoors to a life-threatening emergency. Check out our library of

siren messages to get familiar with alerts you could hear from Berkeley's outdoor warning system.

When we leave, we will stay at…

Evacuation Location 1 (friend, family, or hotel):_____

Address: _____

Phone numbers: (_____)_____-_____ / (_____)_____-_____

Evacuation Zone for this location: _____

Evacuation Location 2 (friend, family, or hotel): _____

Address: _____

Phone numbers: (_____)_____-_____ / (_____)_____-_____

Evacuation Zone for this location: _____

💡 **Tip**: Plan now for places you can stay outside the Berkeley Hills during fire weather and/or fire evacuation. Your options might include friends, family, or a hotel.

If there is a fire evacuation and residents are required to stay away from their homes for a long period, the City will work with the Red Cross to designate shelters for evacuees and their pets who have nowhere else to go. These shelters will be group living situations to meet basic needs. You will sleep on a cot, sharing a large space (ex: a basketball court or community room) with many other evacuees. Your pet will be in a kennel. If you can make your own plans now, you will likely be more comfortable.

Getting help to pack and leave

Think about your household and choose one:

- ☐ No one in our household will need help to pack and leave, **OR**
- ☐ One or more people in our household will need help to pack and leave, so:
  - Before a fire starts, we will get help from _____ to pack and leave. Phone:(_____)_____-_____
  - In an emergency evacuation, I will get help from my neighbor, _____, to pack and leave. Phone:(_____)_____-_____

Tips:

- Answer the following questions:
  - What kinds of help will you need to leave your home?
    - Navigating stairs
    - Lifting heavy items
    - Gathering pets
    - Other: _____
  - Can everyone in your household pack and leave on their own?
  - In an emergency, normal helpers might not be available. Neighbors and people who live close by are the best option. Who is around to help you in emergencies?
- Involve your friends, family, and neighbors in planning now – don't wait for an emergency to ask for help.

How we will get there

Leaving Before a Fire

We will (select all that apply):

- ☐ Drive
- ☐ Take the bus
- ☐ Use Paratransit
- ☐ Take Uber/Lyft/Taxi
- ☐ Ride bike
- ☐ Walk

Leaving After a Fire Starts

We will (select all that apply):

- ☐ Drive*
  - Carpool with: _____ Phone: (____)_____-_____
  - Carpool with: _____ Phone: (____)_____-_____
  - Carpool with: _____ Phone: (____)_____-_____
- ☐ Bike*
- ☐ Walk

*We will <u>always</u> be ready to walk.

Tip: You will have more choices the earlier you leave. If you choose to leave after a fire starts, you must always be ready to walk in case you encounter a traffic jam, get a flat tire, or the roadway is blocked.

Our path of travel

Leaving Before a Fire

Any route we choose to our designated location (family, friend, or hotel)

Leaving After a Fire Starts

If you leave after a fire starts, you should plan multiple routes away from your home in multiple directions. Plan at least 2 routes for driving and another 2 for walking.

- ☐ We have chosen routes out of the hills:
  - 2 or more driving routes
  - 2 or more walking routes
- ☐ We have highlighted routes on a map and placed them in our go-bag (backpack to carry your evacuation needs), see "What we will pack" below

Tips:

- While wind-driven fires generally push from east to west, you may also be able to evacuate to the north or south to get out of harm's way.
- When you choose walking routes, include Berkeley Path Wanderers paths. These paths often offer the most direct path out of the hills.
- Highlight your evacuation routes on a map.
- Practice using the different routes you've chosen to leave your neighborhood. Make it a fun family outing or weekend routine. Habits you create now will help during an emergency.
- During a fire evacuation, if possible, law enforcement personnel will provide fire evacuees with evacuation directions. If you do not receive directions, use main roads to connect to major streets or freeways. Once you are clear of the fire area, go to a friend or family's home or to a hotel. If these are not options for you, drive to a parking lot out of the hazard area and await additional information and instructions.

What we will pack

Leaving Before a Fire

- [ ] Items to be safe and comfortable while we are away
- [ ] Medications, prescriptions, and medical devices
- [ ] Computers, electronics & chargers
- [ ] Irreplaceable items (family treasures, art, photo albums)
- [ ] Other valuables

Leaving After a Fire Starts

Have a go-bag (backpack) packed and ready with basic items:

- [ ] Flashlight/headlamp
- [ ] Area map, marked with driving/ walking evacuation routes
- [ ] Printed list of phone numbers and email addresses for important contacts
- [ ] Map with evacuation routes marked
- [ ] Battery-powered radio and extra batteries
- [ ] Prescriptions or critical medications
- [ ] Extra eyeglasses or contact lenses
- [ ] Extra set of keys
- [ ] Whistle - to signal for help
- [ ] Cell phone charger
- [ ] Copies of important documents (paper copy or jump drive)
- [ ] Cotton face mask or dry bandana for use while evacuating
- [ ] N95, KN95 or surgical mask for use at your evacuation location
- [ ] Toiletries and change of clothing
- [ ] Hand sanitizer
- [ ] **Add last minute**: Wallet, cell phone

Tips:

If you are leaving before a fire starts, focus on:

- Items you need to be safe and comfortable when you arrive at your destination
- Irreplaceable or valuable items that you wouldn't want to lose in a fire.

If you are leaving during a fire evacuation, focus on:

- Items that you need to safely evacuate the fire area
- Items that you need to safely live until you arrive at your personal evacuation location, or until government/Red Cross sheltering and assistance become available
- ***Remember:*** You are responsible for carrying your go-bag. Make sure you can lift and carry your go-bag for your entire evacuation route.

What we will wear

Leaving Before a Fire

Any clothes we choose

Leaving After a Fire Starts

If there is time to change:

- Closed-toe shoes
- Cotton clothes (no polyester!) - Long sleeved shirts, pants, and a hat with a brim
- Cotton mask or dry bandana (**NOT** N95, KN95 or surgical mask which may melt to skin in high temperatures)



Tip: The best clothes for fire evacuation are made of natural fibers including wool that will not melt, and will protect your skin from flying embers.

Planning for our children

Our children will leave before a fire

- Our children will leave (when): _____
- Our children will go to:
  - Same place as household (see above)
  - Different place:
- Name: _____
- Address: _____
- Phone: (_____)_____-_____
- Evacuation Zone for this location: _____

Our children will leave after a fire starts

We are ready to walk with our children:

- ☐ Our children can walk/run for long periods without help.
- ☐ We are ready to carry our children out on foot with carriers/baby wearing, backpack.

Planning for our pets

Our pets will leave before a fire

- Our pets will leave (when): _____
- Our pets will go to:
  - ☐ Same place as household (see above)
  - ☐ Different location (pet boarding, etc.) – see below:
- Name: _____
- Address: _____
- Phone: (_____)_____-_____
- Evacuation Zone for this location: _____

Our pets will leave after a fire starts

We are ready to walk with our pets:

- ☐ Our pets can walk/run for long periods without help. We have leashes ready.
- ☐ We are ready to walk our pets out using carriers (consider a pet carrier with wheels).
- ☐ We have made a plan with our neighbors for them to take our pets if there is an evacuation order and we are not at home.

Before we leave, we will take final steps to protect our home.

Leaving Before a Fire

Inside our house

- ☐ Shut all windows and doors
- ☐ Raise shades and remove curtains
- ☐ Move flammable furniture to the center of the room, away from windows and doors
- ☐ Turn on inside lights
- ☐ Turn off air conditioning

Outside our house

- ☐ Move any flammable outdoor items inside, or move them far away from the home (ex: patio furniture, toys, doormats, trash cans)
- ☐ Move propane BBQs away from structures
- ☐ Connect garden hose with a spray nozzle to outside water valves and spigots
- ☐ DO NOT leave sprinklers on or water running
- ☐ Turn on outside lights
- ☐ Leave a ladder visible for firefighters to use

- [ ] If vents to the attic, basement, and crawlspace are not ember-resistant, seal them with pre-cut plywood or commercial seals
- [ ] Make sure vehicles are parked so that they allow easy access for emergency vehicles both on the street, and in the driveway.

Leaving After a Fire Starts

Evacuation Order ("Leave Now"):

- [ ] Close and lock doors.

Evacuation Warning ("Prepare to Evacuate"):

- [ ] If anyone in your household needs extra time to leave (ex: children, elders, people with mobility constraints), pack up and leave.
- [ ] If no one in your household needs extra time, consider taking the "Leaving Before a Fire" steps to prepare your property.

We have taken steps to protect our home.

Defensible space is a buffer around your home that will slow the spread of fire to your home. **Home hardening** steps prepare your home for wildfire.

Together, hardening your home and creating defensible space around it can increase the chances that your home will survive a fire.

Berkeley hills residents (Fire Zone 2 & 3):

- ☐ We reviewed our home's Defensible Space Report and followed the instructions on defensible space and home hardening.

Tips:

Fire Zones are different from Evacuation Zones. Not sure which Fire Zone you live in? Use this online fire zone map to find out.

The Fire Department conducts annual defensible space inspections for properties in the Berkeley hills (Fire Zones 2 and 3). You can access your Defensible Space Report to get specific instructions to make your home safer.

- *Lost your access code?* Use the "Submit a Request" button at the bottom of the page to access your report.

All Berkeley residents:

- ☐ We use the free Berkeley Chipper Day Program for curbside pickup, chipping, and disposal of vegetation material from our home's yard.

Tip: Even if you live in Fire Zone 1 (the Berkeley flats), you can also take steps to protect your home from fire. Visit FireSafe Berkeley for more information.

Links

Berkeley's Emergency Map	https://protect.genasys.com
Genasys Protect App	Download on Apple's App Store or on Google Play for Android
Sign up for AC Alert	www.ACAlert.org
Outdoor Warning System Map	https://bit.ly/berkeleyoutdoorsirens
Outdoor Warning System Message Library	https://soundcloud.com/cityofberkeley
Map: Berkeley Fire Zones 2 and 3	https://bit.ly/BerkeleyFireZones
Learn more about Fire Weather and Evacuation	www.berkeleyca.gov/wildfire
Berkeley Path Wanderers Paths	https://www.berkeleypaths.org/path-list
Defensible Space Report	https://www.defensiblespacereport.org/berkeley
FireSafe Berkeley	www.berkeleyfiresafe.org
Berkeley Chipper Day Program	https://www.chipperday.com/berkeley/

Contact us: oes@berkeleyca.gov