City of Los Angeles
2018 Local Hazard Mitigation Plan

Eric Garcetti, *Mayor*

Aram Sahakian, *General Manager*
Emergency Management Department

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TETRA TECH

City of Los Angeles 2018 Local Hazard Mitigation Plan

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PREPARED FOR

City of Los Angeles Emergency Management Department

200 N. Spring Street
Room 1533
Los Angeles, California 90012

PREPARED BY

Tetra Tech

1999 Harrison Street
Suite 500
Oakland, CA 94612

Phone: 510.302.6300
Fax: 510.433.0830
tetratech.com

Tetra Tech Project # 103S4869

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ACKNOWLEDGMENTS

City of Los Angeles

- Carol Parks, Special Projects Officer, Emergency Management Department
- Faye Cousin, Emergency Management Coordinator I/Special Projects
- Amrita Spencer, Administrative Intern I.
- Erricka Peden, Secretary

Consultants

- Rob Flaner, CFM, Tetra Tech, Inc., Project Manager
- Denise Davis, Tetra Tech, Inc., Planner
- Jessica Cerutti, CFM, Tetra Tech, Inc., Project Planner
- Carol Bauman, GISP, Tetra Tech, Inc., Risk Assessment Lead
- Stephen Veith, MUP, Tetra Tech, Inc., GIS/Hazus Analyst
- Kari Valentine, CFM, Tetra Tech, Inc., Planner
- Dan Portman, Tetra Tech, Inc., Technical Editor

Stakeholders

- Hassan Baroon, Geosciences and Environment, California State University, Los Angeles
- Eric Boldt, National Oceanic and Atmospheric Administration National Weather Service
- Roy Forbes, Neighborhood Council District 4
- Ken Hudnut, United States Geological Survey
- Steve LaDochy, Geosciences and Environment, California State University, Los Angeles
- Alyssa Newton-Mann, USC Sea Grant
- Nick Sadrpour, USC Sea Grant
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EXECUTIVE SUMMARY

HAZARD MITIGATION OVERVIEW

Hazard mitigation is the use of long-term and short-term policies, programs, projects, and other activities to alleviate the death, injury, and property damage that can result from a disaster. The City of Los Angeles has developed a hazard mitigation plan to reduce risks from disasters to the people, property, economy and environment within the city. The plan complies with federal and state hazard mitigation planning requirements to establish eligibility for funding under Federal Emergency Management Agency (FEMA) grant programs.

UPDATING THE CITY OF LOS ANGELES PLAN

The *City of Los Angeles 2018 Local Hazard Mitigation Plan* is the second comprehensive update to the City's hazard mitigation plan, meeting federal requirements for regular review and update of hazard mitigation plans. The City of Los Angeles prepared its initial local hazard mitigation plan in 2004, and FEMA approved that plan in 2005. A revision was developed in 2010 and approved in July 2011. The 2018 update includes a number of significant changes and enhancements:

- A reorganization and repackaging of the plan to be more user-friendly and conducive to updates
- An enhanced risk assessment
- A new risk ranking methodology
- Updated mission, goals and objectives
- Updated and enhanced public outreach
- A revised mitigation action plan prioritization protocol
- An enhanced definition of critical facilities and infrastructure.

This planning effort was supplemented by a FEMA Hazard Mitigation Assistance grant that covered 75 percent of the cost for development of this plan, with the balance achieved through in-kind contributions. The City of Los Angeles Emergency Management Department managed the project.

PLAN DEVELOPMENT APPROACH

A core planning team was assembled to facilitate the update of this plan, consisting of City of Los Angeles Emergency Management Department staff and a contract consultant. A 27-member steering committee was assembled to oversee the plan update, consisting of both governmental and non-governmental stakeholders within the planning area, which was defined as the incorporated area of the City of Los Angeles. Coordination with other local, state, and federal agencies involved in hazard mitigation occurred throughout the plan update process. The planning team and Steering Committee reviewed the existing hazard mitigation plan, the California statewide hazard mitigation plan, and existing programs that may support hazard mitigation actions.

The planning team implemented a multi-media public involvement strategy that was approved by the Steering Committee. The strategy included participation at popular community events to make the public aware of the hazard mitigation plan update. Public outreach efforts included a hazard mitigation survey, a project website, the use of social media (Facebook, Twitter and Nextdoor) and multiple press releases.

Based on the review of existing plans and programs, the input received through the public involvement strategy, the direction of the Steering Committee, and the findings of a new, detailed risk assessment performed for this update, the planning team assembled a document that meets federal hazard mitigation planning requirements. Once pre-adoption approval of the document has been granted by the California Office of Emergency Services and FEMA Region IX, the final adoption phase will begin. The City of Los Angeles City Council will adopt the updated plan.

RISK ASSESSMENT

Risk assessment is the process of measuring the potential loss of life resulting from hazards, as well as personal injury, economic injury and property damage, in order to determine the vulnerability of people, buildings, and infrastructure to hazard events. For this update, risk assessment models for natural hazards were enhanced with new data and technologies that have become available since 2010. The Steering Committee used the risk assessment to rank risk from natural hazards and to gauge the potential impacts of each natural hazard of concern in the planning area. Human-caused hazards were also included in the risk assessment; however, risk was not ranked for these hazards. Each hazard of concern assessed includes discussion of the following:

- Hazard identification and profile
- Assessment of the impact of hazards on physical, social, and economic assets
- Identification of particular areas of vulnerability
- Estimates of the cost of potential damage, where applicable.

Based on the risk assessment, natural hazards were ranked for the risk they pose to the overall planning area, as shown in Table ES-1.

Table ES-1. Natural Hazard Risk Ranking

Hazard Ranking	Hazard Event	Category
1	Earthquake	High
2	Adverse Weather	High
3	Landslide/Debris Flow	High
4	Wildland/Urban Interface Fire	High
5	Drought	Medium
6	Flood	Medium
7	Dam Failure	Medium
8	Sea Level Rise	Low
9	Tsunami	Low

MISSION STATEMENT, GOALS, AND OBJECTIVES

The Steering Committee collaborated to revise the 2011 mission statement, goals, and objectives for this update. The committee developed new goals and objectives in which the objectives stand alone rather than being subsets of the goals. The Steering Committee added a purpose to the mission statement from the previous plan, resulting in the following new mission statement for this update:

> "To reduce risk and increase resilience, the mission of the City of Los Angeles Local Hazard Mitigation Plan is to establish and promote a comprehensive mitigation policy and program to protect City residents, their property, public facilities, infrastructure and the environment from natural and manmade hazards."

Of five goals in the 2011 hazard mitigation plan, two were unchanged for this update and three were modified; one new goal was added, resulting in the following set of goals:

1. Protect life, property, and cultural resources.
2. Increase public awareness.
3. Coordinate with other programs that can support or enhance hazard mitigation.
4. Increase emergency services effectiveness.
5. Pursue cost-effective and environmentally sound mitigation measures.
6. Strive to increase adaptive capacity to reduce risk from hazard impacts based on future conditions.

Individual Steering Committee members identified 50 plan objectives, of which the following 16 were selected by 50 percent or more of the participants:

1. Reduce repetitive property losses due to flood, fire and earthquake by updating land use, design, and construction policies.
2. Identify natural and manmade hazards that threaten life and property in the City.
3. Use hazard data while reviewing proposed development opportunities.
4. Encourage the incorporation of mitigation measures into repairs, major alterations, new development, and redevelopment practices, especially in areas subject to substantial hazard risk.
5. Encourage and support leadership within the private sector, non-profit agencies and community-based organizations to promote and implement local hazard mitigation activities.
6. Incorporate risk reduction considerations in new and updated infrastructure and development plans to reduce the impacts of hazards.
7. Continue providing City emergency services with training and equipment to address all identified hazards.
8. Develop and provide updated information about threats, hazards, vulnerabilities, and mitigation strategies to state, regional, and local agencies, as well as private sector groups.
9. Establish and maintain partnerships among all levels of government, private sector, community groups, and institutions of higher learning that improve and implement methods to protect life and property.
10. Create financial and regulatory incentives to motivate stakeholders such as homeowners, private sector businesses, and nonprofit community organizations to mitigate hazards and risk.
11. Continue developing and strengthening inter-jurisdictional coordination and cooperation in the area of emergency services.
12. Support the protection of vital records, and strengthening or replacement of buildings, infrastructure, and lifelines to minimize post-disaster disruption and facilitate short-term and long-term recovery.
13. Coordinate state and local efforts to reduce greenhouse gas emissions and implement climate adaptation strategies through hazard mitigation plans and actions.
14. Implement mitigation programs and projects that protect not only life and property, but the environment as well.
15. Promote and implement hazard mitigation plans and projects that are consistent with state, regional and local climate action and adaptation goals, policies, and programs.
16. Advance community resilience through preparation, adoption, and implementation of state, regional and local multi-hazard mitigation plans and projects.

MITIGATION ACTION PLAN

Mitigation actions presented in this update are designed to reduce or eliminate losses resulting from hazard events. The update process resulted in the identification of 113 mitigation actions to be led by 16 departments. The majority of these actions are within the current capabilities of the City of Los Angeles, resulting in high implementation priority over the next five years.

IMPLEMENTATION AND MAINTENANCE

Plan implementation will occur over the next five years as City departments begin to implement the actions identified in this plan. Full implementation of the recommendations of this plan will require time and resources. The measure of the plan's success will be its ability to adapt to changing conditions. The City of Los Angeles assumes responsibility for adopting the recommendations of this plan and committing resources toward implementation. The framework established by this plan prioritizes actions whose benefits exceed their cost. The planning team and Steering Committee developed this plan with extensive public input, and public support of the actions identified in this plan will help ensure the plan's success.

The Steering Committee developed a plan maintenance strategy that includes annual progress reporting, a strategy for continued public involvement, a commitment to plan integration with other relevant plans and programs, and continued oversight from a plan maintenance steering committee.

City of Los Angeles 2018 Local Hazard Mitigation Plan

PART 1—PLANNING PROCESS AND COMMUNITY PROFILE

1. INTRODUCTION TO HAZARD MITIGATION PLANNING

1.1 WHY PREPARE THIS PLAN?

1.1.1 The Big Picture

Hazard mitigation is defined as any action taken to reduce or alleviate the loss of life, personal injury, and property damage that can result from a disaster. It involves long- and short-term actions implemented before, during and after disasters. Hazard mitigation activities include planning efforts, policy changes, programs, studies, improvement projects, and other steps to reduce the impacts of hazards.

For many years, federal disaster funding focused on relief and recovery after disasters occurred, with limited funding for hazard mitigation planning in advance. The Disaster Mitigation Act (DMA; Public Law 106-390), passed in 2000, shifted the federal emphasis toward planning for disasters before they occur. The DMA requires state and local governments to develop hazard mitigation plans as a condition for federal disaster grant assistance. Regulations developed to fulfill the DMA's requirements are included in Title 44 of the Code of Federal Regulations (44 CFR).

The responsibility for hazard mitigation lies with many, including private property owners, commercial interests, and local, state and federal governments. The DMA encourages cooperation among state and local authorities in pre-disaster planning. The enhanced planning network called for by the DMA helps local government articulate accurate needs for mitigation, resulting in faster allocation of funding and more cost-effective risk-reduction projects.

The DMA also promotes sustainability in hazard mitigation. To be sustainable, hazard mitigation needs to incorporate sound management of natural resources and address hazards and mitigation in the largest possible social and economic context.

1.1.2 Purposes for Planning

The City of Los Angeles prepared a hazard mitigation plan in compliance with the DMA that was adopted and approved in July 2011 (City of Los Angeles, 2011). This update to the 2011 plan fulfills a DMA requirement that hazard mitigation plans be regularly updated. It identifies resources, information, and strategies for reducing risk from natural hazards. Elements and strategies in the plan were selected because they meet a program requirement and because they best meet the needs of the City of Los Angeles and its residents. The plan will help guide and coordinate mitigation activities throughout the planning area. It was developed to meet the following objectives:

- Meet or exceed program requirements specified under the DMA.
- Enable the City of Los Angeles to continue using federal grant funding to reduce hazard risk through mitigation.
- Meet the needs of the City of Los Angeles as well as state and federal requirements.
- Create a risk assessment that focuses on City of Los Angeles hazards of concern.
- Meet the planning requirements of the Federal Emergency Management Agency's (FEMA's) Community Rating System (CRS), allowing the City of Los Angeles to maintain or enhance its CRS classification.

- Coordinate existing plans and programs so that high-priority projects to mitigate possible disaster impacts are funded and implemented.

1.2 WHO WILL BENEFIT FROM THIS PLAN?

All residents and businesses of the City of Los Angeles are the ultimate beneficiaries of this hazard mitigation plan. The plan reduces risk for those who live in, work in, and visit the City of Los Angeles. It provides a viable planning framework for all foreseeable natural hazards. Participation in development of the plan by key stakeholders helped ensure that outcomes will be mutually beneficial. The plan's goals and recommendations can lay groundwork for the development and implementation of local mitigation activities and partnerships.

1.3 CONTENTS OF THIS PLAN

This hazard mitigation plan is organized into three primary parts:

- Part 1—Planning Process and Community Profile
- Part 2—Risk Assessment
- Part 3—Mitigation Strategy.

Each part includes elements required under federal guidelines. DMA compliance requirements are cited at the beginning of subsections as appropriate to illustrate compliance.

The following appendices provided at the end of the plan include information or explanations to support the main content of the plan:

- Appendix A—Public outreach information used in preparation of this update
- Appendix B—Descriptions of the sources and methods used to generate hazard maps for this plan
- Appendix C—Review of mitigation actions recommended in the City's previous hazard mitigation plan
- Appendix D— Template for progress reports to be completed as this plan is implemented

2. PLAN UPDATE—WHAT HAS CHANGED

2.1 THE PREVIOUS PLAN

The City of Los Angeles prepared its initial local hazard mitigation plan in compliance with the DMA in 2004, and FEMA approved that plan in 2005. A revision was developed in 2010 and approved in July 2011. The City's defined purpose for the local hazard mitigation plan was to integrate hazard mitigation strategies into the day-to-day activities and programs of the City of Los Angeles. The following goals were established:

- Protect life and property.
- Increase public awareness.
- Strengthen partnerships.
- Increase emergency service effectiveness.
- Ensure environmental and historical preservation.

Review and revision of the hazard mitigation plan included re-prioritizing the risk ratings for hazards in the City of Los Angeles according to new information. Data from annual surveys and recent scientific studies was used to rank each identified hazard in eight categories: magnitude, duration, distribution, area affected, frequency, probability, vulnerability and community profile. The results of this revised rating for the 2011 update are summarized in Table 2-1.

Table 2-1. Risk Ratings for All Hazards and Vulnerabilities

Hazard	Risk Score
High Risk Rating	
Earthquake	22
Terrorism	20
Brush Fire	18
Flood	18
Public Health Issues	18
Hazardous Materials Incident	17
Civil Unrest	16
Transportation	16
Moderate Risk Rating	
Drought	14
Special Events	14
Severe Weather	13
Dam Failure	13
Critical Infrastructure	13
Low Risk Rating	
Tsunami	12
Landslide	11
High-Rise Fire	9
Radiological Incident/Accident	9

The 2011 plan recommended actions for mitigating the risks these hazards present. City departments and agencies were given specific responsibilities for implementing specific mitigation actions, using a mitigation strategy project worksheet created during the 2010 update process.

2.2 WHY UPDATE?

2.2.1 Federal Eligibility

Title 44 of the Code of Federal Regulations (44 CFR) stipulates that hazard mitigation plans must present a schedule for being monitored, evaluated and updated. This provides an opportunity to reevaluate recommendations, monitor the impacts of actions that have been accomplished, and determine if there is a need to change the focus of mitigation strategies. A jurisdiction covered by a plan that has expired is not able to pursue federal funding for which a current hazard mitigation plan is a prerequisite.

2.2.2 Changes in Development

Hazard mitigation plan updates must reflect development changes in the planning area since approval of the previous plan (44 CFR Section 201.6(d)(3)). The update must describe development changes in hazard-prone areas that increased or decreased vulnerability. If no development changes impacted the jurisdiction's overall vulnerability, plan updates may validate the information in the previously approved plan. This requirement ensures that the mitigation strategy continues to address the risk and vulnerability of existing and potential development and takes into consideration possible future conditions that could impact vulnerability.

The City of Los Angeles planning area experienced a 6.28-percent increase in population between 2010 and 2016, an average annual growth rate of 0.90 percent per year. The City has adopted a general plan that governs land-use decisions and policy-making, as well as a building code and specialty ordinances based on state and federal mandates. This hazard mitigation plan update assumes that some new development triggered by the increase in population occurred in hazard areas. All such new development would have been regulated pursuant to local programs and codes. Therefore, it is assumed that hazard vulnerability did not measurably increase even if exposure did. Any new development would have accounted for potential hazard impacts under codes and standards such as the International Building Code and flood damage prevention requirements of the National Flood Insurance Program (NFIP).

2.3 THE UPDATED PLAN—WHAT IS DIFFERENT?

The updated 2018 plan differs from the initial plan in a variety of ways:

- It is reorganized into three parts:
  - Planning process and community profile
  - Risk assessment
  - Hazard mitigation strategy.
- The risk assessment has been enhanced.
- The following new hazards were added to the risk assessment:
  - Critical infrastructure
  - High-rise/high-occupancy building fire
  - Special events
  - Cyber-attack
  - Space weather

- ➢ Hazardous material, transportation and radiological incidents
- ➢ Public health hazards
- ➢ Terrorism and weapons of mass destruction
- ➢ Civil unrest.

- The impacts of climate change on the natural hazards of concern were profiled
- A new risk ranking methodology was used.
- The plan mission statement, goals and objectives were refined.
- An enhanced public outreach effort was conducted.
- A revised mitigation action plan prioritization protocol was used.
- The definition of critical facilities and infrastructure was enhanced.

Table 2-2 indicates the major changes between the two plans as they relate to 44 CFR planning requirements.

Table 2-2. Plan Changes Crosswalk

44 CFR Requirement	Previous Plan	Updated Plan
§201.6(b): In order to develop a more comprehensive approach to reducing the effects of natural disasters, the planning process shall include: (1) An opportunity for the public to comment on the plan during the drafting stage and prior to plan approval; (2) An opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities, and agencies that have the authority to regulate development, as well as businesses, academia and other private and non-profit interests to be involved in the planning process; and (3) Review and incorporation, if appropriate, of existing plans, studies, reports, and technical information.	The 2011 plan update was facilitated through a Local Hazard Mitigation Plan advisory task force made up of representatives from City departments, outside government agencies, special districts within the City limits, educational institutions, private and non-profit business organizations, and community-based organizations. Seventeen neighboring jurisdictions, educational institutions, government agencies, social service and business groups were invited to participate in the initial planning process. All but three invited organizations played active roles in the plan development. Involvement included: • Membership on and participation in Task Force meetings • Provision of technical information • Expert advice and consultation • Assistance in outreach activities • Review of plan components during development. The 2011 plan includes no reference to a formal public engagement strategy for public access to the plan update process.	The plan development process for this update followed the Community Rating System (CRS) 10-step planning process, which features the facilitation of a planning process through an organized steering committee. The process included a robust commitment to public engagement through all phases using multiple media. Chapter 3 of this plan describes the planning process.
§201.6(c)(2): The plan shall include a risk assessment that provides the factual basis for activities proposed in the strategy to reduce losses from identified hazards. Local risk assessments must provide sufficient information to enable the jurisdiction to identify and prioritize appropriate mitigation actions to reduce losses from identified hazards.	The 2011 plan includes a risk assessment of 17 natural and non-natural hazards of concern. These are primarily qualitative risk assessments, except for quantitative modeling for the earthquake hazard using Hazus.	Significant enhancements were made to the risk assessment for the 2018 update. Over 20 hazards of concern were grouped into 14 categories covering both that natural and non-natural hazard spectrum. The risk assessment includes multiple-scenario modeling for dam failure, earthquake, flood and sea-level rise. Hazard profiles are standardized for each hazard of concern, so that there is uniformity in the discussion of each hazard and the information provided can support ranking of risk for each jurisdiction.

44 CFR Requirement	Previous Plan	Updated Plan
§201.6(c)(2)(i): [The risk assessment shall include a] description of the … location and extent of all natural hazards that can affect the jurisdiction. The plan shall include information on previous occurrences of hazard events and on the probability of future hazard events.	The 2011 plan includes qualitative discussion of each hazard of concern that meets the requirement as specified.	A robust profile was created for each hazard profiled that addresses the potential impacts of climate change on the natural hazards of concern. Profiles in each hazard category include information on past events, location, frequency, severity, warning time, secondary impacts, exposure, vulnerability, future trends, scenarios and issues.
§201.6(c)(2)(ii): [The risk assessment shall include a] description of the jurisdiction's vulnerability to the hazards described in paragraph (c)(2)(i). This description shall include an overall summary of each hazard and its impact on the community	Using existing studies and documents, the 2011 plan discussed vulnerability with an emphasis on exposure and land use. There was extensive discussion of vulnerability to the earthquake hazard. The risk assessment used Hazus for the earthquake hazard only.	Vulnerability was assessed for all hazards of concern. The Hazus computer model was used for the dam failure, earthquake, flood and tsunami hazards. These were Level 2 (user defined) analyses using city and county data. Site-specific data on City-identified critical facilities were entered into the Hazus model. Hazus outputs were generated for other hazards by applying an estimated damage function to an asset inventory extracted from Hazus.
§201.6(c)(2)(ii): [The risk assessment] must also address National Flood Insurance Program insured structures that have been repetitively damaged floods	The flood risk assessment section of the plan refers to the City's "Repetitive Loss Plan" that was created in 1994 as part of the City's CRS application. The plan includes no information on the number or types of repetitive losses or the causes of repetitive flooding.	The plan includes a comprehensive analysis of repetitive loss areas that includes an inventory of the number and types of structures in the repetitive loss area. Repetitive loss areas are delineated, causes of repetitive flooding are cited, and these areas are reflected on maps.
§201.6(c)(2)(ii)(A): The plan should describe vulnerability in terms of the types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard area.	The 2011 plan includes facility counts for identified critical facilities and infrastructure that intersect the hazards of concern, but includes no discussion of the general building stock exposure to those hazards.	A complete inventory of the numbers and types of buildings exposed was generated for each hazard of concern—both general building stock and critical facilities and infrastructure. Critical facilities were defined for the planning area and were inventoried by exposure. Each hazard chapter provides a discussion of future development trends.
§201.6(c)(2)(ii)(B): [The plan should describe vulnerability in terms of an] estimate of the potential dollar losses to vulnerable structures identified in paragraph (c)(2)(i)(A) and a description of the methodology used to prepare the estimate.	Replacement costs were estimated for identified critical facilities and infrastructure within the hazard areas assessed. No losses were estimated for general building stock.	Loss estimates in dollars were generated for all hazards of concern. These estimates were generated by Hazus for the dam failure, earthquake, flood, and tsunami hazards as well as sea level rise. For the other hazards, loss potential was defined by a range of percentages of replacement cost for the exposed inventory. The asset inventory was generated in Hazus and was the same for all hazards.

44 CFR Requirement	Previous Plan	Updated Plan
§201.6(c)(2)(ii)(C): [The plan should describe vulnerability in terms of] providing a general description of land uses and development trends within the community so that mitigation options can be considered in future land use decisions.	The 2011 plan includes no discussion of existing land use in the identified hazards areas. Additionally, the plan includes no consistent discussion of the future development trends in identified hazards areas.	There is a discussion of future development trends as they pertain to each hazard of concern. This discussion looks predominantly at the existing land use and the current regulatory environment that dictates this land use.
§201.6(c)(3): The plan shall include a mitigation strategy that provides the jurisdiction's blueprint for reducing the potential losses identified in the risk assessment, based on existing authorities, policies, programs and resources, and its ability to expand on and improve these existing tools.	The 2011 plan identified a mission, five overarching goals, and over 400 actions that strive to meet those goals.	The 2018 update contains a mission statement, goals, objectives, and actions. The actions are city department specific and strive to meet multiple objectives. The objectives are broad, similar to the strategies identified in the 2011 plan. All objectives meet multiple goals and stand alone as components of the plan. A core capability assessment by the City looks at its regulatory, technical, financial, public outreach, National Flood Insurance Program (NFIP) program and adaptive capacity capabilities.
§201.6(c)(3)(i): [The hazard mitigation strategy shall include a] description of mitigation goals to reduce or avoid long-term vulnerabilities to the identified hazards.	The 2011 plan included a mission statement and five goals, with objectives identified to meet each goal	A mission, six goals, and 16 objectives are described in Chapter 21. All are new for this update. Goals and objectives stand on their own merit. Each was selected based on its ability to support a higher level component. Each component was identified based on core capabilities of the City.
§201.6(c)(3)(ii): [The mitigation strategy shall include a] section that identifies and analyzes a comprehensive range of specific mitigation actions and projects being considered to reduce the effects of each hazard, with particular emphasis on new and existing buildings and infrastructure.	Section V of the 2011 plan identifies a prioritization methodology and hundreds of actions to be implemented by the City.	Chapter 22 includes a catalog of mitigation best management practices that was developed through a facilitated process that identified the strengths, weaknesses, obstacles and opportunities of the City for each identified hazard of concern. This catalog identifies actions that manipulate the hazard, reduce exposure to the hazard, reduce vulnerability, and increase mitigation capability. The catalog further segregates actions by scale of implementation. A table in the action plan analyzes each action by mitigation type to illustrate the range of actions selected.
§201.6(c)(3)(ii): [The mitigation strategy] must also address the jurisdiction's participation in the National Flood Insurance Program, and continued compliance with the program's requirements, as appropriate.	Mitigation actions were identified in the 2011 plan that can be associated with the maintenance of full compliance and good standing under the NFIP.	The City of Los Angeles participates in the NFIP and has identified actions stating its commitment to maintain compliance and good standing under the program. The City reviewed its current NFIP programmatic capabilities and included the results in Chapter 4.

44 CFR Requirement	Previous Plan	Updated Plan
§201.6(c)(3)(iii): [The mitigation strategy shall describe] how the actions identified in Section ©(3)(ii) will be prioritized, implemented, and administered by the local jurisdiction. Prioritization shall include a special emphasis on the extent to which benefits are maximized according to a cost benefit review of the proposed projects and their associated costs.	The 2011 plan identified a prioritization strategy for the hundreds of mitigation actions identified in the plan. The strategy is identified in Section V, Part A. Each implementing agency prioritized proposed new projects based on factors including: the five goals in support of the plan's mission; the availability of funding; the relative cost-effectiveness of the project compared to alternatives; the extent to which the proposed project complements existing programs; the extent to which the project addresses risks assessed in Section IV; and the potential of economic and social damage.	A new prioritization scheme was applied for this plan update. Each recommended initiative is prioritized using a qualitative methodology that looked at the objectives the project will meet, the timeline for completion, how the project will be funded, the impact of the project, the benefits of the project and the costs of the project. This prioritization scheme is detailed in Chapter 23.
§201.6(c)(4)(i): [The plan maintenance process shall include a] section describing the method and schedule of monitoring, evaluating, and updating the mitigation plan within a five-year cycle.	Section II of the 2011 plan includes a maintenance strategy that included a schedule for annual review and update.	Chapter 23 of this plan update includes a detailed plan maintenance strategy centered on an annual progress report via an automated platform that will be maintained by the City over the 5-year performance period of the plan. This is an entirely new strategy from the 2011 plan.
§201.6(c)(4)(ii): [The plan shall include a] process by which local governments incorporate the requirements of the mitigation plan into other planning mechanisms such as comprehensive or capital improvement plans, when appropriate.	Section II of the 2011 plans includes a plan maintenance strategy. This strategy did not identify a clear action for plan incorporation.	Chapter 23 details recommendations for incorporating the plan into other planning mechanisms, such as: • General plan • Emergency response plan • Capital improvement programs • Municipal code • The City's resilience plan Specific current and future plan and program integration activities are detailed in the capability assessment in Chapter 4.
§201.6(c)(4)(iii): [The plan maintenance process shall include a] discussion on how the community will continue public participation in the plan maintenance process.	Section II of the 2011 plans includes a plan maintenance strategy. This strategy did not identify a clear action for continued public involvement.	Chapter 23 details a comprehensive strategy for continuing public involvement.
§201.6(c)(5): [The local hazard mitigation plan shall include] documentation that the plan has been formally adopted by the governing body of the jurisdiction requesting approval of the plan (e.g., City Council, County Commission, Tribal Council).	The 2011 plan was adopted by the Los Angeles City Council in July 2011.	Chapter 23 will include all formal adoption and FEMA plan approval documentation once adopted by the City.

3. PLAN UPDATE APPROACH

The process followed to develop the City of Los Angeles 2018 Local Hazard Mitigation Plan had the following primary objectives:

- Secure grant funding
- Form a planning team
- Define the planning area
- Establish a steering committee
- Coordinate with other agencies
- Review existing programs
- Engage the public.

These objectives are discussed in the following sections.

3.1 GRANT FUNDING

This planning effort was supplemented by a FEMA Hazard Mitigation Assistance grant in fiscal year 2014. The City of Los Angeles Emergency Management Department was designated to manage the project. It covered 75 percent of the cost for development of this plan, with the balance achieved through in-kind contributions.

3.2 FORMATION OF THE PLANNING TEAM

The City of Los Angeles hired Tetra Tech, Inc. to assist with development and implementation of the plan. The Tetra Tech project manager assumed the role of the lead planner, reporting directly to the City of Los Angeles project manager. A planning team was formed to lead the planning effort, made up of the following members:

- Carol Parks, City of Los Angeles Emergency Management Department
- Faye Cousin, City of Los Angeles Emergency Management Department
- Amrita Spencer, City of Los Angeles Emergency Management Department
- Rob Flaner, Tetra Tech (project manager)
- Jessica Cerutti, Tetra Tech (lead project planner)
- Denise Davis, Tetra Tech (planner/public outreach discipline lead)
- Carol Baumann, Tetra Tech (risk assessment discipline lead)

This planning team coordinated regularly during the course of this project to track plan development milestones and to identify meeting content for a working group established to help with development of the update.

3.3 DEFINING THE PLANNING AREA

The planning area consists of the incorporated limits for City of Los Angeles. Relevant planning area characteristics are described in Chapter 4. The defined planning area is shown in Figure 3-1.

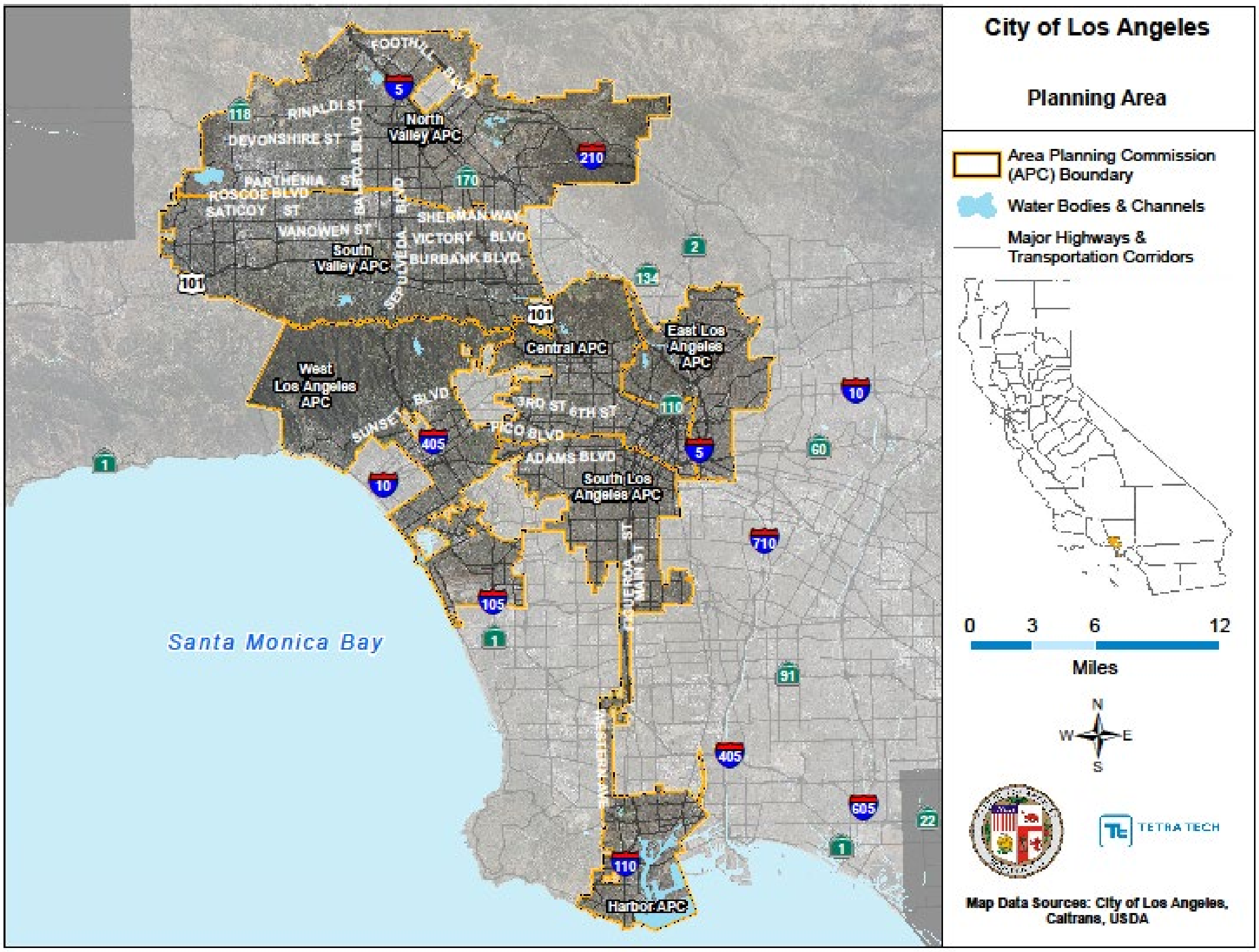

Figure 3-1. Planning Area for This Hazard Mitigation Plan

3.4 THE STEERING COMMITTEE

Hazard mitigation planning enhances collaboration and support among diverse parties whose interests can be affected by hazard losses. A steering committee was formed to oversee all phases of the plan. The members of this committee included key City of Los Angeles staff, residents, and other stakeholders from within the planning area. The planning team assembled a list of candidates representing interests within the planning area that could have recommendations for the plan or be impacted by its recommendations. The team confirmed a committee of -27 members at the kickoff meeting. Seven alternate members were also named. Table 3-1 lists the Steering Committee members.

Leadership roles and ground rules were established during the Steering Committee's initial meeting on January 11, 2017. The Steering Committee agreed to meet twice in the first month of the planning process, and monthly afterward throughout the course of the plan's development. The planning team facilitated each Steering Committee meeting, which addressed a set of objectives based on the work plan established for the planning process. The Steering Committee met seven times from January through July. Meeting agendas, meeting summaries and sign-in sheets are available for review upon request. All Steering Committee meetings were open to the public, and agendas and meeting summaries were posted to the hazard mitigation plan website.

3.5 COORDINATION WITH OTHER AGENCIES

Opportunities for involvement in the planning process must be provided to neighboring communities, local and regional agencies involved in hazard mitigation, agencies with authority to regulate development, businesses, academia, and other private and nonprofit interests (44 CFR, Section 201.6(b)(2)). This task was accomplished by the planning team as follows:

- **Steering Committee Involvement**—Agency representatives were invited to join the Steering Committee.
- **Agency Notification—**The following agencies were invited to participate in the plan development process from the beginning and were kept apprised of plan development milestones:
  - California Office of Emergency Services (Cal OES)
  - California Department of Water Resources (DWR)
  - FEMA Region IX
  - National Oceanic and Atmospheric Administration (NOAA)
  - United States Geological Survey (USGS)
  - University of Southern California, Sea Grant
  - California State University, Pomona
  - California State University, Los Angeles
  - Los Angeles County Office of Emergency Management
  - Residents within Council Districts
  - Community Emergency Response Team (CERT)
  - Neighborhood Council Coalition

  These agencies received meeting announcements, meeting agendas, and meeting minutes by e-mail throughout the plan development process. Some of these agencies supported the effort by attending meetings or providing feedback on issues.

- **Pre-Adoption Review**—All the agencies listed above were provided an opportunity to review and comment on this plan during the public comment period, primarily through the hazard mitigation plan website. Each agency was sent an e-mail message informing them that draft portions of the plan were available for review. In addition, the complete draft plan was sent to Cal OES and FEMA for a pre-adoption review to ensure program compliance.

Table 3-1. Steering Committee Members

Name	Title	Department or Agency
Faye Cousin (Chair)	Emergency Management Coordinator I, Special Projects	Los Angeles Emergency Management Department
Carol Parks (Vice-Chair)	Special Projects Officer	Los Angeles Emergency Management Department
Ahee Han	Policy Director	City of Los Angeles Mayor's Office of Public Safety
Eric Boldt	Warning Coordination Meteorologist	National Oceanic and Atmospheric Administration National Weather Service
Roy Forbes	Resident	Neighborhood Council District 4
Michael Hammett	Officer in Charge of Emergency Preparedness Unit	Los Angeles Police Department
Lisa Hayes	Emergency Preparedness Coordinator	Los Angeles Department of Water and Power
Emily Helder	Public Health Emergency Planner	Los Angeles Emergency Management Department, Public Health
Ken Hudnut	Science Advisor for Risk Reduction, Natural Hazards Mission Area	United States Geological Survey
John Ignatczyk	Captain, Disaster Preparedness Officer	Los Angeles Fire Department
Chris Ipsen	Public Information Officer	City of Los Angeles
Diana Kitching	City Planner	Los Angeles Department of City Planning
Steve LaDochy	Professor, Geography & Urban Analysis	Geosciences and Environment, California State University, Los Angeles
Tim Lee	Chief Information Security Officer	Information Technology
Jonathon Lozon	Police Officer II, Emergency Preparedness Unit	Los Angeles Police Department
Leslie Luke	Deputy Director	Los Angeles County Office of Emergency Management
David Malin	Emergency Management Coordinator II	Los Angeles Harbor Department
EJ Martinez	Emergency Management Coordinator	Los Angeles, Housing and Community Investment
Jeff Napier	Chief Inspector	Los Angeles Department of Building Services
Alyssa Newton-Mann	Regional Planning and Policy Specialist	USC Sea Grant
Richard Pope	ADA Coordinator	Los Angeles Department on Disability
Nick Sadrpour	Science, Research and Policy Specialist	USC Sea Grant
Paul Shively	Valley Bureau CERT Coordinator	Community Emergency Response Team
Susan Shu	Senior Civil Engineer	Bureau of Engineering, Department of Public Works, City of Los Angeles
Clint Simmons	Resident	West Adams Neighborhood Council
Brandy Welch	Emergency Management Coordinator	Los Angeles World Airports
Lin Wu	Professor	Department of Geography, California State University, Pomona - Polytechnic
ALTERNATES		
Connie Sanchez	For Lisa Hayes	Los Angeles Department of Water and Power
Christopher Winn	For John Ignatczyk	Los Angeles Fire Department
Marissa Aho	For Ahee Han	City of Los Angeles Mayor's Office
Brandon Dean	For Emily Helder	Los Angeles Emergency Management Department, Public Health
Michelle Levy	For Diana Kitching	Los Angeles Department of City Planning
Sally Richman	For EJ Martinez	Los Angeles, Housing and Community Investment

3.6 REVIEW OF EXISTING PROGRAMS

Hazard mitigation planning must include review and incorporation, if appropriate, of existing plans, studies, reports and technical information (44 CFR, Section 201.6(b)(3)). Chapter 4 of this plan provides a review of laws and ordinances in effect within the planning area that can affect hazard mitigation actions. In addition, the following programs can affect mitigation within the planning area:

- City of Los Angeles Resilience Plan
- Regional Adapt LA: Coastal Impacts Planning for the Los Angeles Region
- Sustainable City Plan
- Resilience by Design
- California Fire Code
- 2016 California Building Code
- California State Hazard Mitigation Forum
- City Capital Improvement Programs
- City Emergency Operations Plan
- City General Plan
- The Framework Element
- Housing Element
- Safety Element
- City Zoning Ordinances
- City Coastal Program Policies.

An assessment of all City of Los Angeles regulatory, technical and financial capabilities to implement hazard mitigation actions is presented in Chapter 4.

3.7 PUBLIC INVOLVEMENT

Broad public participation in the planning process helps ensure that diverse points of view about the planning area's needs are considered and addressed. The public must have opportunities to comment on disaster mitigation plans during the drafting stages and prior to plan approval (44 CFR, Section 201.6(b)(1)).

3.7.1 Strategy

The strategy for involving the public in this plan emphasized the following elements:

- Include members of the public on the Steering Committee (two residents served on Steering Committee throughout the planning process).
- Use a survey to determine if the public's perception of risk and support of hazard mitigation has changed since the initial planning process.
- Attempt to reach as many planning area residents as possible through the following activities:
    - Development of a public outreach plan, approved by the Steering Committee
    - Attendance at advertised public outreach events and meetings with live interaction
    - Development of a hazard mitigation plan webpage on the City Emergency Management Department website and additional City department websites
    - Use of social media, such as Nextdoor, Instagram, Facebook and Twitter
    - Development and advertisement of a public survey posted on Survey Monkey to collect pertinent information from residents and the business community.

Stakeholders and the Steering Committee

Stakeholders are the individuals, departments, agencies and jurisdictions that have a vested interest in the recommendations of the hazard mitigation plan. The effort to include stakeholders in this process included stakeholder participation on the Steering Committee. The following federal, state, regional, and local stakeholders also played a role in the planning process:

- **Federal Agencies**—FEMA Region IX provided updated planning guidance, provided summary and detailed data for the City from the National Flood Insurance Program (including repetitive loss information), and conducted a plan review. Representatives from NOAA and the USGS served as subject matter experts and advisors on the Steering Committee.
- **State Agencies**—Cal OES provided updated planning guidance and reviewed the draft and final versions of the plan update as part of their state hazard mitigation planning process required by the DMA.
- **Academia**—Representatives from the University of Southern California, California State University, Pomona, and California State University, Los Angeles provided subject matter expertise and data on sea level rise, climate change, earthquake faults and probability. They also served in advisory positions on the Steering Committee.
- **Local Stakeholders**—Jurisdictions within Los Angeles County were given the opportunity to review the draft version of the plan update and remain informed about the planning process. The following organizations received information about the planning process and invitations to provide input:
    - Los Angeles County
    - Alliance of River Communities
    - City of Los Angeles Neighborhood Councils
    - Los Angeles Fire Department Community Emergency Response Teams (CERT)
    - California Coastal Commission
    - Friends of the Los Angeles River
    - Los Angeles Area Chamber of Commerce
    - Water Committee, Sierra Club Angeles Chapter

Survey

A hazard mitigation plan survey (see Figure 3-2) was developed by the planning team with guidance from the Steering Committee. The survey was used to gauge preparedness for all hazards and the level of knowledge of tools and techniques that assist in reducing risk and loss from natural hazards. This survey was designed to help identify areas vulnerable to one or more hazards. The answers to its 21 questions helped guide the Steering Committee in determining planning goals, objectives and mitigation strategies. Surveys were distributed at public-outreach events, and a web-based version of the survey was made available on the hazard mitigation plan website. The complete survey and an analysis of its findings can be found in Appendix A.

Public Events

The planning team attended public events selected by the Steering Committee to make the public aware of the update to the hazard mitigation plan, and invite residents, business owners, and employees to take the online public survey (see Figure 3-3 through Figure 3-6). Residents who attended the events were asked to complete a survey, and each was given an opportunity to provide comments for the Steering Committee. Local media outlets were informed of the events by City press releases.

City of Los Angeles Local Hazard Mitigation Plan Survey March 2017

Survey Introduction

The City of Los Angeles 2011 Local Hazard Mitigation Plan (LHMP) is being updated. The LHMP helps to lessen the City's vulnerability to disasters, and demonstrates the City's commitment to reducing risks from all hazards. Once the LHMP is reviewed and approved by the Federal Emergency Management Agency (FEMA), the City is eligible to apply for pre-disaster and post-disaster assistance to reduce the exposure of its residents to risks associated with the hazards that may occur.

The City would like to engage residents in the revision of the LHMP. The City wants to know what concerns residents most about future disasters, whether they are natural hazards (e.g., earthquakes, floods, and fires), technological hazards (e.g., hazardous materials incidents, power outages, or infrastructure failure), or human-caused hazards (e.g., terrorism, transportation accidents, man-made system failure). The City is concerned about the safety of its residents and businesses, especially during a disaster. This questionnaire is designed to help the City gauge the level of knowledge local residents have about the types of hazards that are prevalent in Los Angeles. The information you provide will help us develop strategies and actions to reduce the risk of injuries and property damage caused by disasters.

The survey consists of 21 questions and provides an opportunity for you to write your comments at the end. When you have finished the survey, please select [Done] on the final page.

The City of Los Angeles thanks you for taking the time to participate in this information-gathering process.

Hazard Survey

1. Which of the following natural hazard events have you or anyone in your household experienced or have been affected by in the past within the Los Angeles area? (Check all that apply)

- ☐ Dam Failure
- ☐ Drought
- ☐ Earthquake
- ☐ Flooding
- ☐ Landslide/Debris Flow
- ☐ Other (please specify)
- ☐ Adverse Weather (wind, lightning, extreme cold or heat, winter storm, tornado, etc.)
- ☐ Tsunami
- ☐ Urban Wildland Interface Fire (wildfire)
- ☐ None

1

Figure 3-2. Sample Page from Survey Distributed to the Public

Figure 3-3. Abilities Expo Event

Figure 3-4. Seismic Retrofit Resource Fair

Figure 3-5. QuakeSmart Preparedness Workshop for Businesses and Organizations

Figure 3-6. QuakeSmart Preparedness Workshop for Businesses and Organizations

The first event was the Abilities Expo, held at the Los Angeles Convention Center on March 25, 2017. The Abilities Expo was a convention of exhibitors for the community of people with disabilities, their families, seniors, veterans and healthcare professionals. The planning team provided emergency and disaster information and spoke with attendees about the plan update process and the public survey.

The Seismic Retrofit Resource Fair was the second event the planning team attended. This event provided resources, information, and materials for owners of soft-story and concrete non-ductile buildings who must comply with a recent mandatory retrofit ordinance for these types of buildings. This event took place at the Los Angeles Convention Center on April 17, 2017. Approximately 10,000 residents were notified of the event via letter from the City of Los Angeles. The planning team provided information to attendees about the public survey and the plan update process. A Hazus work station was present so that property owners could view and receive information about hazards for their specific property address.

The QuakeSmart Preparedness Workshop for Businesses and Organizations was the third live event the planning team attended. This event was a conference for business owners to identify preparedness and mitigation actions needed for business continuity, disaster response, and the cost benefit of preparing for earthquakes and other business interruptions. This event took place on May 18, 2017 at the Cathedral of Our Lady of the Angels. The planning team provided information to attendees about hazards for their specific business address, and spoke with them about the public survey and plan update process. The Hazus work station allowed residents to see information on their property, including exposure and damage estimates for earthquake and flood hazard events. Participating property and business owners were provided printouts of this information for their properties. This tool was effective in illustrating risk to the public. Planning team members were present to answer questions.

On June 17, 2017 the planning team gave a presentation to the Neighborhood Council Coalition - Sierra Club Angeles Chapter at the City of Los Angeles' Emergency Operations Center. The meeting allowed attendees to examine maps and handouts and have direct conversations with project staff. Reasons for planning and information generated for the risk assessment were shared with attendees. This meeting was conducted during the advertised public comment period and was an opportunity to provide comment in person on the proposed draft plan.

Hazard Mitigation Plan Website

During the planning process, a webpage was created on the City of Los Angeles Emergency Management Department website to introduce the hazard mitigation plan update and keep the public apprised of upcoming outreach events, meeting dates and times, public survey, and plan update process (see Figure 3-7). The website address is: http://emergency.lacity.org/hazard-mitigation-plan.

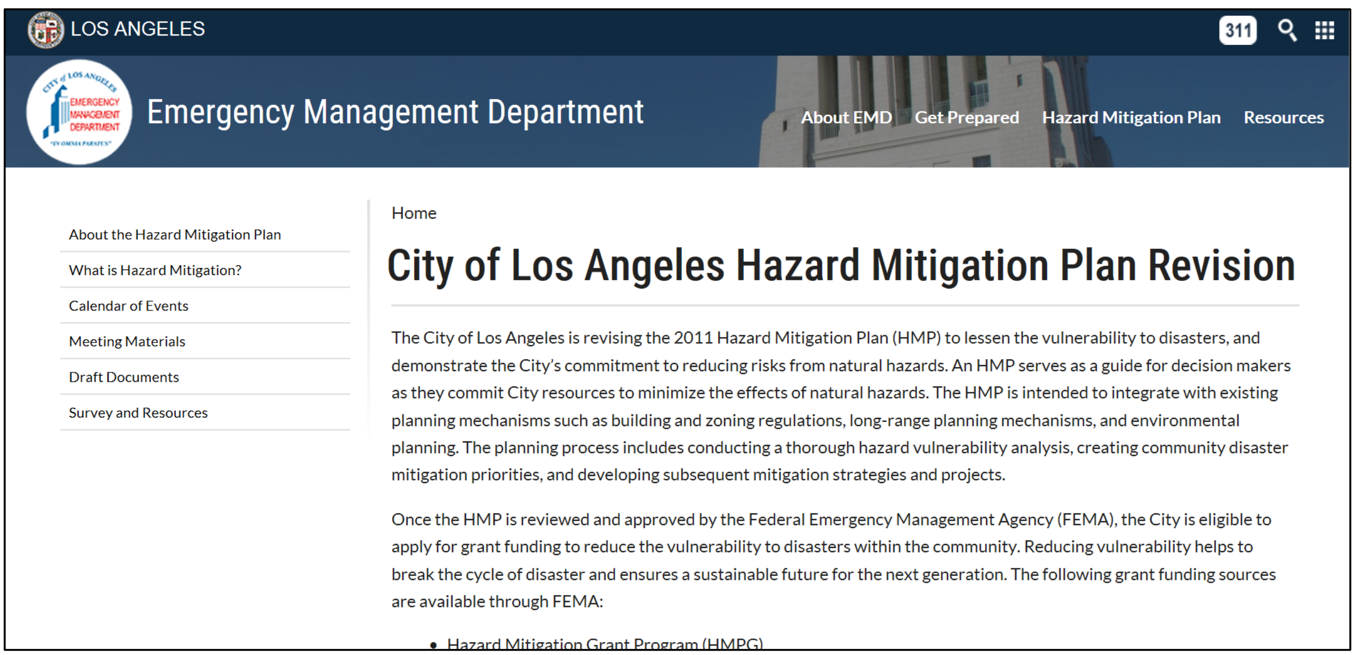

Figure 3-7. Hazard Mitigation Plan Webpage on the Emergency Management Department Website

The site's address was publicized at all public meetings and in all social media releases. Information on the plan development process, the Steering Committee, the survey and drafts of the plan were made available to the public on the website throughout the process. The City of Los Angeles intends to keep a website active after the plan's completion to keep the public informed about successful mitigation projects and future plan updates.

3.7.2 Public Involvement Results

The public involvement strategy used for the plan update introduced the concept of mitigation to the public and provided the Steering Committee with feedback to use in developing the plan. All residents of the planning area had opportunities to provide comment during all phases of the plan update process. Attendance and survey distribution at the public meetings are summarized in Table 3-2.

Table 3-2. Summary of Public Meetings

Date	Location	Number of Public Contacts	Number of Survey Flyers Distributed
March 25, 2017	Abilities Expo, 1201 S Figueroa St, Los Angeles	60	40
April 17, 2017	Seismic Retrofit Fair, 1201 S Figueroa St, Los Angeles	50	30
May 18, 2017	QuakeSmart Conference, 555 West Temple, Los Angeles	35	30
June 17, 2017	Neighborhood Council Coalition, 500 E. Temple Street, Los Angeles	15	15
Total		**160**	**115**

Survey Outreach

Completed surveys were received from 2,328 respondents. Of these respondents, over 79 percent have experienced an earthquake, 57 percent have been affected by drought, and another 40 percent have been affected by adverse weather. Regarding non-natural hazards, 57 percent of the respondents have experienced civil unrest and 50 percent have experienced critical infrastructure failure. Survey results were shared with the Steering Committee. Detailed survey results are provided in Appendix A. Key results are summarized as follows:

- Survey respondents ranked earthquake as the hazard of highest concern, followed by critical infrastructure failure, terrorism, and drought.
- The majority of respondents believe that the best method to receive emergency preparedness information is from the internet, followed by social media and TV news.
- Over 60 percent of respondents who indicated that they live near an earthquake fault do not have earthquake insurance.
- Over 70 percent of respondents indicated that the presence of a hazard risk zone was not disclosed to them when they purchased their home.
- Over 75 percent of the respondents indicated that disclosure of this type of information would have influenced their decision to purchase or move into a home.
- Most respondents stated that incentives would entice them to spend money to mitigate their property. The two most popular incentives were property tax incentives and insurance premium discounts.

Survey responses included 533 “write in” comments. All of these comments were reviewed by the planning team, though many were determined not to be relevant to the plan or its content.

Public Comments on the Draft Plan

A formal, 14 day public comment period was initiated on June 15, 2017. During this comment period, the public was asked to review the proposed draft of the hazard mitigation plan and provide comments to the Planning Team by June 29, 2017. The public comment period was advertised on the hazard mitigation plan website as well as a press release to all media outlets and social media blast through outlets used by the City.

An opportunity to provide public comment in person was provided at the Neighborhood Council Coalition meeting on June 17, 2017 at the Los Angeles Emergency Operations Center on East Temple Street. During this outreach event, members of the public received a handout outlining the basic purpose of the plan and containing a link to view the plan. The handout also included a link to a form to provide comments on the draft plan. The

Planning Team received 10 comments during the public comment period. Those that were deemed relevant to the overall plan by the planning team were incorporated into the final submittal draft of the plan. Most of the comments fell outside the scope of this plan update and were noted by the planning team for consideration under other emergency management programs of the City. Copies of the comments were retained by the planning team and are available upon request.

3.8 PLAN DEVELOPMENT CHRONOLOGY/MILESTONES

Table 3-3 summarizes important milestones in the plan update process.

Table 3-3. Plan Development Chronology/Milestones

Date	Event	Description
2016		
4/13	City releases a request for proposals to update its hazard mitigation plan	Secure contractor support to facilitate update of the City's hazard mitigation plan
6/22	City Selects Tetra Tech as its technical support Contractor	Technical support secured
11/15	Planning Team call #1	Planning process
11/29	Planning team call #2	Planning process
11/30	City executes contract with Tetra Tech for technical support of hazard mitigation plan update	Notice to proceed
2017		
1/4	Planning Team call #3	Planning process
1/11	1st Steering Committee Meeting	• Project overview, work plan, timeline, important milestones. • Steering Committee's role, purpose, expectations, organization, and charter. • Discuss plan review, public outreach capabilities • Discuss current mission statement • Discuss current plan goals/objectives
1/23	Planning Team call #4	Planning process
1/26	2nd Steering Committee Meeting	• Confirm Steering Committee charter • Confirm mission statement • Confirm plan goals/objectives • Confirm hazards of concern – 21 identified • Define and confirm critical facilities • Hazard scenarios discussion
3/20	Public Outreach	• Press release announcing the planning process, website and hazard mitigation survey.
2/21	Planning Team call #5	Planning process
2/23	3rd Steering Committee Meeting	USGS presentation on fault systems and earthquake scenarios that may impact the Los Angeles area. • Risk assessment update • Objectives exercise—confirm plan objectives • Review and confirm critical facilities—have to define • Discuss capability assessment • Discuss prior action status • Hazard mitigation website development
3/22	Planning Team call #6	Planning process
3/23	4th Steering Committee Meeting	• Risk assessment lead report • Preliminary EQ results • Prior mitigation plan action status • Plan maintenance strategy • Confirm hazard mitigation public survey • Confirm public outreach plan • Determine public engagement meetings schedule
3/24	Public Outreach	Web-based hazard survey deployed
3/25	Public Outreach at Abilities Expo	The Abilities Expo, held at the Los Angeles Convention Center, was a convention of exhibitors for the community of people with disabilities, their families, seniors, veterans and healthcare professionals. Risk assessment data shared with the public as well as distribution of hazard specific information and public survey flyers.

Date	Event	Description
4/17	Public Outreach at Seismic Retrofit Resource Fair	The Seismic Retrofit Fair, held at the Los Angeles Convention Center, provided resources, information and materials for owners of soft-story and concrete non-ductile buildings who must comply with the recent mandatory retrofit ordinance for these types of buildings. Distribution of hazard specific information, public survey information, and Hazus data was provided.
4/27	5th Steering Committee Meeting	• Risk assessment update • Prior mitigation plan action status • Action planning workshop scheduled • Public survey update • Public outreach update • Strengths, weaknesses, obstacles, opportunities session
5/2	Planning Team call #7	Planning process
5/10	Planning Team call #8	Planning process
5/16	Planning Team call #9	Planning process
5/18	Public Outreach at QuakeSmart Preparedness Workshop for Businesses and Organizations	The Quakesmart workshop was for business owners to identify preparedness and mitigation actions needed for business continuity, disaster response, and the cost benefit of preparing for earthquakes and other business interruptions. Distribution of hazard specific information, public survey information, and Hazus data was provided.
5/24-25	Action Planning Workshops	Action planning workshops were held at the Los Angeles Emergency Operations Center, 500 E. Temple, Los Angeles from 1:00 to 4:00 on May 24, and from 9:00 to 12:00 on May 25.
5/25	6th Steering Committee Meeting	• Report on action planning workshops • Risk assessment completion • Mitigation best management practices • Public survey update • Public outreach event report • Confirm date for plan completion • Confirm date for public comment period
5/30	Planning Team call #10	Planning process
6/6	Planning Team call #11	Planning process
6/14	Public Outreach	Press release announcing the beginning of the final public comment period.
6/15	Public Outreach	Initiate 2 week final public comment period for review of the draft plan
6/17	Public Outreach for Plan Review and Public Comment Period	A presentation of the draft plan was provided at the City of Los Angeles Neighborhood Council Coalition at the Emergency Operations Center. The presentation was on the planning process and draft plan for public review.
6/22	7th Steering Committee Meeting	The 7th and final Steering Committee meeting for the plan update process was dedicated to presenting the final draft of the plan and allowing the Steering Committee to comment on it to the planning team.
6/29	Public Outreach	Closure of 2-week Final Public Comment period
6/30	Plan Review	Plan sent to Cal OES for review and approval pending adoption
10/31	Approval Pending Adoption	Approval pending adoption received from FEMA Region IX
2018		
1/24	Plan adopted by the Los Angeles City Council	Plan is finalized with the Council's adoption
1/26	Final Approval	FEMA granted final approval of the adopted plan.

4. CITY OF LOS ANGELES PROFILE

4.1 GEOGRAPHIC OVERVIEW

The City of Los Angeles, on the southwest coast of California, is the most populous city in the state, with a 2016 estimated population of 4,030,904 (10 percent of the total population of California). As of the 2010 U.S. Census, the City had an average population density of 8,092 people per square mile. It is the county seat of Los Angeles County. Los Angeles is an irregularly shaped city encompassing over 498 square miles of land (214 square miles of which are hills and mountains) and approximately 29 square miles of water (see Figure 3-1), the state's largest city by area.

4.2 HISTORICAL OVERVIEW

Archeological studies have indicated that people have been living in the area that now surrounds Los Angeles since 3000 B.C. By the time of the arrival of the Spanish in the 1700s, an estimated 5,000 native people lived in the Los Angeles area (McCawley, 1996).

The city that is now Los Angeles was founded in September 1781, with the name "El Pueblo de la Reina de Los Angeles" or "The Town of the Queen of the Angels." By 1800, there were 29 buildings in the community. By 1821, when Mexico became independent of Spain, Los Angeles had grown into the largest self-sustaining farming community in the province of Alta California (Layne, 1935). In 1835, the Mexican Congress declared Los Angeles a city and the capital of Alta California. The City came under the control of the United States in 1848 with the ending of the Mexican American War. Los Angeles was incorporated in the U.S. on April 4, 1850.

The City of Los Angeles mostly remained within its original 28-square-mile area until the 1890s. The first large additions were the districts of Highland Park, Garvanza, and South Los Angeles. In 1906, the approval of the Port of Los Angeles and a change in state law allowed the City to annex "the Shoestring," or Harbor Gateway, a narrow strip from Los Angeles to the port. San Pedro and Wilmington were added in 1909 and Hollywood was added in 1910. Also added in 1910 were Colegrove, Cahuenga, and a part of Los Feliz. By referendum, 170 square miles of the San Fernando Valley, along with the Palms district, were added to the City in 1915, almost tripling its area. Additional annexations brought the City's area to 450 square miles by 1932 and to 469 square miles by 2004 (City of Los Angeles, 2015).

The City's economy began steady growth with completion of the Santa Fe railroad line from Chicago to Los Angeles in 1885 and subsequent immigration from the east (Thompson, 1993). A strong economic base was developed early, in farming, oil, tourism and real estate. Hollywood made the City world famous, and World War II brought new industry, especially high-tech aircraft construction. Since the 1960s old industries have declined, including farming, oil and aircraft, but tourism, entertainment and high tech remain strong.

4.3 MAJOR PAST HAZARD EVENTS

Presidential disaster declarations are typically issued for hazard events that cause more damage than state and local governments can handle without assistance from the federal government. A presidential disaster declaration puts federal recovery programs into motion to help disaster victims, businesses and public entities. Some of the programs are matched by state programs. Declarations are made at the county level, and 27 events since 1969 have drawn presidential disaster declarations that applied to Los Angeles County (see Table 4-1). Los Angeles County has also experienced another 26 federal fire management events since 1978. Review of these events helps identify targets for risk reduction and ways to increase a community's capability to avoid large-scale events in the future.

Table 4-1. Presidential Disaster Declarations Applying to Los Angeles County

Type of Event	FEMA Disaster #	Declaration Date
Severe Winter Storms, Flooding, and Mudslides	4305	3/16/2017
Severe Winter Storms, Flooding, and Debris And Mud Flows	1884	3/8/2010
Wildfires	1810	11/18/2008
Wildfires, Flooding, Mud Flows, and Debris Flows	1731	10/24/2007
Severe Freeze	1689	3/13/2007
Severe Storms, Flooding, Landslides, and Mud and Debris Flows	1585	4/14/2005
Severe Storms, Flooding, Debris Flows, and Mudslides	1577	2/4/2005
Wildfires, Flooding, Mud Flow and Debris Flow	1498	10/27/2003
Severe Winter Storms and Flooding	1203	2/9/1998
Severe Winter Storms, Flooding Landslides, Mud Flow	1046	3/12/1995
Severe Winter Storms, Flooding, Landslides, Mud Flows	1044	1/10/1995
Northridge Earthquake	1008	1/17/1994
Fires, Mud/Landslides, Flooding, Soil Erosion	1005	10/28/1993
Severe Winter Storm, Mud and Landslides, and Flooding	979	2/3/1993
Fire During A Period Of Civil Unrest	942	5/2/1992
Rain/Snow/Wind Storms, Flooding, Mudslides	935	2/25/1992
Severe Freeze	894	2/11/1991
Fires	872	6/30/1990
Severe Storms, High Tides and Flooding	812	2/5/1988
Earthquake and Aftershocks	799	10/7/1987
Coastal Storms, Floods, Slides and Tornadoes	677	2/9/1983
Brush and Timber Fires	635	11/27/1980
Severe Storms, Mudslides and Flooding	615	2/21/1980
Coastal Storms, Mudslides and Flooding	547	2/15/1978
San Fernando Earthquake	299	2/9/1971
Forest and Brush Fires	295	9/29/1970
Severe Storms and Flooding	253	1/26/1969

Many natural hazard events do not trigger federal disaster declarations but have significant impacts on their communities. These events are also important to consider in establishing recurrence intervals for hazards of concern.

4.4 PHYSICAL SETTING

Much of the City of Los Angeles is built within old floodplains and mountains or adjacent to the Pacific Ocean. The population is concentrated in urban centers, which are interspersed by low-density residential neighborhoods. Most of the flat lands of the City have been developed. The remaining open space tends to be concentrated in floodplains or along steep hillside and drainage water courses, which typically have been designated as public park land, recreational, flood control or low intensity uses, consistent with state law. Vulnerability to fires and flooding has increased as development has encroached into the remaining open space areas. Concentrated development and infrastructure have increased the vulnerability of greater numbers of people, businesses and facilities to seismic, fire and flood events, while at the same time providing greater resources for responding to such events.

4.4.1 Topography

The Los Angeles area consists of flat basins defined by the San Gabriel, Santa Susana and Santa Monica Mountains, three major rivers, and the Pacific Ocean (City of Los Angeles Department of City Planning, 2013). The terrain is about 75 percent alluvial plain and 25 percent rugged canyons and hills. Elevations range from 5,074 feet at Sister Elsie Peak in the San Gabriel Mountains to nearly mean sea level in the southwestern part of the City. The San Gabriel and Santa Susana Mountains bound the City on the north and the Santa Monica Mountains extend across the middle of the City. The Palos Verdes Hills and Pacific Ocean bound the City on the south and west (City of Los Angeles, 2010).

4.4.2 Soils and Geology

The 1903 soil survey of Los Angeles (Mesmer, 1903) identifies 17 soil types in the area, as summarized in Table 4-2.

Table 4-2. Identified Soil Types in the Los Angeles Area

Soil	% of Total Survey Area	Soil	% of Total Survey Area	Soil	% of Total Survey Area
Placentia sandy loam	18.1	Oxnard loam	5.4	Maricopa gravelly loam	1.6
Fresno sand	15.9	Fresno fine sand	4.4	Galveston clay	1.3
Santiago silt loam	10.8	Maricopa sandy loam	3.8	Dune sand	0.9
Fresno fine sandy loam	10.6	Los Angeles sandy loam	2.5	River wash	0.5
San Joaquin black adobe	10.3	Fullerton sandy adobe	1.9	Peat	0.3
Oxnard sand	9.8	Sierra adobe	1.9		

Source: Mesmer, 1903

California is divided into several large “geomorphic provinces” defined by similar topography and geologic structure. The northern portion of the City of Los Angeles is in the Transverse Ranges geomorphic province and the southern portion is in the Peninsular Ranges geomorphic province (California Geological Survey, 2002). The boundary between the two provinces is generally the Santa Monica-Hollywood-Raymond fault system along the south edge of the Santa Monica Mountains (Bilodeau, et al., 2007).

The Transverse Ranges geomorphic province is characterized by east-west trending mountains, valleys, and faults that extend eastward from the Channel Islands to the eastern end of the San Bernardino Mountains. Most active faults in the Transverse Ranges are east-west trending faults. Rock types in this province near the City include gneiss, granitic rocks, and sedimentary rocks (Bilodeau et al., 2007). Volcanic rocks are found in the Santa

Monica Mountains. Alluvial sediments are typically in canyon bottoms and valleys, with broad alluvial fans at the mouths of steep canyons.

The Peninsular Ranges geomorphic province extends southward from the south edge of the Transverse Ranges geomorphic province to the tip of Baja California in Mexico (Norris and Webb, 1990). The Peninsular Ranges are characterized by northwest-southeast trending hills and valleys separated by similarly trending faults. Most active faults in the Peninsular Ranges province are northwest trending. Rock types in this province in the Los Angeles region generally include schist and sedimentary rocks. Surface materials in canyon bottoms and basins generally consist of alluvium.

The City of Los Angeles is within a seismically active region that is well known for its many active faults. Due to the area's historical seismicity, it is reasonable to expect future seismic shaking along local or regional faults. The San Andreas Fault is a major tectonic boundary about 34 miles northeast of downtown Los Angeles, outside the city limits. Significant faults within the City include the Newport-Inglewood, Santa Monica, Hollywood, Puente Hills Blind Thrust, Palos Verdes Hills, Verdugo, San Fernando, Northridge, and Santa Susana faults.

Subsurface geology of the area is generally shown in Figure 4-1, which illustrates mapped rock types and seismic faults and folds. The City of Los Angeles is delineated by the blue line in the figure.

4.4.3 Climate

In the basins and valleys along the California coast, climate is subject to wide variations within short distances as a result of the influence of topography on the circulation of marine air. In general, the Los Angeles area has a mild climate characterized by warm, dry summers and cool, wet winters. Temperature and precipitation vary considerably with elevation, topography, and distance from the Pacific Ocean. A storm producing moderate rainfall on the coast (1 inch during a 24-hour period) may produce very heavy rainfall in the mountains (10 to 20 inches during the same 24-hour period). Table 4-3 summarizes key climate data at Los Angeles International Airport on the coast and in downtown Los Angeles.

Table 4-3. Average Los Angeles Climate Data

	L.A. International Airport	Downtown Los Angeles
Period of record	1944 – 2012	1906 – 2012
Average Annual Minimum Temperature	55.3ºF	55.8ºF
Average Annual Maximum Temperature	70.1ºF	74.0ºF
Average Annual Mean Temperature	62.7ºF	64.9ºF
Maximum Temperature	110ºF, September 26, 1963	113ºF, September 27, 2010
Minimum Temperature	27ºF, January 4, 1949	25ºF, February 19, 1911
Average Annual Precipitation	12.02 inches	14.77 inches
One Date Maximum Precipitation	5.60 inches, November 21, 1967	5.88 inches, March 2, 1938

Source: Western Regional Climate Center, 2017

Most precipitation occurs from December through March. Precipitation during the summer is infrequent, and rainless periods of several months are common. Precipitation usually occurs as localized cloudbursts, mostly in the mountains and deserts after summer, and light to moderate rains in winter. Six to eight heavy rain events each year result in most of the total precipitation. In general, the quantity of precipitation increases with elevation.

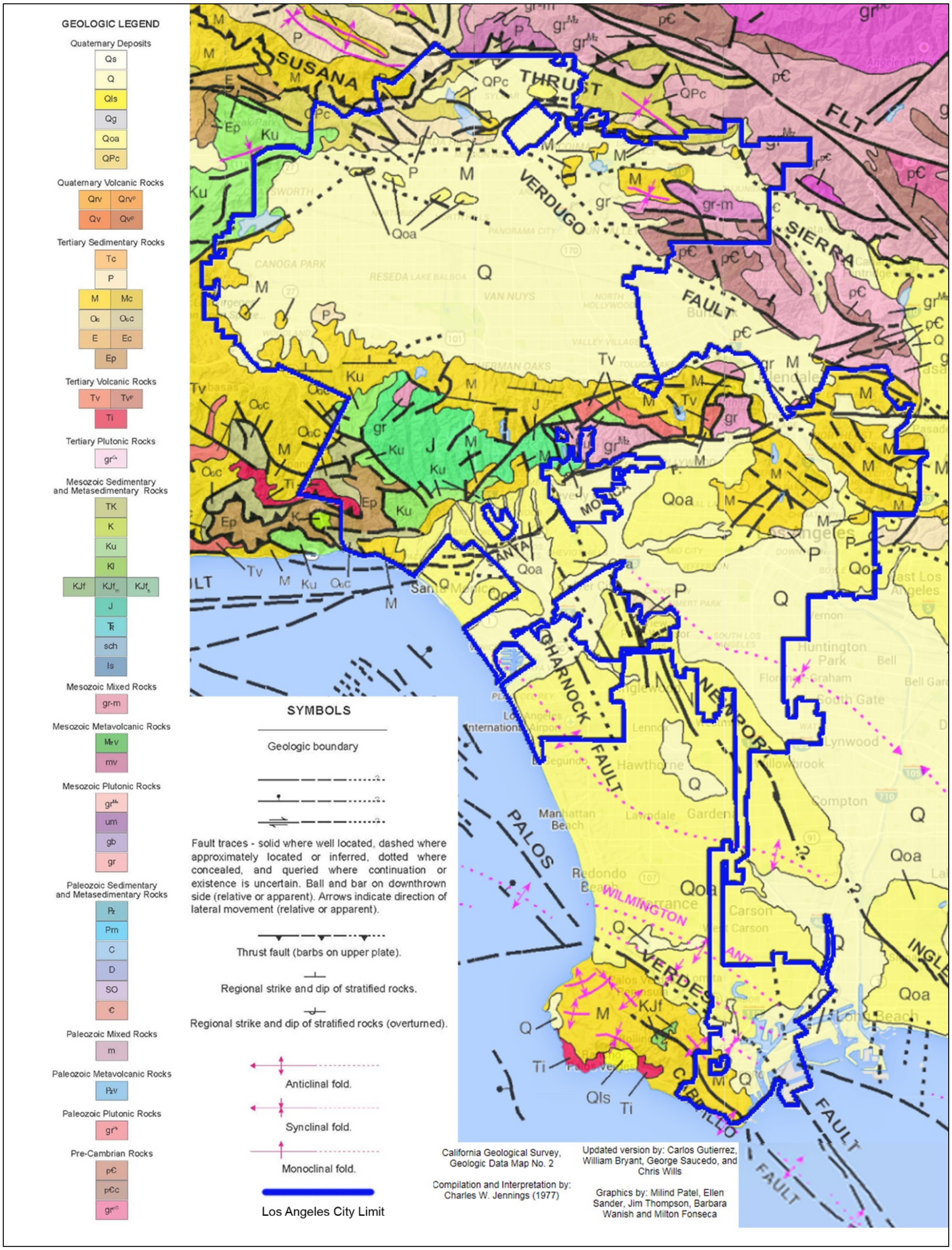

Figure 4-1. Los Angeles Geologic Features

Although the basic air flow above the area is from the west or northwest during most of the year, mountain chains deflect these winds so that, except for the immediate coast, wind direction is more a product of local terrain than of the prevailing circulation. Strong and sometimes damaging winds from the east or northeast occur when there is a strong high-pressure area to the east and an intense low-pressure area approaching the coast from the west. In southern California these winds are called “Santa Ana Winds.” Their air is typically very dry, and the winds are strong and gusty, sometimes exceeding 100 mph, particularly near the mouth of canyons oriented along the direction of airflow. These conditions occasionally lead to serious fire suppression problems and often result in the temporary closing of highways to campers, trucks, and light cars. These land and sea breezes are more pronounced in summer and impact air pollution levels.

The Los Angeles area is almost completely enclosed by mountains on the north and east. In addition, a vertical temperature structure (inversion) in the air along most of coastal California tends to prevent vertical mixing of the air. The geographical configuration and coastal location of the Los Angeles area permit a fairly regular daily reversal of wind direction—offshore at night and onshore during the day (WRCC, 2014).

4.5 DEVELOPMENT PROFILE

4.5.1 Land Use

Development patterns in Los Angeles have evolved in response to factors as diverse as the area’s geological features and the arrival of the automobile. Of 465 square miles of land in the City, 78 percent is developed. Residential land use covers 56 percent of the land, commercial development accounts for 8 percent, and industrial development makes up 7 percent. This high percentage of development has resulted in a large percentage of the area being covered by impervious surfaces, which alters natural drainage characteristics. Most of the developed City is on the coastal plain; development in the hills and mountainous areas is challenging due to steep slopes, landslide areas and unpredictable bedrock. Of the area of the City that is currently undeveloped (22 percent of the total), only 5 percent is considered to be subject to future urban development (City of Los Angeles Department of City Planning, 2013). Table 4-4 summarizes the breakdown of current land use in the City.

Table 4-4. General Plan Land Use within the Planning Area

	Planning Area	
Land Use	Area (acres)	% of total
Agriculture	76.5	0.03%
Commercial	19,354.2	7.65%
Government	17,842.1	7.05%
Industrial	20,816.2	8.23%
Multi-Family Residential	33,399.1	13.20%
Open Space	51,027.3	20.17%
Parking	13.1	0.01%
Single Family Residential	110,411.6	43.65%
Total	**252,940.1**	**100.00%**

A 2008 study by the U.S. Department of Agriculture estimated that 61 percent of the City’s non-mountainous land cover is composed of impervious surfaces, such as paving or development, or water features. The remaining areas are estimated to consist of irrigated grass (12 percent), dry grass or bare soil (6 percent) and tree canopy cover (21 percent) (McPherson et al., 2008).

The City's General Plan and zoning code guide local development. The Land Use Element of the General Plan defines 35 Community Plan areas for guidance of the physical development of the City's neighborhoods. These community plan areas are distributed between seven Area Planning Commissions (APCs):

- Central APC
- East Los Angeles APC
- Harbor APC
- North Valley APC
- South Los Angeles APC
- South Valley APC
- West Los Angeles APC

4.5.2 Critical Facilities and Infrastructure

For consistency, the Steering Committee decided to retain the critical facility categories established for the City's previous (2011) hazard mitigation plan:

- **Critical Operating Facilities**—These facilities—referred to as the City's "Big 20" infrastructure buildings—house most City personnel and are required for the day-to-day conduct of City business:
  - City Hall
  - City Hall East
  - City Hall South
  - LAPD Administration Building
  - Personnel Department Building
  - Piper Technical Center
  - San Pedro Municipal Building
  - Braude Building
  - West Los Angeles City Hall
  - Metro Communication/Dispatch
  - Van Nuys City Hall
  - Figueroa Tower#1
  - Figueroa Tower#2
  - Wilshire Towers
  - Garland Building
  - West Los Angeles Inspection Division
  - Convention Center
  - Valley 911 Building
  - Public Works Broadway Building
  - Emergency Operations Center.
- **Critical Response Facilities**—These City facilities are necessary for hazard event response. They include fire stations, police stations, hospitals, and evacuation centers, such as Los Angeles Unified School District schools, and recreation and park facilities.
- **Critical Infrastructure**—Critical public and private infrastructure has two categories:
  - Critical transportation infrastructure includes freeways, streets, bridges, railroads, airports and the harbor.
  - Critical utilities infrastructure includes potable water systems (treatment and reservoirs), wastewater systems (treatment plants, major interceptors and sewer lines), electric power systems (power plants, substations and major transmissions lines), oil refineries, natural gas systems, and communication systems.

Figure 4-2 through Figure 4-15 show the location of critical facilities and infrastructure in the planning area. Due to the sensitivity of this information, a detailed list of facilities is not provided. The list is on file with the City of Los Angeles. Table 4-5 summarizes the general types of critical facilities and infrastructure, respectively. All critical facilities and infrastructure were analyzed in the risk assessment to help rank risk and identify mitigation actions. The risk assessment for each hazard qualitatively discusses critical facilities with regard to that hazard.

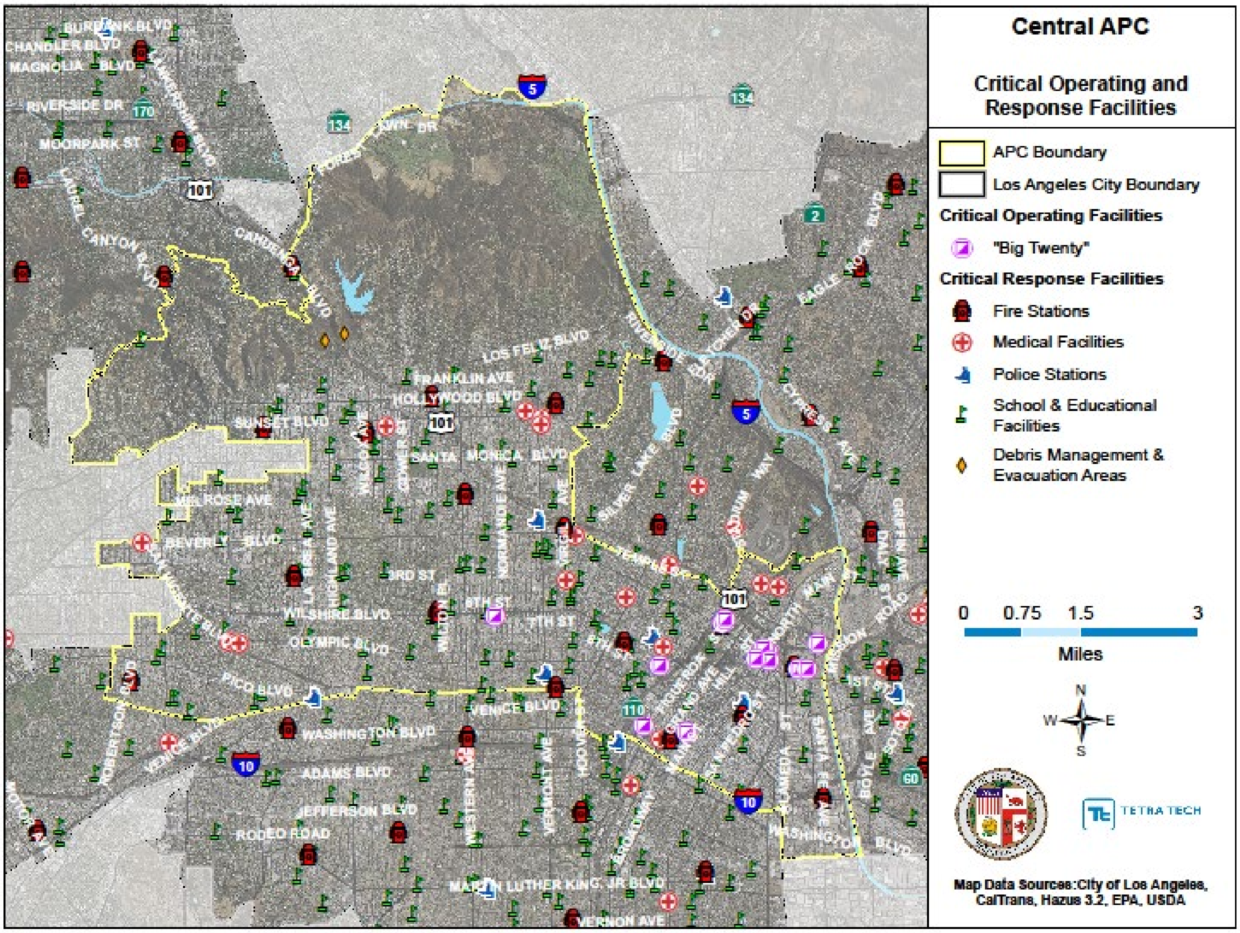

Figure 4-2. Critical Facilities in the Central APC

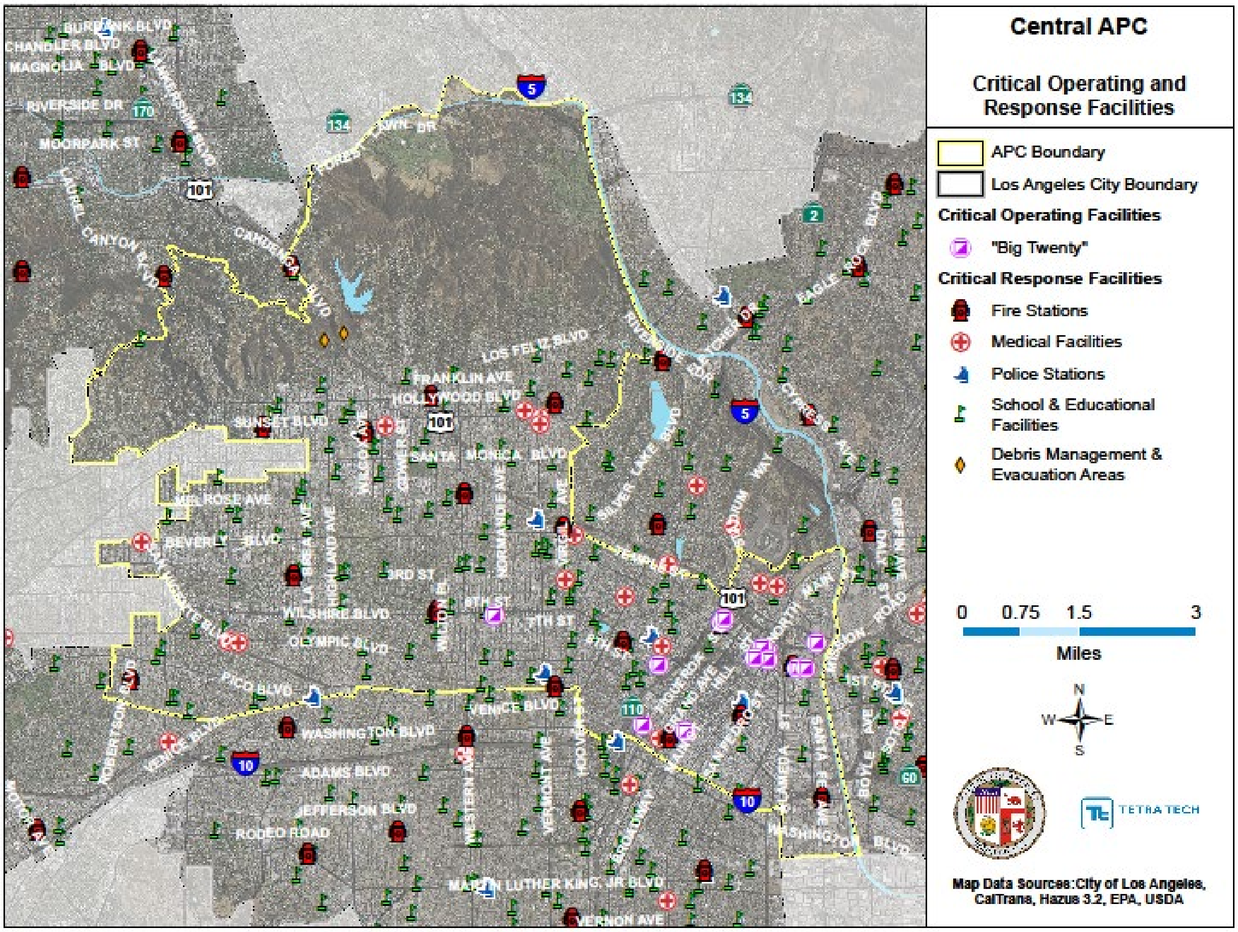

Figure 4-3. Critical Facilities in the East Los Angeles APC

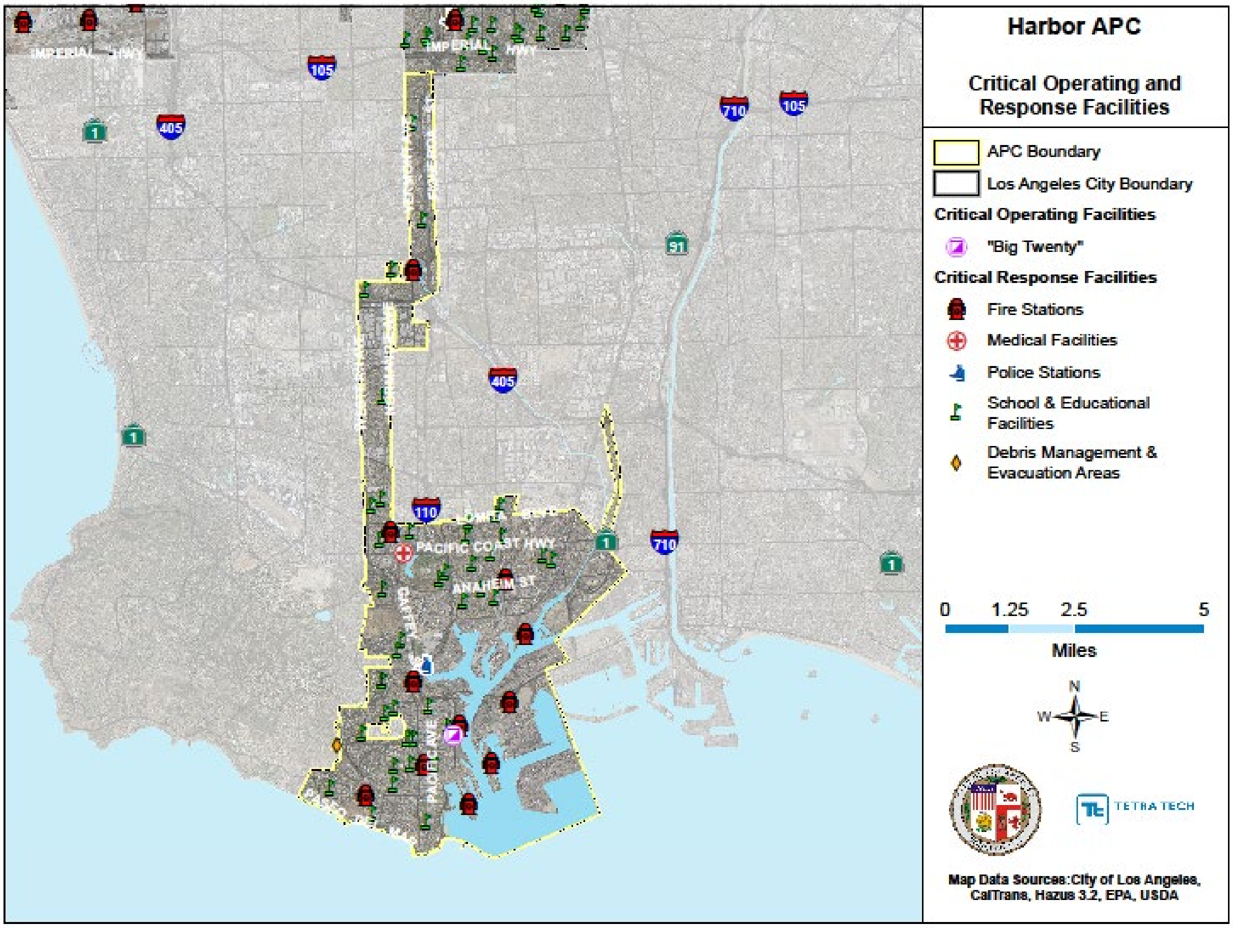

Figure 4-4. Critical Facilities in the Harbor APC

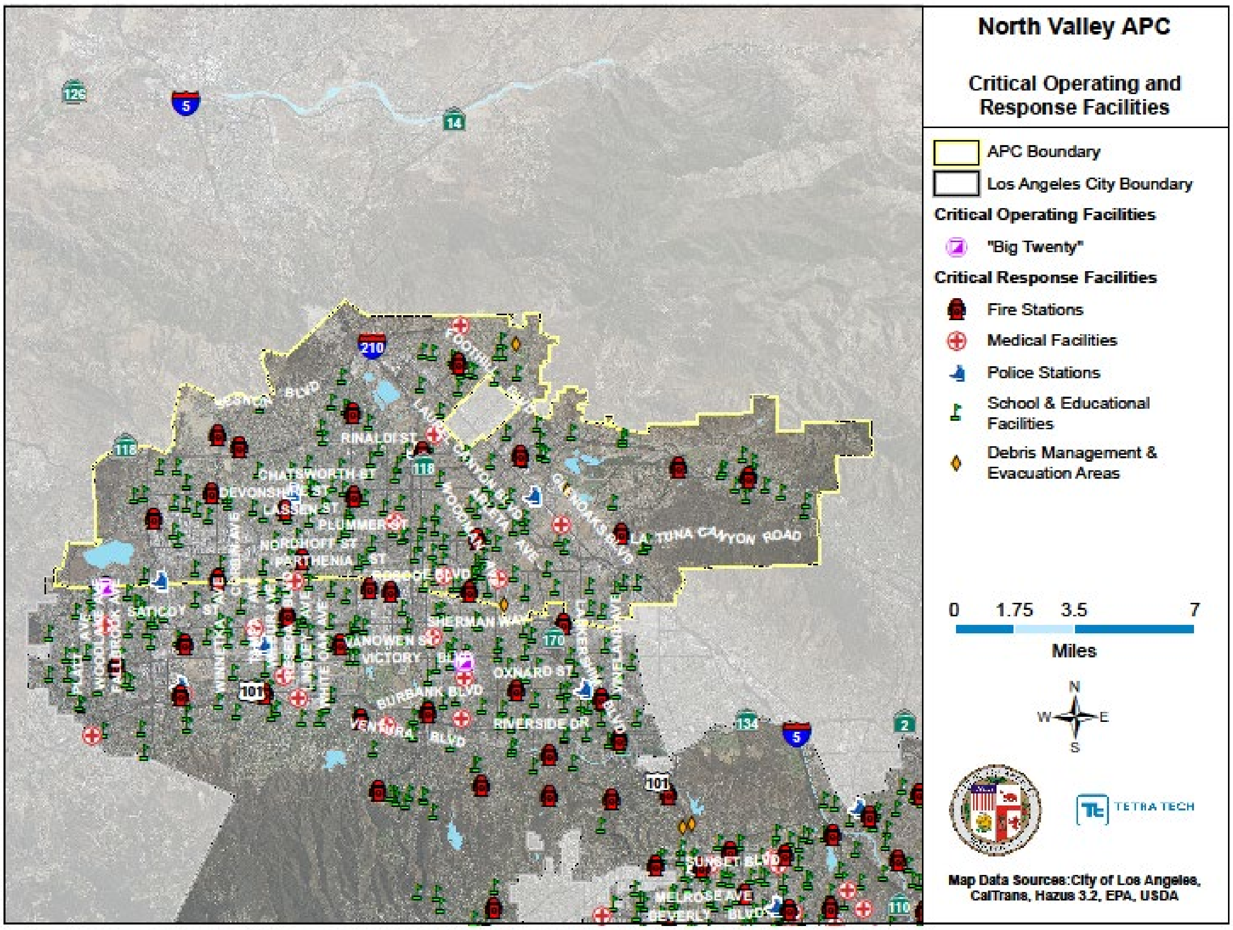

Figure 4-5. Critical Facilities in the North Valley APC

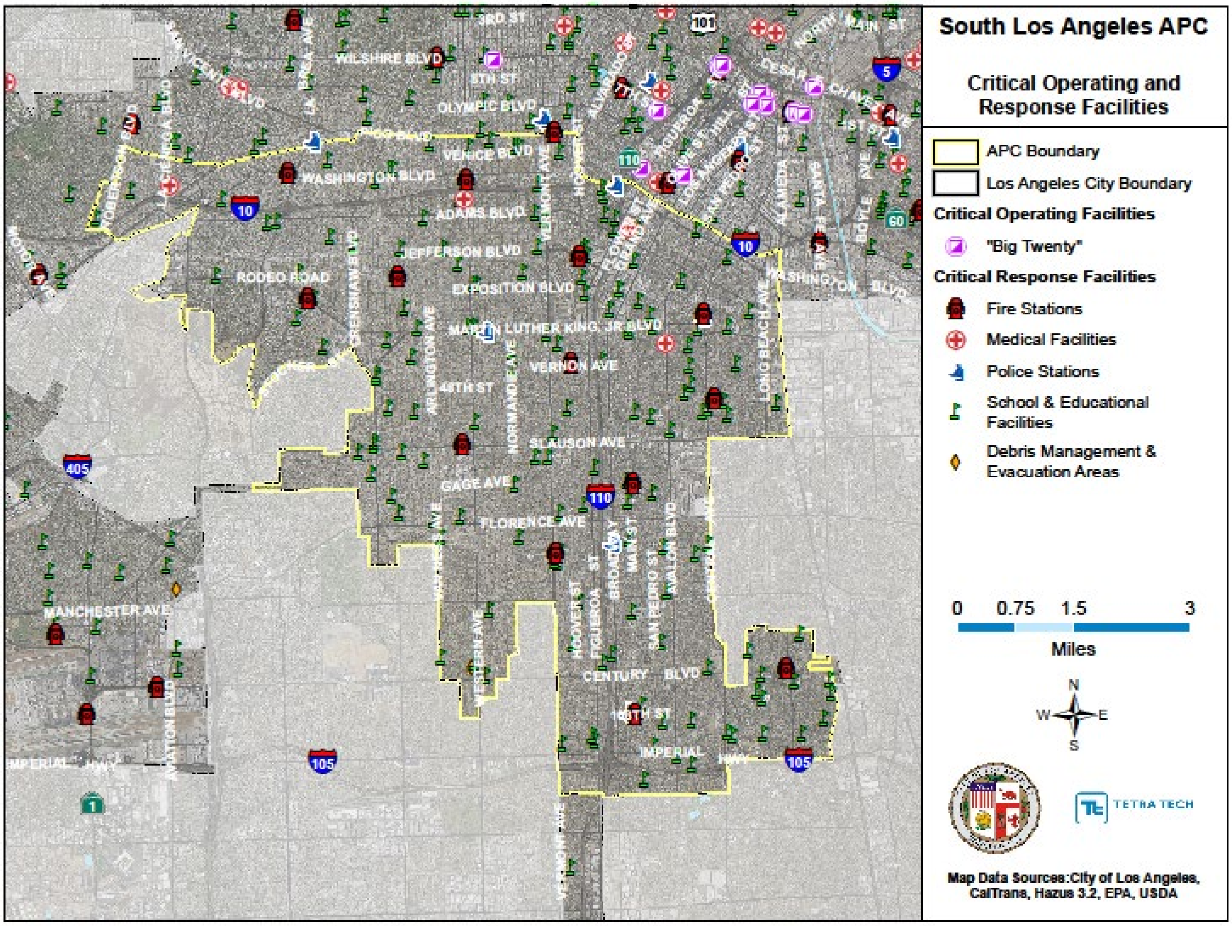

Figure 4-6. Critical Facilities in the South Los Angeles APC

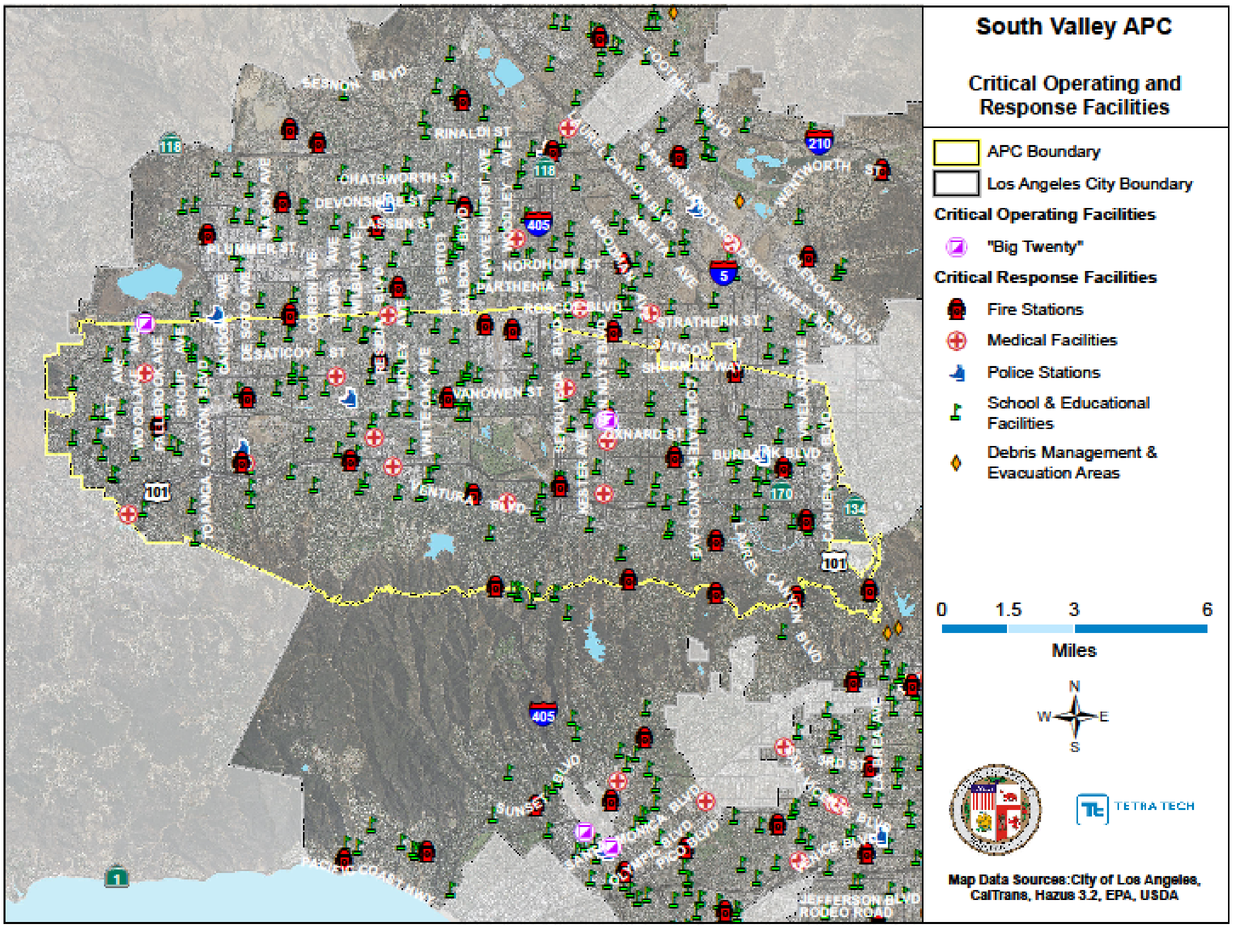

Figure 4-7. Critical Facilities in the South Valley APC

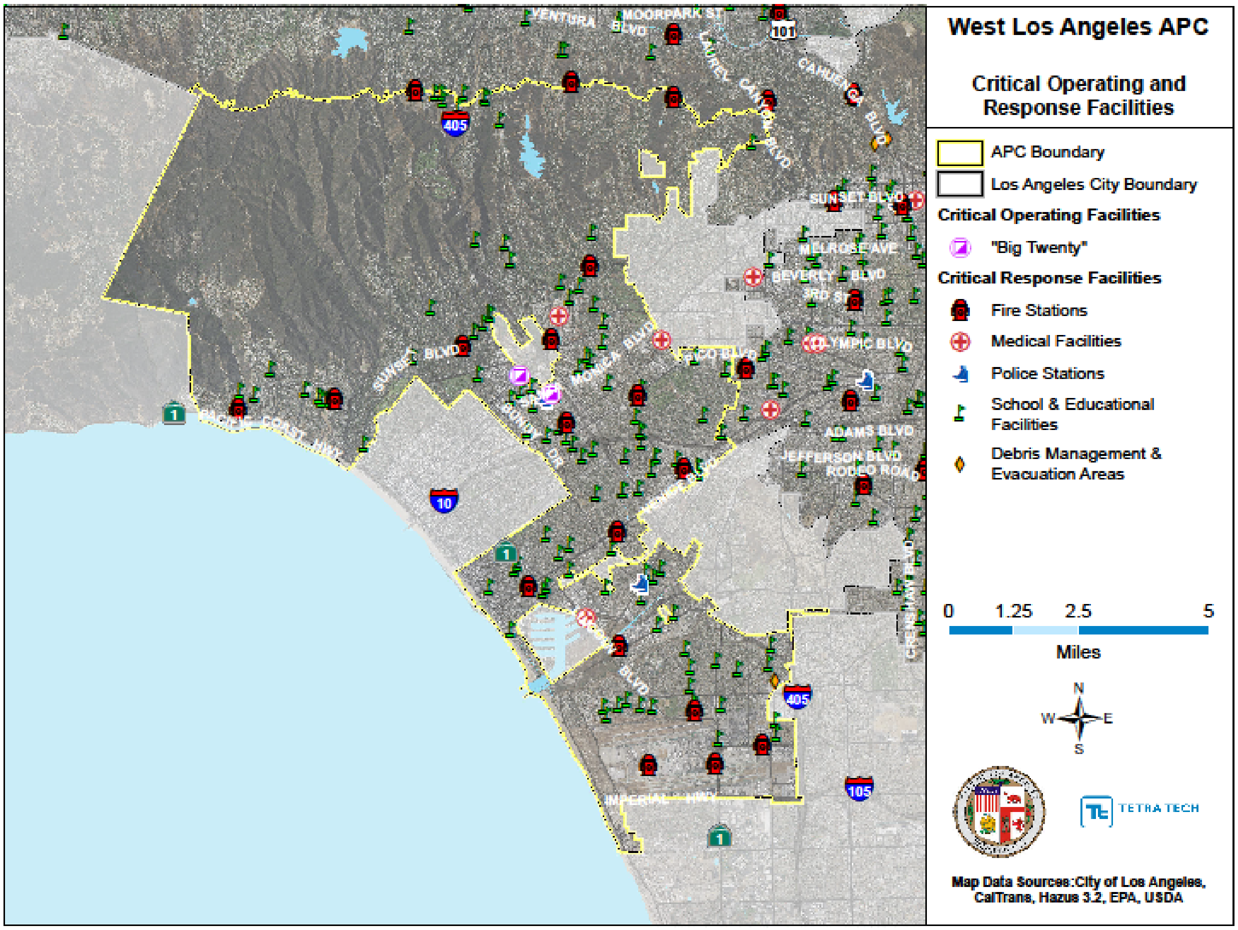

Figure 4-8. Critical Facilities in the West Los Angeles APC

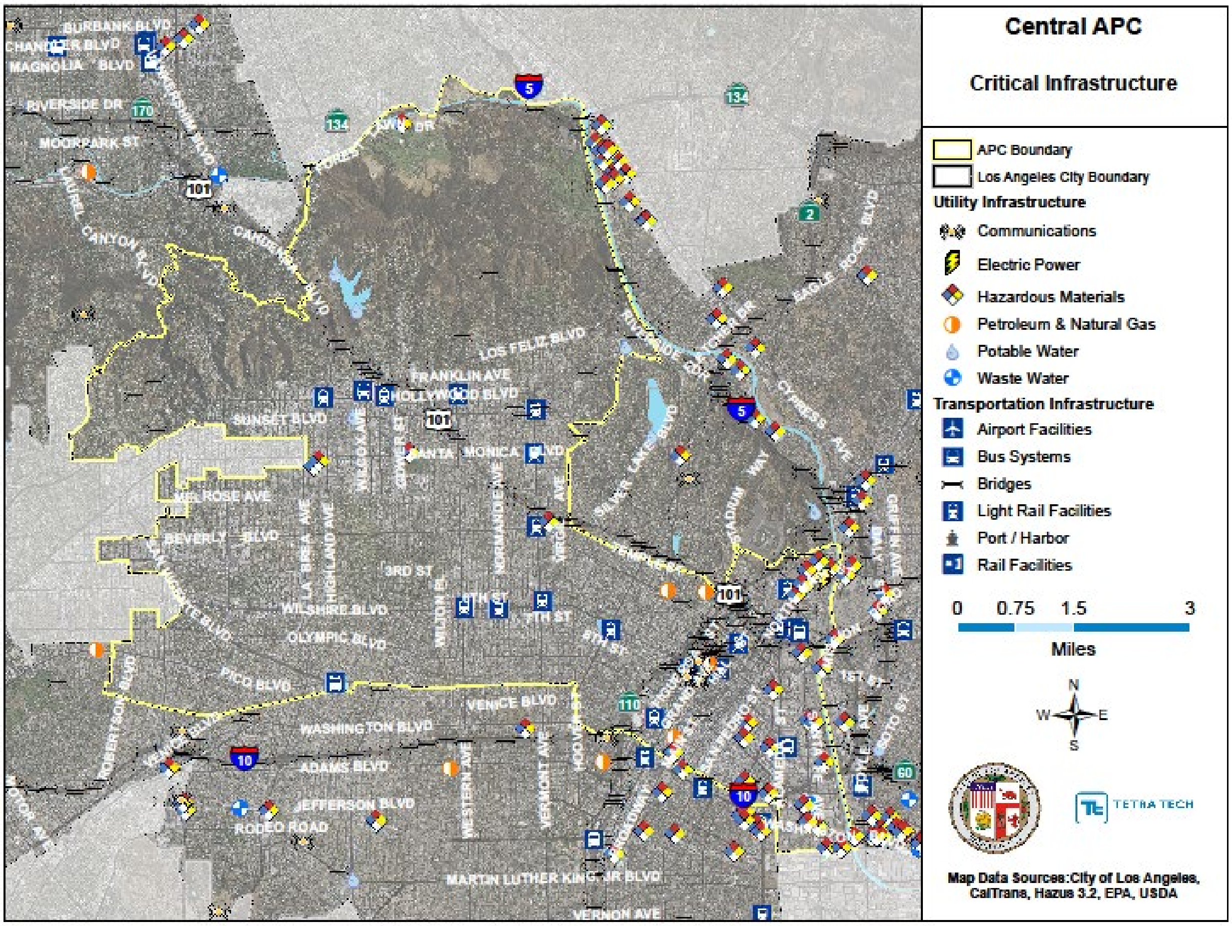

Figure 4-9. Critical Infrastructure in the Central APC

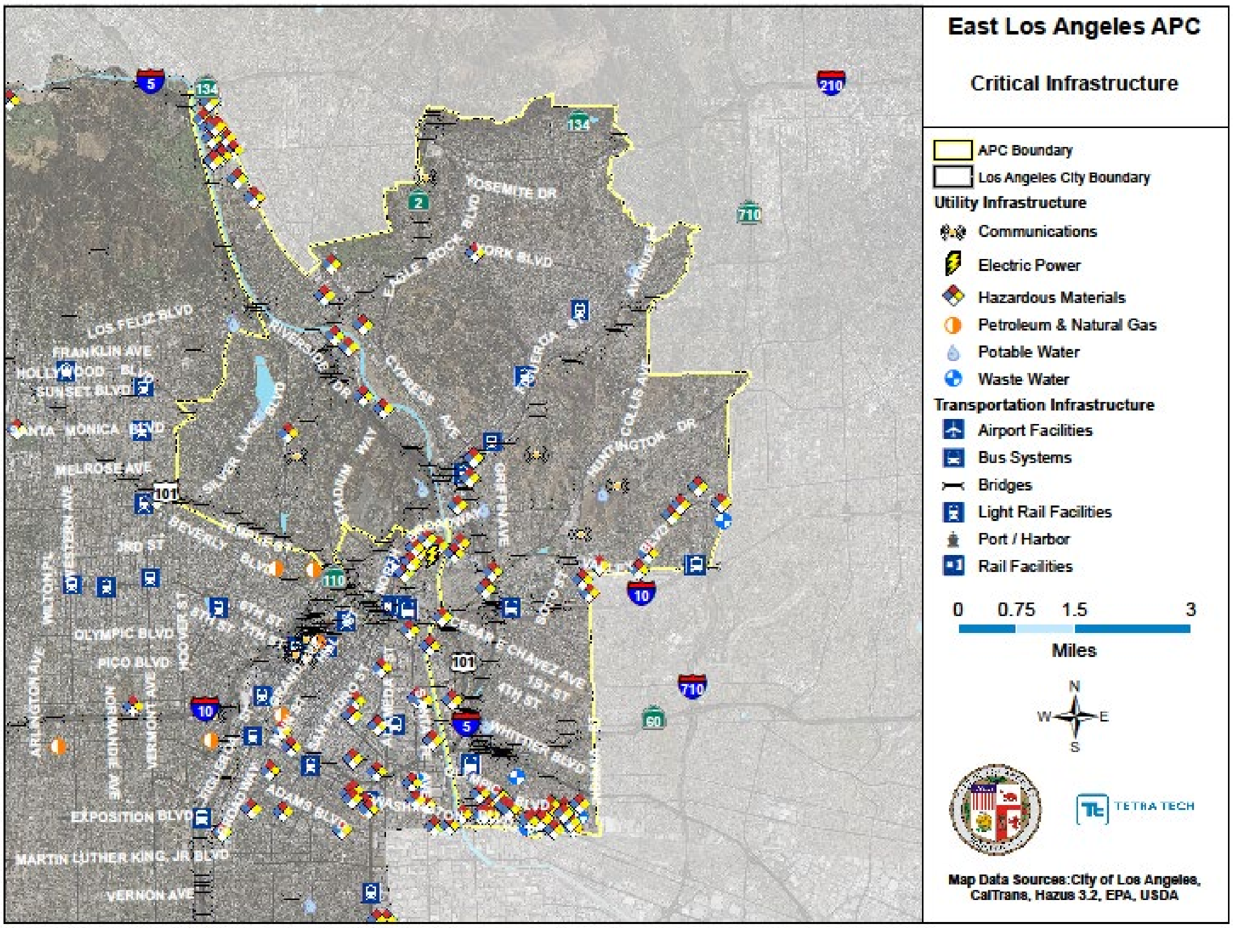

Figure 4-10. Critical Infrastructure in the East Los Angeles APC

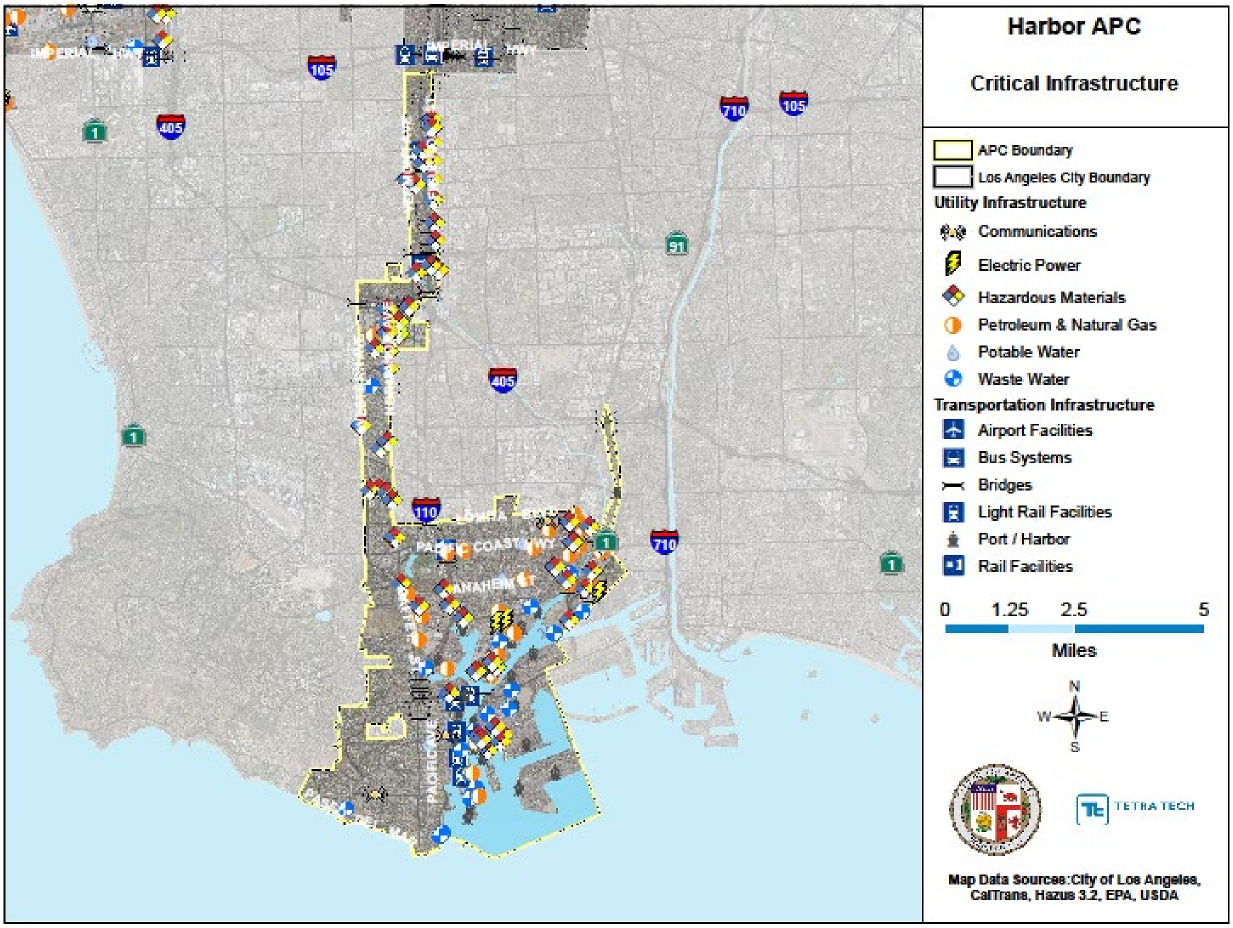

Figure 4-11. Critical Infrastructure in the Harbor APC

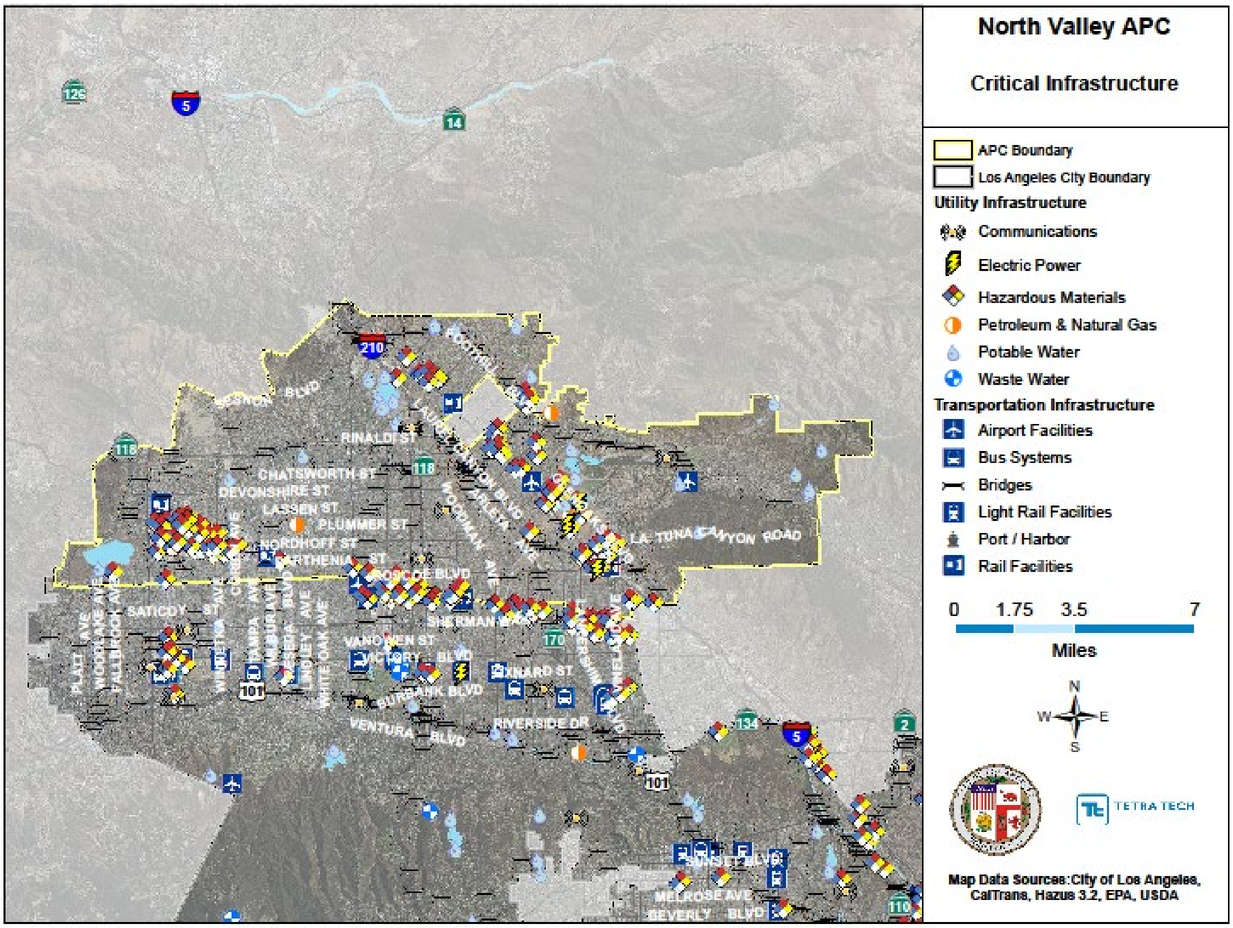

Figure 4-12. Critical Infrastructure in the North Valley APC

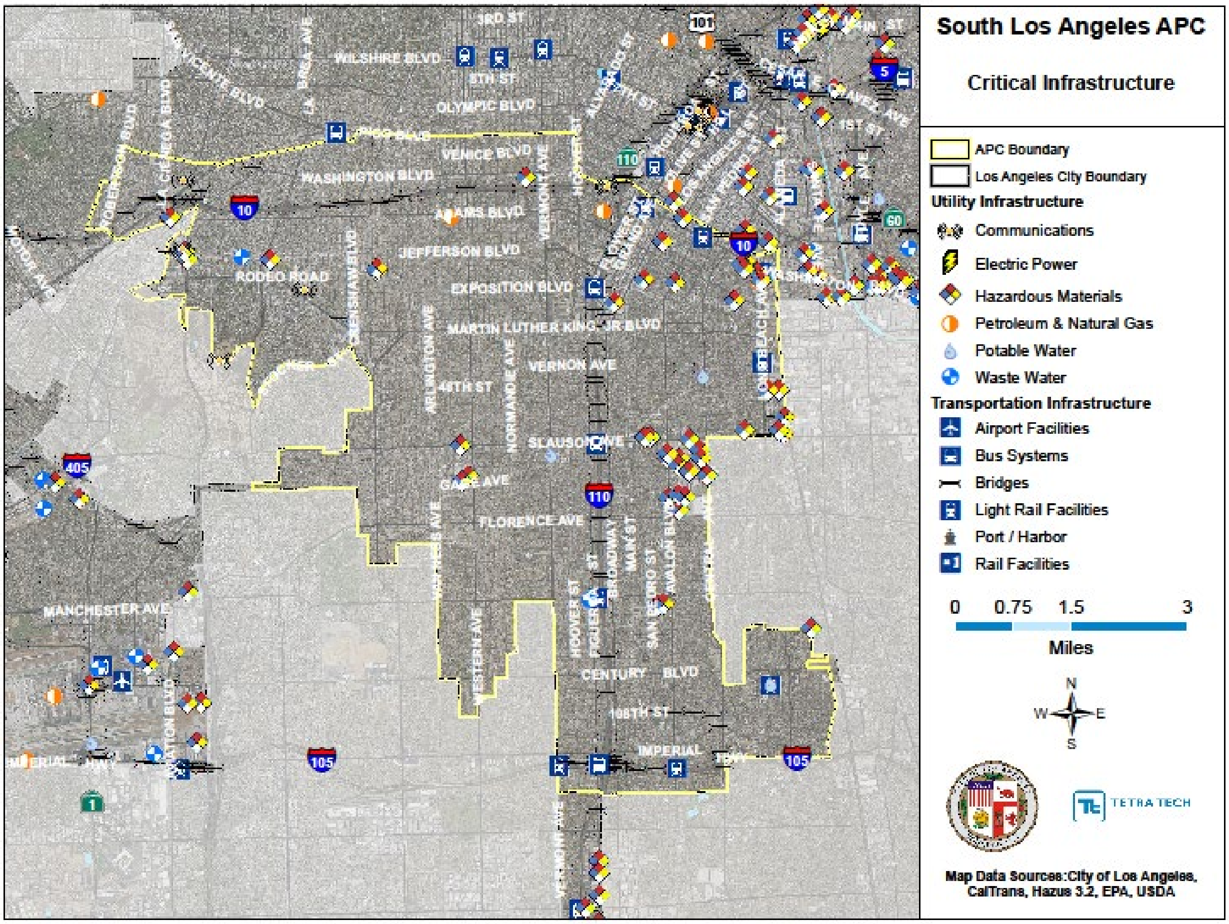

Figure 4-13. Critical Infrastructure in the South Los Angeles APC

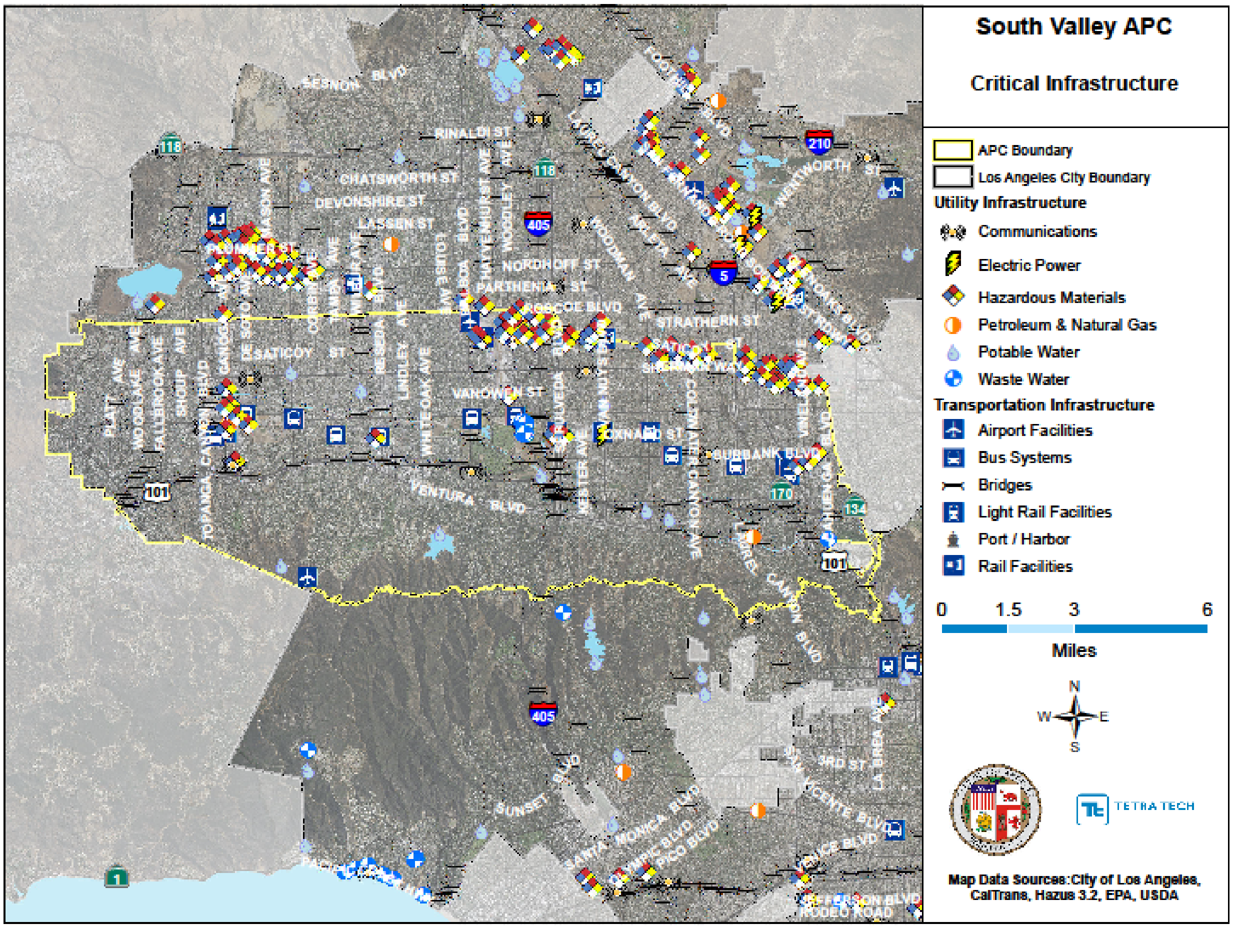

Figure 4-14. Critical Infrastructure in the South Valley APC

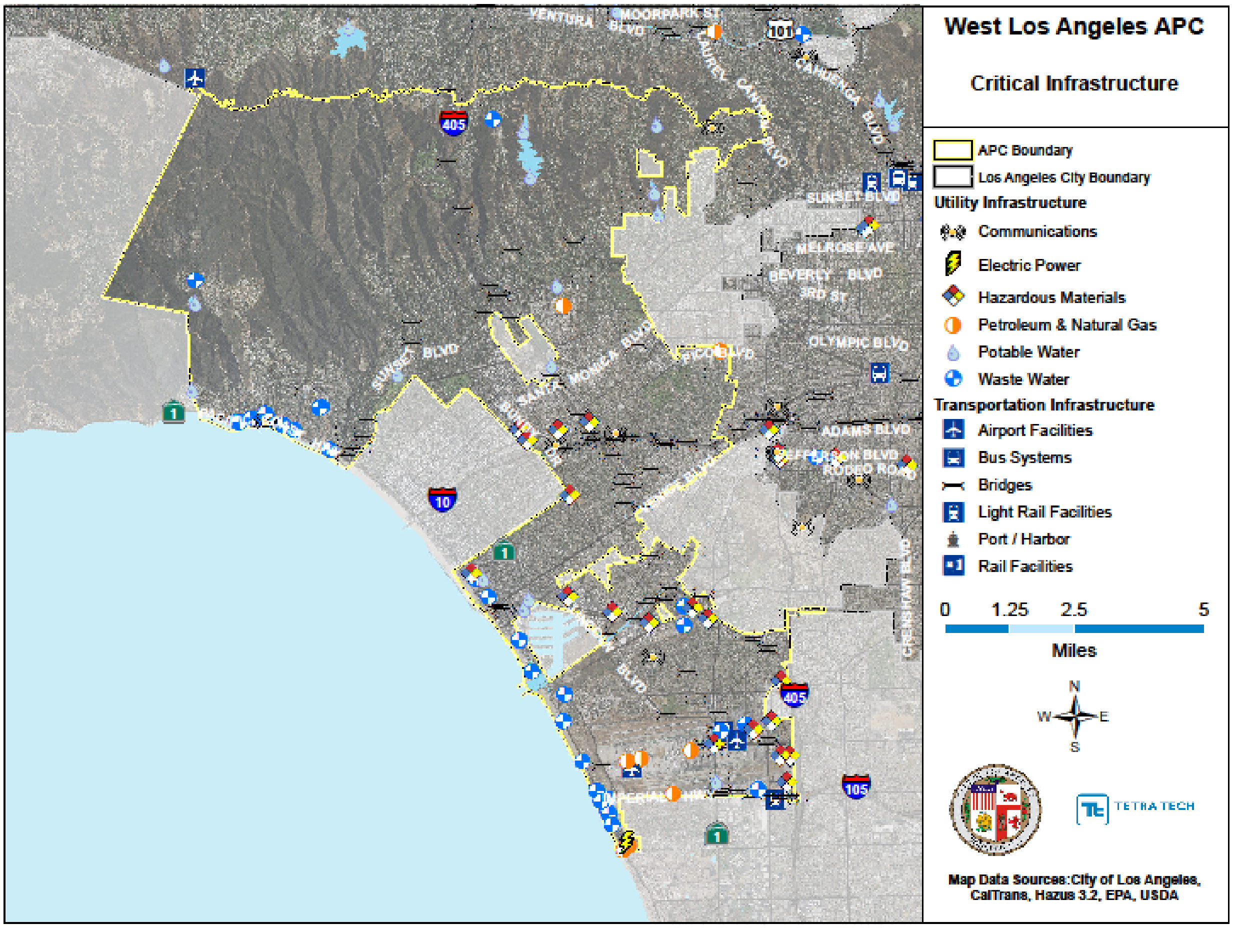

Figure 4-15. Critical Infrastructure in the West Los Angeles APC

Table 4-5. Planning Area Critical Facilities

Category	Central APC	East LA APC	Harbor APC	North Valley APC	South LA APC	South Valley APC	West LA APC	Total
Critical Operating Facilities	14	0	1	0	0	3	2	20
Critical Response Facilities								
Evacuation Centers / Debris Removal	2	1	1	3	1	0	1	9
Fire	17	11	11	17	13	20	17	106
Medical	14	8	1	6	4	11	3	47
Police	6	2	1	4	5	4	2	24
Schools	114	113	43	156	154	163	104	847
Critical Infrastructure—Transportation								
Airports	0	0	0	2	0	3	2	7
Bridges	151	230	70	286	127	190	134	1,188
Bus Systems	4	3	3	0	4	15	1	30
Light Rail	18	4	2	3	8	1	1	37
Port / Harbor	0	0	35	0	0	0	0	35
Railroads	1	1	0	5	0	2	0	9
Critical Infrastructure—Utilities								
Communications	6	5	3	6	5	7	5	37
Electric Power	1	0	3	3	0	1	1	9
Hazardous Materials	28	72	64	132	46	48	18	408
Petroleum & Natural Gas	4	0	32	3	3	6	10	58
Potable Water	4	7	3	27	4	8	14	67
Waste Water	1	4	21	0	2	12	45	85
Overall	**385**	**461**	**294**	**653**	**376**	**494**	**360**	**3,023**

4.5.3 Future Trends in Development

The City's General Plan governs land use decision and policy-making. This hazard mitigation plan will work together with the General Plan to support wise land use in the future by providing vital information on the risk associated with hazards within the city. The City of Los Angeles will incorporate by reference the Hazard Mitigation Plan Update in its General Plan. This will ensure that all future trends in development can be established with the benefits of the information on risk and vulnerability to hazards identified in this plan.

According to Southern California Public Radio (KPCC 89.30), the number of residential building permits reported in the Los Angeles metro area sharply decreased between 2004 and 2009, followed by a sharp increase after 2009. Permits for housing construction in the Los Angeles metropolitan area declined in 2016 compared to the previous year, a reversal in what had been a steady post-recession recovery, according to figures from the U.S. Census Bureau. (KPCC, 2017). Figure 4-16 shows the trends in residential development projects in the planning area since 2005.

Source: KPCC, 2017

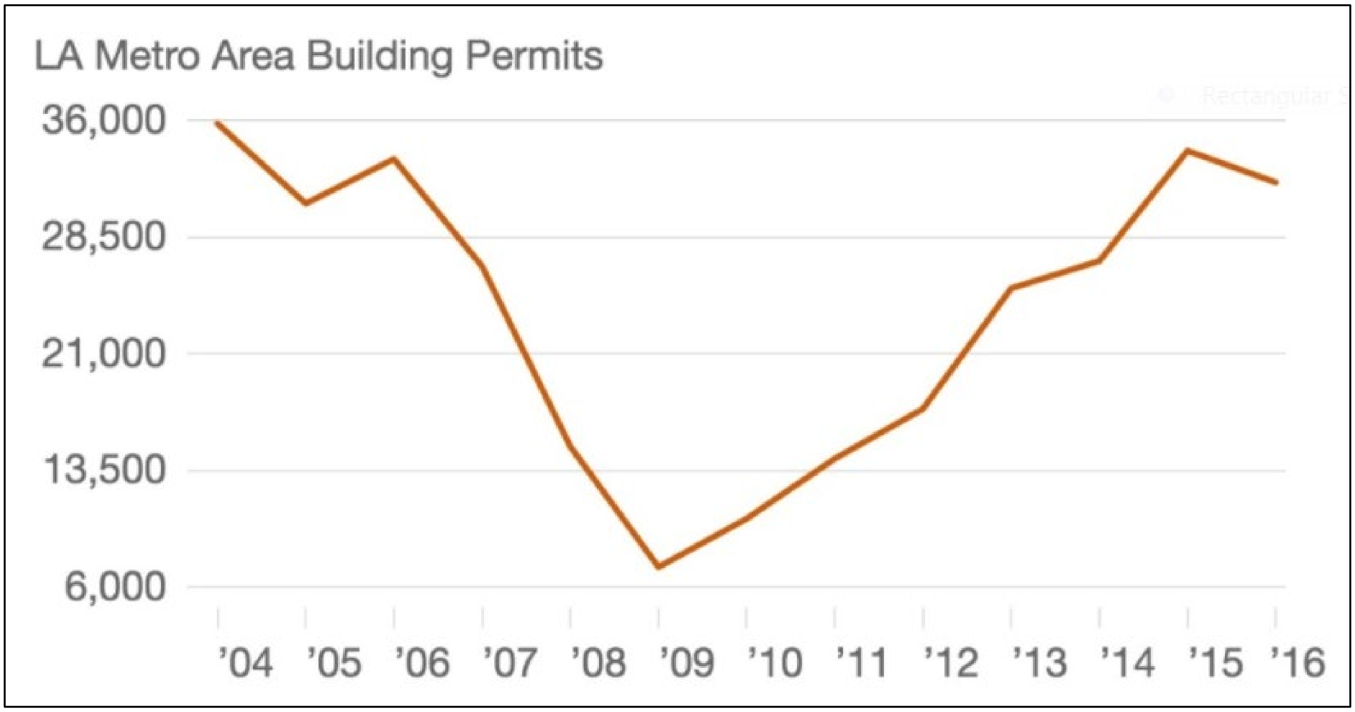

Figure 4-16. Residential Building Permit Trends, 2005 to 2015

4.6 COMMUNITY DEMOGRAPHIC PROFILE

Some populations are at greater risk from hazard events because of decreased resources or physical abilities. Elderly people, for example, may be more likely to require additional assistance. Research has shown that people living near or below the poverty line, the elderly, women, children, ethnic minorities, renters, individuals with disabilities, and others with access and functional needs, all experience more severe effects from disasters than the general population. These vulnerable populations may vary from the general population in risk perception, living conditions, access to information before, during and after a hazard event, capabilities during an event, and access to resources for post-disaster recovery. Indicators of vulnerability—such as disability, age, poverty, and minority race and ethnicity—often overlap spatially and often in the geographically most vulnerable locations. Detailed spatial analysis to locate areas where there are higher concentrations of vulnerable community members would help to extend focused public outreach and education to these most vulnerable residents (Press-Telegram, 2015).

4.6.1 Population Characteristics

Knowledge of the composition of the population and how it has changed in the past and how it may change in the future is needed for making informed decisions about the future. Information about population is a critical part of planning because it directly relates to land needs such as housing, industry, stores, public facilities and services, and transportation. California Department of Finance estimated the City of Los Angeles population to be 4,030,904 as of January 1, 2016.

Population changes are useful socio-economic indicators. A growing population generally indicates a growing economy, while a decreasing population may signify economic decline. Figure 4-17 shows the planning area population change from 1993 to 2016 compared to that of the State of California (California Department of Finance, 2017).

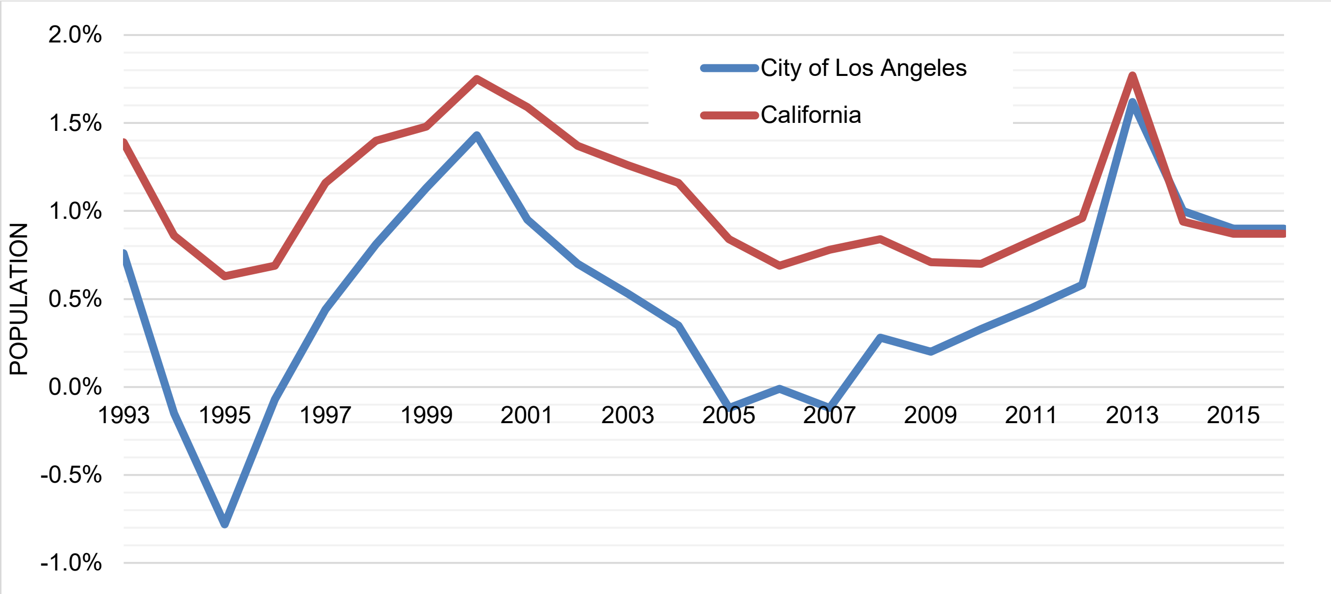

Figure 4-17. California and City of Los Angeles Population Growth

Between 2000 and 2016, California's population grew by 15.89 percent (about 0.93 percent per year) while the planning area's population increased by 9.10 percent (0.54 percent per year). The City and the state both experienced peak population growth in 2000, with the annual growth rate generally slowing from 2000 to 2007. The rate has rapidly increased again since 2007. The City population decreased from 1994 through 1996 and 2005 through 2007. Between 2010 and 2016, the population increased an average of 0.90 percent per year, for a total of 6.28 percent. Table 4-6 shows the population in the planning area from 2000 to 2016.

Table 4-6. Annual Population Data

	City of Los Angeles Population
2000	3,694,742
2001	3,714,515
2002	3,740,481
2003	3,760,410
2004	3,773,549
2005	3,769,131
2006	3,768,645
2007	3,764,063
2008	3,774,497
2009	3,781,952
2010	3,792,621
2011	3,818,120
2012	3,860,986
2013	3,907,519
2014	3,945,037
2015	3,980,423
2016	4,030,904

Source: California Department of Finance, Demographic Research Unit, 2017

4.6.2 Age Distribution

As a group, the elderly are more apt to lack the physical and economic resources necessary for response to hazard events and are more likely to suffer health-related consequences making recovery slower. They are more likely to be vision, hearing, and/or mobility impaired, and more likely to experience mental impairment or dementia. Additionally, the elderly are more likely to live in assisted-living facilities where emergency preparedness occurs at the discretion of facility operators. These facilities are typically identified as "critical facilities" by emergency managers because they require extra notice to implement evacuation. Elderly residents living in their own homes may have more difficulty evacuating their homes and could be stranded in dangerous situations. This population group is more likely to need special medical attention, which may not be readily available during natural disasters due to isolation caused by the event. Specific planning attention for the elderly is an important consideration given the current aging of the American population.

Children under 14 are particularly vulnerable to disaster events because of their young age and dependence on others for basic necessities. Very young children may additionally be vulnerable to injury or sickness; this vulnerability can be worsened during a natural disaster because they may not understand the measures that need to be taken to protect themselves from hazards.

The overall age distribution for the planning area is shown in Figure 4-18. Based on the most recent 5-year estimates from the U.S. Census Bureau's American Community Survey (2011-2015), 11.2 percent of the planning area's population is 65 or older. According to U.S. Census data, 38.6 percent of the over-65 population have disabilities of some kind and 16.2 percent have incomes below the poverty line. The City's population includes 18.1 percent who are 14 or younger. Among children under 18, 32 percent are below the poverty line.

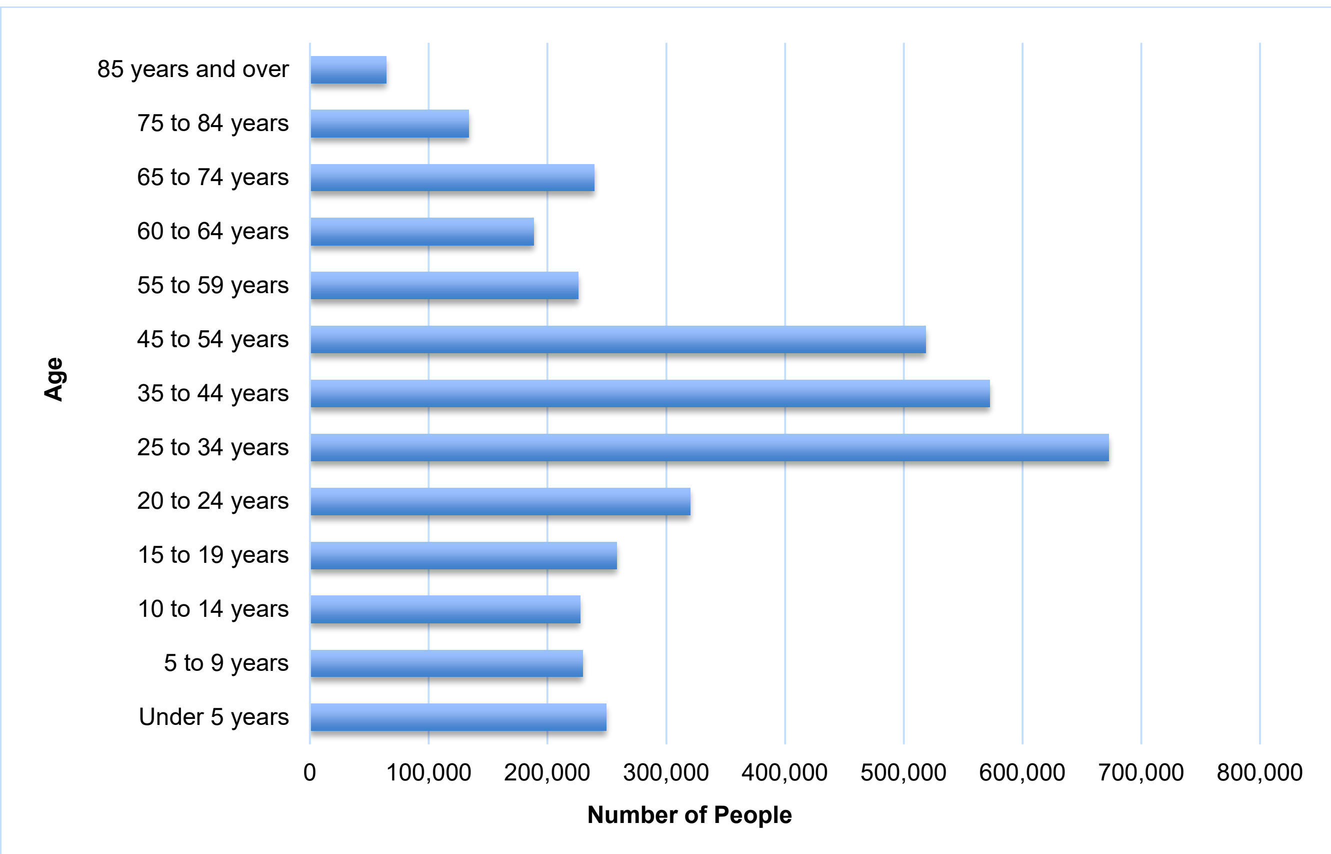

Figure 4-18. Planning Area Age Distribution

4.6.3 Race, Ethnicity and Language

Research shows that racial and ethnic minorities are less likely to be involved in pre-disaster planning and experience higher mortality rates during a disaster event. Post-disaster recovery can be ineffective and is often characterized by cultural insensitivity. Since higher proportions of ethnic minorities live below the poverty line than the majority white population, poverty can compound vulnerability.

Figure 4-19 shows the U.S. Census 2015 racial distribution in the City of Los Angeles based on race categories mandated by U.S. Office of Management and Budget standards. The Census Bureau also reports that 47.8 percent of the planning area population is of Hispanic origin, which indicates the heritage, nationality, lineage, or country of birth of the person or the person's parents or ancestors before arriving in the United States, and may be any race.

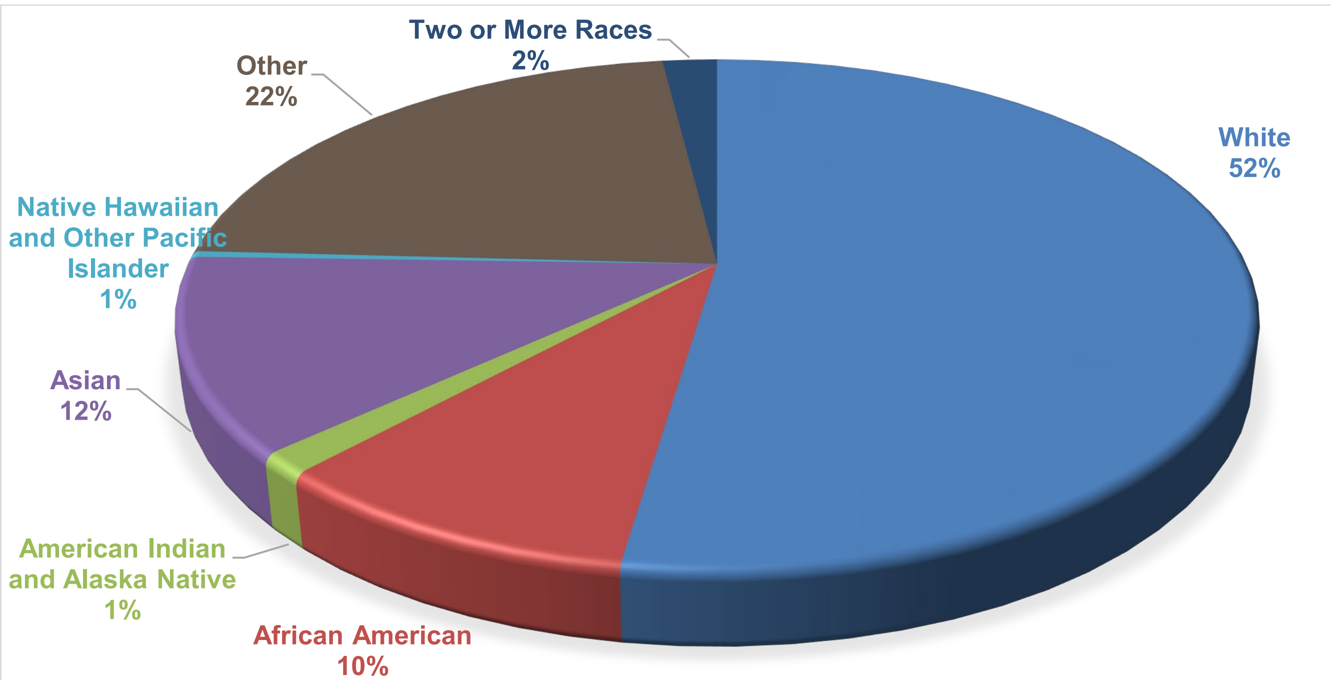

Figure 4-19. Planning Area Race Distribution

The planning area has a 38.2-percent foreign-born population. Other than English, the most commonly spoken language in the planning area is Spanish. The census estimates that 27.7 percent of residents speak English "less than very well."

4.6.4 Individuals with Disabilities or Access and Functional Needs

Individuals with disabilities are more likely to have difficulty responding to a hazard event than the general population. Local government is the first level of response to assist these individuals, and coordination of efforts to meet their access and functional needs is paramount to life safety efforts. It is important for emergency managers to distinguish between functional and medical needs in order to plan for incidents that require evacuation and sheltering. Knowing the percentage of population with a disability gives emergency management personnel and first responders an opportunity to ensure that emergency plans and procedures include considerations for addressing the needs of those residents.

According to the 5-year American Community Survey (2011-2015), there are 378,044 individuals with some form of disability in the City of Los Angeles, representing 9.8 percent of the total.

4.7 ECONOMY

4.7.1 Income

In the United States, individual households are expected to use private resources to prepare for, respond to and recover from disasters to some extent. This means that households living in poverty are automatically disadvantaged when confronting hazards. Additionally, the poor typically occupy more poorly built and inadequately maintained housing. Mobile or modular homes, for example, are more susceptible to damage in earthquakes and floods than other types of housing. In urban areas, the poor often live in older houses and apartment complexes, which are more likely to be made of un-reinforced masonry, a building type that is particularly susceptible to damage during earthquakes. Furthermore, residents below the poverty level are less likely to have insurance to compensate for losses incurred from natural disasters. This means that residents below the poverty level have a great deal to lose during an event and are the least prepared to deal with potential losses. The events following Hurricane Katrina in 2005 illustrated that personal household economics significantly impact people's decisions on evacuation. Individuals who cannot afford gas for their cars will likely decide not to evacuate.

Based on U.S. Census Bureau estimates, per capita income in the planning area in 2015 was $28,761, and the median household income was $50,205. It is estimated that about 12.8 percent of households receive an income between $100,000 and $149,999 per year, and over 14.9 percent of household incomes are above $150,000 annually. About 22 percent of the households in the planning area make less than $25,000 per year and are therefore below the poverty level. The weighted average poverty threshold for a family of four in 2015 was $24,250; for a family of three, $20,090; for a family of two, $15,930.

4.7.2 Industry, Businesses and Institutions

The City of Los Angeles has the 16th largest economy in the world (LATCB, 2015). The Port of Los Angeles handles tens of billions of dollars in industry sales. According to the Los Angeles Tourism & Convention Board, the total value of two-way trade handled at the Los Angeles Customs District in 2014 was a record $426 billion. The City is also home to the Los Angeles International (LAX), L.A./Ontario International and Van Nuys airports, generating billions of dollars in revenue and transporting millions of passengers.

Los Angeles is well known for its higher education institutions, events, sports centers, urban and outdoor recreational tourist attractions, shopping enclaves, dining destinations, and arts and cultural institutions. Los Angeles is regarded as the entertainment capital of the world and is leading in several growth industries, including the fashion, health services/biomedical, and aerospace/technology industries (LATCB, 2015).

The planning area's economy is strongly based in the education/health care/social service industry (22.2 percent), followed by the professional/scientific/management/administrative industry (15.1 percent), and arts/entertainment/recreation industry (12.8 percent). Natural resource industries (<1 percent), and public administration (2.8 percent) make up the smallest sources of the local economy. Figure 4-20 shows the breakdown of industry types in the planning area. According to the Los Angeles Tourism & Convention Board, leisure and hospitality is a leading industry in Los Angeles, employing 464,600 individuals in 2014. The apparel, health care, aerospace product and manufacturing, entertainment industries also employ thousands of employees and generate billions of dollars in revenue.

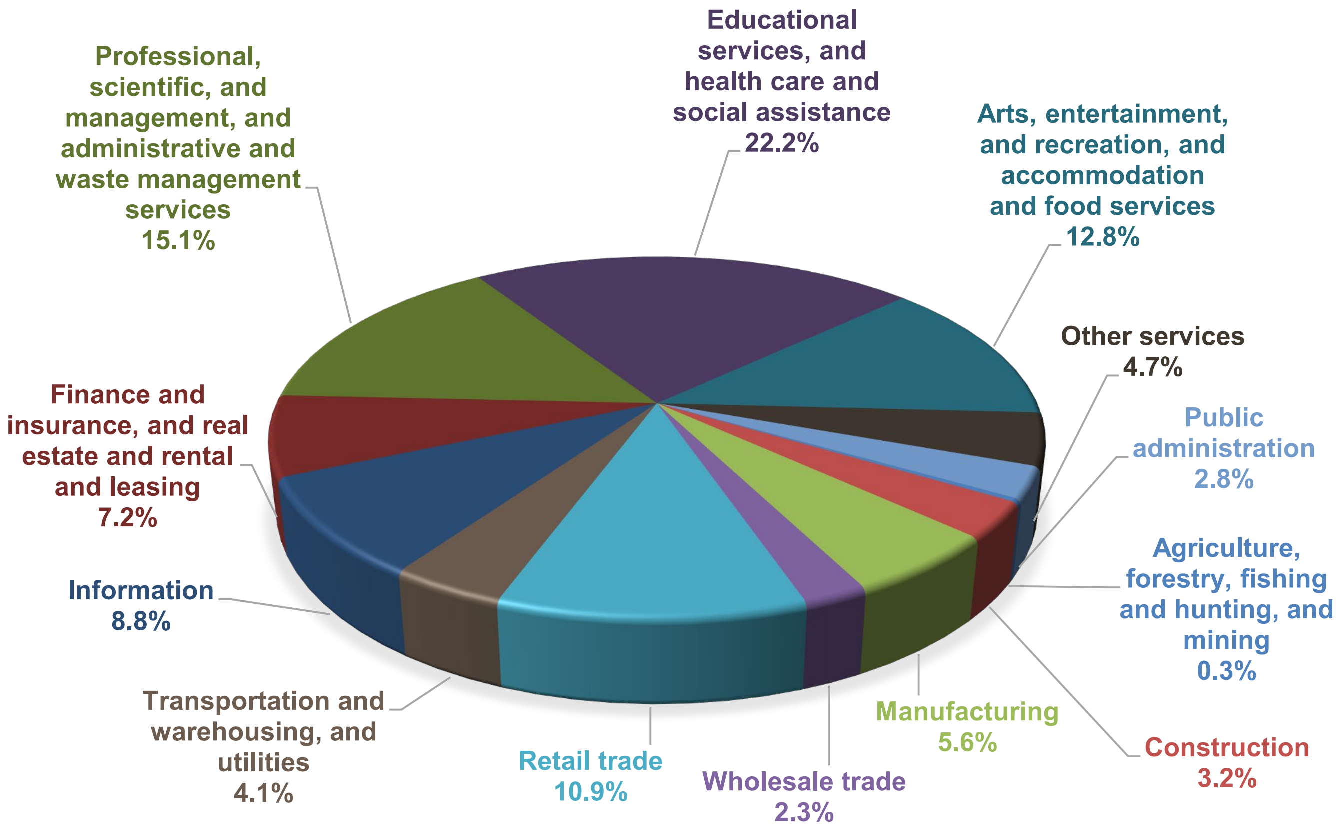

Figure 4-20. Industry in the Planning Area

Online data sources identify the following large employers in Los Angeles County (CA EDD, LA Business Journal, LA Almanac, 2017):

- Government organizations—Los Angeles County, Los Angeles Unified Schools, the City of Los Angeles, the federal government and the State of California
- Universities—The University of California Los Angeles, the University of Southern California and the California Institute of Technology
- Large health-care providers—Kaiser Permanente, Cedars-Sinai Medical Center, Providence Health and Services, Long Beach Memorial Medical Center, Children's Hospital of Los Angeles and Adventist Health
- Large defense contractors—Northrop Grumman Corporation, the Boeing Company, Raytheon Company and Lockheed Martin Corporation
- Major employers in retail—Kroger, Target, The Home Depot, Von's and Costco
- Banks—Bank of America, Wells Fargo, and J.P. Morgan Chase
- Entertainment industry—FX Networks, Walt Disney Company, Warner Bros. Entertainment Inc. and Sony Pictures Entertainment
- Other major employers—VXI Global Solutions call centers, American Apparel, Farmers Insurance Group, UPS, and AT&T Inc.

4.7.3 Employment Trends and Occupations

According to the 5-year American Community Survey (2011-2015), about 66.2 percent of the City of Los Angeles's population 16 years old or older is in the labor force. Of the working-age population, 40.6 percent of men and 59.4 percent of women are in the labor force.

Figure 4-21 compares state and city unemployment trends from 1995 through 2016. The City of Los Angeles unemployment rate was lowest in 2006 at 5.3 percent. The rate peaked at 13.8 percent in 2010, and has declined since then. The City unemployment rate has generally been slightly higher than the statewide rate.

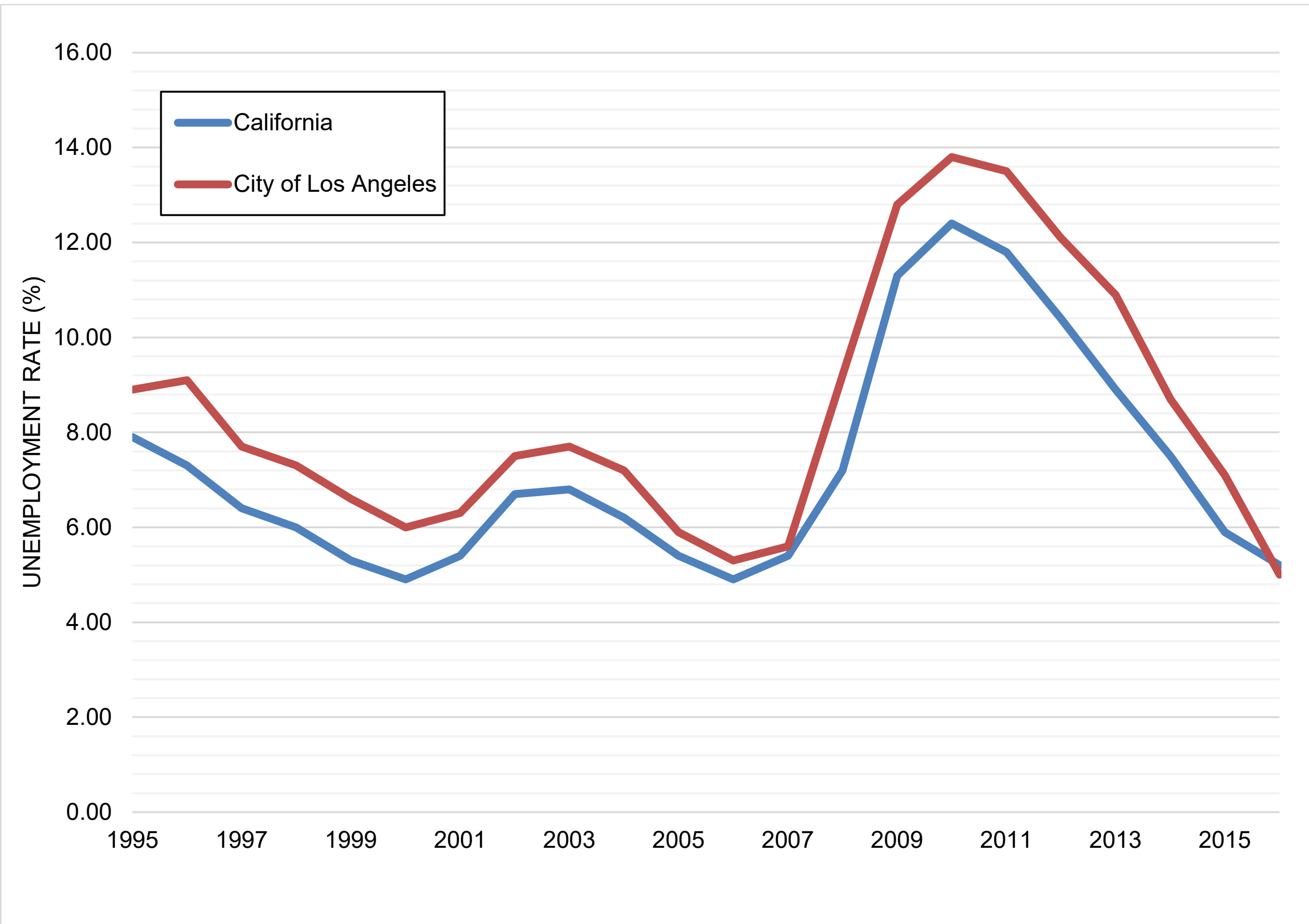

Figure 4-21. California and City of Los Angeles Unemployment Rate

Figure 4-22 shows Census Bureau estimates of employment distribution by occupation category. Management, business, science and arts occupations make up 36 percent of the jobs in the City of Los Angeles. Sales and office occupations make up 23 percent of the local working population.

The U.S. Census estimates that over 67.9 percent of workers in the planning area commute alone (by car, truck or van) to work, and mean travel time to work is 30.1 minutes.

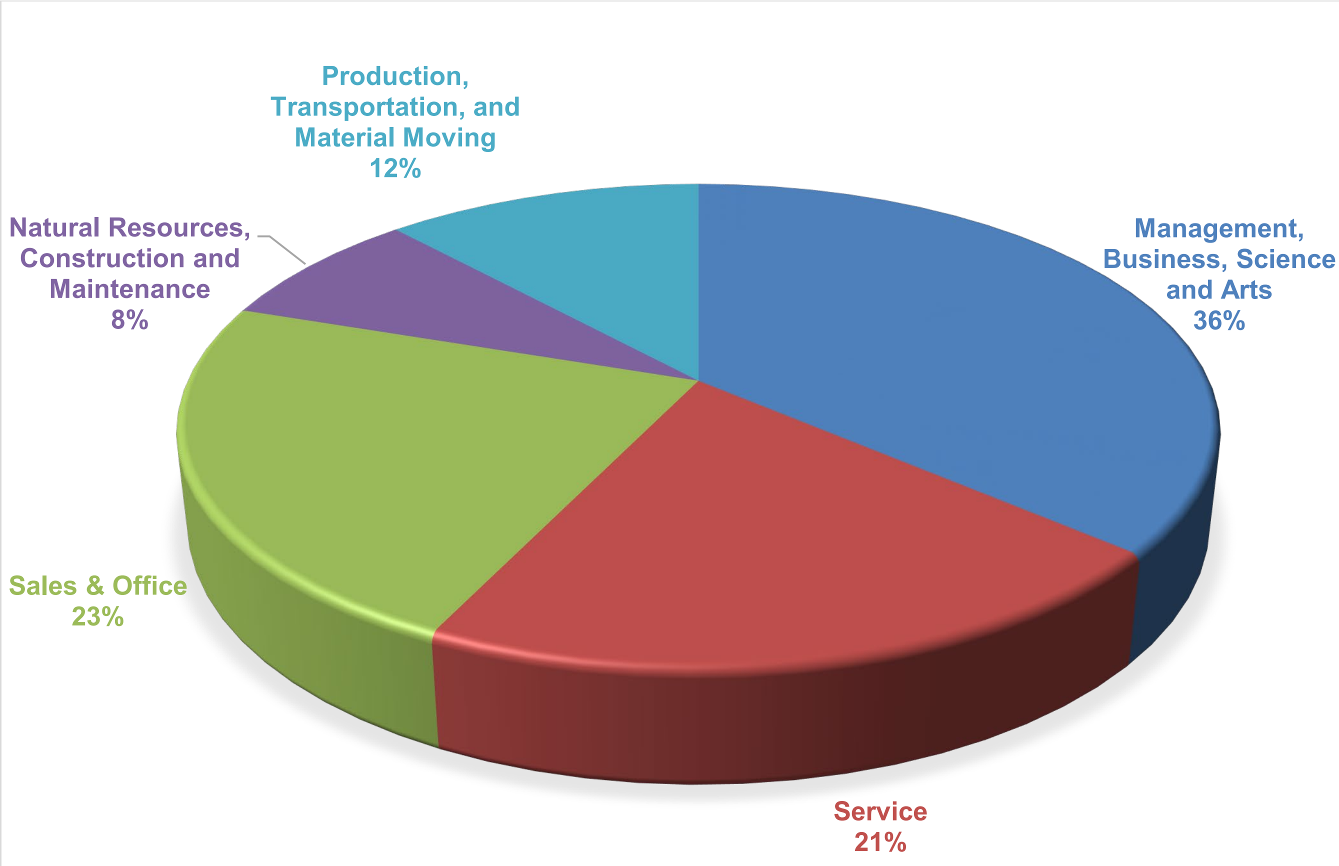

Figure 4-22. Occupations in the City of Los Angeles

4.8 VULNERABLE COMMUNITIES

Nine of the 10 most vulnerable communities in Los Angeles County are located within the City of Los Angeles, according to the Red Cross' PrepareLA Vulnerable Communities Project (American Red Cross, 2014). These communities do not align within the Area Planning Commissions for the City of Los Angeles.

These are Westlake, Historic South-Central, South Park, Central-Alameda, Pico Union, Florence, Watts, Boyle Heights, and Koreatown. They were selected based on eight indicators of vulnerability: race/ethnicity and poverty, single parent head of household, educational attainment, limited English language proficiency, car-less households, age dependency ratio, population density, and the presence of access and functional needs population.

The Office of Environmental Health Hazard Assessment, on behalf of the California Environmental Protection Agency, identified California communities that are disproportionately burdened by many sources of pollution and are socioeconomically disadvantaged. Each of these communities was afforded a CalEnviroScreen score. A significantly above average score was given to each of the City of Los Angeles' most vulnerable communities. The PrepareLA project confirmed the high CalEnviroScreen scores, showing that each of the most vulnerable communities has a high presence of facilities or railway lines that contribute to air pollution. Statistics indicating these communities' vulnerability are summarized in Table 4-7 through Table 4-9. The following sections offer discussions of each individual community.

Table 4-7. Vulnerable Neighborhood Community Assets

Neighborhood	Emergency Response Facilities Assets	Healthcare Facilities Assets	Open Space & Recreation Centers Assets	Community Serving Organization Assets
Westlake	9	20	Recreation facilities near MacArthur Park	30
Historic South-Central	8	11	2	20
South Park	3	3	2	4
Central-Alameda	8	3	4	19
Pico Union	7	5	7	19
Florence	4	4	0	5
Watts	11	3	No information	29
Boyle Heights	17	30	25	42
Koreatown	7	9	4	50

Source: American Red Cross Los Angeles Region (2014). "PrepareLA– Vulnerable Communities Project." Los Angeles, CA.

Table 4-8. Vulnerable Neighborhood Hazards

Neighborhood	CalEnviro-Screen Score	Earthquake Liquefaction Zone Risk	Air Pollutants Risk	Flooding Risk	Extreme Heat Risk
Westlake	71-100%	NE portion of the neighborhood west of Glendale Blvd.	1 hazardous waste facility at NW corner	Around lake at MacArthur Park	Moderate, 13 exceptionally high temperatures/year
Historic South-Central	86-100%	SW corner of the district near Vernon Avenue	2 point source facilities	Low	Moderate, 13 exceptionally high temperatures/year
South Park	86-100%	2/3 of the area	1 railway line, 1 hazardous waste facility in SE portion of the district	Low	Moderate, 13 exceptionally high temperatures/year
Central-Alameda	76-100%	Southern portion	2 hazardous waste facilities, 2 point source facilities, 2 railway lines	Low	Moderate, 13 exceptionally high temperatures/year
Pico Union	76-95%	Low risk	1 point source facility	Low	Moderate, 13 exceptionally high temperatures/year
Florence	86-100%	Entire area	Several railway lines 3 point source facilities	Low	Moderate
Watts	61-100%	Entire area	1 hazardous waste facility, 2 railway lines	Low	Moderate
Boyle Heights	56-90%	Northern portions	Several railway lines, 7 hazardous waste facilities, 6 point source facilities	Low	Moderate
Koreatown	47-79%	Low risk	Low	High	Moderate

Source: American Red Cross Los Angeles Region (2014). "PrepareLA– Vulnerable Communities Project." Los Angeles, CA.

Table 4-9. Vulnerable Neighborhood Race/Ethnicity, Educational Attainment, and Language Ability

Neighborhood	Population	Race/Ethnicity Other Than White	Educational Attainment (HS Diploma or Higher)	Speak English Less Than Very Well/ Non-English Languages
Westlake	104,246	95.2%	54.4%	58.4% (Spanish, Korean, Tagalog)
Historic South-Central	46,892	98.8%	34.9%	58.4% (Spanish, Korean, Thai)
South Park	32,938	98.8%	39.8%	48.5% (Spanish, Korean, Thai)
Central-Alameda	42,124	99.5%	33.6%	48.5% (Spanish, Korean, Thai)
Pico Union	41,545	96.4%	46.5%	59.8% (Spanish, Korean, Tagalog)
Florence	47,839	99.1%	42.5%	44.7% (Spanish, Cambodian, Mon-Kmer)
Watts	39,362	99.3%	46.4%	31.8% (Spanish, Korean, Japanese)
Boyle Heights	89,498	97.8%	45.4%	51.6% (Spanish, Chinese, Tagalog)
Koreatown	108,363	92.5%	69.5%	56.6% (Spanish, Korean, Tagalog)

Source: American Red Cross Los Angeles Region (2014). "PrepareLA– Vulnerable Communities Project." Los Angeles, CA.

4.8.1 Westlake Community

Westlake is a commercial neighborhood in central Los Angeles near MacArthur Park, bordered by Silver Lake, Echo Park, Downtown, Pico-Union, and Koreatown. With over 100,000 residents in 2.72 square miles (46,201 people per square mile), it is the second densest neighborhood in Los Angeles County. The median household income is low, with 67.4 percent below 200 percent of the federal poverty line. The percent of households without access to a vehicle is 35.4 percent. An age dependency ratio of 47 percent means that for every 100 working age adults there are 47 dependents, a rate slightly lower than the city's other vulnerable communities.

4.8.2 Historic South-Central Community

Historic South-Central is 3 miles southwest of Downtown Los Angeles, east of the I-110 freeway and south of the I-10 freeway. Almost 47,000 residents live within in a 2.5-square-mile area, placing it among the city's 20 densest neighborhoods. Historic South-Central's population is more than 77 percent low-income and almost 45 percent single-parent households. Just over one-quarter of all households do not have a car. The number of dependents in the area is slightly higher than average, with 62 dependents for every 100 working age adults.

4.8.3 South Park Community

South Park is just south of Historic South-Central, east of the I-110 freeway and bounded by Vernon Avenue to the north and Slauson Avenue to the south. The neighborhood is home to just under 33,000 people and covers 1.4 square miles. With over 24,000 people per square mile, it is one of Los Angeles County's densest communities. One in five households does not have a vehicle and an age dependency ratio of 68.9 percent means that for every 100 working age adults there are nearly 70 dependents.

4.8.4 Central-Alameda Community

The Central-Alameda district is just east of Historic South-Central and South Park. It is bounded by Central Avenue to the west, Slauson Street to the south, Alameda Street to the East, and Washington Boulevard to the north. The neighborhood has over 42,000 residents and covers 2.2 square miles, placing it among the city's 20 densest neighborhoods. More than two-thirds of households are low-income. Just 33 percent of residents over the age of 25 hold at least a high school diploma. One in five households does not have a vehicle. For every 100 working age adults there are about 66 dependents.

4.8.5 Pico Union Community

The Pico-Union district is immediately south of the Westlake and Koreatown neighborhoods. It is bounded by Olympic Boulevard on the north, the I-110 freeway to the east, and the I-10 freeway to the south. Over 41,000 people reside in its 1.67 square miles, making it one of the County's densest communities. More than 71 percent are low-income. More than half the population over the age of 25 does not hold a high school diploma or its equivalent. Three in 10 households lack a vehicle. There are 52 dependents for every 100 working age adults.

4.8.6 Florence Community

The Florence neighborhood is just south of Historic South-Central and South Park. Just fewer than 48,000 people reside within its 2.8 square miles. Florence has 71.4 percent low-income households, and more than 44 percent are headed by a single parent.

4.8.7 Watts Community

Watts lies north of the I-105 freeway and contains the public housing developments of Imperial Courts, Jordan Downs, and Nickerson Gardens. The area of Watts is 2.1 square miles, with just under 40,000 people, ranking it among the city's 10 densest neighborhoods. Over 71 percent are low-income. Nearly 20 percent of households lack an automobile. The age dependency ratio in Watts is the highest among the most vulnerable communities, with 84 dependents for every 100 working age adults.

4.8.8 Boyle Heights Community

Boyle Heights is a mainly residential neighborhood just east of the Los Angeles River and west of Indiana Street. Over 89,000 people live in its area of 6.5 square miles. Nearly 70 percent of households are low-income and almost 21 percent of households do not have access to a vehicle. The age dependency ratio is high, with almost 70 dependents for every 100 working age adults.

4.8.9 Koreatown Community

Koreatown is just west of Westlake. The district is home to over 108,000 people and covers 2.7 square miles. With a population density of nearly 52,000 people per square mile, it is one of the densest areas of both the City and County of Los Angeles. Nearly 60 percent of households are low-income. Almost 28 percent do not have access to a vehicle. Just fewer than 25 percent of households are headed by a single parent.

4.9 LAWS AND ORDINANCES

Existing laws, ordinances, plans and programs at the federal, state and local level can support or impact hazard mitigation actions identified in this plan. Hazard mitigation plans are required to include a review and incorporation, if appropriate, of existing plans, studies, reports, and technical information as part of the planning process (44 CFR, Section 201.6(b)(3)). The following federal and state programs have been identified as programs that may interface with the actions identified in this plan. Each of these programs enhances capabilities to implement the mitigation actions in this plan or has a nexus with the mitigation actions in this plan. The purpose of this section is to inform a thorough review of local capability to implement the actions, as presented in in Section 4.9.4.

4.9.1 Federal

Disaster Mitigation Act

The DMA is the current federal legislation addressing hazard mitigation planning. It emphasizes planning for disasters before they occur. It specifically addresses planning at the local level, requiring plans to be in place before Hazard Mitigation Assistance grant funds are available to communities. This plan is designed to meet the requirements of DMA, improving eligibility for future hazard mitigation funds.

Emergency Watershed Program

The USDA Natural Resources Conservation Service (NRCS) administers the Emergency Watershed Protection (EWP) Program, which responds to emergencies created by natural disasters. Eligibility for assistance is not dependent on a national emergency declaration. The program is designed to help people and conserve natural resources by relieving imminent hazards to life and property caused by floods, fires, windstorms, and other natural occurrences. EWP is an emergency recovery program. Financial and technical assistance are available for the following activities (Natural Resources Conservation Service, 2016):

- Remove debris from stream channels, road culverts, and bridges
- Reshape and protect eroded banks
- Correct damaged drainage facilities
- Establish cover on critically eroding lands
- Repair levees and structures
- Repair conservation practices.

This federal program has objectives similar to those of the Disaster Mitigation Act and could be a funding source for actions identified in this plan.

Emergency Relief for Federally Owned Roads Program

The U.S. Forest Service's Emergency Relief for Federally Owned Roads Program was established to assist federal agencies with repair or reconstruction of tribal transportation facilities, federal lands transportation facilities, and other federally owned roads that are open to public travel and have suffered serious damage by a natural disaster over a wide area or by a catastrophic failure. The program funds both emergency and permanent repairs (Office of Federal Lands Highway, 2016). Eligibility under this program corresponds with some of the goals and objectives for this plan, so this could be a funding source for actions identified in this plan.

National Flood Insurance Program

The National Flood Insurance Program (NFIP) makes federally backed flood insurance available to homeowners, renters, and business owners in participating communities. For most participating communities, FEMA has prepared a detailed Flood Insurance Study. The study presents water surface elevations for floods of various magnitudes, including the 1-percent annual-chance flood (called the 100-year flood or base flood) and the 0.2-percent annual chance flood (the 500-year flood). Base flood elevations and the boundaries of the 1-percent-annual-chance and 0.2-percent-annual-chance floodplains are shown on Flood Insurance Rate Maps (FIRMs), which are the principle tool for identifying the extent and location of the flood hazard. FIRMs are the most detailed and consistent data source available, and for many communities they represent the minimum area of oversight under the local floodplain management program. In recent years, FIRMs have been digitized as Digital Flood Insurance Rate Maps (DFIRMs), which are more accessible to residents, local government and stakeholders.

Participants in the NFIP must, at a minimum, regulate development in floodplain areas in accordance with NFIP criteria. Before issuing a permit to build in a floodplain, they must ensure that three criteria are met:

- New buildings and those undergoing substantial improvements must, at a minimum, be elevated to protect against damage by the 1-percent annual-chance flood.
- New floodplain development must not aggravate existing flood problems or increase damage to other properties.
- New floodplain development must exercise a reasonable and prudent effort to reduce its adverse impacts on threatened and endangered species.

Full compliance and good standing under the NFIP are prerequisites for all of the FEMA grant programs to which this plan acts as a keyway.

Community Rating System

The Community Rating System (CRS) is a voluntary program within the NFIP that encourages floodplain management activities that exceed the minimum NFIP requirements. Flood insurance premiums are discounted to reflect the reduced flood risk resulting from community actions meeting the following three goals of the CRS:

- Reduce flood losses.
- Facilitate accurate insurance rating.
- Promote awareness of flood insurance.

For participating communities, flood insurance premium rates are discounted in increments of 5 percent. For example, a Class 1 community would receive a 45 percent premium discount, and a Class 9 community would receive a 5 percent discount. The CRS classes for local communities are based on 18 creditable activities in the following categories:

- Public information
- Mapping and regulations
- Flood damage reduction
- Flood preparedness.

Figure 4-23 shows the nationwide number of CRS communities by class as of October 2016, when there were 1,391 communities receiving flood insurance premium discounts under the CRS program.

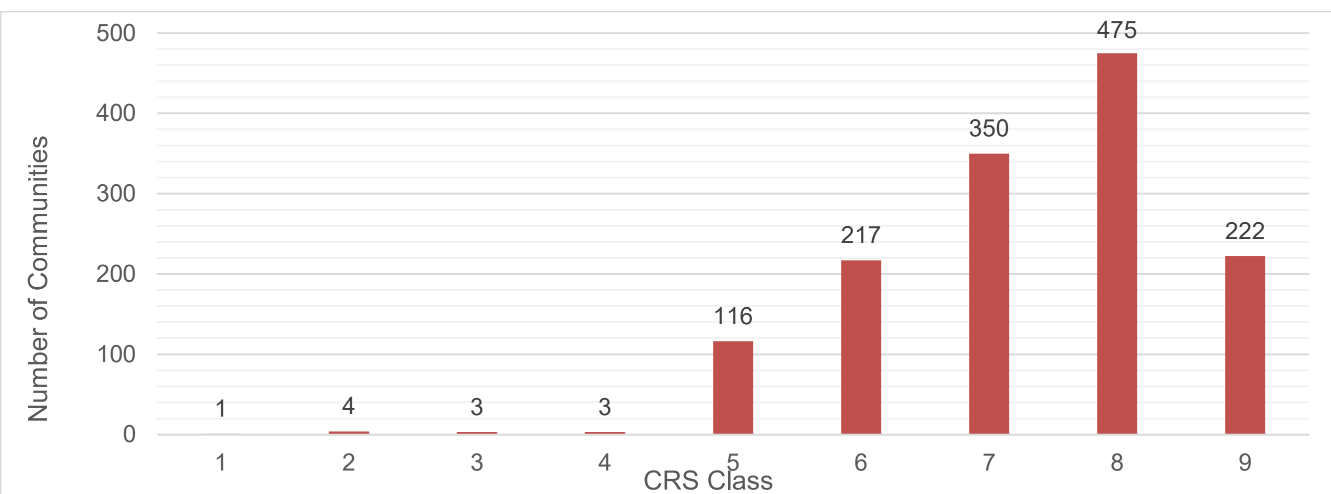

Figure 4-23. CRS Communities by Class Nationwide as of October 2016

CRS activities can help to save lives and reduce property damage. Communities participating in the CRS represent a significant portion of the nation's flood risk; over 66 percent of the NFIP's policy base is located in these communities. Communities receiving premium discounts through the CRS range from small to large and represent a broad mixture of flood risks, including both coastal and riverine flood risks. The City of Los Angeles has participated in the CRS program since 1991. Many of the programs the City is receiving credit for under the CRS program strive to reduce the impacts from flood-related hazards within the City.

Presidential Executive Orders 11988 and 13690

Executive Order 11988 requires federal agencies to avoid to the extent possible the long and short-term adverse impacts associated with the occupancy and modification of floodplains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative. It requires federal agencies to provide leadership and take action to reduce the risk of flood loss, minimize the impact of floods on human safety, health, and welfare, and restore and preserve the natural and beneficial values of floodplains. The requirements apply to the following activities (FEMA, 2015a):

- Acquiring, managing, and disposing of federal lands and facilities
- Providing federally undertaken, financed, or assisted construction and improvements
- Conducting federal activities and programs affecting land use, including but not limited to water and related land resources planning, regulation, and licensing.

Executive Order 13690 expands Executive Order 11988 and acknowledges that the impacts of flooding are anticipated to increase over time due to the effects of climate change and other threats. It mandates a federal flood risk management standard to increase resilience against flooding and help preserve the natural values of floodplains. This standard expands management of flood issues from the current base flood level to a higher vertical elevation and corresponding horizontal floodplain. The goal is to address current and future flood risk and ensure that projects funded with taxpayer dollars last as long as intended (Office of the Press Secretary, 2015). All actions identified in this plan will seek full compliance with all presidential executive orders that may interface with the given action.

The Clean Water Act

The federal Clean Water Act (CWA) employs regulatory and non-regulatory tools to reduce direct pollutant discharges into waterways, finance municipal wastewater treatment facilities, and manage polluted runoff. These tools are employed to achieve the broader goal of restoring and maintaining the chemical, physical, and biological integrity of the nation's surface waters so that they can support "the protection and propagation of fish, shellfish, and wildlife and recreation in and on the water."

Evolution of CWA programs over the last decade has included a shift from a program-by-program, source-by-source, pollutant-by-pollutant approach to more holistic watershed-based strategies. Under the watershed approach, equal emphasis is placed on protecting healthy waters and restoring impaired ones. A full array of issues are addressed, not just those subject to CWA regulatory authority. Involvement of stakeholder groups in the development and implementation of strategies for achieving and maintaining water quality and other environmental goals is a hallmark of this approach.

The CWA is important to hazard mitigation in several ways. There are often permitting requirements for any construction within 200 feet of water of the United States, which may have implications for mitigation projects identified by a local jurisdiction. Additionally, CWA requirements apply to wetlands, which serve important functions related to preserving and protecting the natural and beneficial functions of floodplains and are linked with a community's floodplain management program. Finally, the National Pollutant Discharge Elimination

System is part of the CWA and addresses local stormwater management programs. Stormwater management plays a critical role in hazard mitigation by addressing urban drainage or localized flooding issues within jurisdictions.

Any action identified in this plan that has overlap with the scope of the CWA will need to comply with the act. All FEMA hazard mitigation project grant applications require full compliance with all federal acts that may interface with the action.

Presidential Executive Order 11990

Executive Order 11990 requires federal agencies to provide leadership and take action to minimize the destruction, loss or degradation of wetlands, and to preserve and enhance the natural and beneficial values of wetlands. The requirements apply to the following activities (National Archives, 2016):

- Acquiring, managing, and disposing of federal lands and facilities
- Providing federally undertaken, financed, or assisted construction and improvements
- Conducting federal activities and programs affecting land use, including but not limited to water and related land resources planning, regulation, and licensing.

All actions identified in this plan will seek full compliance with all presidential executive orders that may interface with the given action.

Endangered Species Act

The federal Endangered Species Act (ESA) was enacted in 1973 to conserve species facing depletion or extinction and the ecosystems that support them. The act sets forth a process for determining which species are threatened and endangered and requires the conservation of the critical habitat in which those species live. The ESA provides broad protection for species of fish, wildlife and plants that are listed as threatened or endangered. Provisions are made for listing species, as well as for recovery plans and the designation of critical habitat for listed species. The ESA outlines procedures for federal agencies to follow when taking actions that may jeopardize listed species and contains exceptions and exemptions. It is the enabling legislation for the Convention on International Trade in Endangered Species of Wild Fauna and Flora. Criminal and civil penalties are provided for violations of the ESA and the Convention.

Federal agencies must seek to conserve endangered and threatened species and use their authorities in furtherance of the ESA's purposes. The ESA defines three fundamental terms:

- **Endangered** means that a species of fish, animal or plant is "in danger of extinction throughout all or a significant portion of its range." (For salmon and other vertebrate species, this may include subspecies and distinct population segments.)
- **Threatened** means that a species "is likely to become endangered within the foreseeable future." Regulations may be less restrictive for threatened species than for endangered species.
- **Critical habitat** means "specific geographical areas that are…essential for the conservation and management of a listed species, whether occupied by the species or not."

Five sections of the ESA are of critical importance to understanding it:

- **Section 4: Listing of a Species**—The National Oceanic and Atmospheric Administration Fisheries Service (NOAA Fisheries) is responsible for listing marine species; the U.S. Fish and Wildlife Service is responsible for listing terrestrial and freshwater aquatic species. The agencies may initiate reviews for listings, or residents may petition for them. A listing must be made "solely on the basis of the best scientific and commercial data available." After a listing has been proposed, agencies receive comment and conduct further scientific reviews for 12 to 18 months, after which they must decide if the listing is warranted. Economic impacts cannot be considered in this decision, but it may include an evaluation of the adequacy of local and state protections. Critical habitat for the species may be designated at the time of listing.

- **Section 7: Consultation**—Federal agencies must ensure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of a listed or proposed species or adversely modify its critical habitat. This includes private and public actions that require a federal permit. Once a final listing is made, non-federal actions are subject to the same review, termed a "consultation." If the listing agency finds that an action will "take" a species, it must propose mitigations or "reasonable and prudent" alternatives to the action; if the proponent rejects these, the action cannot proceed.
- **Section 9: Prohibition of Take—**It is unlawful to "take" an endangered species, including killing or injuring it or modifying its habitat in a way that interferes with essential behavioral patterns, including breeding, feeding or sheltering.
- **Section 10: Permitted Take**—Through voluntary agreements with the federal government that provide protections to an endangered species, a non-federal applicant may commit a take that would otherwise be prohibited as long as it is incidental to an otherwise lawful activity (such as developing land or building a road). These agreements often take the form of a "Habitat Conservation Plan."
- **Section 11: Citizen Lawsuits**—Civil actions initiated by any citizen can require the listing agency to enforce the ESA's prohibition of taking or to meet the requirements of the consultation process.

Any action identified in this plan that has overlap with the ESA will need to comply with the act. All FEMA hazard mitigation project grant applications require full compliance with all federal acts that may interface with the action.

National Environmental Policy Act

The National Environmental Policy Act (NEPA) requires federal agencies to consider the environmental impacts of proposed actions and reasonable alternatives to those actions, alongside technical and economic considerations. NEPA established the Council on Environmental Quality (CEQ), whose regulations (40 CFR Parts 1500-1508) set the standard for NEPA compliance. Consideration of environmental impacts and decision-making process is documented in an environmental impact statement or environmental assessment. Environmental impact assessment requires the evaluation of reasonable alternatives to a proposed action, solicitation of input from organizations and individuals that could be affected, and the unbiased presentation of direct, indirect, and cumulative environmental impacts. Any action identified in this plan that has overlap with the scope of NEPA will need to comply with the act. All FEMA hazard mitigation project grant applications require full compliance with all federal acts that may interface with the action.

National Incident Management System

The National Incident Management System (NIMS) is a systematic approach for government, nongovernmental organizations, and the private sector to work together to manage incidents involving hazards. The NIMS provides a flexible but standardized set of incident management practices. Incidents typically begin and end locally, and they are managed at the lowest possible geographical, organizational, and jurisdictional level. In some cases, success depends on the involvement of multiple jurisdictions, levels of government, functional agencies, and emergency responder disciplines. These cases necessitate coordination across a spectrum of organizations. Communities using NIMS follow a comprehensive national approach that improves the effectiveness of emergency management and response personnel across the full spectrum of potential hazards (including natural hazards, technological hazards, and human-caused hazards) regardless of size or complexity. Although participation is voluntary, federal departments and agencies are required to make adoption of NIMS by local and state jurisdictions a condition to receive federal preparedness grants and awards.

Hazard mitigation is one of the four phases of emergency management (preparedness, response, recovery and mitigation), and this plan is a viable support tool for any of these phases. Since NIMS is a response function, information in the hazard mitigation plan can support the implementation and update of all NIMS-compliant plans within the City.

Americans with Disabilities Act

The Americans with Disabilities Act (ADA) seeks to prevent discrimination against people with disabilities in employment, transportation, public accommodation, communications, and government activities. Title II of the ADA deals with compliance with the Act in emergency management and disaster-related programs, services, and activities. It applies to state and local governments as well as third parties, including religious entities and private nonprofit organizations. Any action identified in this plan that has overlap with the scope of the ADA will need to comply with the act. All FEMA hazard mitigation project grant application require full compliance with all federal acts that may interface with the action.

The ADA has implications for sheltering requirements and public notifications. During an emergency alert, officials must use a combination of warning methods to ensure that all residents have all necessary information. Those with hearing impairments may not hear radio, television, sirens, or other audible alerts, while those with visual impairments may not see flashing lights or other visual alerts. Two technical documents for shelter operators address physical accessibility needs of people with disabilities, as well as medical needs and service animals.

The ADA intersects with disaster preparedness programs in regards to transportation, social services, temporary housing, and rebuilding. Persons with disabilities may require additional assistance in evacuation and transit (e.g., vehicles with wheelchair lifts or paratransit buses). Evacuation and other response plans should address the unique needs of residents. Local governments may be interested in implementing a special-needs registry to identify the home addresses, contact information, and needs for residents who may require more assistance.

Civil Rights Act of 1964

The Civil Rights Act of 1964 prohibits discrimination based on race, color, religion, sex or nation origin and requires equal access to public places and employment. The Act is relevant to emergency management and hazard mitigation in that it prohibits local governments from favoring the needs of one population group over another. Local government and emergency response must ensure the continued safety and well-being of all residents equally, to the extent possible. Any action identified in this plan that has overlap with the Civil Rights Act will need to comply with the act. All FEMA hazard mitigation project grant application require full compliance with all federal acts that may interface with the action.

Community Development Block Grant Disaster Resilience Program

In response to disasters, Congress may appropriate additional funding for the U.S. Department of Housing and Urban Development Community Development Block Grant programs to be distributed as Disaster Recovery grants (CDBG-DR). These grants can be used to rebuild affected areas and provide seed money to start the recovery process. CDBG-DR assistance may fund a broad range of recovery activities, helping communities and neighborhoods that otherwise might not recover due to limited resources. CDBG-DR grants often supplement disaster programs of the Federal Emergency Management Agency, the Small Business Administration, and the U.S. Army Corps of Engineers. Housing and Urban Development generally awards noncompetitive, nonrecurring CDBG-DR grants by a formula that considers disaster recovery needs unmet by other federal disaster assistance programs. To be eligible for CDBG-DR funds, projects must meet the following criteria:

- Address a disaster-related impact (direct or indirect) in a presidentially declared county for the covered disaster

- Be a CDBG-eligible activity (according to regulations and waivers)
- Meet a national objective.

Incorporating preparedness and mitigation into these actions is encouraged, as the goal is to rebuild in ways that are safer and stronger. The CDGB-DR program is a potential alternative source of funding for actions identified in this plan.

Army Corps of Engineers Programs

The U.S. Army Corps of Engineers has several civil works authorities and programs related to flood risk and flood hazard management:

- The Floodplain Management Services program offers 100-percent federally funded technical services such as development and interpretation of site-specific data related to the extent, duration and frequency of flooding. Special studies may be conducted to help a community understand and respond to flood risk. These may include flood hazard evaluation, flood warning and preparedness, or flood modeling.
- For more extensive studies, the Corps of Engineers offers a cost-shared program called Planning Assistance to States and Tribes. Studies under this program generally range from $25,000 to $100,000 with the local jurisdiction providing 50 percent of the cost.
- The Corps of Engineers has several cost-shared programs (typically 65 percent federal and 35 percent non-federal) aimed at developing, evaluating and implementing structural and non-structural capital projects to address flood risks at specific locations or within a specific watershed:
    - The Continuing Authorities Program for smaller-scale projects includes Section 205 for Flood Control, with a $7 million federal limit and Section 14 for Emergency Streambank Protection with a $1.5 million federal limit. These can be implemented without specific authorization from Congress.
    - Larger scale studies, referred to as General Investigations, and projects for flood risk management, for ecosystem restoration or to address other water resource issues, can be pursued through a specific authorization from Congress and are cost-shared, typically at 65 percent federal and 35 percent non-federal.
    - Watershed management planning studies can be specifically authorized and are cost-shared at 50 percent federal and 50 percent non-federal.
- The Corps of Engineers provides emergency response assistance during and following natural disasters. Public Law 84-99 enables the Corps to assist state and local authorities in flood fight activities and cost share in the repair of flood protective structures. Assistance is provided in the flowing categories:
    - **Preparedness**—The Flood Control and Coastal Emergency Act establishes an emergency fund for preparedness for emergency response to natural disasters; for flood fighting and rescue operations; for rehabilitation of flood control and hurricane protection structures. Funding for Corps of Engineers emergency response under this authority is provided by Congress through the annual Energy and Water Development Appropriation Act. Disaster preparedness activities include coordination, planning, training and conduct of response exercises with local, state and federal agencies.
    - **Response Activities**—PL 84-99 allows the Corps of Engineers to supplement state and local entities in flood fighting urban and other non-agricultural areas under certain conditions (Engineering Regulation 500-1-1 provides specific details). All flood fight efforts require a project cooperation agreement signed by the public sponsor and the sponsor must remove all flood fight material after the flood has receded. PL 84-99 also authorizes emergency water support and drought assistance in certain situations and allows for “advance measures” assistance to prevent or reduce flood damage conditions of imminent threat of unusual flooding.

- **Rehabilitation—**Under PL 84-99, an eligible flood protection system can be rehabilitated if damaged by a flood event. The flood system would be restored to its pre-disaster status at no cost to the federal system owner, and at 20-percent cost to the eligible non-federal system owner. All systems considered eligible for PL 84-99 rehabilitation assistance have to be in the Rehabilitation and Inspection Program prior to the flood event. Acceptable operation and maintenance by the public levee sponsor are verified by levee inspections conducted by the Corps on a regular basis. The Corps has the responsibility to coordinate levee repair issues with interested federal, state, and local agencies following natural disaster events where flood control works are damaged.

All of these authorities and programs are available to the City of Los Angeles to support any intersecting mitigation actions.

4.9.2 State

Alquist-Priolo Earthquake Fault Zoning Act

The Alquist-Priolo Earthquake Fault Zoning Act was enacted in 1972 to mitigate the hazard of surface faulting to structures for human occupancy. The Alquist-Priolo Earthquake Fault Zoning Act's main purpose is to prevent construction of buildings used for human occupancy on the surface trace of active faults. Before a new project is permitted, cities and counties require a geologic investigation to demonstrate that proposed buildings will not be constructed on active faults. The act addresses only the hazard of surface fault rupture and is not directed toward other earthquake hazards, such as liquefaction or seismically induced landslides. The law requires the State of California geologist to establish regulatory zones around the surface traces of active faults and to issue appropriate maps. The maps are distributed to all affected cities, counties, and state agencies for their use in planning and controlling new or renewed construction. Local agencies must regulate most development projects within the zones. Projects include all land divisions and most structures for human occupancy. All seismic hazard mitigation actions identified in this plan will seek full compliance with the Alquist-Priolo Earthquake Fault Zoning Act.

California General Planning Law

California state law requires that every county and city prepare and adopt a comprehensive long-range plan to serve as a guide for community development. The general plan expresses the community's goals, visions, and policies relative to future land uses, both public and private. The general plan is mandated and prescribed by state law (Cal. Gov. Code §65300 et seq.), and forms the basis for most local government land use decision-making.

The plan must consist of an integrated and internally consistent set of goals, policies, and implementation measures. In addition, the plan must focus on issues of the greatest concern to the community and be written in a clear and concise manner. City actions, such as those relating to land use allocations, annexations, zoning, subdivision and design review, redevelopment, and capital improvements, must be consistent with the plan.

The City of Los Angeles has a general plan that is currently compliant with this law and has committed to integrating this mitigation plan with its general plan through other provisions referenced below (AB-2140 and SB-379).

California Environmental Quality Act

The California Environmental Quality Act (CEQA) was passed in 1970, shortly after the federal government passed the National Environmental Policy Act, to institute a statewide policy of environmental protection. CEQA requires state and local agencies in California to follow a protocol of analysis and public disclosure of the potential environmental impacts of development projects. CEQA makes environmental protection a mandatory part of every California state and local agency's decision making process.

CEQA establishes a statewide environmental policy and mandates actions all state and local agencies must take to advance the policy. For any project under CEQA's jurisdiction with potentially significant environmental impacts, agencies must identify mitigation measures and alternatives by preparing an environmental impact report and may approve only projects with no feasible mitigation measures or environmentally superior alternatives.

All discretionary actions require environmental review pursuant to CEQA. However, the CEQA guidelines list classes of projects that have been determined to not have a significant effect on the environment—referred to as categorical exemptions. These include feasibility and planning studies for possible future action. Planning processes such as hazard mitigation planning meet the criteria for this exemption, so the City of Los Angeles has determined that this plan update is categorically exempt from the formal CEQA protocol. The City will initiate the formal CEQA protocol on any project recommended in this plan that requires adherence to this protocol at the initiation of the project. Any project action identified in this plan will seek full CEQA compliance upon implementation.

Assembly Bill 162: Flood Planning

This California State Assembly bill passed in 2007 requires cities and counties to address flood-related matters in the land use, conservation, and safety and housing elements of their general plans. The land use element must identify and annually review the areas covered by the general plan that are subject to flooding as identified in floodplain mapping by either FEMA or the state Department of Water Resources (DWR). Upon the next revision of the housing element on or after January 1, 2009, the conservation element of the general plan must identify rivers, creeks, streams, flood corridors, riparian habitat, and land that may accommodate floodwater for the purposes of groundwater recharge and stormwater management. The safety element must identify information regarding flood hazards including:

- Flood hazard zones
- Maps published by FEMA, DWR, the U.S. Army Corps of Engineers, the Central Valley Flood Protection Board, California Office of Emergency Services (Cal OES), etc.
- Historical data on flooding
- Existing and planned development in flood hazard zones.

The general plan must establish goals, policies and objectives to protect from unreasonable flooding risks including:

- Avoiding or minimizing the risks of flooding new development
- Evaluating whether new development should be located in flood hazard zones
- Identifying construction methods to minimize damage.

Assembly Bill (AB) 162 establishes goals, policies and objectives to protect from unreasonable flooding risks. It establishes procedures for the determination of available land suitable for urban development, which may exclude lands where FEMA or DWR has determined that the flood management infrastructure is not adequate to avoid the risk of flooding.

The City of Los Angeles has developed a Comprehensive Flood Hazard Management Plan that was most recently updated in 2016 and is fully complaint with this bill and FEMA's CRS program. The flood management plan is considered to be fully integrated by reference in this hazard mitigation plan.

Assembly Bill 2140: General Plans—Safety Element

This bill provides that the state may allow for more than 75 percent of public assistance funding under the California Disaster Assistance Act only if the local agency is in a jurisdiction that has adopted a local hazard mitigation plan as part of the safety element of its general plan. The local hazard mitigation plan needs to include elements specified in this legislation. In addition this bill requires Cal OES to give federal mitigation funding preference to cities and counties that have adopted local hazard mitigation plan. The intent of the bill is to encourage cities and counties to create and adopt hazard mitigation plans.

Assembly Bill 70: Flood Liability

This bill provides that a city or county may be required to contribute a fair and reasonable share to compensate for property damage caused by a flood to the extent that it has increased the state's exposure to liability for property damage by unreasonably approving new development in a previously undeveloped area that is protected by a state flood control project, unless the city or county meets specified requirements.

Assembly Bill 32: The California Global Warming Solutions Act

This bill addresses greenhouse gas emissions. It identifies the following potential adverse impacts of global warming:

> "… the exacerbation of air quality problems, a reduction in the quality and supply of water to the state from the Sierra snowpack, a rise in sea levels resulting in the displacement of thousands of coastal businesses and residences, damage to marine ecosystems and the natural environment, and an increase in the incidences of infectious diseases, asthma, and other human health-related problems."

AB 32 establishes a state goal of reducing greenhouse gas emissions to 1990 levels by 2020 (a reduction of approximately 25 percent from forecast emission levels) with further reductions to follow. The law requires the state Air Resources Board to do the following:

- Establish a program to track and report greenhouse gas emissions.
- Approve a scoping plan for achieving the maximum technologically feasible and cost-effective reductions from sources of greenhouse gas emissions.
- Adopt early reduction measures to begin moving forward.
- Adopt, implement and enforce regulations—including market mechanisms such as "cap and-trade" programs—to ensure that the required reductions occur.

The Air Resources Board recently adopted a statewide greenhouse gas emissions limit and an emissions inventory, along with requirements to measure, track, and report greenhouse gas emissions by the industries it determined to be significant sources of greenhouse gas emissions.

Assembly Bill 2800: Climate Change—Infrastructure Planning

This California State Assembly bill passed in 2016. Until July 1, 2020, it requires state agencies to take into account the current and future impacts of climate change when planning, designing, building, operating, maintaining, and investing in state infrastructure. The bill requires agencies to establish a Climate-Safe Infrastructure Working Group by July 1, 2017, for the purpose of examining how to integrate scientific data concerning projected climate change impacts into state infrastructure engineering, and maintaining the group until July 1, 2020.

Senate Bill 97: Guidelines for Greenhouse Gas Emissions

Senate Bill 97, enacted in 2007, amended CEQA to clearly establish that greenhouse gas emissions and the effects of greenhouse gas emissions are appropriate subjects for CEQA analysis. It directed the Governor's Office of Planning and Research to develop draft CEQA guidelines for the mitigation of greenhouse gas emissions or their effects by July 1, 2009 and directed the California Natural Resources Agency to certify and adopt the CEQA Guidelines by January 1, 2010.

Senate Bill 1000: General Plan Amendments—Safety and Environmental Justice Elements

Senate Bill 1000, adopted in 2016, amends California's Planning and Zoning Law in two ways:

- The original law established requirements for initial revisions of general plan safety elements to address flooding, fire, and climate adaptation and resilience. It also required subsequent review and revision as necessary based on new information. Senate Bill 1000 specifies that the subsequent reviews and revision based on new information are required to address only flooding and fires (not climate adaptation and resilience).
- Senate Bill 1000 adds a requirement that, upon adoption or revision of any two other general plan elements on or after January 1, 2018, an environmental justice element be adopted for the general plan or environmental justice goals, policies and objectives be incorporated into other elements of the plan.

Senate Bill 1241: General Plans: Safety Element—Fire Hazard Impacts

In 2012, Senate Bill 1241 passed requiring that all future general plans address fire risk in state responsibility areas and very high fire hazard severity zones in their safety element. In addition, the bill requires cities and counties to make certain findings regarding available fire protection and suppression services before approving a tentative map or parcel map.

Senate Bill 379: General Plans: Safety Element—Climate Adaptation

Senate Bill (SB) 379 builds upon the flood planning inclusions into the safety and housing elements and the hazard mitigation planning safety element inclusions in general plans outlined in AB 162 and AB 2140, respectively. SB 379 focuses on a new requirement that cities and counties include climate adaptation and resiliency strategies in the safety element of their general plans beginning January 1, 2017. In addition, this bill requires general plans to include a set of goals, policies and objectives, and specified implementation measures based on the conclusions drawn from climate adaptation research and recommendations.

This update process for this hazard mitigation plan was conducted with the intention of full compliance with this bill. However, at the time of the update, there was no clear guidance from the state on what constitutes full compliance or what protocol is to be used to determine compliance. When such guidance has been established, the City will submit this plan or its subsequent updates to the state for review and approval.

California State Building Code

California Code of Regulations Title 24 (CCR Title 24), also known as the California Building Standards Code, is a compilation of building standards from three sources:

- Building standards that have been adopted by state agencies without change from building standards contained in national model codes
- Building standards that have been adopted and adapted from the national model code standards to meet California conditions
- Building standards authorized by the California legislature that constitute extensive additions not covered by the model codes adopted to address particular California concerns.

The state Building Standards Commission is authorized by California Building Standards Law (Health and Safety Code Sections 18901 through 18949.6) to administer the processes related to the adoption, approval, publication, and implementation of California's building codes. These building codes serve as the basis for the design and construction of buildings in California. The national model code standards adopted into Title 24 apply to all occupancies in California except for modifications adopted by state agencies and local governing bodies. Since 1989, the Building Standards Commission has published new editions of Title 24 every three years.

On January 1, 2014, California Building Code Accessibility Standards found in Chapter 11B incorporated the 2010 Americans with Disabilities Act (ADA) Standards as the model accessibility code for California. The purpose for this incorporation was to ensure consistency with federal guidelines. As a result of this incorporation, the California standards will fully implement and include 2010 ADA Standards within the California Building Code while maintaining enhanced levels of accessibility already provided by existing California accessibility regulations. The City has adopted building codes that are in full compliance with the California State Building Code.

Standardized Emergency Management System

CCR Title 19 establishes the Standardized Emergency Management System (SEMS) to standardize the response to emergencies involving multiple jurisdictions. SEMS is intended to be flexible and adaptable to the needs of all emergency responders in California. It requires emergency response agencies to use basic principles and components of emergency management. Local governments must use SEMS by December 1, 1996 in order to be eligible for state funding of response-related personnel costs under CCR Title 19 (Sections 2920, 2925 and 2930). Individual agencies' roles and responsibilities contained in existing laws or the state emergency plan are not superseded by these regulations. This hazard mitigation plan is considered to be a support document for all phases of emergency management, including those associated with SEMS.

State of California Multi-Hazard Mitigation Plan

Under the DMA, California must adopt a federally approved state multi-hazard mitigation plan to be eligible for certain disaster assistance and mitigation funding. The intent of the *State of California Multi-Hazard Mitigation Plan* is to reduce or prevent injury and damage from hazards in the state through the following:

- Documenting statewide hazard mitigation planning in California
- Describing strategies and priorities for future mitigation activities
- Facilitating the integration of local and tribal hazard mitigation planning activities into statewide efforts
- Meeting state and federal statutory and regulatory requirements.

The plan is an annex to the *State Emergency Plan*, and it identifies past and present mitigation activities, current policies and programs, and mitigation strategies for the future. It also establishes hazard mitigation goals and objectives. The plan will be reviewed and updated annually to reflect changing conditions and new information, especially information on local planning activities.

Under 44 CFR Section 201.6, local hazard mitigation plans must be consistent with their state's hazard mitigation plan. In updating this plan, the Steering Committee reviewed the California State Hazard Mitigation Plan to identify key relevant state plan elements (see Section 3.6).

California Coastal Management Program

The California Coastal Management Program under the California Coastal Act requires each city or county lying wholly or partly within the coastal zone to prepare a Local Coastal Plan. The specific contents of such plans are not specified by state law, but they must be certified by the Coastal Commission as consistent with policies of the Coastal Act (Public Resources Code, Division 20). The Coastal Act has provisions relating to geologic hazards, but does not mention tsunamis specifically. Section 30253(1) of the Coastal Act, states that new development shall minimize risks to life and property in areas of high geologic, flood, and fire hazard. Development should be prevented or limited in high hazard areas whenever possible. However, where development cannot be prevented or limited, land use density, building value, and occupancy should be kept at a minimum. There are identified coastal zones in Los Angeles, and the City has developed a local coastal plan to address them. Any mitigation project identified in this plan that intersects the mapped coastal zone will be consistent with the recommendations of the City's coastal plan.

Governor's Executive Order S-13-08

Governor's Executive Order S-13-08 enhances the state's management of climate impacts from sea level rise, increased temperatures, shifting precipitation and adverse weather events. It required the following key actions:

- Initiate California's first statewide climate change adaptation strategy to assess expected climate change impacts, identify where California is most vulnerable, and recommend adaptation policies by early 2009. This effort will improve coordination within state government so that better planning can more effectively address climate impacts on human health, the environment, the state's water supply and the economy.
- Request that the National Academy of Science establish an expert panel to report on sea level rise impacts in California, to inform state planning and development efforts.
- Issue interim guidance to state agencies for how to plan for sea level rise in designated coastal and floodplain areas for new projects.
- Initiate a report on critical infrastructure projects vulnerable to sea level rise.

Los Angeles Regional Water Quality Control Board

The Los Angeles Regional Water Quality Control Board protects ground and surface water quality in the Los Angeles region. It is one of nine regional boards statewide under the California Environmental Protection Agency. The board conducts the following activities to protect ground and surface waters under its jurisdiction (California State Water Resources Control Board, 2015):

- Address region-wide and specific water quality concerns through updates of the Water Quality Control Plan (Basin Plan) for the Los Angeles Region.
- Prepare, monitor compliance with, and enforce waste discharge requirements.
- Implement and enforce local stormwater control efforts.
- Regulate cleanup of contaminated sites that have polluted groundwater or surface water or could do so.
- Enforce water quality laws, regulations, and waste discharge requirements.
- Coordinate with other public agencies and groups that are concerned with water quality.
- Inform and involve the public on water quality issues.

4.9.3 City of Los Angeles

This section identifies locally sponsored programs, plans, and studies that can support or enhance the core capabilities of the City and the mitigation actions identified in this plan. Many were put in place by the City in response to the federal and state programs described in Sections 4.9.1 and 4.9.2. Each can be leveraged by the City to support or enhance the implementation of actions identified in Chapter 23 of this plan. These programs, plans and studies are to be considered in addition to the core capabilities identified in Section 4.9.4, and they are hereby integrated into this hazard mitigation plan by reference. Mitigation actions identified in the programs, plans and studies are considered to be fully integrated into this hazard mitigation plan by reference.

General Plan

The Los Angeles General Plan is a comprehensive set of purposes, policies and programs to guide the future form and development of the City. The plan is approved by the City Council and the Mayor and adopted by the Planning Commission. The General Plan is both a strategic and long-term document, broad in scope and specific in nature. It is implemented by decisions that direct the allocation of public resources and that shape private development, which affects the lives of the residents and business community. The General Plan is prepared and maintained by the Department of City Planning and must comply with the California General Planning Law. The law requires specific planning elements, including land use, circulation, housing, conservation, open space, noise, safety, and air quality. The City of Los Angeles' General Plan consists of the following elements:

- Plan for a Healthy LA: A Health and Wellness Element of the General Plan, March 2015
- The Citywide General Plan Framework: An Element of the General Plan, August 2001
- Air Quality Element: An Element of the City of Los Angeles General Plan, November 1992
- Conservation Element of the City of Los Angeles General Plan, September 2001
- The Housing Element 2013 – 2021 of the City of Los Angeles General Plan, December 2013
- Noise Element of the City of Los Angeles General Plan, February 1999
- The Open Space Element of the City of Los Angeles General Plan, June 1973
- Service Systems Element of the City of Los Angeles General Plan, Unknown Date
- Safety Element of the City of Los Angeles General Plan, November 1996
- Mobility Plan 2035, An Element of the General Plan, September 2016 (used to be Transportation Plan)
- The Land Use Element of the General Plan, July 2003 (consisting of 35 community plans)

The Safety Element addresses protection from unreasonable risks associated with natural disasters, including fire and rescue, stormwater and inundation, slope failure and subsidence, seismic events, and hazardous materials. The Safety Element includes the Emergency Operations Organization and other interagency coordination, the California State safety element requirements, and emergency response, disaster recovery and hazard mitigation.

The Department of City Planning is reviewing all of the General Plan elements and establishing a suggested schedule for updating those plans that are still pending as well as developing a sequence for updating other existing elements. New laws, requirements, resources, and research that affect general planning include SB 375 (sustainable communities strategies), SB 5 (flood management), SB 743 (vehicle miles traveled), SB 244 (island or fringe communities), AB 52 (tribal consultation), and AB 2140 (local hazard mitigation plans).

Comprehensive Zoning Code

The Zoning Code regulates all land, building, structures, and uses within the City of Los Angeles. Since 2013, the City has been in the process of creating a new zoning code for the 21st century. The original zoning regulations were developed in 1946 and had not been revised since then. A new initiative called, "Plan re:code LA" is the City's latest effort to update the zoning code with an engaged community vision, policies and implementation strategies, alignment with various adopted plans, land use and zoning maps, and address the issues of unique neighborhoods with needs that differ by neighborhood.

Los Angeles Municipal Code Chapter 1, Article 2, also known as the Comprehensive Zoning Plan of the City of Los Angeles, coordinates all City zoning regulations and provisions in order to regulate the location and use of buildings, structures and land. The goals of the Comprehensive Zoning Plan are to encourage the most appropriate use of land; to stabilize the value of property; to provide adequate open spaces; to prevent and fight fires; to prevent undue concentration of population; to lessen street congestion; to facilitate adequate provisions for transportation, water, sewerage, schools, parks and other public requirements; and to promote health, safety and the general welfare in accordance with the General Plan. It includes designation of zones that allow for floodplains and flood control facilities and presents design standards including those that deal with flood prevention and control.

Multi-Hazard Related Activities of City Departments

Several city departments perform activities and collect data related to hazard mitigation issues. The following is a summary of key city activities related to hazard and risk management:

- Department of Public Works, Bureau of Engineering
    - Maintain FEMA Flood Insurance Rate Map data.
    - Maintain a map of hillside areas.

    - Maintain records of drainage complaints. Complaints are investigated by staff engineers or maintenance crews. Complaints have been entered into a database and geo-coded for display on the GIS.
    - Maintain a list of known deficiencies. A project is identified to address each deficiency, so the deficiency list serves as a list of proposed projects. The projects can also be displayed on the GIS.
    - Assess infrastructure damage through field investigations after major storms.
    - Prepare geotechnical reports related to geologically unstable areas.
    - Maintain a database of FEMA Repetitive Loss Properties.

- Department of Public Works

    - Assess infrastructure damage through field investigations after major hazard incidents.
    - Identify areas in need of frequent maintenance of the flood control system.
    - Provide post-disaster debris clearance.

- Department of Building and Safety

    - Identify mud-prone and landslide areas throughout the City.
    - Track the number of building permits issued in flood risk areas.
    - Lead the Safety Assessment Program using volunteers and mutual aid building inspectors in safety evaluation of the built environment in the aftermath of a disaster.

- Planning Department

    - Maintain demographic, building, land use and zoning data.
    - Provide hazard descriptions of fire and rescue, stormwater, inundation and other water action, slope failure and subsidence, seismic events, and hazardous materials and phases of disasters such as hazard mitigation, and multi-hazard emergency response and disaster recovery provided by the Safety Element of the General Plan.
    - Maintain tsunami maps, dam failure inundation maps and landslide hazard identification maps from the safety element of the General Plan (input from the State Division of Mines and Geology and the State Office of Emergency Services).
    - Assess City policy in maintaining open space and the effectiveness of regulatory and preventive standards in preventing flood damage.
    - Maintain list of natural and beneficial areas within the City (wetlands, riparian areas, sensitive areas, and habitat for rare or endangered species).

- Emergency Management Department

    - Establish and maintain a comprehensive citywide planning, training/exercise and coordination effort for mitigation, preparedness, response and recovery for multi-hazard incidents.
    - Activate and operate the City Emergency Operations Center for coordination of all-hazards incidents.
    - Maintain emergency operations plans and associated hazard-specific and functional support annexes for the City to respond to events.
    - Chair a City Tsunami Task Force, with recommendations for community outreach, educational programs, and tsunami signage in hazard areas.
    - Provide disaster awareness and emergency preparedness information to the public.
    - Provide emergency public information regarding emergency alert and warning, notifications, evacuations, and sheltering for the public and City personnel.

- Port of Los Angeles

- Maintain tsunami signage program.
- Evacuate vessels for the safety of crew members.
- Evacuate Port facilities and the Port area.
- Procure and maintain emergency supplies and equipment.
- Establish damage assessment and prioritization procedures.
- Identify shelter facilities.
- Provide employee emergency preparedness training.

- Department of Water and Power
  - Implement necessary planning in the design, construction, reconstruction and maintenance of water and power systems to carry out hazard and risk mitigation measures.
  - Security and Emergency Management Division to oversee security and emergency preparedness strategies, programs, and measures for the department.
  - Develop an Urban Water Management Plan every five years to comply with California's Urban Water Management Planning Act.

- Los Angeles Housing and Community Investment Department (HCID)
  - Systematic Code Enforcement Program—Under this award-winning proactive program, inspectors have legal authority from the City for code enforcement over all multi-family rental properties in the city. Building and Safety does not do this; HCID does. On a four-year cycle, on a schedule coordinated with every landlord, HCID systematically inspects all multi-family properties in the city on a variety of codes (building, plumbing, electrical and mechanical, health and safety, etc.) to ensure that life and fire safety systems are working and the property meets habitability standards.
  - Lead Hazard Remediation Program—This program provides grants to property owners to make their properties lead-safe and to eliminate health and safety hazards. The grants are primarily targeted to low-income families with children under the age of six. The program also provides education regarding the dangers of lead-based paint and health and safety hazards.

City of Los Angeles Resilience Program

The City of Los Angeles is committed to addressing resilience by strengthening the city's physical, social, and economic foundations. The Mayor's Office has adopted far-reaching strategies to develop the tools the City needs to rebound from major crises—including storms, earthquakes, and economic recessions—if and when they come. Led by the Mayor's office, the City's resilience program is based on plans and programs summarized below.

100 Resilient Cities

In 2013, the City of Los Angeles was selected as an inaugural member of 100 Resilient Cities network pioneered by the Rockefeller Foundation, an organization that helps cities confront 21st century challenges. The network gives cities tools to develop a road map to resilience:

- Financial and logistical guidance for establishing an innovative new position in city government—a Chief Resilience Officer—to lead the city's resilience efforts
- Expert support for development of a robust resilience strategy
- Connection with service providers and others who can help implement resilience strategies
- Membership in a global network of member cities that share best practices and support pioneering resilience.

Through these actions, the 100 Resilient Cities network aims to build urban resilience and establish guidelines for resilience among governments, non-governmental organizations, the private sector, and individual residents.

Resilience by Design

Released in December 2014, Resilience by Design addresses Los Angeles' greatest earthquake vulnerabilities, including building retrofitting and steps to secure the water supply and communications infrastructure. The report presents recommendations of the Mayoral Seismic Safety Task Force. These recommendations suggest strategic solutions to protect the lives of residents; improve the capacity of the City to respond to earthquakes; prepare the City to recover quickly from earthquakes; and protect the economy of the City and all of Southern California. The Mayoral Seismic Task Force evaluated four areas of seismic vulnerability: pre-1980 "non-ductile reinforced concrete" buildings: pre-1980 "soft-first story" buildings; water system infrastructure (including impact on firefighting capability); and telecommunications infrastructure.

The Sustainable City pLAn

The Sustainable City pLAn is a road map for a Los Angeles that is environmentally healthy, economically prosperous, and equitable in opportunity for all—now and over the next 20 years. The pLAn focuses on both short-term results and long-term goals to transform the City. The pLAn provides the following:

- A vision for Los Angeles' future—Presents a clear vision and details specific long-term outcomes to be achieved over the next two decades in 14 key aspects of the environment, the economy and measures of social equity.
- A pathway to short-term results that lay the foundation for long-term outcomes—Creates a set of near-term, back-to-basics outcomes by 2017 that create a foundation to achieve transformational change by 2025 and 2035.
- A framework to build out policies—Lays out strategies and priority initiatives that will be developed and detailed to deliver the tangible outcomes in the pLAn.
- A platform for collaboration—Creates a platform for collaboration to identify, create, and strengthen programs, policies, and partnerships that cut across bureaucratic boundaries to improve the city and neighborhoods.
- A set of tools to help manage Los Angeles—Provides the Mayor with a set of tools to ensure implementation and empower the men and women who work for the City.
- A dashboard of sustainability metrics to transparently measure progress—Identifies and tracks clear metrics to measure progress and share how everyone—in city operations, and as Angelenos—is doing along with way.
- A pathway for engaging our residents—Builds on leadership throughout Los Angeles, while providing Angelenos ways and opportunities to participate in creating tangible improvements to their lives, their neighborhoods, and the entire city.

Enhanced Watershed Management Plans

In order to improve water quality, comply with water quality mandates and address water supply issues, cities and community stakeholders throughout Los Angeles County are working to develop Enhanced Watershed Management Plans for each of the county's four watersheds—Ballona Creek, Dominguez Channel, Santa Monica Bay and Los Angeles River. The efforts are being led by a Watershed Management Group for each watershed.

Each plan will identify projects to improve water quality, promote water conservation, enhance recreational opportunities, manage flood risk, improve local aesthetics, and support public education. Each will outline water quality priorities, watershed control measures, reasonable assurance analysis, project scheduling and the monitoring, assessment and adaptive management of projects. The plans are to be submitted to the Los Angeles Regional Water Quality Control Board by June 28, 2015 (City of Los Angeles Stormwater Program, 2015).

Greater Los Angeles County Region Integrated Regional Water Management Plan

Municipalities and groups across the Greater Los Angeles County Region collaborated to develop an Integrated Regional Water Management Plan in 2006 that focuses on water resource management. The plan identifies solutions over the next 20 years to reduce dependence on imported water, clean up local groundwater and stormwater, enhance in-stream water quality, improve habitat, and expand parks and open space. The plan can support development of local funding sources and help local jurisdictions comply with regulatory mandates. It provides a tool for achieving planning targets for the region and improving the sustainability of water resources and ecological health of local watersheds. More sustainable water resources will improve the quality of life for all communities. (Los Angeles County Department of Public Works, 2015)

Los Angeles County Flood Control District

The Los Angeles County Flood Control Act (ACT) was adopted by the State Legislature in 1915, after a disastrous regional flood took a heavy toll on lives and property. The Act established the Los Angeles County Flood Control District and empowered it to provide flood protection, water conservation, recreation and aesthetic enhancement within its boundaries. The Flood Control District is governed, as a separate entity, by the County of Los Angeles Board of Supervisors.

In 1984, the Flood Control District entered into an operational agreement with the Los Angeles County Department of Public Works transferring planning and operational activities to the Department of Public Works. Watershed Management Division is the planning and policy arm of the Flood Control District. Public Works Flood Maintenance and Water Resources Divisions, respectively, oversee its maintenance and operational efforts.

The Flood Control District encompasses more than 3,000 square miles, 85 cities and approximately 2.1 million land parcels. It includes the vast majority of drainage infrastructure within incorporated and unincorporated areas in every watershed, including 500 miles of open channel, 2,800 miles of underground storm drains, and an estimated 120,000 catch basins. The District includes portions of the City of Los Angeles.

U.S. Army Corps of Engineers Los Angeles River Ecosystem Restoration Feasibility Study

The City of Los Angeles, in conjunction with the U.S. Army Corps of Engineers, prepared the Final Integrated Feasibility Report, which includes the Final Feasibility Report and Environmental Impact Statement/Environmental Impact Report for the proposed Los Angeles River Ecosystem Restoration Project. The City Council adopted the Study in June 2016.

Prior to the recent report, the Los Angeles River Ecosystem Restoration Integrated Feasibility Report documented an ongoing study that was initiated in 2003 to determine whether there is a federal interest in ecosystem restoration along the Los Angeles River within the City of Los Angeles. The study included a hydraulic analysis along the proposed project's 11-mile extent that produced a set of floodplain maps. The purpose of the hydraulic analysis was to produce baseline and with-project snapshots of potential impacts that an ecosystem restoration plan might have on the flood conveyance capacity of the river.

Los Angeles River Revitalization Master Plan

The following content is excerpted from the Los Angeles River Revitalization Master Plan (City of Los Angeles, 2015).

The Los Angeles River flows 51 miles through some of the most diverse communities in Southern California. It stretches 32 miles within the City of Los Angeles, from Owensmouth in the upper reaches of the northwest San Fernando Valley, all the way to the border with Vernon at the southern end of downtown. The river is typically dry during summer, but can fill with fast-flowing waters during the rainy season.

Community leaders, elected officials, residents, environmental groups, recreational groups, and others have explored ways to restore the river's natural benefits while maintaining flood protection and safety. In 2002, the Los Angeles City Council Ad Hoc Committee on the Los Angeles River was created to encourage community involvement in river improvements and to help coordinate river-related projects in the City. As a result of the Ad Hoc River Committee's efforts, the City began the preparation of a Revitalization Master Plan that would identify proposals to make the Los Angeles River a "front door" to the City, supporting diverse civic activities. The Ad Hoc River Committee established the following goals for the Los Angeles River Revitalization Plan:

- Establish environmentally sensitive guidelines for improving communities along the river by providing open space, housing, retail spaces, and places for public institutions.
- Improve the environment, enhance water quality, improve water resources, and improve the ecological functioning of the river.
- Provide public access to the river.
- Provide significant recreation space and open space, and improve natural habitats.
- Preserve and enhance the flood control features of the river.
- Foster community awareness of and pride in the Los Angeles River.

The 18-month revitalization planning process looked at improvements along the river that would enhance neighborhoods, protect wildlife, promote the health of the river, and leverage economic development. The finished master plan outlines a 20-year blueprint for development and management of the Los Angeles River to be implemented by the City of Los Angeles. It calls for an extensive community engagement effort that will include public workshops at key project milestones, participation in neighborhood and community events, and an interactive web site (www.lariver.org).

The City of Los Angeles Floodplain Management Plan (2015)

Recent history has demonstrated how the City of Los Angeles can be significantly impacted by flooding. On November 12, 2003, 5.6 inches of precipitation fell during a 4-hour period over the Watts area of Los Angeles and portions of the City of Carson, causing significant flooding in areas not previously considered at risk for flooding. National Weather Service records show a total of 37.25 inches of rain at the downtown Los Angeles Civic Center during the rainy season of 2004-2005—the second highest recorded seasonal rainfall (the highest was 38.18 inches in 1883-1884). In 2014, Hurricane Marie brought one of the largest hurricane-related surf events in decades to Southern California, leading to overall losses of $20 million. Hurricane Marie tied for the sixth most-intense Pacific hurricane on record.

Even though the City of Los Angeles has adopted multiple mitigation and flood control projects and plans, it is constantly seeking additional ways to mitigate flood impacts in the community. Additionally, as a participant in the Community Rating System, the City can use an updated floodplain management plan as a key step toward significant reductions in flood insurance premiums.

Administered by the City of Los Angeles Department of Public Works Bureau of Engineering, the *2015 City of Los Angeles Floodplain Management Plan* provides a blueprint for flood risk reduction and management for the City. The plan is centered upon a comprehensive flood hazard risk assessment that looks at coastal, riverine, urban drainage, dam failure and tsunami hazards as well as a forward look at the possible increase in risk to these hazards caused by global climate change. The plan identifies and prioritizes 80 flood risk reduction actions to be implemented over a 5-year performance period. Progress reports on the status of the implementation of the actions in the plan are prepared by the Bureau of Engineering annually.

4.9.4 Capability Assessment

The planning team performed an inventory and analysis of existing authorities and capabilities called a "capability assessment." A capability assessment creates an inventory of an agency's mission, programs and policies, and evaluates its capacity to carry them out. It presents a toolkit for implementation of the hazard mitigation plan.

The assessment identifies potential gaps in core capabilities, and filling those gaps may eventually become actions in the plan. Assessment findings were shared with city departments as they developed the action plans shown in Chapter 23. If a department identified an opportunity to add or expand a capability, then doing so has been identified as a mitigation action. The City views each core capability to be fully adaptable as needed to meet the best interests of the City. Every code can be amended, and every plan can be updated. This adaptability is considered to be an overarching City capability that is acknowledged by this reference.

An assessment of legal and regulatory capabilities is presented in Table 4-10. The column labeled "Integration Opportunity" in this table identifies capabilities that can support or be supported by components of this plan. Where "yes" is indicated in this column, the City has considered actions to integrate these capabilities with the plan.

Table 4-10. Legal and Regulatory Capability

	Local Authority	Other Jurisdiction Authority	State Mandated	Integration Opportunity?
Codes, Ordinances & Requirements				
Building Code	Yes	No	Yes	No
Comment: City of Los Angeles Municipal Code, Chapter IX, Article I, amended by Ordinance No. 182,850, effective 1/3/2014 Ordinance No. 183893 Establish mandatory standards for earthquake hazard reduction in existing wood-frame buildings with soft, weak, or open-front walls and existing non-ductile concrete buildings. Signed 10/13/2015, effective 11/22/2015.				
Zoning Code	Yes	No	Yes	No
Comment: City of Los Angeles Municipal Code, Chapter I, Article 2 and Article 3, amended by Ordinance No. 138,800, effective 6/13/1969				
Subdivisions	Yes	No	Yes	No
Comment: City of Los Angeles Municipal Code, Chapter I, Article 7, added by Ordinance No. 122,064, effective 6/14/1962				
Stormwater Management	Yes	Yes, LA County	Yes	Yes
Comment: City of Los Angeles Municipal Code, Chapter VI, Article 4.4, Section 64.70, Article and Section added by Ordinance. No. 172,176, effective 10/1/1998. ***Integration Opportunity:*** City-owned facilities constructed under this code may be eligible for FEMA HMA grants. All future updates to this plan should consider eligible stormwater management activities as potential actions for this plan.				
Post-Disaster Recovery	Yes	No	No	Yes
Comment: City of Los Angeles, Administrative Code, Division 8, Chapter 3, Section 8.61 amended by Ordinance No. 165,083, effective 9/4/1989 ***Integration Opportunity***: The City should inform the next update to this code using all of this plan's information on risk and vulnerability associated with the hazards assessed.				
Real Estate Disclosure	No	No	Yes	No
Comment: State of California Natural Hazards Disclosure Act, effective 6/1/1998 (California Civil Code Section 1002.6c)				
Growth Management	Yes	Yes	Yes	Yes
Comment: City of Los Angeles Municipal Code, Article 1.5, Section 11.5.6 General Plan, amended by Ordinance 173,268, effective 7/1/2000, Operational 7/1/2000. Other jurisdictional authority is with the Southern California Association of Governments. *General Planning Law – Cal. Gov. Code §65300 et seq.* ***Integration Opportunity***: See comments below for the General Plan				

	Local Authority	Other Jurisdiction Authority	State Mandated	Integration Opportunity?
Site Plan Review	Yes	No	No	No
Comment: City of Los Angeles, Municipal Code, Chapter I, Article 6.1, Section 16.05, Renumbered and amended by Ordinance No. 166,127, effective 9/23/1990; operational 10/13/1990.				
Environmental Protection	No	Yes, LA County	Yes	No
Comments: County of Los Angeles has authority for Environmental Protection				
Flood Damage Prevention	Yes	No	Yes	No
Comments: *Flood Hazard Specific Plan*, ordinance No. 172081, effective 7/3/1998.				
Emergency Management	Yes	No	Yes	Yes
Comments: Emergency Operations Ordinance No. 153772, signed 1980 established a multi-agency Emergency Operations Organization. It is under the director of Mayor and administration of an Emergency Operations Board. ***Integration Opportunity***: The City of LA Emergency Management Department is an integral part of the multi-agency Emergency Operations Organization created by this code. LAEMD is also the lead for this mitigation plan. Therefore this integration has already occurred.				
Climate Change	Yes	Yes	Yes	Yes
Comments: *Los Angeles' Sustainable City pLAn*, 2015. SB 97 directs California Environmental Quality Act (CEQA) Guidelines to address greenhouse gas emissions. Other state policies include AB 32, and SB 375, SB 379 and regulations of the Climate Action Plan. Los Angeles County adopted the AB 32 *Community Climate Action Plan* as part of *Los Angeles County General Plan 2035* on 10/ 6/2015. ***Integration Opportunity***: The "Sustainable City pLAn" has been integrated by reference into this plan (see Section 4.9.3). All future updates to this plan will continue to use this plan as a source document. Additionally, any future update to the Sustainable City pLAn will look to this mitigation plan for information that can support its update.				
Planning Documents				
General Plan	Yes	No	Yes	Yes
Comment: Consists of a framework last adopted in 2001, 11 citywide elements adopted from 1991 through 2016, and land use elements for 35 community plan areas, adopted from 1981 through 2000. ***Integration Opportunity***: Based on directives from AB-2140, SB-379 and SB-1000, the City will fully integrate this mitigation plan into the safety element of its general plan upon its next update.				
Capital Improvement Plan	Yes	No	No	Yes
What types of capital facilities does the plan address? City buildings and projects (fire facilities/fire stations, animal shelters, police facilities, seismic retrofit program of bridges, construction projects such as neighborhood city halls, Chicago Building, Police SID Tech Lab, El Pueblo Capital Program, youth recreational and cultural facilities, street and transportation projects, clean stormwater, recharge groundwater and provide cleaner beaches projects, zoo exhibits). Public housing, community investments.				
Comment: City of Los Angeles Capital Improvement Program, 2008-09 to 2012-13 (last version available online) ***Integration Opportunity***: This integration is ongoing. In the development of the action plan for this update, the City reviewed its capital improvement plan to identify actions that are eligible for FEMA grant funding. All future updates to the City's capital improvement plans will look to this plan to potentially leverage FEMA grant funding for project implementation.				
Floodplain Plan	Yes	No	No	Yes
Comment: City of Los Angeles Floodplain Management Plan, Adopted 10/7/2015. ***Integration Opportunity:*** The latest version of the City of Los Angeles Floodplain Management Plan was incorporated by reference into this plan update. Information from the floodplain management plan informed the flood hazard risk assessment for this plan, and actions from the floodplain management plan have been included in this plan.				
Stormwater Plans	Yes	Yes	Yes	No
Comment: *Standard Urban Stormwater Mitigation Plan*, adopted by the State Regional Water Quality Control Board in 2000, *Enhanced Watershed Management Plan* under development				
Habitat Conservation Plan	Yes	No	No	No
Comment: *Greater Los Angeles County Open Space for Habitat and Recreation Plan, 2012.* In 2000, the Port of Los Angeles and Port of Long Beach created a biological survey of the Los Angeles-Long Beach Harbor habitat conditions and marine biological communities "Biological Baseline Surveys". Updated in 2013-2014.				

	Local Authority	Other Jurisdiction Authority	State Mandated	Integration Opportunity?
Economic Development Plan	Yes	No	No	No
Comment: *Economic Development in Los Angeles: A New Approach for a World Class City*, December 2012, Chapter 7 of framework element of the *Los Angeles General Plan, Los Angeles County Strategic Plan for Economic Development 2010-2014*				
Shoreline Management Plan	Yes	No	Yes	No
Comment: *Local Coastal Program Land Use Plan*, Venice				
Community Wildfire Protection Plan	No	No	No	No
Comments: *Santa Monica Mountains Community Wildfire Protection Plan*, 2010				
Response/Recovery Planning				
Comprehensive Emergency Management Plan	Yes	No	Yes	No
Comment: *Emergency Operation Master Plan and Procedures*, September 2006 ***Integration Opportunity***: Although there is no viable way to integrate this mitigation plan into the EOP, information in the hazard mitigation plan on risk and vulnerability can inform future updates to the EOP.				
Threat & Hazard Identification & Risk Assessment	Yes	No	No	Yes
Comments: Los Angeles / Long Beach Urban Area Security Initiative ***Integration Opportunity***: Information on risk and vulnerability contained in this plan can inform future updates to the City's THIRA.				
Terrorism Plan	Yes	No	No	No
Comments: Los Angeles Operational Area Terrorism Plan; City of Los Angeles Police Department Counter-Terrorism and Special Operations Bureau				
Post-Disaster Recovery Plan	Yes	No	No	Yes
Comment: Annex to the *Emergency Operations Master Plan, Recovery and Reconstruction Plan*, September 2006 ***Integration Opportunity:*** Information on risk and vulnerability contained in this plan can inform future updates to the City's Post-Disaster Recovery Plan.				
Continuity of Operations Plan	Yes	No	Yes	Yes
Comment: The City Council has provided for the preservation of the City government in the event of an emergency (City of Los Angeles Administrative Code, Section 8.25), The alternates to key positions in the regular departments and agencies of government, or of business and industry, are shown in the *City's Continuity of Operations/Continuity of Government Plan* (COOP/COG) and department emergency plans, executive or administrative orders or the equivalent issued by department or agency authorities. ***Integration Opportunity***: Information on risk and vulnerability contained in this plan can inform future updates to the City's Continuity of Operations/Continuity of Government Plan.				
Public Health Plan	No	Yes, LA County	No	No
Comments: *Community Health Improvement Plan, 2015-2020;* Prehospital Care Policy Ref. No. 842.1 Minimum EMS Resource Guidelines for Mass Gatherings and Special Events				

An assessment of administrative and technical capabilities is presented in Table 4-11. An assessment of fiscal capabilities is presented in Table 4-12. Classifications under various community mitigation programs are presented in Table 4-13. Development and permitting capabilities are presented in Table 4-14. Information on NFIP compliance is presented in Table 4-15. An assessment of education and outreach capabilities is presented in Table 4-16. The community's adaptive capacity for the impacts of climate change is presented in Table 4-17.

Table 4-11. Administrative and Technical Capability

Staff/ Personnel Resources	Available (Y or N)	Department or Agency (Positions)
Planners or engineers with knowledge of land development and land management practices	Yes	Department of City Planning
Engineers or professionals trained in construction practices related to buildings and/or infrastructure	Yes	Department of Building and Safety
Planners or engineers with an understanding of natural hazards	Yes	Department of Public Works, Bureau of Engineering and Bureau of Sanitation
Floodplain manager	Yes	City Engineer, Bureau of Engineering
Surveyors	Yes	Department of Public Works, City Engineer
Personnel skilled or trained in GIS Applications	Yes	City of Los Angeles Survey Division
Scientist familiar with local natural hazards	Yes	Various, including Bureau of Engineering and City Planning
Emergency manager	Yes	Emergency Management Department and all other departments (Fire, Police, Public Works, Building & Safety, City Planning, Water and Power, Port of Los Angeles, World Airports, etc.)
Grant writers	Yes	Emergency Management Department, General Manager
Staff with expertise or training in benefit/cost analysis	Yes	Department of City Planning

Table 4-12. Fiscal Capability

Financial Resources	Accessible or Eligible to Use (Y or N)
Community Development Block Grants	Yes
Capital Improvements Project Funding	Yes
Authority to Levy Taxes for Specific Purposes	Yes
User Fees for Water, Sewer, Gas or Electric Service	Yes
Incur Debt through General Obligation Bonds	Yes
Incur Debt through Special Tax Bonds	Yes
Incur Debt through Private Activity Bonds	Yes
Withhold Public Expenditures in Hazard-Prone Areas	Yes
State-Sponsored Grant Programs	Yes
Development Impact Fees for Homebuyers or Developers	Yes

Table 4-13. Community Classifications

	Participating?	Classification	Date Classified
Community Rating System	Yes	Class 7	1991
Building Code Effectiveness Grading Schedule	Yes	2/2	2014
Public Protection	Yes	Class 1	1947
Firewise	No	—	—
Storm Ready	Yes	NOAA	January 27, 2012
Tsunami Ready	Yes	NOAA	January 27, 2012

Table 4-14. Development and Permitting Capability

Criterion	Response
Does your jurisdiction issue development permits? • **If no, who does? If yes, which department?**	Yes
Does your jurisdiction have the ability to track permits by hazard area?	Yes (Flood Hazard Only)
Does your jurisdiction have a buildable lands inventory?	Yes

Table 4-15. National Flood Insurance Program Compliance

Criterion	Response
What local department is responsible for floodplain management?	Department of Public Works
Who is your floodplain administrator? (department/position)	City Engineer
Are any certified floodplain managers on staff in your jurisdiction?	No
What is the date of adoption of your flood damage prevention ordinance?	Ordinance No. 172081, Effective July 3, 1998
When was the most recent Community Assistance Visit or Community Assistance Contact?	August 19, 2015. Next Community Assistance Visit tentatively scheduled for August 2017
Does your jurisdiction have any outstanding NFIP compliance violations that need to be addressed? • **If so, please state what they are**	No
Do your flood hazard maps adequately address the flood risk within your jurisdiction? • **If no, please state why**	The City constantly works with federal, state and regional agencies to prepare accurate flood hazard maps based on best available data. The City understands that floodplains are dynamic so current mapping may not always reflect true flood risk.
Does your floodplain management staff need any assistance or training to support its floodplain management program? • **If so, what type of assistance/training is needed?**	City floodplain management personnel always seek opportunities to enhance their floodplain management capabilities
Does your jurisdiction participate in the Community Rating System (CRS)? • **If so, is your jurisdiction seeking to improve its CRS Classification?** • **If not, is your jurisdiction interested in joining the CRS program?**	Yes

Table 4-16. Education and Outreach

Criteria	Response
Do you have a Public Information Officer or Communications Office?	The City has multiple personnel that serve this capacity of each department of City government
Do you have personnel skilled or trained in website development?	Each City department has a website with personnel dedicated to its development and maintenance
Do you have hazard mitigation information available on your website? • **If yes, please briefly describe.**	Yes The City has established a hazard mitigation planning website within the Emergency Management Department website at: http://emergency.lacity.org/hazard-mitigation-plan
Do you utilize social media for hazard mitigation education and outreach? • **If yes, please briefly describe.**	The City has extensive social media capability that includes Facebook, Twitter, and Nextdoor
Do you have any resident boards or commissions that address issues related to hazard mitigation?	The City has identified 96 Neighborhood Councils that could facilitate this capability.
Do you have any other programs already in place that could be used to communicate hazard-related information? • **If yes, please briefly describe.**	Yes Community Emergency Response Team, Volunteer programs
Do you have any established warning systems for hazard events?	Yes
• **If yes, please briefly describe.**	The City has some warning capacity for severe weather, flood and tsunami. See the City's 2015 Flood Hazard Management Plan for more detailed descriptions of these capabilities.

Table 4-17. Adaptive Capacity for Climate Change

Adaptive Capacity Assessment Question	Jurisdiction Rating
Technical Capacity	
Jurisdiction-level understanding of potential climate change impacts	Medium
Comment: *This hazard mitigation plan has provided the City with a better understanding*	
Jurisdiction-level monitoring of climate change impacts	Low
Comment: *None provided.*	
Technical resources to assess proposed strategies for feasibility and externalities	Low
Comment: *None provided.*	
Jurisdiction-level capacity for development of greenhouse gas emissions inventory	Low
Comment: *None provided.*	
Capital planning and land use decisions informed by potential climate impacts	Low
Comment: *None provided.*	
Participation in regional groups addressing climate risks	Medium
Comment: *None provided.*	
Implementation Capacity	
Clear authority/mandate to consider climate change impacts during public decision-making processes	Medium
Comment: *None provided.*	
Identified strategies for greenhouse gas mitigation efforts	Medium
Comment: *None provided.*	
Identified strategies for adaptation to impacts	Medium
Comment: *None provided.*	
Champions for climate action in local government departments	Low
Comment: *None provided.*	
Political support for implementing climate change adaptation strategies	Medium
Comment: *None provided.*	
Financial resources devoted to climate change adaptation	Low
Comment: *None provided.*	
Local authority over sectors likely to be negative impacted	Low
Comment: *None provided.*	
Public Capacity	
Local residents knowledge of and understanding of climate risk	Low
Comment: *None provided.*	
Local residents support of adaptation efforts	Low
Comment: *None provided.*	
Local residents' capacity to adapt to climate impacts	Low
Comment: *None provided.*	
Local economy current capacity to adapt to climate impacts	Low
Comment: *None provided.*	
Local ecosystems capacity to adapt to climate impacts	Low
Comment: *None provided.*	

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PART 2—RISK ASSESSMENT

5. HAZARDS OF CONCERN, RISK ASSESSMENT METHODOLOGY

Risk assessment is the process of measuring the potential loss of life, personal injury, economic injury, and property damage resulting from identified hazards. It allows emergency management personnel to establish early response priorities by identifying potential hazards and vulnerable assets. The process focuses on the following elements:

- **Hazard identification**—Use all available information to determine what types of hazards may affect a jurisdiction, how often they can occur, and their potential severity.
- **Exposure identification—**Estimate the total number of people and properties in the jurisdiction that are likely to experience a hazard event if it occurs.
- **Vulnerability identification and loss estimation**—Assess the impact of hazard events on the people, property, environment, economy and lands of the region, including estimates of the cost of potential damage or cost that can be avoided by mitigation.

The risk assessment for this hazard mitigation plan update evaluates the risk of natural hazards prevalent in the planning area and meets requirements of the Disaster Mitigation Act (44 CFR, Section 201.6(c)(2)). To protect individual privacy and the security of critical facilities, information on properties assessed is presented in aggregate, without details about specific individual properties.

5.1 IDENTIFIED HAZARDS OF CONCERN

The Steering Committee considered the full range of natural hazards that could affect the planning area and then listed hazards that present the greatest concern. The process incorporated a review of state and local hazard planning documents as well as information on the frequency of, magnitude of, and costs associated with hazards that have struck the planning area or could do so. Anecdotal information regarding natural hazards and the perceived vulnerability of the planning area's assets to them was also used. Based on the review, this plan addresses the following hazards of concern (presented in alphabetical order; the order of listing does not indicate the hazards' relative severity):

- Adverse weather
- Climate change and sea-level rise
- Dam failure
- Drought
- Earthquake
- Flood
- Landslide
- Tsunami
- Wildland/Urban Interface Fire
- Human-caused hazards.

5.2 RISK ASSESSMENT TOOLS

5.2.1 Mapping

National, state, county, and city databases were reviewed to locate available spatially based data relevant to this planning effort. Maps were produced using geographic information system (GIS) software to show the spatial extent and location of hazards when such datasets were available. Data used for this plan update represents the best science currently available. All data used was approved by the City of Los Angeles for use in this plan update. These maps are included in the hazard profile chapters of this document. Sources and methods used to generate the maps are described in Appendix B.

5.2.2 Hazus

Overview

FEMA developed the standardized GIS-based software program Hazards U.S. (Hazus) to estimate losses caused by earthquakes, hurricanes and floods and identify areas that face the highest risk and potential for loss. Hazus is used to support risk assessments, mitigation planning, and emergency planning and response. It provides a wide range of inventory data, such as demographics, building stock, critical facilities, and transportation and utility infrastructure, and multiple models to estimate potential losses from natural disasters. The program maps and calculates hazard data and damage and economic loss estimates for buildings and infrastructure. Its advantages include the following:

- Provides a consistent methodology for assessing risk across geographic and political entities.
- Provides a way to save data so that they can readily be updated as population, inventory, and other factors change and as mitigation planning efforts evolve.
- Facilitates review of mitigation plans because it helps to ensure that FEMA methodologies are incorporated.
- Supports grant applications by calculating benefits using FEMA definitions and terminology.
- Produces hazard data and loss estimates that can be used in communication with local stakeholders.
- Is administered by the local government and can be used to manage and update a hazard mitigation plan throughout its implementation.

Levels of Detail for Evaluation

Hazus provides default data for inventory, vulnerability, and hazards; these default data can be supplemented with local data to provide a more refined analysis. The model can carry out three levels of analysis:

- **Level 1**—All of the information needed to produce an estimate of losses is included in the software’s default data. These data are derived from national databases and describe in general terms the characteristic parameters of the planning area.
- **Level 2**—More accurate estimates of losses require more detailed information about the planning area. To produce Level 2 estimates of losses, detailed information is required about local geology, hydrology, hydraulics, and building inventory, as well as data about utilities and critical facilities. This information is needed in a GIS format.
- **Level 3**—This level of analysis generates the most accurate estimate of losses. It requires detailed engineering and geotechnical information to customize it for the planning area.

5.3 RISK ASSESSMENT APPROACH

The risk assessments in this plan describe the risks associated with each hazard of concern identified. The following steps were used to define the risk of each hazard:

- **Identify and profile each hazard**—The following information is given for each hazard:
    - The local history of previous events associated with the hazard
    - Geographic areas most affected by the hazard
    - Estimated event frequency
    - A qualitative assessment of the potential severity of events associated with the hazard
    - Warning time likely to be available for response.
- **Determine exposure to each hazard**—Exposure was assessed by overlaying hazard maps with an inventory of structures, facilities, and systems to decide which of them would be exposed to each hazard.
- **Assess the vulnerability of exposed facilities**—Vulnerability of exposed structures and infrastructure was evaluated by interpreting the probability of occurrence of each event and assessing structures, facilities, and systems that are exposed to each hazard.

5.3.1 Dam Failure, Earthquake, Tsunami, Sea Level Rise and Flood

The following hazards were evaluated using Hazus:

- **Flood**—A Level 2 user-defined analysis was performed for general building stock in flood zones and for critical facilities and infrastructure. Current flood mapping for the planning area was used to delineate flood hazard areas and estimate potential losses from the 1-percent-annual-chance and 0.2-percent-annual-chance flood events. To estimate damage that would result from a flood, Hazus uses pre-defined relationships between flood depth at a structure and resulting damage, with damage given as a percent of total replacement value. Curves defining these relationships have been developed for damage to structures and for damage to typical contents within a structure. By inputting flood depth data and known property replacement cost values, dollar-value estimates of damage were generated.
- **Dam Failure**—A Level 2 analysis was run using the flood methodology described above.
- **Sea Level Rise**—A Level 2 analysis was run using the flood methodology described above.
- **Tsunami**—A modified Level 2 analysis was run using the flood methodology described above.
- **Earthquake**—A Level 2 analysis was performed to assess earthquake exposure and vulnerability for five scenario events:
    - A Magnitude 7.2 event on the Newport-Inglewood Fault with an epicenter 32 miles southeast of downtown Los Angeles.
    - A Magnitude 7.3 event on the Palos Verde Fault with an epicenter 55 miles south southeast of downtown Los Angeles.
    - A Magnitude 7.0 event on the Puente Hills Fault with an epicenter 11.5 miles northeast of downtown Los Angeles.
    - A Magnitude 7.8 event on the San Andreas Fault with an epicenter 150 miles east southeast of downtown Los Angeles.
    - A Magnitude 6.8 event on the Santa Monica Fault with an epicenter 9.5 miles northwest of downtown Los Angeles.

5.3.2 Drought

The risk assessment methodologies used for this plan focus on damage to structures. The risk assessment for drought was more limited and qualitative than the assessment for the other hazards of concern because drought does not affect structures.

5.3.3 All Other Assessed Hazards

Historical datasets were not adequate to model future losses for most of the hazards of concern. However, areas and inventory susceptible to some of the hazards of concern were mapped by other means, and exposure was evaluated. A qualitative analysis was conducted for other hazards using the best available data and professional judgment.

5.4 SOURCES OF DATA USED IN HAZUS MODELING

5.4.1 Building and Cost Data

Replacement cost values and detailed structure information derived from parcel and tax assessor data provided by the City of Los Angeles were loaded into Hazus. When available, an updated inventory was used in place of the Hazus defaults for critical facilities and infrastructure.

Replacement cost is the cost to replace the entire structure with one of equal quality and utility. Replacement cost is based on industry-standard cost-estimation models published in *RS Means Square Foot Costs* (RS Means, 2017). It is calculated using the RS Means square foot cost for a structure, which is based on the Hazus occupancy class (i.e., multi-family residential or commercial retail trade), multiplied by the square footage of the structure from the tax assessor data. The construction class and number of stories for single-family residential structures also factor into determining the square-foot costs.

5.4.2 Hazus Data Inputs

The following hazard datasets were used for the Hazus Level 2 analysis conducted for the risk assessment:

- **Flood**—The effective Digital Flood Insurance Rate Map (DFIRM) for the planning area was used to delineate flood hazard areas and estimate potential losses from the 1-percent-annual-chance and 0.2-percent-annual-chance flood events. For the City's 2015 Floodplain Management Plan, the DFIRM floodplain boundaries and base flood elevation information, and Los Angeles County's 5-foot digital elevation model data, were used to generate flood depth grids. These depth grids were updated with Letter of Map Revision data issued since 2015, and integrated into the Hazus model for this plan.
- **Dam Failure—**For the City's 2015 Floodplain Management Plan, dam inundation area data provided by the County, and the County's 5-foot digital elevation model were used to develop depth grids. These depth grids were integrated into the Hazus model for this plan. Inundation areas for the following dams were included: Lower Franklin No.2, Los Angeles Reservoir, Mulholland, Pacoima, Sepulveda, Silver Lake, Devils Gate, Eagle Rock, Elysian, Encino, Big Tijunga No. 1, Green Verdugo, Greystone Reservoir, Hansen, Lopez, Palos Verdes Reservoir, Riviera Reservoir, Santa Ynez Canyon, Stone Canyon, and Upper Franklin.
- **Tsunami—**For the City's 2015 Floodplain Management Plan, tsunami inundation zone data, provided by the California Department of Conservation, and the County's 5-foot digital elevation model were used to develop depth grids. These depth grids were integrated into the Hazus model for this plan.
- **Sea Level Rise**—Depth grids for sea level rises of 25-cm and 150-cm with 100-year storm surge provided by the U.S. Geological Survey (USGS) were integrated into the Hazus model. This Coastal Storm Modeling System data is identified by California's Cal-Adapt program as a sea level rise data resource.

- **Earthquake**—Earthquake shake maps prepared by the USGS were used for the analysis of this hazard. Landslide susceptibility data from the California Geological Survey and the City's liquefaction zones data were also integrated into the Hazus model.

5.4.3 Other Local Hazard Data

Locally relevant information on hazards was gathered from a variety of sources. Frequency and severity indicators include past events and the expert opinions of geologists, emergency management specialists, and others. Data sources for specific hazards were as follows:

- **Landslide**—Susceptibility to deep-seated landslides data were provided by the California Geological Survey, dated 2011. Areas categorized as very high (source data Category X) and high (Categories VII, VIII, and IX) were used in the exposure analysis. This data was approved by the Building and Safety Division as the appropriate data to use for this assessment.
- **Adverse Weather**—No GIS format adverse weather area datasets were identified for the City of Los Angeles.
- **Wildfire**—Fire severity data was acquired from California Department of Forestry and Fire Protection (CAL FIRE).
- **Climate Change**—Climate change related projections, data and visualization tools were provided by Cal-Adapt, an online resource that provides information on how climate change might affect local communities in California, unless otherwise indicated. The data available on Cal-Adapt is from a variety of organizations in the scientific community and represents peer-reviewed science.

5.4.4 Data Source Summary

Table 5-1 summarizes the data sources used for the risk assessment for this plan.

5.5 LIMITATIONS

Loss estimates, exposure assessments, and hazard-specific vulnerability evaluations rely on the best available data and methodologies. Uncertainties are inherent in any loss estimation methodology and arise in part from incomplete scientific knowledge concerning natural hazards and their effects on the built environment. Uncertainties also result from the following:

- Approximations and simplifications necessary to conduct a study
- Incomplete or outdated inventory, demographic or economic parameter data
- The unique nature, geographic extent, and severity of each hazard
- Mitigation measures already employed
- The amount of advance notice residents have to prepare for a specific hazard event.
- The liquefaction zones data used in the earthquake analysis did not include the level of liquefaction susceptibility information required by the Hazus model. For the purpose of the analysis, it was assumed that areas within the zones had a moderate susceptibility.

These factors can affect loss estimates by a factor of two or more. Therefore, potential exposure and loss estimates are approximate and should be used only to understand relative risk. Over the long term, the City of Los Angeles will collect additional data to assist in estimating potential losses associated with other hazards.

Table 5-1. Hazus Model Data Documentation

Data	Source	Date	Format
Building footprints	City of Los Angeles	2014	Digital (GIS) format
Address points	City of Los Angeles	2016	Digital (GIS) format
Property parcels (includes tax roll data such as use code, year built, number of stories, and square footage)	Los Angeles County	2015	Digital (GIS) format
Soft-story apartments	City of Los Angeles	2016	Digital (spreadsheet) format
Building replacement cost	RS Means	2017	Paper format
Demographic data	FEMA Hazus version 3.2	2010	Digital (GIS and tabular) format
Population data	U.S. Census Bureau American Community Survey 5-Year Population Estimates	2015	Digital (tabular) format
Flood depth grids (created from FEMA effective DFIRM data)	2015 City of Los Angeles Floodplain Management Plan	2015	Digital (GIS) format
Letters of Map Revision	FEMA	2016	Digital (GIS) format
Tsunami inundation depth grids (created from CA Dept. of Conservation data)	2015 City of Los Angeles Floodplain Management Plan	2015	Digital (GIS) format
Earthquake shake maps	USGS Earthquake Hazards Program website	2012-2015	Digital (GIS) format
Susceptibility to Deep-Seated Landslides	CA Geological Survey	2011	Digital (GIS) format
Liquefaction zones	Los Angeles County (via City of Los Angeles GIS data portal)	2016	Digital (GIS) format
National Earthquake Hazard Reduction Program Soils	California Department of Conservation	2008	Digital (GIS) format
Dam inundation depth grids (created from Los Angeles County data)	2015 City of Los Angeles Floodplain Management Plan	2015	Digital (GIS) format
Coastal Storm Modeling System sea level rise data (version 3.0 Phase 2)	U.S. Geological Survey	2017	Digital (GIS) format
Fire Hazard Severity Zones in Local Responsibility Area	CA Dept. of Forestry and Fire Protection	2008	Digital (GIS) format
Digital Elevation Model (5ft resolution)	Los Angeles County	2006	Digital (GIS) format
General Plan Land Use	City of Los Angeles	2015	Digital (GIS) format
Critical Facilities and Assets			
Critical facilities inventory	2015 City of Los Angeles Floodplain Management Plan	2015	Digital (GIS) format
Big 20 buildings	City of Los Angeles	2017	Digital (text) format
Locations/Points of Interest	Los Angeles County	2016	Digital (GIS) format
Hospitals	Los Angeles County	2011	Digital (GIS) format
County-owned facilities	Los Angeles County	2016	Digital (GIS) format
Port of Los Angeles berths, docks, slips	Los Angeles County	2014	Digital (GIS) format

6. ADVERSE WEATHER

6.1 GENERAL BACKGROUND

Adverse weather refers to any dangerous meteorological phenomenon with the potential to cause damage, serious social disruption, or loss of human life. It includes thunderstorms, high winds, tornadoes, waterspouts, extreme temperatures, fog, ice storms, and dust storms.

Adverse weather can be categorized into two groups: systems that form over wide geographic areas are classified as general adverse weather; those with a more limited geographic area are classified as localized adverse weather. Adverse weather, technically, is not the same as extreme weather, which refers to unusual weather events at the extremes of the historical distribution for a given area.

The most common adverse weather events in Los Angeles are extreme heat, high winds, and tornadoes. These are described in the following sections. Flooding and beach erosion issues associated with adverse weather are discussed in Chapter 10.

DEFINITIONS

Extreme Heat—Temperatures that hover 10 degrees or more above the average high temperature for a region and last for several weeks. Humid or muggy conditions occur when a "dome" of high atmospheric pressure traps hazy, damp air near the ground. Extremely dry and hot conditions can lead to dust storms and low visibility.

Severe Local Storm—Small atmospheric systems, including tornadoes, thunderstorms, windstorms, ice storms and snowstorms. Typically, major impacts from a severe local storm are on transportation infrastructure and utilities. These storms may cause a great deal of destruction and even death, but their impact is generally confined to a small area.

Thunderstorm—Any rain event that includes thunder and lightning. A typical thunderstorm is about 15 miles in diameter and lasts about 30 minutes.

Tornado—Tornadoes are funnel clouds of varying sizes that touch ground. They can affect an area up to three-quarters of a mile wide, with a path of varying length. Tornadoes are measured using the Fujita Scale ranging from F0 to F5, or the Enhanced Fujiti Scale.

Windstorm—A storm featuring violent winds. Windstorms are generally short-duration events involving straight-line winds or gusts of over 50 mph, strong enough to cause property damage.

6.1.1 Extreme Heat

Extreme heat is defined as temperatures that hover 10 ºF or more above the average high temperatures for a region for several weeks. In Los Angeles, the summers are hot, but the combination of high temperature and high humidity, which are requirements for the National Weather Service (NWS) to declare a heat emergency, are relatively rare.

According to the *California Climate Adaptation Strategy*, heat waves have claimed more lives in California than all other declared disaster events combined. Despite this history, not a single heat emergency was proclaimed at the state or federal level between 1960 and 2016. Heat emergencies are often slow to develop and usually hurt vulnerable populations. It could take a number of days of oppressive heat for a heat wave to have a significant or quantifiable impact in Los Angeles. Heat waves do not strike victims immediately, but rather their cumulative effects slowly take the lives of vulnerable populations.

Los Angeles is experiencing more heat waves and more extreme heat days. Heat waves have increased by more than three per century and extreme heat days have increased by 23 per century. Both have more than tripled over the past 100 years as a consequence of the steady warming of Los Angeles. The average annual maximum temperature in Los Angeles has warmed by 5.0°F, and the average annual minimum temperature has warmed by

4.2°F. The greatest rate of change was during the summer for both maximum and minimum temperature, with late fall and early winter having the least rates of change. There was also an increase in heat wave duration. Heat waves lasting longer than six days occurred regularly after the 1970s but were nonexistent from 1906 until 1956, when the first six-day heat wave was recorded (Tamrazian et al. 2008).

Because of its expansive urban size, Los Angeles is identified as an urban heat island (UHI). UHIs develop in urban areas where natural surfaces are paved with asphalt or covered by buildings. Radiation from the sun is absorbed by these surfaces during the day and re-radiated at night, raising ambient temperatures. UHIs have high nighttime minimum temperatures compared to neighboring areas. Waste heat from air conditioners, vehicles, and other equipment contributes to the UHI effect.

6.1.2 High Winds

High winds are generally short-duration events involving straight-line winds or gusts of over 50 mph, strong enough to cause property damage. High winds or a windstorm are especially dangerous in areas with significant tree stands and areas with exposed property, poorly constructed buildings, manufactured housing units, major infrastructure, and above-ground utility lines. A windstorm can topple trees and power lines, cause damage to residential, commercial and critical facilities, and leave tons of debris in its wake.

Types of Damaging Winds

Damaging winds are classified as those exceeding 60 mph. Damage from such winds accounts for half of all adverse weather reports in the lower 48 states and is more common than damage from tornadoes. Wind speeds can reach up to 100 mph and can produce a damage path extending for hundreds of miles. There are seven types of damaging winds:

- **Straight-line winds—**Any thunderstorm wind that is not associated with rotation; this term is used mainly to differentiate from tornado winds. Most thunderstorms produce some straight-line winds as a result of outflow generated by the thunderstorm downdraft.
- **Downdrafts—**A small-scale column of air that rapidly sinks toward the ground.
- **Downbursts—**A strong downdraft with horizontal dimensions larger than 2.5 miles resulting in an outward burst or damaging winds on or near the ground. Downburst winds may begin as a microburst and spread out over a wider area, sometimes producing damage similar to a strong tornado. Although usually associated with thunderstorms, downbursts can occur with showers too weak to produce thunder.
- **Microbursts—**A small concentrated downburst that produces an outward burst of damaging winds at the surface. Microbursts are generally less than 2.5 miles across and short-lived, lasting only 5 to 10 minutes, with maximum wind speeds up to 168 mph. There are two kinds of microbursts: wet and dry. A wet microburst is accompanied by heavy precipitation at the surface. Dry microbursts, common in places like the high plains and the intermountain west, occur with little or no precipitation reaching the ground.
- **Gust front**—A gust front is the leading edge of rain-cooled air that clashes with warmer thunderstorm inflow. Gust fronts are characterized by a wind shift, temperature drop, and gusty winds out ahead of a thunderstorm. Sometimes the winds push up air above them, forming a shelf cloud or detached roll cloud.
- **Derecho—**A derecho is a widespread thunderstorm wind caused when new thunderstorms form along the leading edge of an outflow boundary (the boundary formed by horizontal spreading of thunderstorm-cooled air). The word “derecho” is of Spanish origin and means “straight ahead.” Thunderstorms feed on the boundary and continue to reproduce. Derechos typically occur in summer when complexes of thunderstorms form over plains, producing heavy rain and severe wind. The damaging winds can last a long time and cover a large area.
- **Bow Echo—**A bow echo is a linear wind front bent outward in a bow shape. Damaging straight-line winds often occur near the center of a bow echo. Bow echoes can be 200 miles long, last for several hours, and produce extensive wind damage at the ground.

Santa Ana Winds

Santa Ana winds are a principal feature of Los Angeles weather. These are offshore winds, usually warm, blowing from the mountains to the coast, and occurring principally in fall and winter, with a frequency peaking in December. Santa Ana winds are marked by light coastal winds, clean air and low humidity. They may last from a day to over a week. The Santa Ana condition is usually one of warm temperatures when the rest of the United States is in the grip of winter. High pressure builds over the Great Basin in fall and winter as cold air travels into that region from Canada. When the surface pressure gradient reaches or exceeds 10 millibars, as measured from Tonopah, Nevada, to Los Angles, wind gusts can reach 70 mph in the mountains and below passes and canyons near Los Angeles.

Santa Ana winds broadly affect the Los Angeles area. Winds tend to channel below specific passes and canyons, coming in gust clusters. High winds may blow in one neighborhood, while a few blocks away there are only gentle warm breezes. Offshore winds from the northeast or east must reach 30 mph or more below passes and canyons to reach minimum criteria for Santa Ana wind advisories. Typically wind speeds are in the 40 to 55 mph range, and in extreme cases, winds can gust locally to over 100 mph.

6.1.3 Tornadoes

A tornado is a violently rotating column of air extending between, and in contact with, a cloud and the surface of the earth. Tornadoes are often (but not always) visible as a funnel cloud. On a local-scale, tornadoes are the most intense of all atmospheric circulations and wind can reach destructive speeds of more than 300 mph. A tornado's vortex is typically a few hundred meters in diameter, and damage paths can be up to 1 mile wide and 50 miles long. Figure 6-1, adapted from FEMA, illustrates the potential impacts and damage from tornadoes of different magnitude. Tornadoes can occur throughout the year at any time of day but are most frequent in the spring during the late afternoon.

In 2007, NWS began rating tornadoes using the Enhanced Fujita Scale (EF-scale). The EF-scale is a set of wind estimates (not measurements) based on damage. It uses 3-second gusts estimated at the point of damage based on a judgment of 8 levels of damage to 28 indicators. These estimates vary with height and exposure. Standard measurements are taken by weather stations in openly exposed area. Table 6-1 describes the EF-scale ratings (NOAA 2007).

Table 6-1. The Fujita Scale and Enhanced Fujita Scale

Fujita (F) Scale			Derived		Operational Enhanced Fujita (EF) Scale	
F Number	Fastest ¼ mile (mph)	3-second gust (mph)	EF Number	3-second gust (mph)	EF Number	3-second gusts (mph)
0	40-72	45-78	0	65-85	0	65-85
1	73-112	79-117	1	86-109	1	86-110
2	113-157	118-161	2	110-137	2	111-135
3	158-207	162-209	3	138-167	3	136-165
4	208-260	210-261	4	168-199	4	166-200
5	261-318	262-317	5	200-234	5	Over 200

The south coastal region of California, including the Los Angeles area, has the greatest incidence of tornadoes in the state. The cause of most Los Angeles area tornadoes is the terrain of the basin—specifically the natural curvature of the shoreline and the location of the coastal mountains. Tornadoes in the Los Angeles area are typically less severe than those in other parts of the country. They are typically not high in intensity and are short-lived. There is no record of a Los Angeles tornado causing a fatality, and the state has never proclaimed a state of emergency or had a federal disaster declared as the result of a tornado. Nevertheless, the frequency of tornadoes and the density of the Los Angeles urban area make tornadoes a relevant hazard for the City.

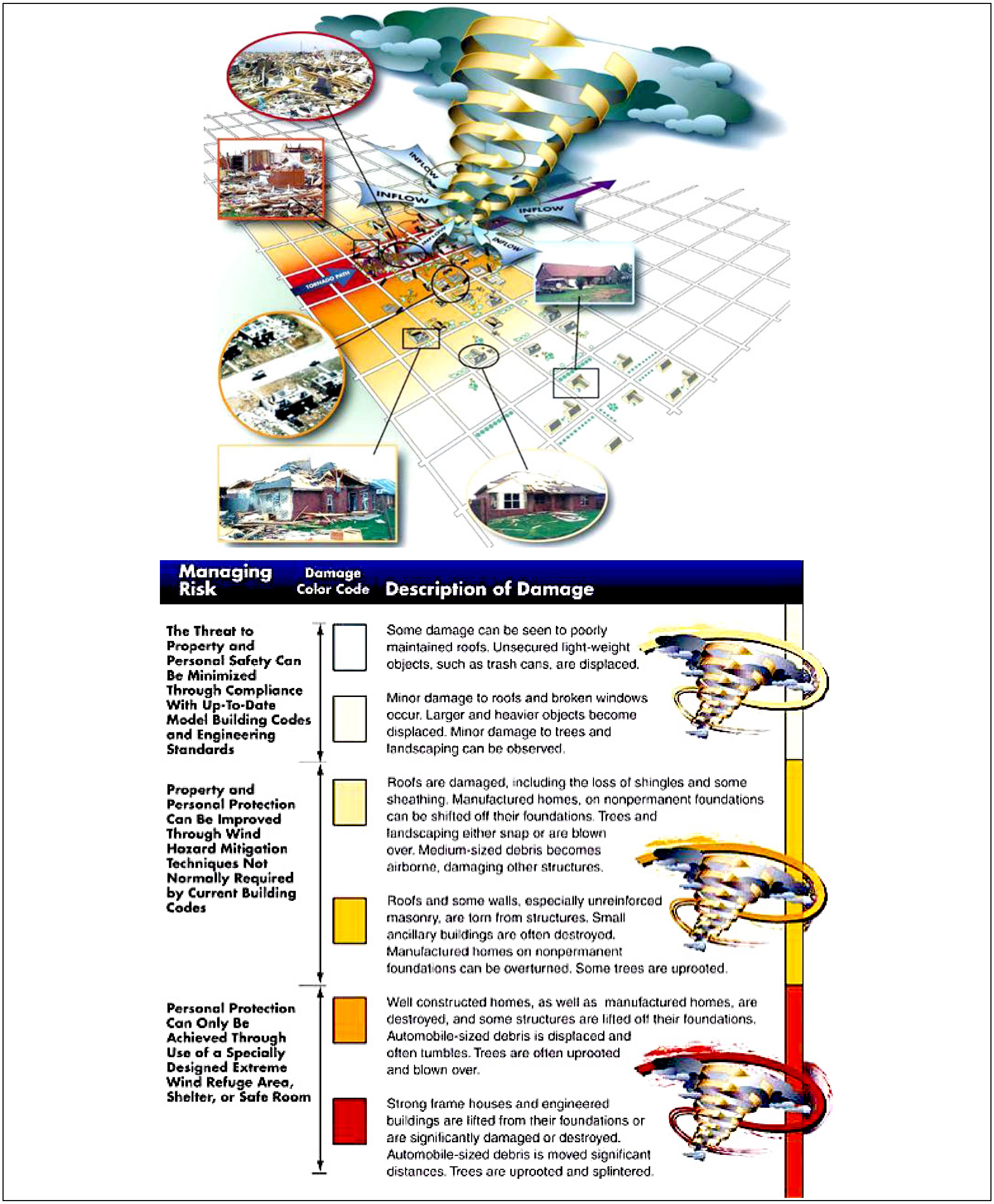


Figure 6-1. Potential Impact and Damage from a Tornado

6.2 HAZARD PROFILE

6.2.1 Past Events

Los Angeles has not been included in any federal declarations for extreme heat, high winds or tornado. According to the Western Regional Climate Center, the planning area averages 20 days a year with temperatures exceeding 90°F, and those days may be included in a heat wave event. A storm event database maintained by NOAA's National Centers for Environmental Information (NCEI) lists three excessive heat events in the planning area:

- **July 2006**—In July 2006, California and Nevada were impacted by a heat wave that was unprecedented with respect to the magnitude and duration of high temperatures, especially high nighttime minimums; great areal extent, as it simultaneously impacted both northern and Southern California; and very high humidity levels (Los Angeles Times, 25 July 2006). The events are credited with 163 deaths in California. A temperature of 119ºF was recorded in Woodland Hills, with high humidity.
- **August 30 – September 3, 2007**—The combination of above normal temperatures and relative humidity produced excessive heat across the planning area. Eight fatalities occurred related to the heat. Heat index values were between 105 and 112 degrees.
- **June 20 – 21, 2008**—The combination of strong high pressure centered over Arizona and weak offshore flow generated extreme heat conditions across Central and Southern California. Across many sections of the area, afternoon temperatures climbed to between 100ºF and 114ºF, setting numerous high temperature records. The extreme heat resulted in several power outages due to excessive electrical use.

Los Angeles County has experienced both high wind and thunderstorm wind events. The strongest winds, from the north, are Santa Ana winds in winter. As an example of the impacts from high wind storms, a windstorm on Nov. 30, 2011 left 300,000 customers without power, some over one week. The NCEI storm events database lists the following wind events from 1996 to 2016:

- 173 high wind events, with 96 categorized as damaging winds events
- 25 thunderstorm events, with 7 categorized as damaging wind events.

According to NCEI storm events database, Los Angeles County experienced 35 tornadoes from 1970 through 2016, with 34 injuries and over $60 million in property damage. The recorded tornado events are rated as F0 (25 events), EF0 (two events), F1 (six events), and the strongest recorded F2 (three events). The following are notable tornado events in the City of Los Angeles:

- **March 1, 1983**—An F2 tornado touched down in South-Central Los Angeles. It caused approximately $25 million in damage, including 100 homes, and injured 30 people. It stopped about 1 mile before reaching the Los Angeles civic center area.
- **December 12, 2014**—An EF0 tornado developed in south Los Angeles. The tornado damaged the roof of an apartment complex, two residential roofs and a steel billboard.

6.2.2 Location

Adverse weather events have the potential to happen anywhere in the planning area. Extreme heat events may be exacerbated in the City where reduced air flow, reduced vegetation, and increased generation of waste heat can contribute to temperatures that are several degrees higher than in surrounding less urbanized areas. High wind events affect an entire region.

6.2.3 Frequency

The adverse weather events for the planning area are often related to high winds associated with winter storms and thunderstorms. Based on a record of 103 damaging wind events (over 60 mph) in 21 years, the planning area will continue to experience these on an annual basis.

Even though the NCEI storm events database lists only two documented past events for extreme heat, Steering Committee members for this update report that extreme heat days occur a few days each year during summer.

Tornadoes may occur in any month and at any hour of the day, but they occur with the greatest frequency from November through March. There are only three recorded F2 tornado events from 1970 to 2016, therefore on average, a considerable tornado may occur every six years. There is a 68 percent chance of a light to moderate tornado occurring in any year.

6.2.4 Severity

The most common problems associated with severe storms are immobility and loss of utilities. Fatalities are uncommon, but can occur. Roads may become impassable due to flooding, downed trees, or a landslide. Power lines may be downed due to high winds, and services such as water or phone may not be able to operate without power. Physical damage to homes and facilities can be caused by wind or flooding.

Extreme heat can cause heat exhaustion, in which the body becomes dehydrated, resulting in an imbalance of electrolytes. Without intervention, heat exhaustion can lead to collapse and heatstroke. Heatstroke occurs when perspiration cannot occur and the body overheats. Without intervention, heatstroke can lead to confusion, coma, and death. Extreme heat is the primary weather-related cause of death in the U.S. In a 10-year record of weather fatalities across the nation from (2006-2015), excessive heat claimed more lives each year than floods, lightning, tornadoes, and hurricanes. In 2015, heat claimed 25 lives, though none of them were in California (NWS 2016b). Extreme heat events do not typically impact buildings; however, losses may be associated with the UHI effect and overheating of HVAC systems. These extreme heat events can lead to drought, impact water supplies, and lead to an increase in heat-related illnesses and deaths.

High winds are a frequent problem in the planning area and have been known to damage utilities. The wind speed given in wind warnings issued by the NWS is for a one-minute average; gusts may be 25 to 30 percent higher.

Tornadoes generally have low intensity in the planning area, but if a major tornado were to strike the dense planning area, damage could be widespread. Businesses could be forced to close for an extended period or permanently, fatalities could be high, many people could be homeless for an extended period, and routine services such as telephone or power could be disrupted. Buildings may be damaged or destroyed. California ranks 32nd among states for frequency of tornadoes, 44th for the frequency of tornados per square mile, 36th for injuries, and 31st for cost of damage. The state has no reported deaths from tornadoes.

6.2.5 Warning Time

Meteorologists can often predict the likelihood of severe storms. This can give several days of warning time. However, meteorologists cannot predict the exact time of onset or severity of the storm. Some storms may come on more quickly and have only a few hours of warning time. NOAA issues watch, warning, and advisory information for extreme heat, high winds, and tornadoes.

The NWS is producing experimental forecasts called HeatRisk to assess the heat risk to local thresholds in California, Nevada, Utah, and Arizona (see Figure 6-2). The numeric (0-4) and color (green, yellow, orange, red and magenta) scales are similar to the NWS air quality index.

Source: NWS, 2017

Numerical Value	Meaning	Who/What is at Risk?	How Common is this Heat?	For those at risk, what actions can be taken?
0	• Level of heat poses **little to no risk**	• No elevated risk	Very Common	• No additional preventative actions should be necessary.
1	• Heat of this type is **tolerated by most**; however there is a **low risk for sensitive groups** to experience health effects	• Primarily those who are extremely sensitive to heat	Very Common	• Increase hydration • Reduce time spent outdoors or stay in the shade when the sun is strongest • Open windows at night and use fans to bring cooler air inside buildings
2	• **Moderate risk for members of heat sensitive groups** to experience health effects • **Some risk for the general population who are exposed to the sun and are active** • For those without air conditioning, **living spaces can become uncomfortable during the day**, but should cool below dangerous levels at night	• Primarily heat sensitive groups, especially those without effective cooling or hydration • Some transportation and utilities sectors	• Fairly common most locations • Very common in southern regions of country	• Reduce time in the sun between 10 a.m. and 4 p.m. • Stay hydrated • Stay in a cool place during the heat of the day • Move outdoor activities to cooler times of the day • Open windows at night and use fans to bring cooler air inside buildings and circulate air
3	• **High Risk for much of the population who are 1) exposed to the sun and active or 2) are in a heat sensitive group** • **Dangerous to anyone without proper hydration or adequate cooling** • **Poor air quality** is possible • **Power interruptions may occur** as electrical demands increase	• Much of the population, especially those who are heat sensitive and anyone without effective cooling or hydration • Most transportation and utilities sectors	• Uncommon most northern locations • Fairly common in southern regions of country	• Try to avoid being outdoors in the sun between 10 a.m. and 4 p.m. • Stay hydrated • Stay in a cool place especially during the heat of the day • If you have access to air conditioning, use it. Fans may not be adequate • Cancel outdoor activities during the heat of the day
4	• **Very High Risk for entire population** • **Very dangerous to anyone without proper hydration or adequate cooling.** • **This is a multi-day excessive heat event.** Prolonged heat is dangerous to anyone not prepared. • **Poor air quality** is likely. • **Power outages are increasingly likely** as electrical demands may reach critical levels.	• Entire population is at risk. • For heat sensitive groups, especially people without effective cooling, **this level of heat can be deadly**. • Most transportation and utilities sectors	• Rare most locations • Occurs up to a few times a year in southern regions of country, especially the Desert Southwest	• Avoid being outdoors in the sun between 10 a.m. and 4 p.m. • Stay hydrated • Stay in a cool place, including overnight • If you have access to air conditioning, use it. Fans will not be adequate • Cancel outdoor activities during the heat of the day

Figure 6-2. NWS HeatRisk Forecasting System

The NWS continues to issue excessive heat watches, excessive heat warnings and heat advisories to warn of an extreme heat event (a “heat wave”) within the next 36 hours. If NWS forecasters predict an excessive heat event beyond 36 hours, then the NWS will issue messaging in the form of a special weather statement, partner emails and social media out between the three- to seven-day timeframe. The NWS will use the HeatRisk output (Figure 6-2) to determine if an excessive heat watch/warning or heat advisory is warranted. The NWS issues the following types of heat-related advisories:

- **Heat Advisory**—Tied to events where HeatRisk output is on the orange/red (Level 2-3) thresholds (orange will not be an automatic heat advisory).
- **Excessive Heat Watch/Warning**— Tied to events where HeatRisk output is on the red/magenta (Level 3-4) thresholds.

These advisories are intended to raise the public’s awareness to prevent heat illnesses from occurring. If significantly hot weather is forecasted, the NWS will issue an excessive heat watch generally two to three days in advance. An excessive heat watch is a way to give the public and emergency officials a warning that extreme temperatures are expected. If significantly hot temperatures remain in the forecast for 24 to 28 hours, the excessive heat watch will be upgraded to an excessive heat warning, indicating that extreme heat has either arrived or is expected soon.

6.3 SECONDARY IMPACTS

A secondary impact of extreme heat is poor air quality, which can occur during summer months, when stagnant atmospheric conditions trap humid air and pollutants near the ground and closer to residents. Ozone, a major component of smog, is created in the presence of sunlight via reactions between chemicals in gasoline vapors and industrial smoke stacks. Hot weather can increase ozone levels. High ozone levels often cause or worsen respiratory problems. The longer a given heat wave lasts and the hotter the temperature is, the greater the risk of adverse impacts on human health or infrastructure. Additionally, climate change is likely to bring hotter temperatures, more hot days, and more frequent heat waves. As the population ages and climate change brings more extreme heat events, rates of heat-related impairments and deaths may rise.

High winds and tornadoes may cause loss of power if utility service is disrupted. Debris carried by high winds can also result in injury or property damage. Tornadoes may cause fires resulting from damage to natural gas infrastructure. Hazardous materials may be released if a structure is damaged that stores such materials or if such a material is in transport.

6.4 EXPOSURE

6.4.1 Population

It can be assumed that all residents of Los Angeles are exposed to some extent to extreme heat, high winds, and tornadoes.

6.4.2 Property

According to the Los Angeles County Assessor, there are 746,352 buildings within the census tracts that define the planning area. Most of these buildings are residential. All of these buildings are considered to be exposed to the adverse weather hazard. The frequency and degree of damage will depend on specific locations. Typically the only impact extreme heat has on general building stock is increased demand on air conditioning equipment, which may cause strain on electrical systems.

6.4.3 Critical Facilities and Infrastructure

Extreme heat poses a risk to ground transportation infrastructure. For instance, high temperatures can cause railroad tracks and wires, and pavement and joints on roads and bridges to crack, buckle, or sag, resulting in service disruptions, potentially hazardous travel conditions, and the need for costly repairs.

Power outages or roaming blackouts may occur as a result of extreme heat events that strain and overheat circuits. During a blackout, all critical facilities and infrastructure that are reliant upon electricity for power will be severely impacted unless they are connected to a backup power source. Additional facilities on higher ground may also be exposed to wind damage or damage from falling trees.

6.4.4 Environment

The environment is highly exposed to adverse weather events. Natural habitats and park areas are exposed to the elements and risk damage and destruction. Prolonged extreme heat can degrade landscape quality, lakes and vegetation. High winds and tornadoes can cause entire trees to topple.

6.5 VULNERABILITY

6.5.1 Population

According to the EPA, those at greater risk to the adverse effects of excessive heat events are individuals with physical or mobility constraints, cognitive impairments, economic constraints, and social isolation. Such populations include the elderly, young children, low income people, people with life-threatening illnesses and those who are overweight. Power outages can be life threatening to those dependent on electricity for life support. Outdoor recreational users may also be more vulnerable to adverse weather events.

The homeless are particularly vulnerable to extreme heat during the summer when increased humidity keeps nighttime temperatures above 80°F. The cumulative effects over several days of continuous exposure to heat, without relief, put the homeless at serious risk of heat stroke or worse. Others at significant risk are low income populations who do not have access to air conditioning. This population, like the homeless, would lack nighttime relief from the heat, elevating their risk of heat stroke or other complications.

6.5.2 Property

All property is vulnerable to adverse weather, but structures in poor condition or in vulnerable locations may risk the most damage. Northern portions of the City are more vulnerable to high Santa Ana winds, and buildings in higher elevations and on ridges may be more prone to wind damage in general. Homes near mature trees or overhead power lines may be more susceptible to wind damage and blackouts.

It is estimated that 92 percent of residential structures in Los Angeles were built without the influence of a building code with provisions for wind loads. Those that are located under or near overhead lines or near large trees may be vulnerable to falling ice or may be damaged in the event of a collapse.

Loss estimations for the adverse weather hazard are not based on damage functions, because no such damage functions have been generated. Instead, loss estimates were developed representing 10 percent, 30 percent and 50 percent of the replacement value of exposed structures. This allows emergency managers to select a range of potential economic impact based on an estimate of the percent of damage to the general building stock. Damage in excess of 50 percent is considered to be substantial by most building codes and typically requires total reconstruction of the structure. Table 6-2 lists the loss estimates by Area Planning Commission (APC) within the City of Los Angeles.

Table 6-2. Loss Potential for Adverse Weather

Area Planning Commission	Total Building Value (Structure and Contents)	10% of Total Building Value	30% of Total Building Value	50% of Total Building Value
Central	$191,217,052,041	$19,121,705,204	$57,365,115,612	$95,608,526,020
East Los Angeles	$66,257,497,608	$6,625,749,761	$19,877,249,282	$33,128,748,804
Harbor	$40,999,775,796	$4,099,977,580	$12,299,932,739	$20,499,887,898
North Valley	$115,609,300,175	$11,560,930,017	$34,682,790,052	$57,804,650,087
South Los Angeles	$98,455,728,673	$9,845,572,867	$29,536,718,602	$49,227,864,337
South Valley	$145,505,548,380	$14,550,554,838	$43,651,664,514	$72,752,774,190
West Los Angeles	$109,858,703,574	$10,985,870,357	$32,957,611,072	$54,929,351,787
Total	**$767,903,606,246**	**$76,790,360,625**	**$230,371,081,874**	**$383,951,803,123**

6.5.3 Critical Facilities and Infrastructure

Incapacity and loss of roads are the primary transportation failures resulting from adverse weather, mostly associated with secondary impacts. High winds can cause significant damage to trees and power lines, blocking roads with debris, incapacitating transportation, and disrupting ingress and egress.

6.5.4 Environment

The vulnerability of the environment to adverse weather is the same as the exposure.

6.6 FUTURE TRENDS IN DEVELOPMENT

All future development will be affected by adverse storms. The ability to withstand impacts lies in sound land use practices and consistent enforcement of codes and regulations for new construction. The City of Los Angeles has adopted the International Building Code in response to California mandates. This code is equipped to deal with the impacts of adverse weather events. Land use policies identified in the City’s general plan also address many of the secondary impacts of the adverse weather hazard. With these tools, the City of Los Angeles is well equipped to deal with future growth and the associated impacts of adverse weather.

6.7 SCENARIO

Although extreme heat and high winds occur on an annual basis, secondary impacts can be significant for the densely populated City of Los Angeles. A worst-case event would involve prolonged high winds during a winter storm accompanied by an EF3 tornado. Such an event would have both short-term and longer-term effects. Initially, schools and roads would be closed due to power outages caused by the tornado event. The tornado would cause structural damage, injury, fatalities and displacement of people from their homes.

6.8 ISSUES

Important issues associated with an adverse weather in the planning area include the following:

- Older building stock in the planning area is built to low code standards or none at all. These structures could be highly vulnerable to adverse weather events such as windstorms.
- The UHI of Los Angles makes the homeless and vulnerable communities susceptible to heat exhaustion.
- The City may need to open cooling/warming stations during extreme temperature events.
- Redundancy of power supply and communications equipment must be evaluated.
- The capacity for backup power generation is limited.

- Dead or dying trees as a result of drought conditions are more susceptible to falling during severe storm events.
- Adverse weather events are likely to increase as a result of climate change impacts, including the potential for extreme heat.

7. DAM FAILURE

7.1 GENERAL BACKGROUND

7.1.1 Causes of Dam Failure

Dam failures in the United States typically occur in one of four ways:

- Overtopping of the primary dam structure, which accounts for 34 percent of all dam failures, can occur due to inadequate spillway design, settlement of the dam crest, blockage of spillways, and other factors.
- Foundation defects due to differential settlement, slides, slope instability, uplift pressures, and foundation seepage can also cause dam failure. These account for 30 percent of all dam failures.
- Failure due to piping and seepage accounts for 20 percent of all failures. These are caused by internal erosion due to piping and seepage, erosion along hydraulic structures such as spillways, erosion due to animal burrows, and cracks in the dam structure.
- Failure due to problems with conduits and valves, typically caused by the piping of embankment material into conduits through joints or cracks, constitutes 10 percent of all failures.

The remaining 6 percent of U.S. dam failures are due to miscellaneous causes. Many dam failures in the United States have been secondary results of other disasters. The prominent causes are earthquakes, landslides, extreme storms, massive snowmelt, equipment malfunction, structural damage, foundation failures, and sabotage. The most likely disaster-related causes of dam failure in the Los Angeles vicinity are earthquakes, excessive rainfall, and landslides.

Poor construction, lack of maintenance and repair, and deficient operational procedures are preventable or correctable by a program of regular inspections. Terrorism and vandalism are serious concerns that all operators of public facilities must plan for; these threats are under continuous review by public safety agencies.

DEFINITIONS

Dam—Any artificial barrier, together with appurtenant works, that does or may impound or divert water, and that either (a) is 25 feet or more in height from the natural bed of the stream or watercourse at the downstream toe of the barrier (or from the lowest elevation of the outside limit of the barrier if it is not across a stream channel or watercourse) to the maximum possible water storage elevation; or (b) has an impounding capacity of 50 acre-feet or more. (CA Water Code, Division 3.)

Dam Failure—An uncontrolled release of impounded water due to structural deficiencies in dam.

Emergency Action Plan—A formal document that identifies potential emergency conditions at a dam and specifies actions to be followed to minimize property damage and loss of life. The plan specifies actions the dam owner should take to alleviate problems at a dam. It contains procedures and information to assist the dam owner in issuing early warning and notification messages to responsible downstream emergency management authorities of the emergency situation. It also contains inundation maps to show emergency management authorities the critical areas for action in case of an emergency.

High Hazard Dam—Dams where failure or improper operation will probably cause loss of human life.

Significant Hazard Dam—Dams where failure or improper operation will result in no probable loss of human life but can cause economic loss, environmental damage or disruption of lifeline facilities, or can impact other concerns. Significant hazard dams are often located in rural or agricultural areas but could be located in areas with population and significant infrastructure.

7.1.2 Regulatory Oversight

National Dam Safety Act

Potential for catastrophic flooding due to dam failures led to passage of the National Dam Safety Act (Public Law 92-367). The National Dam Safety Program requires a periodic engineering analysis of the majority of dams in the country; exceptions include the following:

- Dams under jurisdiction of the Bureau of Reclamation, Tennessee Valley Authority, or International Boundary and Water Commission
- Dams constructed pursuant to licenses issued under the Federal Power Act
- Dams that the Secretary of the Army determines do not pose any threat to human life or property.

The goal of this FEMA-monitored effort is to identify and mitigate the risk of dam failure so as to protect lives and property of the public. The National Dam Safety Program is a partnership among the states, federal agencies, and other stakeholders that encourages individual and community responsibility for dam safety. Under FEMA's leadership, state assistance funds have allowed all participating states to improve their programs through increased inspections, emergency action planning, and purchases of needed equipment. FEMA has also expanded existing and initiated new training programs. Grant assistance from FEMA provides support for improvement of dam safety programs that regulate most of the dams in the United States.

California Division of Safety of Dams

California's Division of Safety of Dams (DSOD) monitors the dam safety program at the state level and maintains a working list of dams in the state. When a new dam is proposed, DSOD engineers and geologists inspect the site and the subsurface. Upon submittal of an application, the DSOD reviews the plans and specifications prepared by the owner to ensure that the dam is designed to meet minimum requirements and that the design is appropriate for the known geologic conditions. After approval of the application, the DSOD inspects all aspects of the construction to ensure that the work is done in accordance with the approved plans and specifications. After construction, the DSOD inspects each dam to ensure that it is performing as intended and is not developing problems. The DSOD periodically reviews the stability of dams and their major appurtenances in light of improved design approaches and requirements, as well as new findings regarding earthquake hazards and hydrologic estimates in California. Over 1,200 dams are inspected by DSOD engineers on a yearly schedule to ensure performance and maintenance of dams (California DSOD, 2017).

U.S. Army Corps of Engineers Dam Safety Program

The U.S. Army Corps of Engineers operates and maintains approximately 700 dams nationwide. It is also responsible for safety inspections of federal and non-federal dams in the United States that meet size and storage limitations specified in the National Dam Safety Act. The Corps of Engineers has inventoried dams; surveyed each state and federal agency's capabilities, practices and regulations regarding design, construction, operation and maintenance of the dams; and developed guidelines for inspection and evaluation of dam safety. The Corps maintains the National Inventory of Dams that contains information about a dam's location, size, purpose, type, last inspection and regulatory facts (U.S. Army Corps of Engineers, 2017). Table 7-1 provides the most recent inspection dates for the dams in Los Angeles County and in City of Los Angeles that can impact the city.

Federal Energy Regulatory Commission Dam Safety Program

The Federal Energy Regulatory Commission (FERC) cooperates with a large number of federal and state agencies to ensure and promote dam safety. More than 3,000 dams are part of regulated hydroelectric projects in the FERC program. Two-thirds of these are more than 50 years old. As dams age, concern about their safety and integrity grows, so oversight and regular inspection are important.

Table 7-1. Los Angeles County Dam Inspection Dates

Dam Name	Inspection Date	Dam Name	Inspection Date
10th and Western	09/04/2014	Lopez[a]	03/04/2014
Big Tujunga	02/04/2015	Los Angeles Reservoir[a]	08/22/2014
Devils Gate	10/14/2014	Lower Franklin #2[a]	09/30/2014
Diederich Reservoir	09/04/2014	Lower Van Norman Bypass	08/22/2014
Eagle Rock[a]	09/16/2014	Mulholland[a]	09/16/2014
Elysian[a]	09/16/2014	Pacoima	11/05/2014
Encino[a]	09/10/2014	Palos Verdes Reservoir	01/21/2015
Glen Oaks 968	09/04/2014	Riviera Reservoir[a]	09/03/2014
Green Verdugo	09/17/2014	Santa Ynez Canyon[a]	09/17/2014
Greystone	09/03/2014	Sepulveda	02/12/2015
Hansen Rec Lake[a]	03/21/2014	Silver Lake[a]	09/30/2014
Ivanhoe	Not Available	Solano	06/21/2011
Laguna Reg. Basin	10/14/2014	Stone Canyon[a]	09/10/2014
		Upper Franklin Dam	07/27/2006

a. Dams located within Los Angeles city limits
Source: National Inventory of Dams, https://catalog.data.gov/dataset/national-inventory-of-dams, 2017

FERC inspects hydroelectric projects on an unscheduled basis to investigate the following:

- Potential dam safety problems
- Complaints about constructing and operating a project
- Safety concerns related to natural disasters
- Issues concerning compliance with the terms and conditions of a license.

Every five years, an independent engineer approved by the FERC must inspect and evaluate projects with dams higher than 32.8 feet (10 meters) or with a total storage capacity of more than 2,000 acre-feet.

FERC monitors and evaluates seismic research and applies it in investigating and performing structural analyses of hydroelectric projects. FERC also evaluates the effects of potential and actual large floods on the safety of dams. During and following floods, FERC visits dams and licensed projects, determines the extent of damage, if any, and directs any necessary studies or remedial measures the licensee must undertake. The FERC publication *Engineering Guidelines for the Evaluation of Hydropower Projects* guides the FERC engineering staff and licensees in evaluating dam safety. The publication is frequently revised to reflect current information and methodologies.

FERC requires licensees to prepare emergency action plans and conducts training sessions on how to develop and test these plans. The plans outline an early warning system if there is an actual or potential sudden release of water from a dam due to failure. The plans include operational procedures that may be used, such as reducing reservoir levels and reducing downstream flows, as well as procedures for notifying affected residents and agencies responsible for emergency management. These plans are frequently updated and tested to ensure that everyone knows what to do in emergency situations.

7.2 HAZARD PROFILE

7.2.1 Past Events

According to the 2013 California State Hazard Mitigation Plan, there have been nine dam failures in the state since 1950, some of which occurred in Los Angeles County. Overtopping caused two of the failures, and the others were caused by seepage or leaks. The historical record indicates that California has had about 45 failures of non-federal dams. The failures occurred for a variety of reasons, the most common being overtopping. Other reasons include shortcomings in the dams or an inadequate assessment of surrounding geomorphologic characteristics. The sections below describe significant dam failure events directly relevant to the City of Los Angeles.

St. Francis Dam, 1928

The most catastrophic dam failure in California's history was that of the St. Francis Dam in Los Angeles County in March 1928. This failure resulted in the deaths of more than 450 people and destruction of nearly 1,000 homes and buildings. Numerous roads and bridges were destroyed or damaged beyond repair. The DSOD came into existence as a direct result of this catastrophe.

Baldwin Hills Reservoir Collapse, 1963

On December 14, 1963, the dam at the head of Cloverdale Road broke in the Baldwin Hills section of Los Angeles. Lost homes, ruined property, and even death resulted from a river of rushing water from the broken dam. Automobiles, fragments of houses, and chunks of concrete were carried along the flood's path and deposited on the ruins of Village Green. Eighteen persons were rescued by helicopter and flown out to a safety.

1971 Earthquake

In 1971, a magnitude 6.7 earthquake had the following impacts on dams in the Los Angeles area:

- Perched above the densely populated San Fernando Valley, the 142-foot-high, 2,100-foot-long Lower San Fernando Dam held a reservoir 1.6 miles long and as much as 130 feet deep and supplied 80 percent of the City's water supply. The quake shook loose a massive slide in the upstream slope of the Lower San Fernando Dam that lowered the crest about 30 feet and carried away much of upstream concrete facing of the dam. Resulting severe damage of the dam forced 80,000 residents to evacuate homes in an 11-square-mile area down the valley while the water behind the earthen dam was lowered over a three-day period. The damage was so heavy that the dam could not be repaired to safely hold its water supply in the event of another large earthquake. The $33 million Los Angeles Dam and Reservoir was built in 1975-76 about 3,000 feet up the valley from the old Lower San Fernando Dam, and the old dam was reconstructed to provide a holding basin for stormwater and to back up the new dam.
- Several thousand people were evacuated from homes south of Van Norman Dam in Mission Hills when Van Norman Lake reportedly sank 1 foot. A 60-foot section of the concrete dam at the lake's southern edge collapsed, and portions were reported as still crumbling during the evacuation. The dam holds back more than 6 billion gallons of water and is the largest in the City's water system.
- Cracks were reported in the Hansen Dam on Sepulveda Boulevard in Lakeview Terrace.

1994 Northridge Earthquake

Thirteen dams in the greater Los Angeles area moved or cracked during the 1994 Northridge Earthquake. The most seriously damaged was the Pacoima Dam, about 8 miles from the epicenter. However, none were severely damaged, in part due to completion of retrofitting pursuant to the 1972 State Dam Safety Act. The Los Angeles Dam showed only minor deformation and superficial cracking.

7.2.2 Location

According to the California DSOD, there are 90 dams in Los Angeles County. Table 7-2 lists the dams that have the potential to impact the City of Los Angeles should they fail. Dam locations are shown in Figure 7-1.

Table 7-2. Dams in Los Angeles County with Potential to Impact City of Los Angeles

Name	Hazard Class[a]	Water Course	Owner	Year Built	Dam Type[d]	Crest Length (feet)	Height (feet)	Storage Capacity (acre-feet)	Drainage area (sq. mi.)
10th and Western	1A	Off stream	City of Glendale	1924	ERTH	725	28	46	1.03
Big Tujunga	1A	Big Tujunga Creek	Los Angeles County	1931	VARA	505	220	5,750	81.7
Devils Gate	1A	Arroyo Seco	Los Angeles County	1920	GRAV	252	108	2,600	29.7
Diederich Res	1A	Off stream	City of Glendale	1950	ERTH	100	60	174	0
Eagle Rock[b]	1A	Off Stream	City of Los Angeles	1953	ERTH	495	113	254	0
Elysian[b]	1A	Los Angeles River Tributary	City of Los Angeles	1943	ERTH	480	71	167	0.08
Encino[b]	1A	Encino Creek	City of Los Angeles	1924	ERTH	1,850	168	9789	1.4
Glen Oaks 968	1A	Off Stream	City of Glendale	1949	ERTH	220	62	28	0
Green Verdugo	1A	Tujunga Wash Tributary	City of Los Angeles	1953	ERTH	452	118	99	0.04
Greystone	1A	Off Stream	City of Beverley Hills	1970	RECT	1,140	75	60	0
Hansen Rec Lake[b]	1A	Off Stream	City of Los Angeles	1999	ERTH	3,600	50	85	0.01
Ivanhoe[c]	N/A	Off stream	City of Los Angeles	1906	ERTH	430	458	180	N/A
Laguna Reg. Basin	1A	Laguna Wash	Los Angeles County	1970	ERTH	380	43	310	5.55
Lopez[b]	1A	Arroyo Grande Creek	San Luis Obispo County	1969	ERTH	1,120	166	52,500	70
Los Angeles Res[b]	1A	San Fernando Creek	City of Los Angeles	1977	ERTH	3,415	130	10,000	9
Lower Franklin No. 2[b]	1A	Franklin Canyon	City of Los Angeles	1982	ERTH	410	49	920	1.12
Lower Van Norman Bypass[c]		Off stream	City of Los Angeles	1970	ERTH	600	78	240	0.03
Mulholland[b]	1A	Weid Canyon	City of Los Angeles	1924	GRAV	933	195	4,036	1
Pacoima	1A	Pacoima Creek	Los Angeles County	1929	VARA	640	365	3,777	27.8
Palos Verdes Res	1A	LA Harbor Tributary	Metropolitan Water District	1939	ERTH	2,150	82	1,100	1
Riviera Res. [b]	1A	Off Stream	City of Santa Monica	1962	RECT	1,280	40	76	0
Santa Ynez Canyon[b]	1A	Santa Ynez Canyon Tributary	City of Los Angeles	1968	ERTH	455	157	356	0.23
Sepulveda	1A	Los Angeles River	Corps of Engineers	1941	CONC	15,270	57	--	--
Silver Lake[b]	1A	Ballona Creek Tributary	City of Los Angeles	1906	ERRK	760	43	2,020	0.12
Solano[c]	N/A	Off stream	City of Los Angeles	1904	ERTH	915	620	17	0.99
Stone Canyon[b]	1A	Stone Canyon Creek	City of Los Angeles	1924	ERTH	1,150	188	10,372	1.4
Upper Franklin	N/A	N/A	National Park Service	1915	ERTH	260	40	150	N/A

a. Downstream Hazard Class 1A: > 300 lives at risk, 1B: 31 to 300 lives at risk, 1C: 7 to 30 lives at risk.
b. Dams located within Los Angeles city limits
c. No inundation mapping available for these dams
d. Dam Type: ERTH = earth fill; VARA = arch; GRAV = gravity; RECT = reinforced concrete tank; CONC = concrete; ERRK = rock fill
Source: California DWR, 2015.

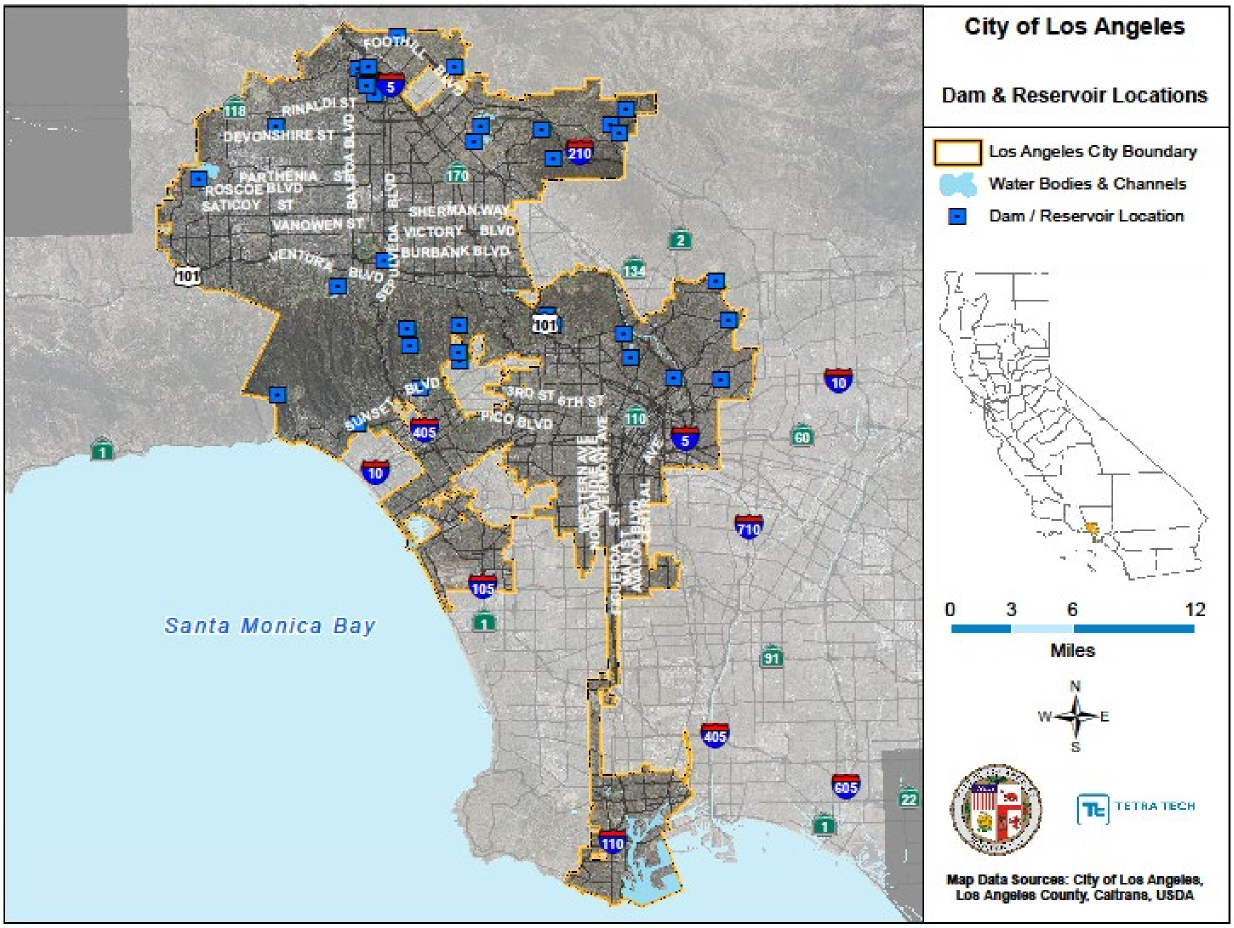


Figure 7-1. Dam Locations Within the Planning Area

Over one third of the land area and population in the City is potentially threatened by dam failure. Inundation maps have been developed for all of these dams. These maps are the basis for the dam failure risk analysis contained in this chapter, but they are not available to the public and are not included in this plan for security purposes. City emergency management officials have access to the data to support response or recovery from a dam failure event. Questions regarding probable exposure to dam failure inundation should be directed to the City of Los Angeles Emergency Management Department.

7.2.3 Frequency

Dam failure events are infrequent and usually coincide with events that cause them, such as earthquakes, landslides and excessive rainfall and snowmelt. There is a "residual risk" associated with dams that remains after safeguards have been implemented. The residual risk is associated with events beyond those that the facility was designed to withstand. However, the probability of dam failure is low in today's regulatory environment.

7.2.4 Severity

Dam failure can be catastrophic to all life and property downstream. The U.S. Army Corps of Engineers developed the classification system shown in Table 7-3 for the hazard potential of dam failures. The rating system is based on the potential consequences of a dam failure; it does not address the probability of such failures.

Table 7-3. Corps of Engineers Hazard Potential Classification

Hazard Category[a]	Direct Loss of Life[b]	Lifeline Losses[c]	Property Losses[d]	Environmental Losses[e]
Low	None (rural location, no permanent structures for human habitation)	No disruption of services (cosmetic or rapidly repairable damage)	Private agricultural lands, equipment, and isolated buildings	Minimal incremental damage
Significant	Rural location, only transient or day-use facilities	Disruption of essential facilities and access	Major public and private facilities	Major mitigation required
High	Certain (one or more) extensive residential, commercial, or industrial development	Disruption of essential facilities and access	Extensive public and private facilities	Extensive mitigation cost or impossible to mitigate

a. Categories are assigned to overall projects, not individual structures at a project.
b. Loss of life potential based on inundation mapping of area downstream of the project. Analyses of loss of life potential should take into account the population at risk, time of flood wave travel, and warning time.
c. Indirect threats to life caused by the interruption of lifeline services due to project failure or operational disruption; for example, loss of critical medical facilities or access to them.
d. Damage to project facilities and downstream property and indirect impact due to loss of project services, such as impact due to loss of a dam and navigation pool, or impact due to loss of water or power supply.
e. Environmental impact downstream caused by the incremental flood wave produced by the project failure, beyond what would normally be expected for the magnitude flood event under which the failure occurs.

Source: U.S. Army Corps of Engineers, 1995

7.2.5 Warning Time

Warning time for dam failure depends on the cause of the failure. In case of extreme precipitation or snowmelt, evacuations can be planned with sufficient time. In the event of a structural failure due to earthquake, there may be no warning time. A dam's structural type also affects warning time. Earthen dams do not tend to fail completely or instantaneously. Once a breach is initiated, discharging water erodes the breach until the reservoir is empty or the breach resists further erosion. Concrete dams also tend to begin with a partial breach. The time of breach formation ranges from a few minutes to a few hours (U.S. Army Corps of Engineers, 1997). The City of Los Angeles has established protocols for flood warning and response to imminent dam failure in the flood warning portion of its adopted emergency operations plan.

7.3 SECONDARY IMPACTS

Dam failure can cause severe downstream flooding, depending on the magnitude of the failure. Other potential secondary impacts of dam failure are landslides around the reservoir perimeter, bank erosion on the rivers, and destruction of downstream habitat.

7.4 EXPOSURE

Exposure to the dam failure hazard was assessed by use of spatial analysis. Dam inundation areas for which inundation mapping was available were combined into a single inundation area. The combined dam failure inundation area includes the following dams:

- Big Tijunga No. 1
- Devils Gate
- Eagle Rock
- Elysian
- Encino
- Green Verdugo
- Greystone Res
- Hansen Rec Lake
- Lopez
- Los Angeles Reservoir
- Lower Franklin No. 2
- Mulholland
- Pacoima
- Palos Verdes Res
- Riviera Res
- Santa Ynez Canyon
- Sepulveda
- Silver Lake
- Stone Canyon
- Upper Franklin.

This area was overlaid with planning area general building stock. The flood module of the Hazus risk assessment platform was used to assess dam failure. Hazus uses census data at the block level and FEMA floodplain data, which has a level of accuracy acceptable for planning purposes. Where possible, the Hazus data for this risk assessment was enhanced using GIS data from local, state and federal sources.

7.4.1 Population

All populations in a dam failure inundation zone would be exposed to the risk of a dam failure. The potential for loss of life is affected by the capacity and number of evacuation routes available to populations living in areas of potential inundation. The estimated population living in the mapped inundation areas within the planning area is 1,553,114 or 39.8 percent of the total planning-area population.

7.4.2 Property

Structures

Based on assessor parcel data, the Hazus model estimated that there are 292,601 structures within the combined dam failure inundation area. The Hazus-derived value of exposed buildings by Area Planning Commission (APC) is summarized in Table 7-4. This methodology estimated $340 billion worth of building-and-contents exposure to dam failure inundation, representing 44.4 percent of the total replacement value of the planning area.

Land Use

Some land uses are more vulnerable to dam failure inundation, such as single-family homes, while others are less vulnerable, such as agricultural land or parks. Table 7-5 shows the existing land use of all parcels in the combined dam inundation area, including those in public/open space uses, for the planning area. Open space uses make up about 12 percent of the combined dam inundation area. These are favorable, lower-risk uses for dam inundation areas. The amount of the dam inundation area contains vacant, developable land is not known. This would be valuable information for gauging the future development potential of the dam inundation area.

Table 7-4. Exposure and Value of Structures in Dam Failure Inundation Areas

Area Planning Commission	Number of Buildings Exposed	Value of Structures Exposed	Value of Contents Exposed	Total (Structure and Contents) Exposed	% of Total Value Exposed
Central	39,314	$54,215,144,986	$43,066,508,136	$97,281,653,123	50.9%
East Los Angeles	8,285	$8,718,646,162	$7,929,448,885	$16,648,095,048	25.1%
Harbor	584	$1,125,941,991	$1,203,290,913	$2,329,232,904	5.7%
North Valley	58,199	$25,981,401,490	$19,728,119,922	$45,709,521,412	39.5%
South Los Angeles	79,092	$41,294,490,165	$31,497,066,083	$72,791,556,249	73.9%
South Valley	77,847	$45,352,442,478	$30,253,996,760	$75,606,439,238	52.0%
West Los Angeles	28,550	$17,984,324,642	$12,555,856,543	$30,540,181,185	27.8%
Total	**291,871**	**$194,672,391,915**	**$146,234,287,243**	**$340,906,679,158**	**44.4%**

Table 7-5. General Plan Land Use in Dam Failure Inundation Areas

Land Use	Combined Dam Inundation Area	
	Area (acres)	% of total
Agriculture	0.0	0.00%
Commercial	6,713.3	9.24%
Government	6,951.2	9.57%
Industrial	10,533.5	14.50%
Multi-Family Residential	15,705.2	21.61%
Open Space	9,068.9	12.48%
Parking	8.9	0.01%
Single Family Residential	23,680.9	32.59%
Total	**72,661.8**	**100.00%**

7.4.3 Critical Facilities

Table 7-6 summarizes the number of the planning area's critical facilities that are in the mapped inundation areas.

Table 7-6. Critical Facilities and Infrastructure in Dam Failure Inundation Areas

APC	Critical Operating Facilities	Critical Response Facilities	Critical Infrastructure—Transportation	Critical Infrastructure—Utilities	Total
Central	5	65	69	32	**171**
East Los Angeles	0	13	66	33	**112**
Harbor	0	1	11	15	**27**
North Valley	0	76	125	82	**283**
South Los Angeles	0	127	86	55	**268**
South Valley	2	87	138	63	**290**
West Los Angeles	1	35	49	21	**106**
Total	**8**	**404**	**544**	**301**	**1,257**

7.4.4 Environment

Reservoirs held behind dams affect many ecological aspects of a river. River topography and dynamics depend on a wide range of flows, but rivers below dams often experience long periods of very stable flow conditions or saw-tooth flow patterns caused by releases followed by no releases. Water releases from dams usually contain very little suspended sediment; this can lead to scouring of river beds and banks.

The environment would be exposed to a number of risks in the event of dam failure. The inundation could introduce many foreign elements into local waterways. This could result in destruction of downstream habitat and could have detrimental effects on many species of animals, especially endangered species such as salmon.

7.5 VULNERABILITY

7.5.1 Population

Vulnerable populations are all populations downstream from dam failures that are incapable of escaping the area within the allowable time frame. This population includes the elderly and young who may be unable to get themselves out of the inundation area. The vulnerable population also includes those who would not have adequate warning from a television or radio emergency warning system. A geographic analysis of demographics using the Hazus model identified populations vulnerable to the dam failure hazard as follows:

- **Economically Disadvantaged Populations**—It is estimated that 55 percent of the households within the combined dam inundation areas are economically disadvantaged, defined as having household incomes of $50,000 or less.
- **Population over 65 Years Old**—It is estimated that 9 percent of the population in the census blocks that intersect the combined dam inundation areas are over 65 years old.
- **Population under 16 Years Old**—It is estimated that 24 percent of the population within census blocks located in or near the combined dam inundation areas are under 16 years of age.

7.5.2 Property

Vulnerable properties are those closest to the dam inundation area. These properties would experience the largest, most destructive surge of water. Low-lying areas are also vulnerable since they are where the dam waters would collect. Transportation routes are vulnerable to dam inundation and have the potential to be wiped out, creating isolation issues. This includes all roads, railroads and bridges in the path of the dam inundation. Those that are most vulnerable are those that are already in poor condition and would not be able to withstand a large water surge. Utilities such as overhead power lines, cable and phone lines could also be vulnerable. Loss of these utilities could create additional isolation issues for the inundation areas.

It is estimated that there could be up to $108 billion of losses from dam failures affecting the planning area. This represents 14.1 percent of the total replacement value of the planning area. Table 7-7 summarizes the loss estimates for dam failure. The Hazus analysis also estimated the amount of debris that would be caused by a dam failure in the planning area, as summarized in Table 7-8.

7.5.3 Critical Facilities

Table 7-9 summarizes the Hazus results for potential damage from dam failure to critical facilities in the dam failure inundation area.

Table 7-7. Loss Estimates for Dam Failure

Area Planning Commission	Buildings Impacted	Value of Structures Damaged	Value of Contents Damaged	Total Value (Structure and Contents) Damaged	% of Total Value Damaged
Central	23,496	$11,764,854,423	$16,104,622,969	$27,869,477,392	14.6%
East Los Angeles	6,022	$2,033,175,464	$2,448,366,240	$4,481,541,704	6.8%
Harbor	454	$84,369,803	$132,082,642	$216,452,445	0.5%
North Valley	36,582	$5,787,154,365	$6,162,016,744	$11,949,171,110	10.3%
South Los Angeles	75,892	$15,432,886,043	$18,745,359,132	$34,178,245,175	34.7%
South Valley	60,165	$11,133,349,064	$9,737,597,319	$20,870,946,383	14.3%
West Los Angeles	17,907	$4,636,020,393	$4,300,107,899	$8,936,128,292	8.1%
Total	**220,518**	**$50,871,809,556**	**$57,630,152,946**	**$108,501,962,501**	**14.1%**

Table 7-8. Estimated Debris

Area Planning Commission	Debris to Be Removed (tons) from Combined Dam Inundation
Central	1,712,077
East Los Angeles	336,748
Harbor	4,376
North Valley	949,319
South Los Angeles	3,448,095
South Valley	1,717,866
West Los Angeles	893,068
Total	9,061,549

Table 7-9. Potential Damage to Critical Facilities in Dam Failure Inundation Area

	Number of Facilities Affected	Average % of Total Value Damaged	
		Structure	Content
Critical Operating Facilities	3	9.52	41.88
Critical Response Facilities	227	N/A	N/A
Critical Infrastructure—Transportation	275	3.35	43.38
Critical Infrastructure—Utilities	134	30.38	47.90
Total/Average	**639**	**14.42**	**44.39**

7.5.4 Environment

The environment would be vulnerable to a number of risks in the event of dam failure. The inundation could introduce foreign elements into local waterways, resulting in destruction of downstream habitat and detrimental effects on many species of animals, especially endangered species such as the Santa Ana sucker and arroyo chub. The extent of the vulnerability of the environment is the same as the exposure of the environment.

7.6 FUTURE TRENDS IN DEVELOPMENT

Dam failures are low-probability, high-consequence events. Because of this, it is not typically practical for local governments to regulate new development in dam failure inundation areas. Land use will be directed by the City of Los Angeles General Plan and zoning ordinance adopted under state law. The safety element of the General Plan establishes standards and plans for the protection of the community from hazards. Dam failure is currently not addressed as a stand-alone hazard in the safety element, but flooding is. The City of Los Angeles has established comprehensive policies regarding sound land use in identified flood hazard areas. Most of the areas vulnerable to the more severe impacts from dam failure intersect the mapped flood hazard areas. Flood-related policies in the general plan will help to reduce the risk associated with the dam failure hazard for all future development in the City. Any new development outside of a flood hazard area will most likely not include provisions that would mitigate the impacts from a dam failure.

While probability of dam failure is low, probability of flooding associated with changes in dam operational parameters in response to extreme rainfall events is higher. Dam designs and operations are developed based on hydrographs from historical records. If these hydrographs change significantly over time due to effects of climate change, current dam designs and operations may become overwhelmed. Specified release rates and impound thresholds may have to be changed, which could result in increased discharges downstream of these facilities, thus increasing probability and severity of flooding.

7.7 SCENARIO

An earthquake in the region could lead to liquefaction of soils around a dam. This could occur without warning during any time of the day. Human activity such as a terrorist attack also could trigger a catastrophic failure of a dam that impacts the planning area.

7.8 ISSUES

The most significant issue associated with dam failure involves the properties and populations in the inundation zones. Flooding as a result of a dam failure would significantly impact these areas. There is often limited warning time for dam failure. These events are frequently associated with other natural hazard events such as earthquakes, landslides or adverse weather, which limits their predictability and compounds the hazard. Important issues associated with dam failure hazards include the following:

- California's AB 2800 enacts legislation that will require engineers and climate scientists to collaborate to help the state design and build infrastructure that will withstand the unavoidable impacts of a changing climate.
- Federally regulated dams have an adequate level of oversight and sophistication in the development of emergency action plans for public notification in the unlikely event of failure. However, the protocol for notification of downstream residents of imminent failure needs to be tied to local emergency response planning.
- Mapping for federally regulated dams is already required and available; however, mapping for non-federal-regulated dams that estimates inundation depths is needed to better assess the risk associated with dam failure from these facilities.
- Most dam failure mapping required at federal levels requires determination of the probable maximum flood. While the probable maximum flood represents a worst-case scenario, it is generally the event with the lowest probability of occurrence. For non-federal-regulated dams, mapping of dam failure scenarios that are less extreme than the probable maximum flood but have a higher probability of occurrence can be valuable to emergency managers and community officials downstream of these facilities. This type of mapping can illustrate areas potentially impacted by more frequent events to support emergency response and preparedness.
- The concept of residual risk associated with structural flood control projects should be considered in the design of capital projects and the application of land use regulations.
- Addressing security concerns and the need to inform the public of the risk associated with dam failure is a challenge for public officials.

8. DROUGHT

8.1 GENERAL BACKGROUND

Drought is a significant decrease in water supply relative to what is "normal" in a given location. A part of the climate cycle of most regions, drought originates from a deficiency of precipitation over an extended period of time, usually a season or more. This leads to a water shortage for some activity, group or environmental sector.

Determination of when drought begins is based on impacts on water users and assessments of the available water supply, including water stored in surface reservoirs or groundwater basins. Different water agencies have different criteria for defining drought. Some issue drought watch or drought warning announcements. The California water code does not include a statutory definition of drought; however, the code frequently focuses on drought conditions during times of water shortages (California Code of Regulations (CCR) 2016).

DEFINITIONS

Drought—The cumulative impacts of long periods of dry weather. These can include deficiencies in surface and subsurface water supplies and general impacts on health, well being, and quality of life.

Meteorological drought—Precipitation at levels below normal over a period of time. Meteorological measurements are the first indicators of drought and are usually region-specific.

Agricultural Drought—Inadequate soil moisture to meet the needs of a particular crop at a particular time.

Hydrological Drought—Deficiencies in surface and subsurface water supplies.

Socioeconomic Drought—Drought impacts on health, wellbeing, and quality of life.

8.1.1 Monitoring Drought

The National Oceanic and Atmospheric Administration has developed several indices to measure drought impacts and severity and to map their extent and locations:

- The ***Palmer Crop Moisture Index*** measures weekly short-term drought to quantify drought impacts on agriculture during the growing season. Figure 8-1 shows this index for the week ending March 11, 2017.
- The ***Palmer Z Index*** measures monthly short-term drought. Figure 8-2 shows this index for February 2017.
- The ***Palmer Drought Index*** measures the duration and intensity of long-term drought-inducing circulation patterns. Long-term drought is cumulative, so the intensity of drought during a given month is dependent on the current weather patterns plus the cumulative patterns of previous months. Weather patterns can change quickly from a long-term drought pattern to a long-term wet pattern, and the Palmer Drought Index can respond fairly rapidly. Figure 8-3 shows this index for March 11, 2017.
- The hydrological impacts of drought (e.g., reservoir levels, groundwater levels, etc.) take longer to develop and it takes longer to recover from them. The ***Palmer Hydrological Drought Index*** quantifies long-term hydrological effects. It responds more slowly to changing conditions than the Palmer Drought Index. Figure 8-4 shows this index for February 2017.
- While the Palmer indices consider precipitation, evapotranspiration and runoff, the ***Standardized Precipitation Index*** considers only precipitation. In the Standardized Precipitation Index, an index of zero indicates the median precipitation amount; the index is negative for drought and positive for wet conditions. The Standardized Precipitation Index is computed for time scales ranging from one month to 24 months. Figure 8-5 shows the 24-month Standardized Precipitation Index map for March 2015 through February 2017.

Source: NOAA, NWS. 2017

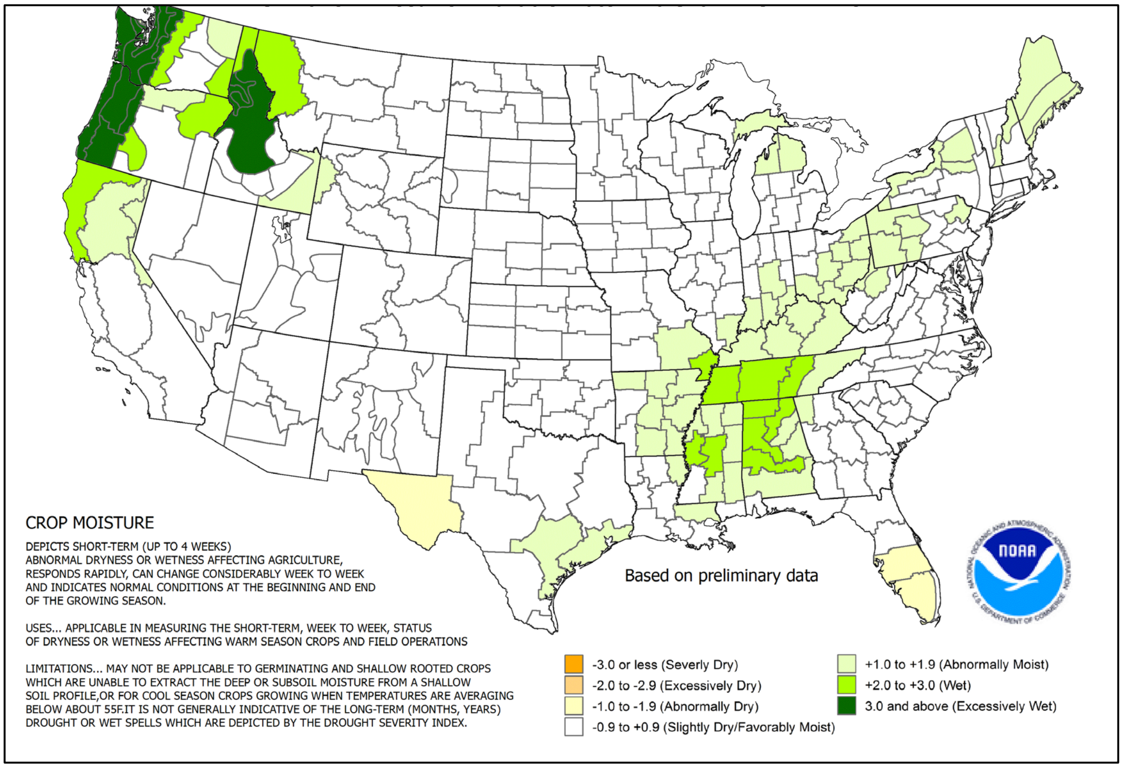


Figure 8-1. Palmer Crop Moisture Index for Week Ending March 11, 2017

Source: NOAA, NWS. 2017a

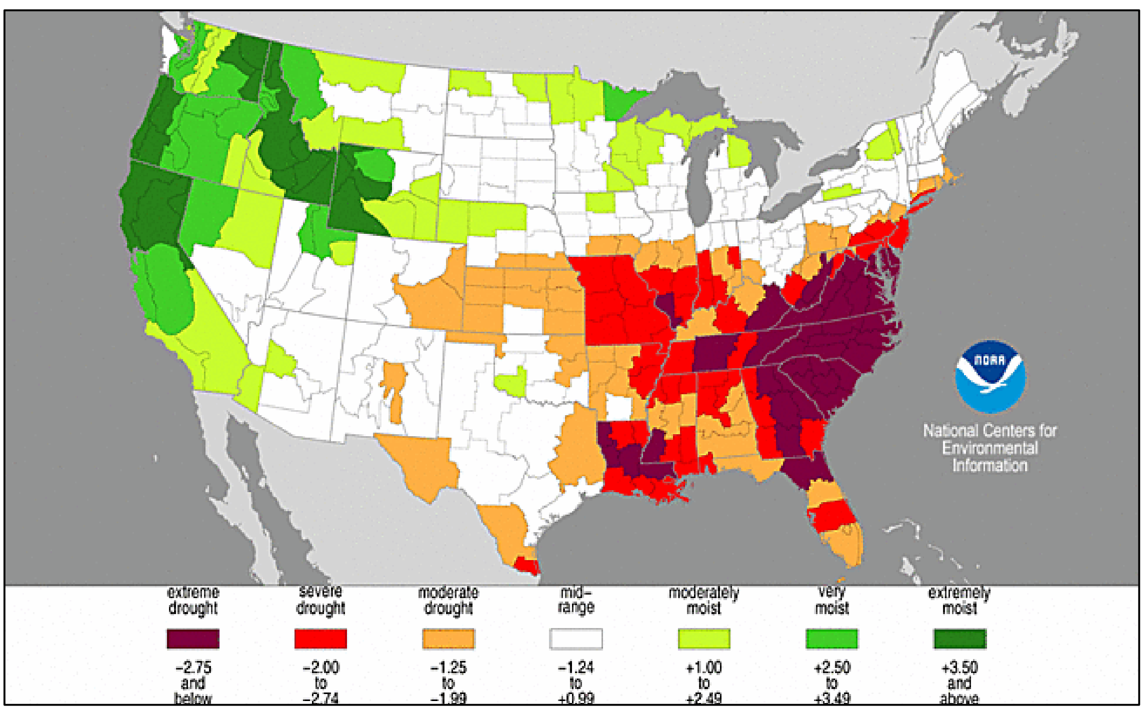


Figure 8-2. Palmer Z Index Short-Term Drought Conditions (February 2017)

Source: NOAA, NWS. 2017b

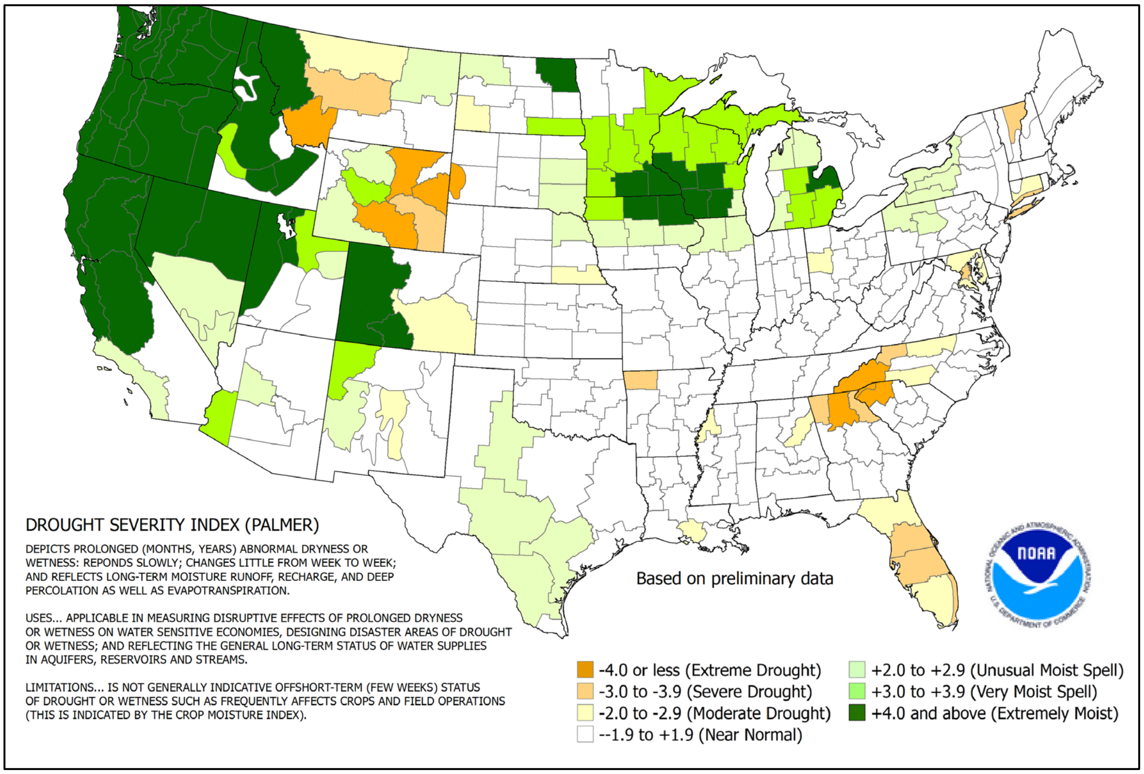


Figure 8-3. Palmer Drought Severity Index (March 11, 2017)

Source: NOAA, NWS. 2017c

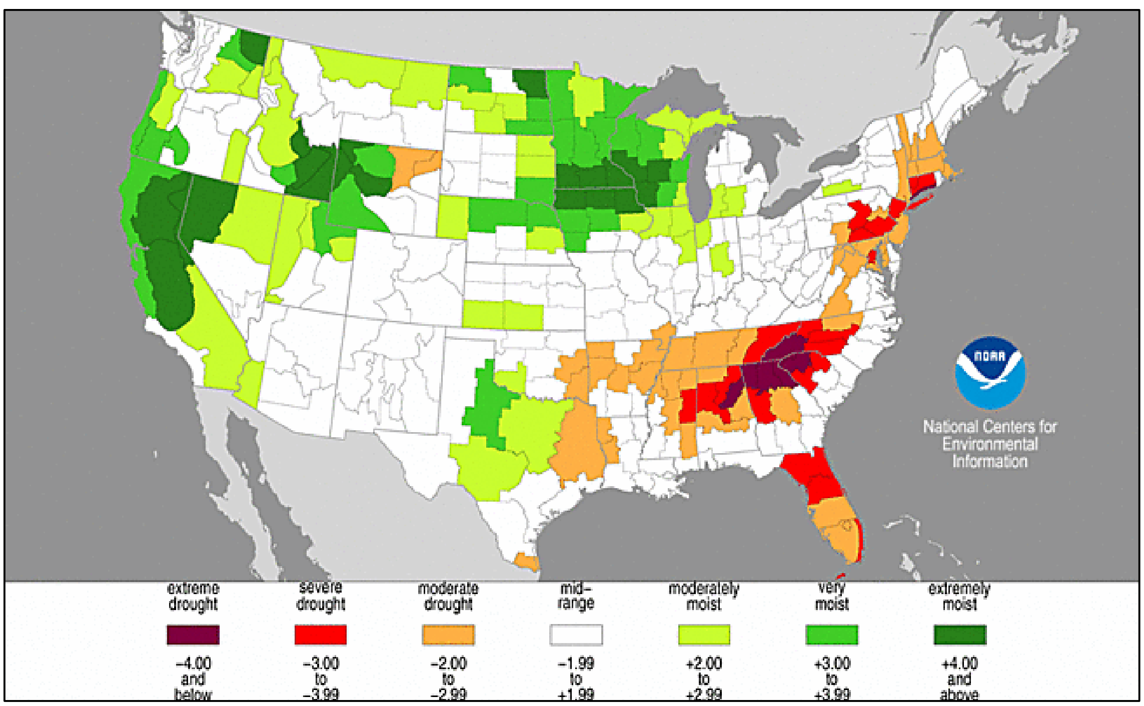


Figure 8-4. Palmer Hydrological Drought Index (February 2017)

Source: NOAA, NWS. 2017d

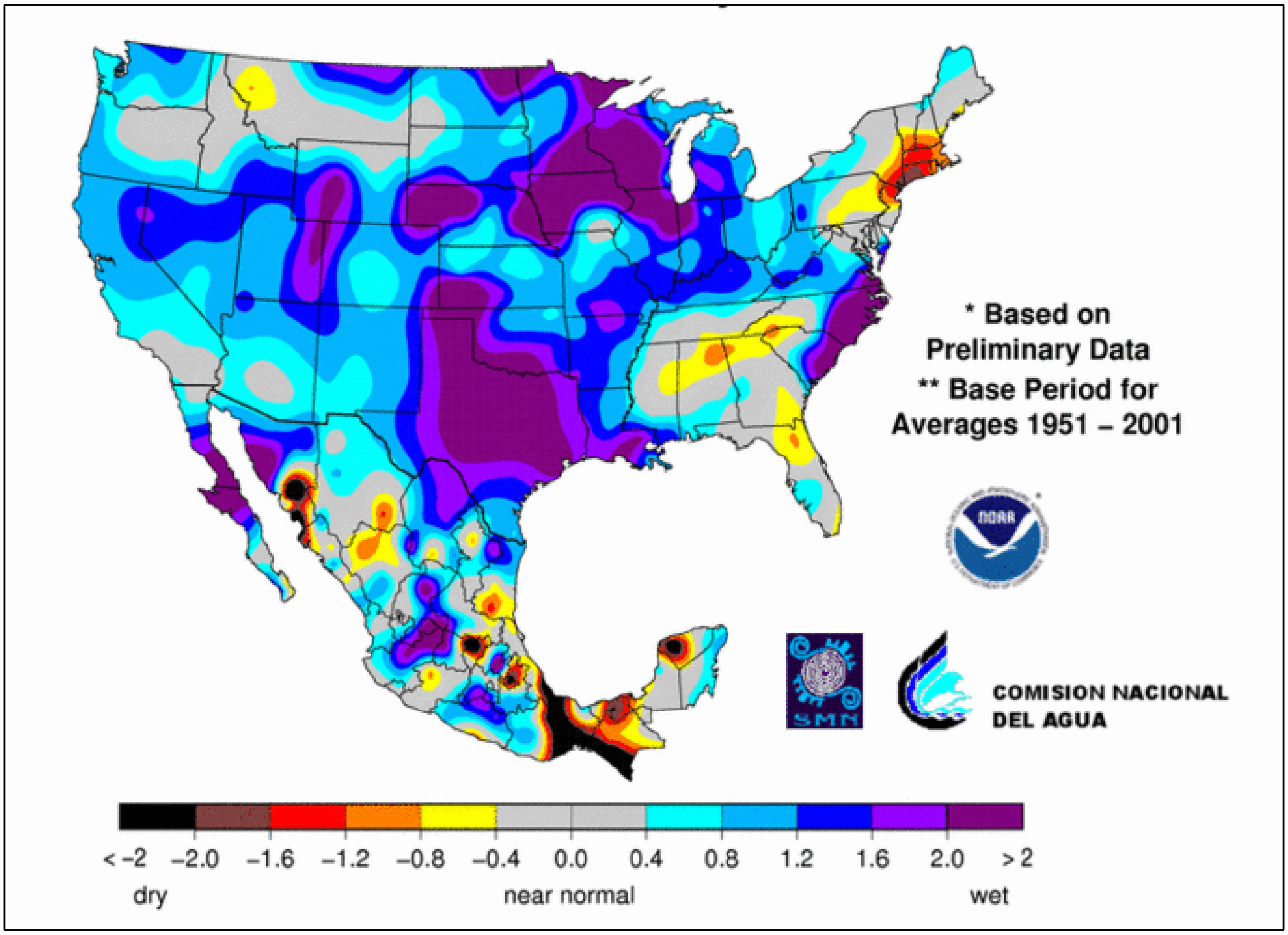


Figure 8-5. 24-Month Standardized Precipitation Index (March 2015 – February 2017)

8.1.2 Drought in California

Most of California's precipitation comes from storms moving across the Pacific Ocean. The path followed by the storms is determined by the position of an atmospheric high pressure belt that normally shifts southward during the winter, allowing low pressure systems to move into the state. On average, 75 percent of California's annual precipitation occurs between November and March, and 50 percent occurs between December and February. A persistent Pacific high pressure zone over California in mid-winter signals a tendency for a dry water year.

A typical water year produces about 100 inches of rainfall over the North Coast, 50 inches of precipitation (combination of rain and snow) over the Northern Sierra, 18 inches in the Sacramento area, and 12 to 14 inches in the planning area. In extremely dry years, these totals can fall to as little as a third of these amounts.

The Sierra Nevada snowpack serves as the primary agent for replenishing water in the City of Los Angeles and for much of the state. A reduction in spring snowpack runoff, due to drier winters or to increasing temperatures leading to more rain than snow, can increase risk of summer or fall water shortages throughout the region.

8.1.3 Local Water Supply

The Los Angeles Department of Water and Power (LADWP), which operates water and power for the City, reports the following sources of local water supply for 2011 through 2015 (see Figure 8-6):

- The Los Angeles Aqueduct from the eastern Sierra Nevada Mountains provided 29 percent of local water
- The City purchased 57 percent of its water from the Metropolitan Water District of Southern California:
  - 48 percent from the California aqueducts
  - 9 percent from the Colorado River Aqueduct
- 12 percent was from groundwater,
- 2 percent was from recycled water.

Source: Los Angeles Department of Water and Power, 2017

Figure 8-6. Primary Water Supply Sources for City of Los Angeles

In general, the District is trying to conserve as much of its water as possible from the California aqueducts, and more water is being imported from the Colorado River.

Customers in the City used an average of 113 gallons per day per capita in 2014-2015. Residential users accounted for about 68 percent, and commercial/industrial users accounted for 32 percent. (LADWP, 2017)

8.1.4 Defined Drought Stages

During critically dry years, the California State Water Resources Control Board can mandate water entitlements on water right holders to address statewide water shortages. Table 8-1 shows the state drought management program stages mandated to water right holders.

Table 8-1. State Drought Management Program

Drought Stage	State Mandated Customer Demand Reduction	Rate Impacts
Stage 0 or 1	<10%	Normal rates
Stage 2	10 to 15%	Normal rates; Drought surcharge
Stage 3	15 to 20%	Normal rates; Drought surcharge
Stage 4	>20%	Normal rates, Drought surcharge

LADWP defined Emergency Water Conservation Plan Ordinance restrictions by phases in *2015 Urban Water Management Plan* (Chapter 3, Water Conservation). It enacts the state's mandates by activating Phases I through VI, with water conservation, prohibited uses, and penalties for violation that steadily increase by phase.

8.2 HAZARD PROFILE

Droughts originate from a deficiency of precipitation resulting from an unusual weather pattern. If the weather pattern lasts a short time (a few weeks or a couple months), the drought is considered short-term. If the weather pattern becomes entrenched and the precipitation deficits last for several months or years, the drought is considered to be long-term. It is possible for a region to experience a long-term circulation pattern that produces drought, and to have short-term changes in this long-term pattern that result in short-term wet spells. Likewise, it is possible for a long-term wet circulation pattern to be interrupted by short-term weather spells that result in short-term drought.

8.2.1 Past Events

Statewide Droughts

The California Department of Water Resources has state hydrologic data back to the early 1900s (CA DWR, 2017). The hydrologic data show multi-year droughts from 1912 to 1913, 1918 to 1920, 1922 to 1924 and 1928 to 1934. The following sections describe additional prolonged periods of drought in California since then, all of which impacted the City of Los Angeles to some degree.

1976 to 1977 Drought

California had one of its most severe droughts due to lack of rainfall during the winters of 1976 and 1977. 1977 was the driest period on record in California to that time, with the previous winter recorded as the fourth driest. The cumulative impact led to widespread water shortages and severe water conservation measures throughout the state. Only 37 percent of the average Sacramento Valley runoff was received, with just 6.6 million acre-feet recorded. A federal disaster declaration was declared, but it did not apply to Los Angeles County.

1987 to 1992 Drought

California received precipitation well below average levels for four consecutive years. While the Central Coast was most affected by the lack of rainfall and low runoff, the Sierra Nevada range in Northern California and City of Los Angeles was also affected. During this drought, only 56 percent of average runoff for the Sacramento Valley was received, totaling just 10 million acre-feet. By February 1991, all 58 counties in California were suffering from drought conditions. Urban areas as well as rural and agricultural areas were impacted. In 1988, the City adopted a plumbing retrofit ordinance to mandate the installation of conservation devices in all properties and require water-efficient landscaping in new construction. An amendment to the ordinance in 1999 required the installation of ultra-low-flush toilets in single-family and multifamily residences prior to resale.

2007 to 2009 Drought

The governor issued an Executive Order that proclaimed a statewide drought emergency on June 4, 2008 after spring 2008 was the driest spring on record and snowmelt runoff was low. On February 27, 2009, the governor proclaimed a state of emergency for the entire state as the severe drought conditions continued widespread impacts and the largest court-ordered water restriction in state history (at the time).

2012 to 2016 Drought

California's latest drought set several records:

- The period from 2012 to 2014 ranked as the driest three consecutive years for statewide precipitation.
- 2014 set new climate records for statewide average temperatures and for record-low water allocations in the State Water Project and federal Central Valley Project.
- 2013 set minimum annual precipitation records for many communities.

On January 17, 2014 the governor declared a state of emergency for drought throughout California. This declaration followed release of a report that stated that California had had the least amount of rainfall in its 163-year history. Californians were asked to voluntarily reduce their water consumption by 20 percent. Drought conditions worsened into 2015. On April 1, 2015, following the lowest snowpack ever recorded, the governor announced actions to save water, increase enforcement to prevent wasteful water use, streamline the state's drought response, and invest in new technologies to make California more drought-resilient. The governor directed the State Water Resources Control Board to implement mandatory water reductions in cities and towns across California to reduce water usage by 25 percent on average. The LADWP was assigned a 16-percent water conservation target by the State Water Resources Control Board.

Drought Impact Reporter

The National Drought Mitigation Center developed the Drought Impact Reporter in response to the need for a national drought impact database for the United States. Information comes from a variety of sources: on-line, drought-related news stories and scientific publications, members of the public who visit the website and submit a drought-related impact for their region, members of the media, and members of relevant government agencies. The Drought Impact Reporter contains information on 98 impacts from droughts that specifically affected the City of Los Angeles from 2006 through January 2017. The following are the categories and reported number of impacts (note that some impacts have been assigned to more than one category):

- Agriculture—6
- Business and Industry—13
- Energy—0
- Fire—3
- Plants and Wildlife—12

- Relief, Response, and Restrictions—58
- Society and Public Health—45
- Tourism and Recreation—4
- Water Supply and Quality—71.

8.2.2 Location

Drought is a regional phenomenon. A drought that affects the planning area would affect the entirety of the area simultaneously and has the potential to directly or indirectly impact every person in the county as well as adversely affect the local economy.

8.2.3 Frequency

Historical drought data for the planning area indicate there have been four significant multi-year droughts in the last 40 years (1976 to 2016). For approximately 12 of the last 40 years, the City has been included in various levels of drought. This equates to a drought every three years on average, or a 30 percent chance of a drought in any given year. As temperatures increase, the probability of future droughts will likely increase as well.

8.2.4 Severity

Drought can have a widespread impact on the environment and the economy, although it typically does not result in loss of life or damage to property, as do other natural disasters. Nationwide, the impacts of drought occur in the following categories: agriculture; business and industry; energy; fire; plants and wildfire; relief, response and restrictions; tourism and recreation; and water supply and quality sectors. The National Drought Mitigation Center uses three categories to describe likely drought impacts:

- **Economic Impacts**—These impacts of drought cost people or businesses money (i.e., farmers' crops are destroyed, water supply is too low and money must be spent on irrigation or to drill new wells; businesses that sell boats and fishing equipment are not able to sell their goods; water companies must spend money on new or additional water supplies)
- **Environmental Impacts**—Plants and animals depend on water, just like people. When a drought occurs, their food supply can shrink and their habitat can be damaged
- **Social Impacts—**These impacts affect people's health and safety. Social impacts include public safety, health, conflicts between people when there is not enough water to go around, and changes in lifestyle.

The severity of a drought depends on the degree of moisture deficiency, the duration, and the size and location of the affected area. The longer the duration of the drought and the larger the area impacted, the more severe the potential impacts.

Drought generally does not affect groundwater sources as quickly as surface water supplies, but groundwater supplies generally take longer to recover. Reduced precipitation during a drought means that groundwater supplies are not replenished at a normal rate. This can lead to a reduction in groundwater levels and problems such as reduced pumping capacity or wells going dry. Shallow wells are more susceptible than deep wells. Reduced replenishment of groundwater affects streams. Much of the flow in streams comes from groundwater, especially during the summer when there is less precipitation and after snowmelt ends. Reduced groundwater levels mean that even less water will enter streams when stream flows are lowest.

8.2.5 Warning Time

Droughts are climatic patterns that occur over long periods of time. Only generalized warning can take place due to the numerous variables that scientists have not pieced together well enough to make accurate and precise predictions.

Empirical studies conducted over the past century have shown that meteorological drought is never the result of a single cause. It is the result of many causes, often synergistic in nature; these include global weather patterns that produce persistent, upper-level high-pressure systems along the West Coast with warm, dry air resulting in less precipitation.

Scientists at this time do not know how to predict drought more than a month in advance for most locations. Predicting drought depends on the ability to forecast precipitation and temperature. Anomalies of precipitation and temperature may last from several months to several decades. California is currently finishing a several-year-long drought, while other areas in the United States may undergo droughts as short as 1 or 2 months. How long they last depends on interactions between the atmosphere and the oceans, soil moisture and land surface processes, topography, internal dynamics, and the accumulated influence of weather systems on the global scale.

8.3 SECONDARY IMPACTS

The secondary impact most commonly associated with drought is wildfire. A prolonged lack of precipitation dries out vegetation, which becomes increasingly susceptible to ignition as the duration of the drought extends. Millions of board feet of timber have been lost, and in many cases erosion occurred, which caused serious damage to aquatic life, irrigation, and power production by heavy silting of streams, reservoirs, and rivers.

Drought also is often accompanied by extreme heat, exposing people to the risk of sunstroke, heat cramps and heat exhaustion. Pets and livestock are also vulnerable to heat-related injuries. Crops can be vulnerable as well.

8.4 EXPOSURE

Drought can affect a wide range of economic, environmental, and social activities. Its impacts can span many sectors of the economy because water is integral to the ability to produce goods and provide services. The impacts can reach well beyond the area undergoing physical drought. Vulnerability of an activity to drought depends on its water demand and the water supplies available to meet the demand.

California’s 2005 Water Plan and subsequent updates indicate that water demand in the state will increase through 2030. The Department of Water Resources predicts a modest decrease in agricultural water use, but an urban water use increase of 1.5 to 5.8 million acre-feet per year (DWR 2005). The 2013 update to the Water Plan explores measures, benchmarks, and successes in increasing agricultural and urban water use efficiency.

8.5 VULNERABILITY

8.5.1 Population

The City of Los Angeles is vulnerable to drought events. Drought can affect people’s health and safety, including health problems related to low water flows, poor water quality, or dust. Drought can also lead to loss of human life (National Drought Mitigation Center, 2017). Other possible impacts include recreational risks; effects on air quality; diminished living conditions related to energy, air quality, and hygiene; compromised food and nutrition; and increased incidence of illness and disease (Centers for Disease Control and Prevention, 2012). Droughts can also lead to reduced local firefighting capabilities.

LADWP and other regional stakeholders have devoted considerable time and effort to protect life, safety, and health during times of consecutive dry years. Provisions and measures have been taken to analyze and account for anticipated water shortages. With coordination with residents in the planning area, the LADWP has the ability to minimize and reduce impacts on residents and water consumers in the City.

8.5.2 Property

No structures will be directly affected by drought conditions, though some structures may become vulnerable to wildfires, which are more likely following years of drought. Droughts can also have significant impacts on landscapes, which could cause a financial burden to property owners. However, these impacts are not considered critical in planning for impacts from the drought hazard.

8.5.3 Critical Facilities

Critical facilities as defined for this plan will continue to be operational during a drought. A benefit of water conservation in the City is delaying the need for sewer facility expansions by reducing wastewater discharge into the sewer collection and treatment system. Critical facility elements such as landscaping may not be maintained due to limited resources, but the risk to the planning area's critical facilities inventory will be largely aesthetic. For example, when water conservation measures are in place, landscaped areas will not be watered and may die. These aesthetic impacts are not considered significant.

8.5.4 Environment

Environmental losses are the result of damage to plants, animals, wildlife habitat, and air and water quality; forest and range fires; degradation of landscape quality; loss of biodiversity; and soil erosion. Some of the effects are short-term and conditions quickly return to normal following the end of the drought. Other environmental effects linger for some time or may even become permanent. Wildlife habitat, for example, may be degraded through the loss of wetlands, lakes, and vegetation. However, many species will eventually recover from this temporary condition. The degradation of landscape quality, including increased soil erosion, may lead to a more permanent loss of biological productivity. Although environmental losses are difficult to quantify, growing public awareness and concern for environmental quality has forced public officials to focus greater attention on these effects.

8.5.5 Economic Impact

Economic impact will be largely associated with industries that use water or depend on water for their business. For example, landscaping businesses were affected in the droughts of the past as the demand for service significantly declined because landscaping was not watered. Agricultural industries will be impacted if water usage is restricted for irrigation.

A prolonged drought can affect a community's economy significantly. Increased demand for water and electricity may result in shortages and higher costs of these resources. Industries that rely on water for business may be impacted the most (e.g., landscaping businesses). Although most businesses will still be operational, they may be affected aesthetically—especially the recreation and tourism industry. Moreover, droughts within another area could affect food supply and price for City residents.

8.6 FUTURE TRENDS IN DEVELOPMENT

The City of Los Angeles has a General Plan that includes policies directing land use and dealing with issues of water supply and the protection of water resources. This plan provides the capability at the local level to protect future development from the impacts of drought. The City of Los Angeles reviewed its General Plan under the capability assessment performed for this effort. Deficiencies identified by this review can be addressed by mitigation actions to increase the capability to deal with future trends in development.

8.7 SCENARIO

An extreme, multiyear drought associated with record-breaking rates of low precipitation and high temperatures—such as the most recent drought across the State of California——is the worst-case scenario. Combinations of low precipitation and high temperatures could occur over several consecutive years. Intensified by such conditions, extreme wildfires could break out throughout the planning area, increasing the need for water. Surrounding communities, also in drought conditions, could increase their demand for water supplies relied upon by the City of Los Angeles, causing social and political conflicts. If such conditions persisted for several years, the economy of the City of Los Angeles could experience setbacks, especially in water dependent industries.

8.8 ISSUES

The planning team has identified the following drought-related issues:

- Identification and development of alternative water supplies
- Large residential populations stressing the water supply
- Utilization of groundwater recharge techniques to stabilize the groundwater supply
- The probability of increased multi-year drought and durations due to climate change, and the associated need to consider long-term conservation measures
- Loss of much of the water transported from aqueducts to leaks and evaporation
- Recycled water opportunities
- The capture and storage of urban runoff.

9. EARTHQUAKE

9.1 GENERAL BACKGROUND

An earthquake is the vibration of the earth's surface following a release of energy in the earth's crust. This energy can be generated by a sudden dislocation of the crust or by a volcanic eruption. Most destructive quakes are caused by dislocations of the crust. The crust may first bend and then, when the stress exceeds the strength of the rocks, break and snap to a new position. In the process of breaking, vibrations called "seismic waves" are generated. These waves travel outward from the source of the earthquake at varying speeds.

Geologists have found that earthquakes tend to reoccur along faults, which are zones of weakness in the earth's crust. Even if a fault zone has recently experienced an earthquake, there is no guarantee that all the stress has been relieved. Another earthquake could still occur. In fact, relieving stress along one part of a fault may increase it in another part.

California is seismically active because of movement of the North American Plate, on which everything east of the San Andreas Fault sits, and the Pacific Plate, which includes coast communities west of the fault. The planning area is on the Pacific Plate, which is constantly moving northwest past the North American Plate, at a relative rate of movement of about 2 inches per year.

DEFINITIONS

Earthquake—The shaking of the ground caused by an abrupt shift of rock along a fracture in the earth or a contact zone between tectonic plates. Earthquakes are typically measured in both magnitude and intensity.

Epicenter—The point on the earth's surface directly above the hypocenter of an earthquake. The location of an earthquake is commonly described by the geographic position of its epicenter and by its focal depth.

Fault—A fracture in the earth's crust along which two blocks of the crust have slipped with respect to each other.

Hypocenter—The region underground where an earthquake's energy originates

Liquefaction— Loosely packed, water-logged sediments losing their strength in response to strong shaking, causing major damage during earthquakes.

Active faults have experienced displacement in historical time. However, inactive faults, where no such displacements have been recorded, also have the potential to reactivate or experience displacement along a branch sometime in the future. An example of a fault zone that has been reactivated is the Foothills Fault Zone. The zone was considered inactive until evidence of an earthquake (approximately 1.6 million years ago) was found near Spenceville, California. Then, in 1975, an earthquake occurred on another branch of the zone near Oroville, California (now known as the Cleveland Hills Fault). The State Division of Mines and Geology indicates that increased earthquake activity throughout California may cause movement along currently inactive fault systems.

9.1.1 Earthquake Classifications

Earthquakes are typically classified in one of two ways: By the amount of energy released, measured as magnitude; or by the impact on people and structures, measured as intensity.

Magnitude

An earthquake's magnitude is a measure of the energy released at the source of the earthquake. It is based on the amplitude of the earthquake waves recorded on instruments. It is commonly expressed by ratings on the Richter scale and the moment magnitude (M_W) scale. The Richter scale magnitude is based on the amplitude of the largest energy wave released by the earthquake. Richter scale readings are suitable for smaller earthquakes; however, because it is a logarithmic scale, the scale does not distinguish clearly the magnitude of large earthquakes above a certain level. Table 9-1 summarizes Richter scale magnitudes and corresponding earthquake effects.

Table 9-1. Richter Magnitude Scale

Richter Magnitude	Earthquake Effects
2.5 or less	Usually not felt, but can be recorded by seismograph
2.5 to 5.4	Often felt, but causes only minor damage
5.5 to 6.0	Slight damage to buildings and other structures
6.1 to 6.9	May cause a lot of damage in very populated areas
7.0 to 7.9	Major earthquake; serious damage
8.0 or greater	Great earthquake; can totally destroy communities near the epicenter

The moment magnitude (M_W) scale was introduced in 1979 to address shortcomings of the Richter scale while maintaining consistency. It is based on the seismic moment of the earthquake. For medium-sized earthquakes, moment magnitude values are similar to Richter values—a magnitude 5.0 earthquake is about 5.0 on both scales. Unlike other scales, the moment magnitude scale does not saturate at the upper end; there is no upper limit to the magnitude it can measure. However, this has the side-effect that the scales diverge for smaller earthquakes (Hanks and Hiroo, 1979). The M_W scale, described in Table 9-2, is currently the most commonly used magnitude scale.

Table 9-2. Moment Magnitude Class

Magnitude Class	Magnitude Range (M_W=magnitude)
Great	$M_W \geq 8$
Major	$M_W = 7.0 – 7.9$
Strong	$M_W = 6.0 – 6.9$
Moderate	$M_W = 5.0 – 5.9$
Light	$M_W = 4.0 – 4.9$
Minor	$M_W = 3.0 – 3.9$
Micro	$M_W < 3$

Intensity

The intensity of an earthquake is based on the observed effects of ground shaking on people, buildings, and natural features, and varies with location. The intensity of earthquake shaking lessens with distance from the earthquake epicenter. The Modified Mercalli Intensity (MMI) scale expresses intensity of an earthquake and describes how strong a shock was felt at a particular location in values. The MMI is currently the most commonly used intensity scale (see Table 9-3).

9.1.2 Ground Motion

During an earthquake when the ground is shaking, it also experience acceleration. The peak acceleration is the largest increase in velocity recorded by a particular station during an earthquake. Earthquake hazard assessment based on expected ground motion involves determining the annual probability that certain ground motion accelerations will be exceeded, then summing the annual probabilities over a time period of interest.

Table 9-3. Modified Mercalli Intensity Scale

Mercalli Intensity	Shaking	Description
I	Not Felt	Not felt except by a very few under especially favorable conditions.
II	Weak	Felt only by a few persons at rest, especially on upper floors of buildings.
III	Weak	Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it as an earthquake. Standing cars may rock slightly. Vibrations similar to the passing of a truck.
IV	Light	Felt indoors by many, outdoors by few during the day. At night, some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like heavy truck striking building. Standing cars rocked noticeably.
V	Moderate	Felt by nearly everyone; many awakened. Some dishes, windows broken. Unstable objects overturned. Pendulum clocks may stop.
VI	Strong	Felt by all, many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight.
VII	Very Strong	Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable damage in poorly built or badly designed structures; some chimneys broken.
VIII	Severe	Damage slight in specially designed structures; considerable damage in ordinary substantial buildings with partial collapse. Damage great in poorly built structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned.
IX	Violent	Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb. Damage great in substantial buildings, with partial collapse. Buildings shifted off foundations.
X	Extreme	Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations. Rails bent.

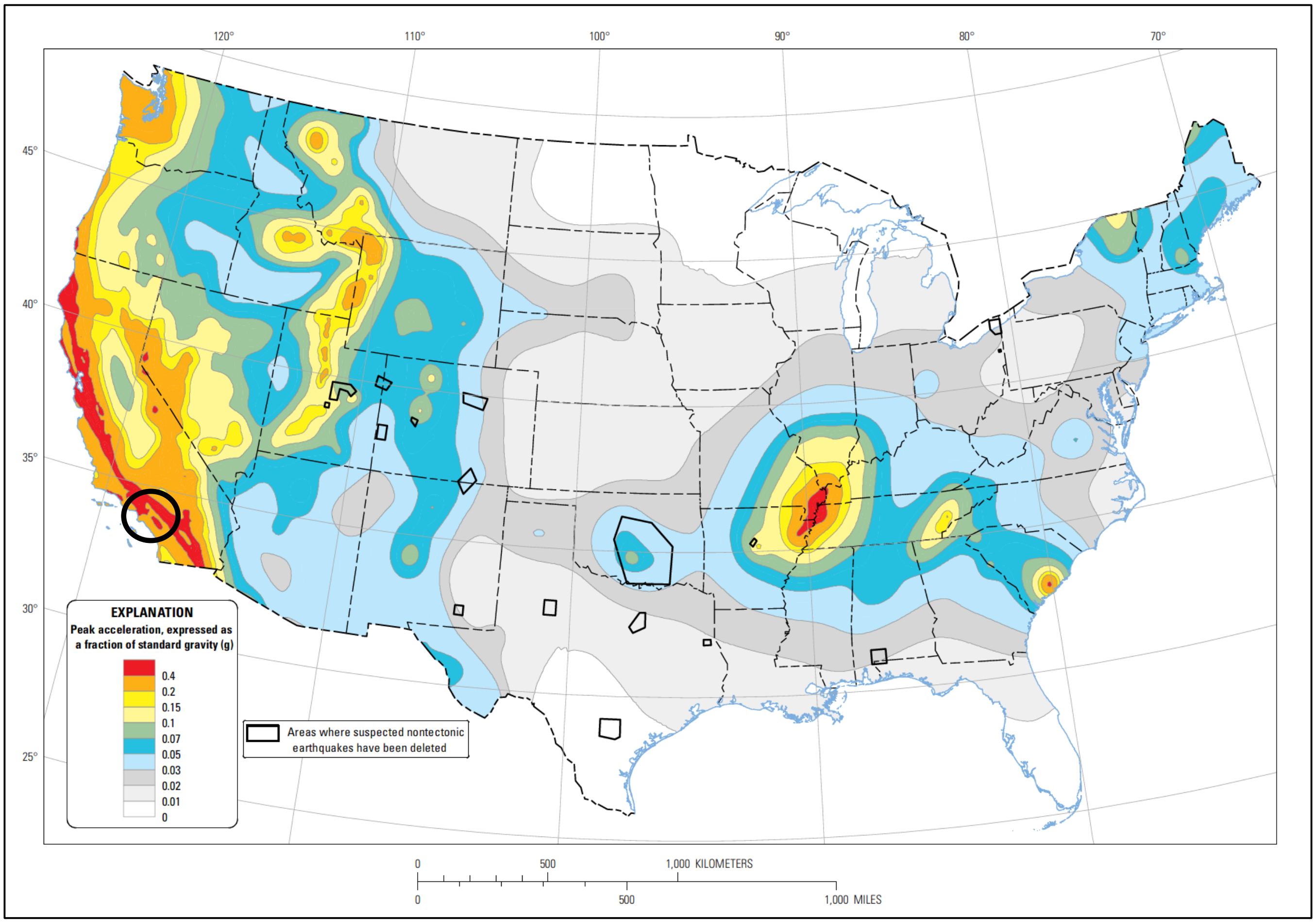
Source: USGS 2014

The most commonly mapped ground motion parameters are the horizontal and vertical peak ground accelerations (PGA) for a given soil or rock type. PGA expresses the severity of an earthquake and is a measure of how hard the earth shakes, or accelerates, in a given geographic area. Instruments called accelerographs record levels of ground motion due to earthquakes at stations throughout a region. PGA is measured in g (the acceleration due to gravity) or expressed as a percent acceleration force of gravity (%g). These readings are recorded by state and federal agencies that monitor and predict seismic activity.

National maps of earthquake shaking hazards have been produced since 1948. They provide information for creating and updating seismic design requirements for building codes, insurance rate structures, earthquake loss studies, retrofit priorities and land use planning used in the U.S. Scientists frequently revise these maps to reflect new information and knowledge. After thorough review of the studies, professional organizations of engineers update the seismic-risk maps and seismic design requirements contained in building codes (Brown et al., 2001).The USGS updated the National Seismic Hazard Maps in 2014, superseding the 2008 maps. New seismic, geologic, and geodetic information on earthquake rates and associated ground shaking were incorporated into these revised maps. The 2014 map (see Figure 9-1) represents the best available data as determined by the USGS.

Maps of PGA values form the basis of seismic zone maps that are included in building codes such as the International Building Code. Buildings, bridges, highways and utilities built to meet modern seismic design requirements are typically able to withstand earthquakes better, with less damages and disruption. Building codes that include seismic provisions specify the horizontal force due to lateral acceleration that a building should be able to withstand during an earthquake. PGA values are directly related to these lateral forces that could damage “short period structures” (e.g. single-family dwellings). Longer period response components determine the lateral forces that damage larger structures with longer natural periods (apartment buildings, factories, high-rises, bridges). Table 9-4 lists damage potential and perceived shaking by PGA factors, compared to the Mercalli scale.

Source: USGS 2014



Black circle indicates the approximate location of the City of Los Angeles

Figure 9-1. Peak Acceleration (%g) with 10% Probability of Exceedance in 50 Years

Table 9-4. Mercalli Scale and Peak Ground Acceleration Comparison

Modified Mercalli Scale	Perceived Shaking	Potential Structure Damage		Estimated PGA[a] (%g)
		Resistant Buildings	Vulnerable Buildings	
I	Not Felt	None	None	<0.17%
II-III	Weak	None	None	0.17% – 1.4%
IV	Light	None	None	1.4% – 3.9%
V	Moderate	Very Light	Light	3.9% – 9.2%
VI	Strong	Light	Moderate	9.2% – 18%
VII	Very Strong	Moderate	Moderate/Heavy	18% – 34%
VIII	Severe	Moderate/Heavy	Heavy	34% – 65%
IX	Violent	Heavy	Very Heavy	65% – 124%
X – XII	Extreme	Very Heavy	Very Heavy	>124%

a. PGA measured in percent of g, where g is the acceleration of gravity

Sources: USGS, 2008; USGS, 2010

9.1.3 Effect of Soil Types

The impact of an earthquake on structures and infrastructure is largely a function of ground shaking, distance from the source of the quake, and liquefaction, a secondary effect of an earthquake in which soils lose their shear strength and flow or behave as liquid, thereby damaging structures that derive their support from the soil. Liquefaction generally occurs in soft, unconsolidated sedimentary soils.

A program called the National Earthquake Hazard Reduction Program (NEHRP) creates maps based on soil characteristics to help identify locations subject to liquefaction. Table 9-5 summarizes NEHRP soil classifications. NEHRP Soils B and C typically can sustain ground shaking without much effect, dependent on the earthquake magnitude. The areas that are most affected by ground shaking have NEHRP Soils D, E and F. In general, these areas are most susceptible to liquefaction.

Table 9-5. NEHRP Soil Classification System

NEHRP Soil Type	Description	Mean Shear Velocity to 30 m (m/s)
A	Hard Rock	1,500
B	Firm to Hard Rock	760-1,500
C	Dense Soil/Soft Rock	360-760
D	Stiff Soil	180-360
E	Soft Clays	< 180
F	Special Study Soils (liquefiable soils, sensitive clays, organic soils, soft clays >36 m thick)	Depends on soil type

The USGS has created a soil-type map for the Los Angeles area that provides rough estimates of site effects based on surface geology. NEHRP soil types were assigned to a geologic unit based on the average velocity of that unit, and USGS notes that this approach can lead to some inaccuracy. For instance, a widespread unit consisting of Quaternary sand, gravel, silt, and mud has been assigned as Class C soil types; however, some of the slower soil types in this unit fall under Class D. USGS does not have any way of differentiating units for slower-velocity soils in its digital geologic dataset (USGS, 2016e).

9.2 HAZARD PROFILE

9.2.1 Past Events

Los Angeles has been included in three FEMA declarations for earthquakes: the 1994 Northridge Earthquake (DR-1008), the 1987 earthquakes (DR-799), and the 1971 San Fernando Earthquake (DR-299). Table 9-6 lists earthquakes of magnitude 5.0 or greater within a 100-mile radius of the planning area.

The 1994 Northridge Earthquake was the most recent earthquake to greatly affect the city. It was the most costly seismic event in California since the 1906 San Francisco Earthquake. The infrastructure of the metropolitan area was severely disrupted. Freeways collapsed, power systems for the city and linked communities as far away as Oregon were temporarily blacked out, and communications were disrupted. Table 9-7 lists estimated damage.

Officially lasting approximately 30 seconds, and with a magnitude of M6.7, this earthquake caused significant damage to buildings in every area of the city. Of 57 fatalities attributed to this quake, 16 were a result of the collapse of a single structure—the Northridge Meadows apartment building. The ground motion was measured throughout Southern California, including intensity readings of 1.82 g near the Ventura Freeway in the Tarzana area. Ground motions as strong as 1.21 g were measured as far away as Inglewood (approximately 25 miles from Northridge). One “g” of ground motion is enough to make unsecured buildings literally hop off their foundations.

Table 9-6. Earthquakes Magnitude 5.0 or Larger Within 100-mile Radius of the Planning Area

Date	Magnitude	Epicenter Location	Fault Line
03/29/2014 Brea Earthquake	5.1	Near Brea, CA	Puente Hills fault
07/29/2008	5.44	Near Chino Hills, CA	Whittier fault
01/17/1994 Northridge Earthquake	6.7	20 miles west-northwest of LA	Northridge Thrust
06/28/1991 Sierra Madre Earthquake	5.8	12 miles northeast of Pasadena, CA	Clamshell-Sawpit Canyon fault
02/28/1990 Upland Earthquake	7.9	30 miles east of LA	San Jose fault
01/18/1989 Malibu Earthquake	5.0	20 miles south of Malibu, CA	N/A
12/03/1988 Pasadena Earthquake	5.0	Below City of Pasadena, CA	Raymond fault
06/26/1988 Upland Earthquake	7.9	30 miles east of LA	San Jose fault
06/10/1988 Tejon Ranch Earthquake	6.8	Northeast of Frazier Park, CA	N/A
10/01/1987 Whittier Narrows Earthquake	5.9	Southeast of Pasadena	Puente Hills fault
01/01/1979 Malibu Earthquake	5.2	South of Malibu, CA	N/A
08/13/1978 Santa Barbara Earthquake	5.1	Southeast of Santa Barbara, CA	unknown
02/21/1973 Point Mugu Earthquake	5.3	Near Oxnard, 45 miles west of LA	San Fernando fault
02/09/1971 San Fernando Earthquake	6.5	Near Sylmar, CA	San Fernando fault
12/4/1948 Desert Hot Springs Earthquake	6.0	Near Desert Hot Springs, 100 miles east of LA	S. Branch San Andreas fault
6/30/1941 Santa Barbara Earthquake	5.5	6 miles ESE of Santa Barbara, CA	N/A
3/10/1933 Long Beach Earthquake	6.4	3 miles south of Huntington Beach, CA	Newport-Inglewood fault

Source: Southern California Earthquake Data Center, 2017

Table 9-7. Northridge Earthquake Estimated Damages

	Number	Estimated Losses
Residential	86,457	$1,150,939,340
Commercial	6,236	$459,955,246
Mix Use	224	$7,568,900
Total	**92,917**	**$1,618,463,486**

Source: City of Los Angeles, 2011

According to the scientists of the U.S. Geological Survey (USGS) and the Southern California Earthquake Center, the Northridge Earthquake raised nearby mountains by as much as 70 centimeters. The fault, which was previously unknown, appears to be truncated by the fault that broke in the similarly sized 1971 San Fernando Earthquake, the two faults abutting at a depth of 5 miles. The Northridge Earthquake caused many times more damage than the 1971 event, primarily because its fault is directly under the densely populated valley, whereas the 1971 fault lies under the mountains.

9.2.2 Location

Major Faults

The City of Los Angeles is located in a region of high seismicity with numerous local faults, as shown on Figure 9-2. The primary seismic hazard for the City is potential ground shaking from these major known faults, especially the Newport-Inglewood, Palos Verde, Puente Hills, San Andreas, and Santa Monica faults, which are further described in the sections below.

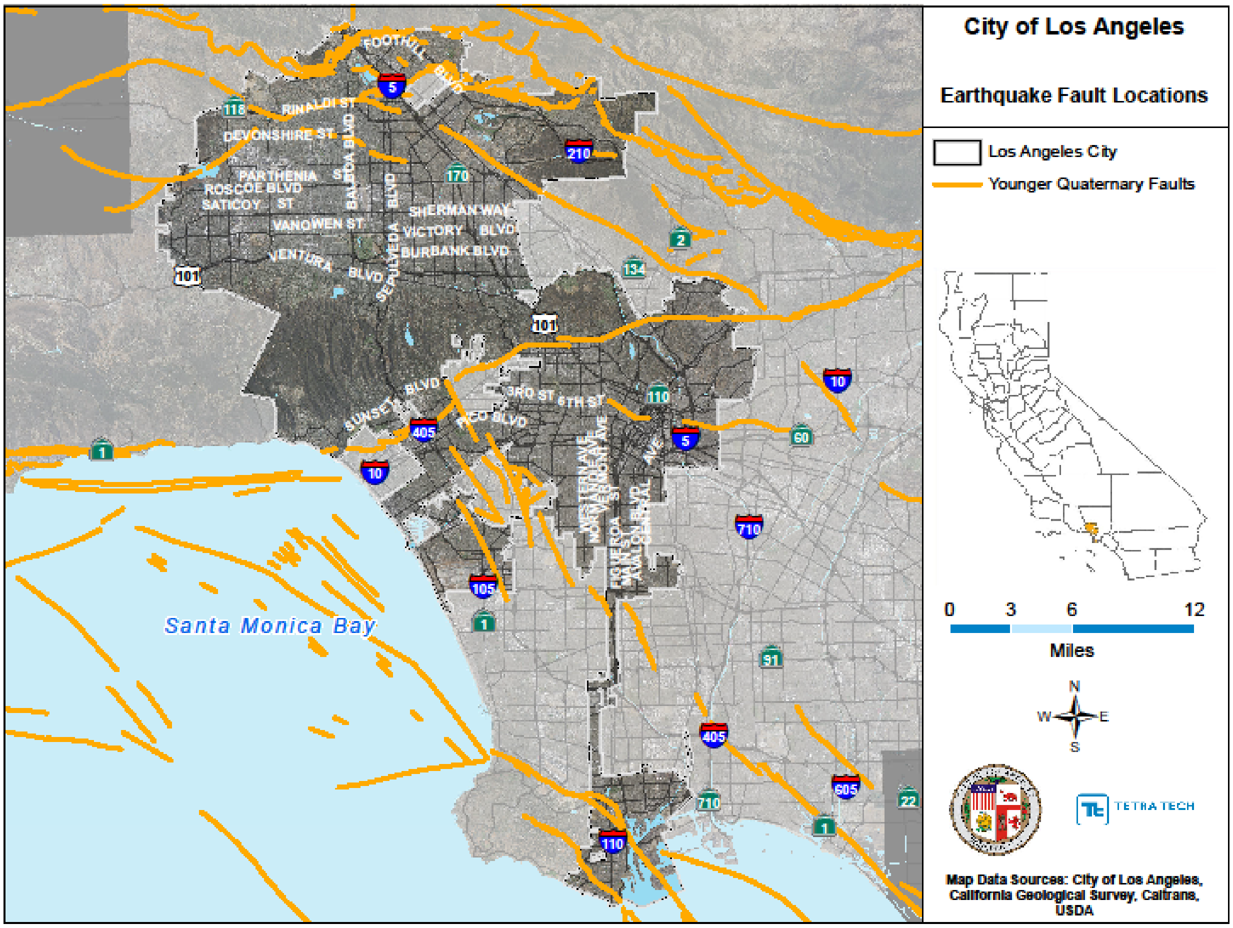


Figure 9-2. Earthquake Fault Locations

Newport-Inglewood

The Newport-Inglewood fault is a right-lateral strike-slip fault that extends for 47 miles from Culver City southeast through Inglewood and other coastal communities to Newport Beach, at which point the fault extends east-southeast into the Pacific Ocean where it is known as the Rose Canyon Fault. The fault can be inferred on the Earth's surface as passing along and through a line of hills extending from Signal Hill to Culver City. This is the second most active fault in California and is capable of producing an earthquake with a magnitude of 6.3 to 7.5.

Palos Verde

The Palos Verde fault extends from the Pacific Ocean and comes ashore near the southwest point of the Redondo Beach-Torrance border. The fault then curves around the base of the Palos Verdes Peninsula roughly midway between the Pacific Coast Highway and the peninsula. It continues this southerly course until it runs into the Los Angeles Harbor.

Puente Hills

The Puente Hills fault, also known as the Puente Hills thrust system, is an active geological fault that runs about 25 miles in three discrete sections from the Puente Hills region in the southeast to just south of Griffith Park in the northwest. The fault is known as a blind thrust fault due to the lack of surface features normally associated with thrust faults. This fault is capable of producing an earthquake with a magnitude between 7.0 and 7.5.

San Andreas

The San Andreas fault is a continental transform fault that extends roughly 800 miles through California. It forms the tectonic boundary between the Pacific Plate and the North American Plate, and its motion is right-lateral strike-slip (horizontal). The fault divides into three segments, each with different characteristics and a different degree of earthquake risk, the most significant being the southern segment, which passes within about 35 miles of Los Angeles.

Santa Monica

The Santa Monica fault is one of several northeast-southwest-trending, north-dipping, reverse faults that extend through the Los Angeles metropolitan area for approximately 50 miles. This fault is capable of producing an earthquake with a magnitude of 6.0 to 7.0.

Mapping of Earthquake Impact

The impact of an earthquake is largely a function of the following components:

- Ground shaking (ground motion accelerations)
- Liquefaction (soil instability)
- Distance from the source (both horizontally and vertically).

Mapping that shows the impacts of these components was used to assess the risk of earthquakes within the planning area. While the impacts of these components can build upon each other during an earthquake, the mapping looks at each component individually.

Shake Maps

A shake map is a representation of ground shaking produced by an earthquake. The information it presents is different from the earthquake magnitude and epicenter that are released after an earthquake because shake maps focus on the ground shaking resulting from the earthquake, rather than the parameters describing the earthquake source. An earthquake has only one magnitude and one epicenter, but it produces a range of ground shaking at sites throughout the region, depending on the distance from the earthquake, the rock and soil conditions at sites, and variations in the propagation of seismic waves from the earthquake due to complexities in the structure of the earth's crust. A shake map shows the extent and variation of ground shaking in a region immediately following significant earthquakes.

Ground motion and intensity maps are derived from peak ground motion amplitudes recorded on seismic sensors (accelerometers), with interpolation based on estimated amplitudes where data are lacking, and site amplification corrections. Color-coded instrumental intensity maps are derived from empirical relations between peak ground motions and Modified Mercalli intensity. Earthquake scenario maps describe the expected ground motions and effects of hypothetical large earthquakes for a region. The following scenarios were assessed for this plan:

- Newport-Inglewood Fault Scenario—A Magnitude 7.2 event with a depth of 7.5 miles and epicenter 32 miles southeast of downtown Los Angeles. See Figure 9-3.
- Palos Verde Fault Scenario—A Magnitude 7.3 event with a depth of 7.0 miles and epicenter 55 miles south-southeast of downtown Los Angeles. See Figure 9-4.
- Puente Hills Fault Scenario—A Magnitude 7.0 event with a depth of 7.6 miles and epicenter 11.5 miles northeast of downtown Los Angeles. See Figure 9-5.
- San Andreas Fault Scenario—A Magnitude 7.8 event with a depth of 4.7 miles and epicenter 150 miles east-southeast of downtown Los Angeles. See Figure 9-6.
- Santa Monica Fault Scenario—A Magnitude 6.8 event with a depth of 5.7 miles and epicenter 9.5 miles northwest of downtown Los Angeles. See Figure 9-7.

NEHRP Soil Maps

NEHRP soil types define the locations that will be significantly impacted by an earthquake. NEHRP Soils B and C typically can sustain low-magnitude ground shaking without much effect. The areas that are most commonly affected by ground shaking have NEHRP Soils D, E and F. NEHRP soil classifications in each APC are shown in Figure 9-8 through Figure 9-14.

Liquefaction Maps

When the ground liquefies, sandy or silty materials saturated with water behave like a liquid, causing pipes to leak, roads and airport runways to buckle, and building foundations to be damaged. In general, areas with NEHRP Soils D, E and F are susceptible to liquefaction. If there is a dry soil crust, excess water will sometimes come to the surface through cracks in the confining layer, bringing liquefied sand with it, creating sand boils. Liquefaction susceptibility in each APC is shown in Figure 9-15 through Figure 9-21.

9.2.3 Frequency

California experiences hundreds of earthquakes each year, most with minimal damage and magnitudes below 3.0 on the Richter Scale. Earthquakes that cause moderate damage to structures occur several times a year. According to the USGS, a strong earthquake measuring greater than 5.0 on the Richter Scale occurs every two to three years and major earthquakes of more than 7.0 on the Richter Scale occur once a decade. The San Andreas Fault has the potential for experiencing major to great events. The State Hazard Mitigation Plan indicates that in the next 30 years in California there is over a 99-percent probability of a magnitude 6.7 earthquake and a 94-percent probability of a magnitude 7.0 earthquake.

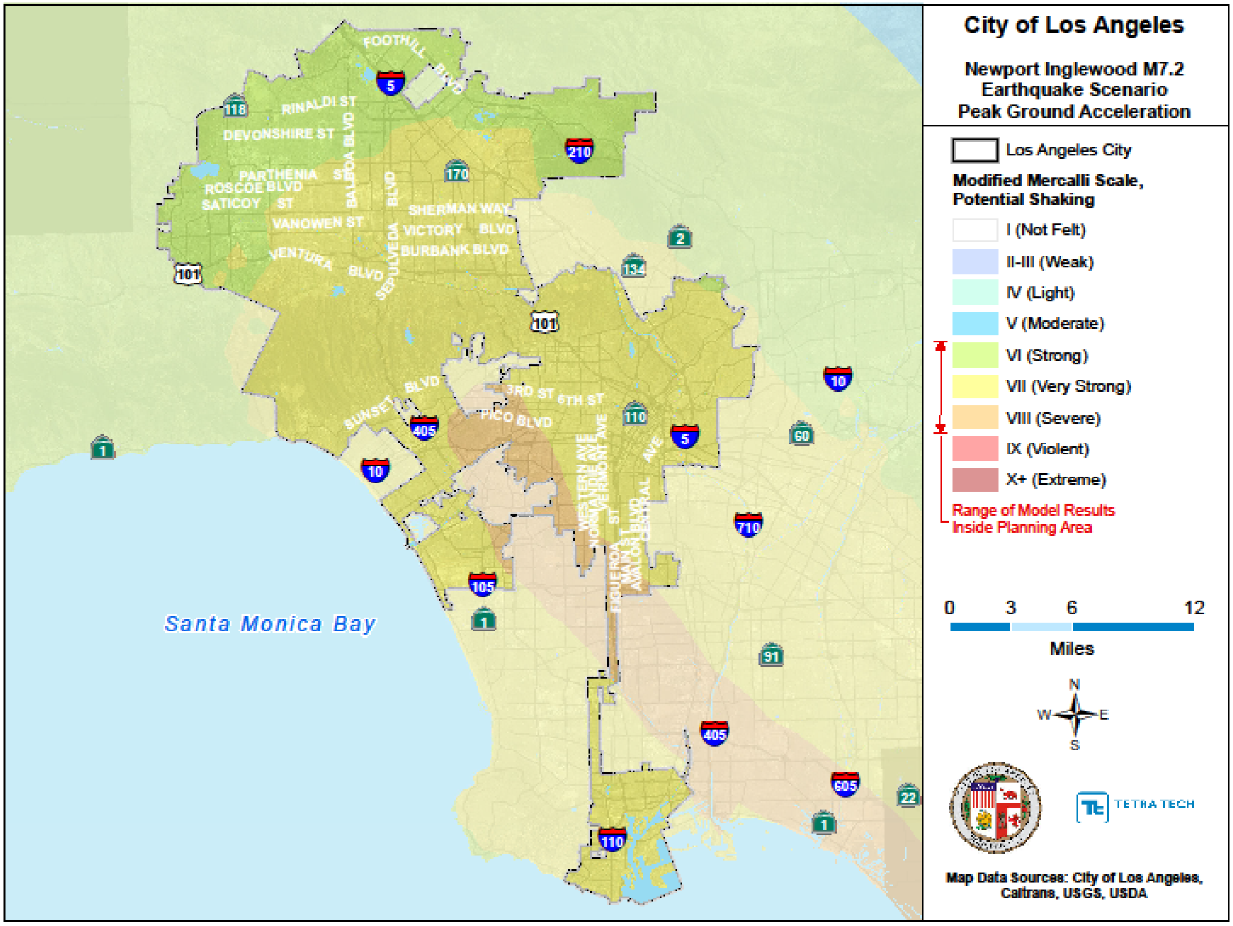


Figure 9-3. Newport-Inglewood Fault Scenario Peak Ground Acceleration

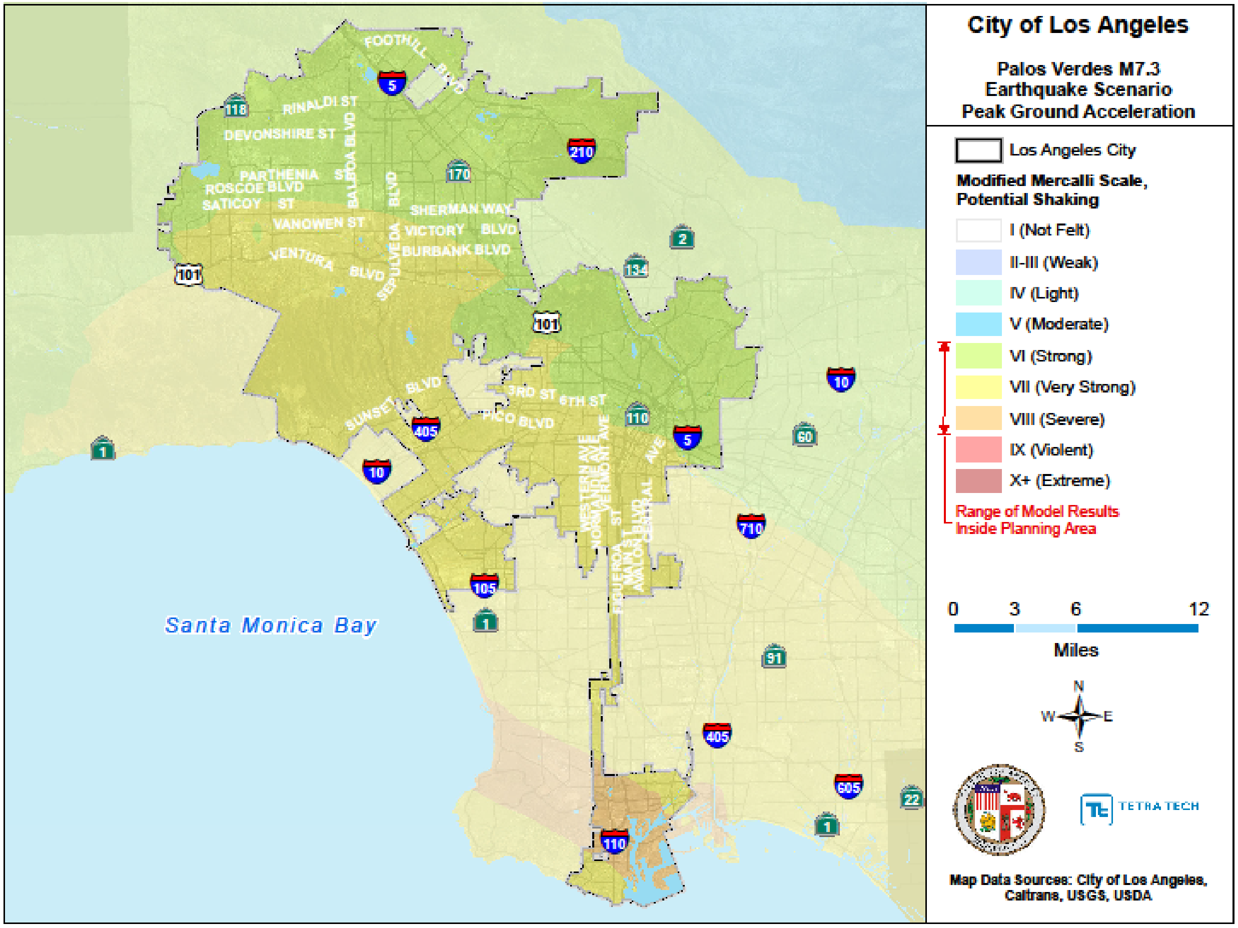


Figure 9-4. Palos Verde Fault Scenario Peak Ground Acceleration

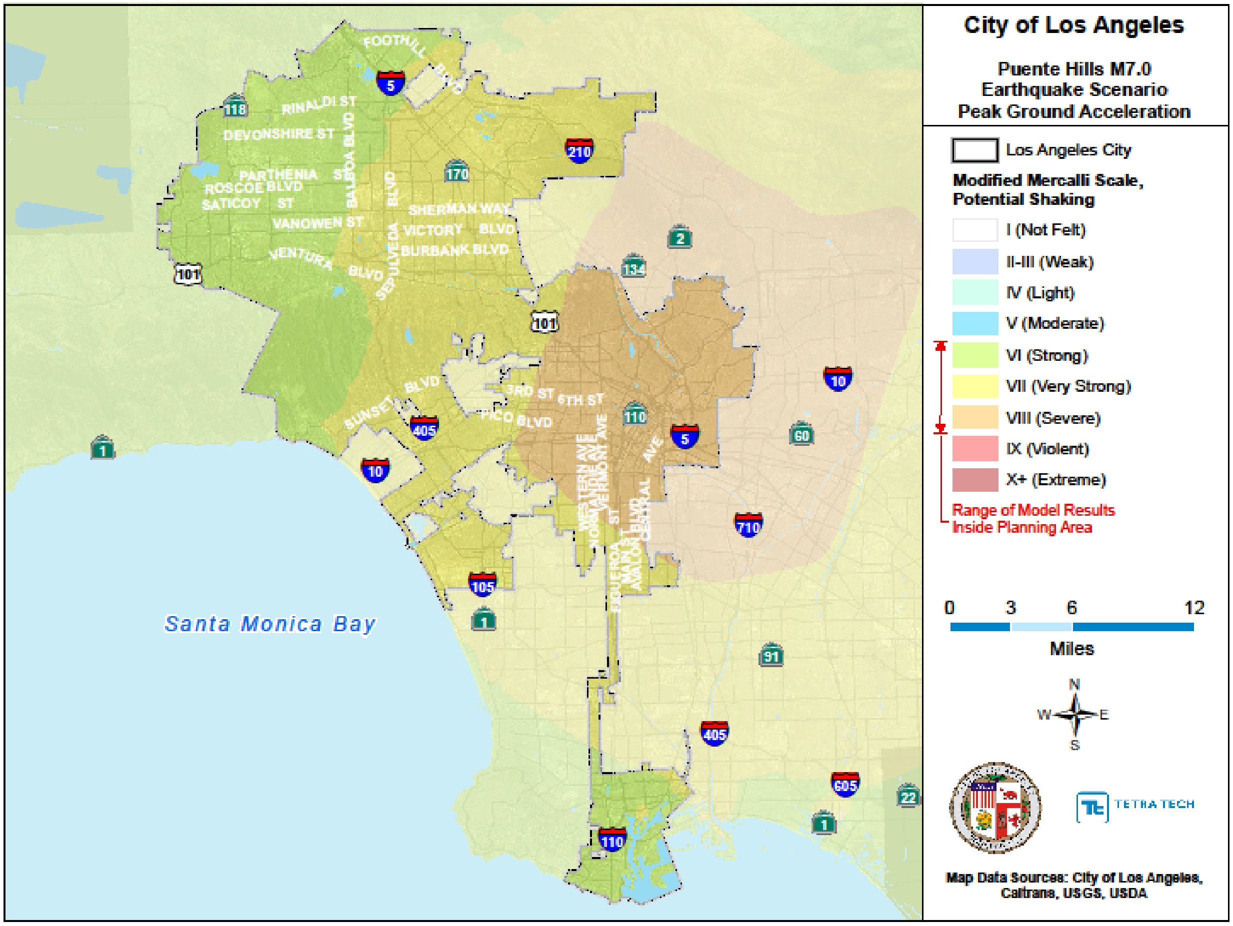


Figure 9-5. Puente Hills Fault Scenario Peak Ground Acceleration

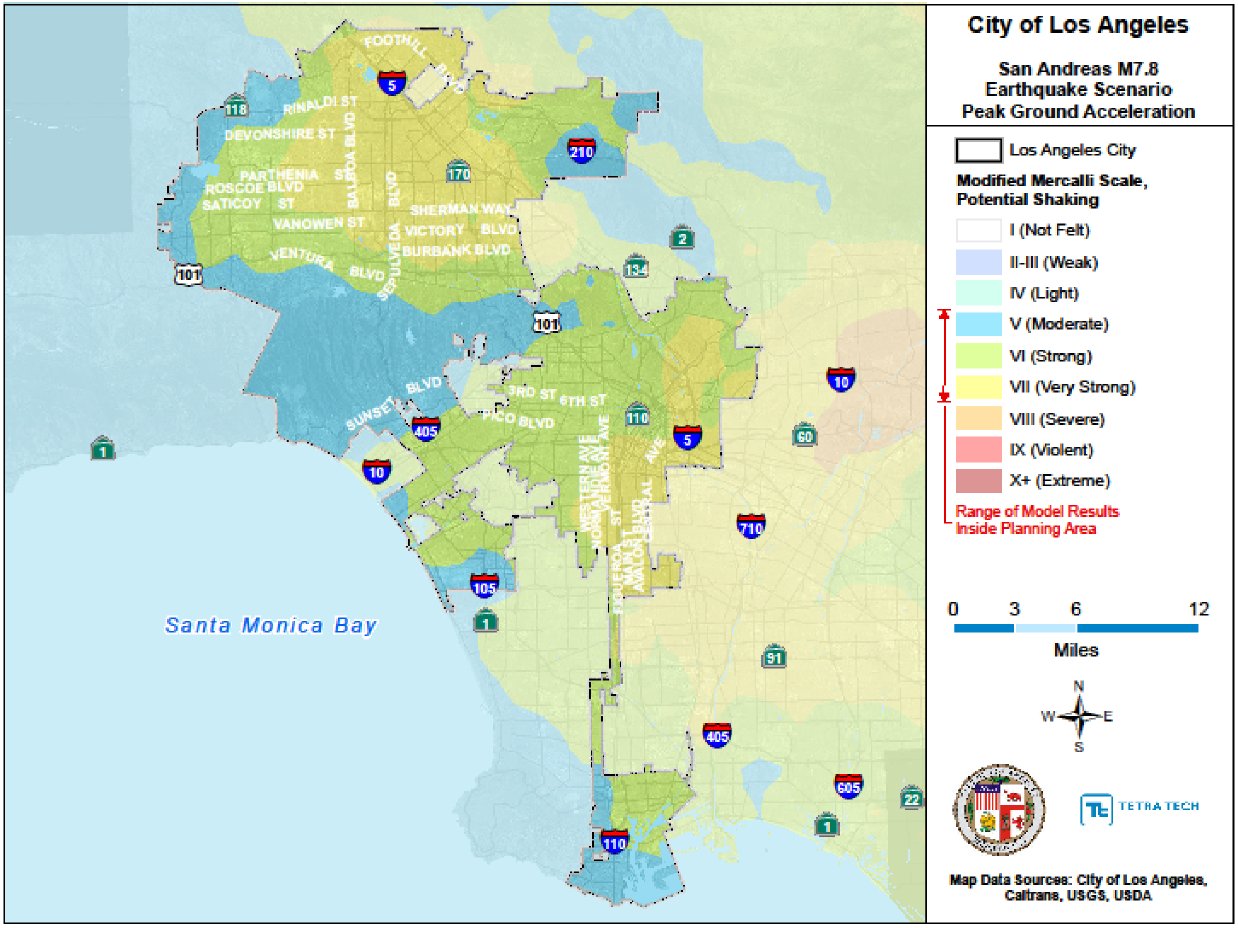


Figure 9-6. San Andreas Fault Scenario Peak Ground Acceleration

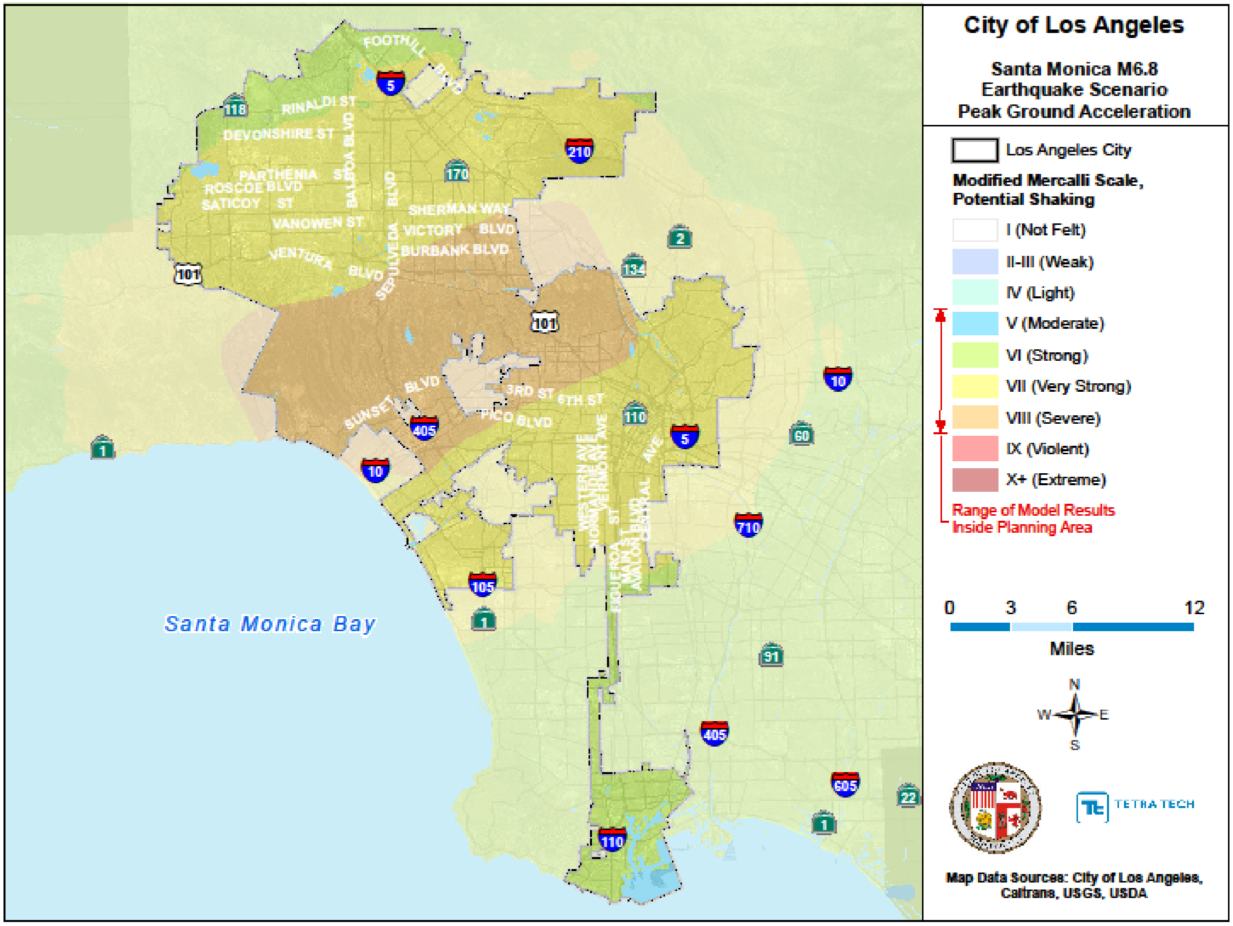


Figure 9-7. Santa Monica Fault Scenario Peak Ground Acceleration

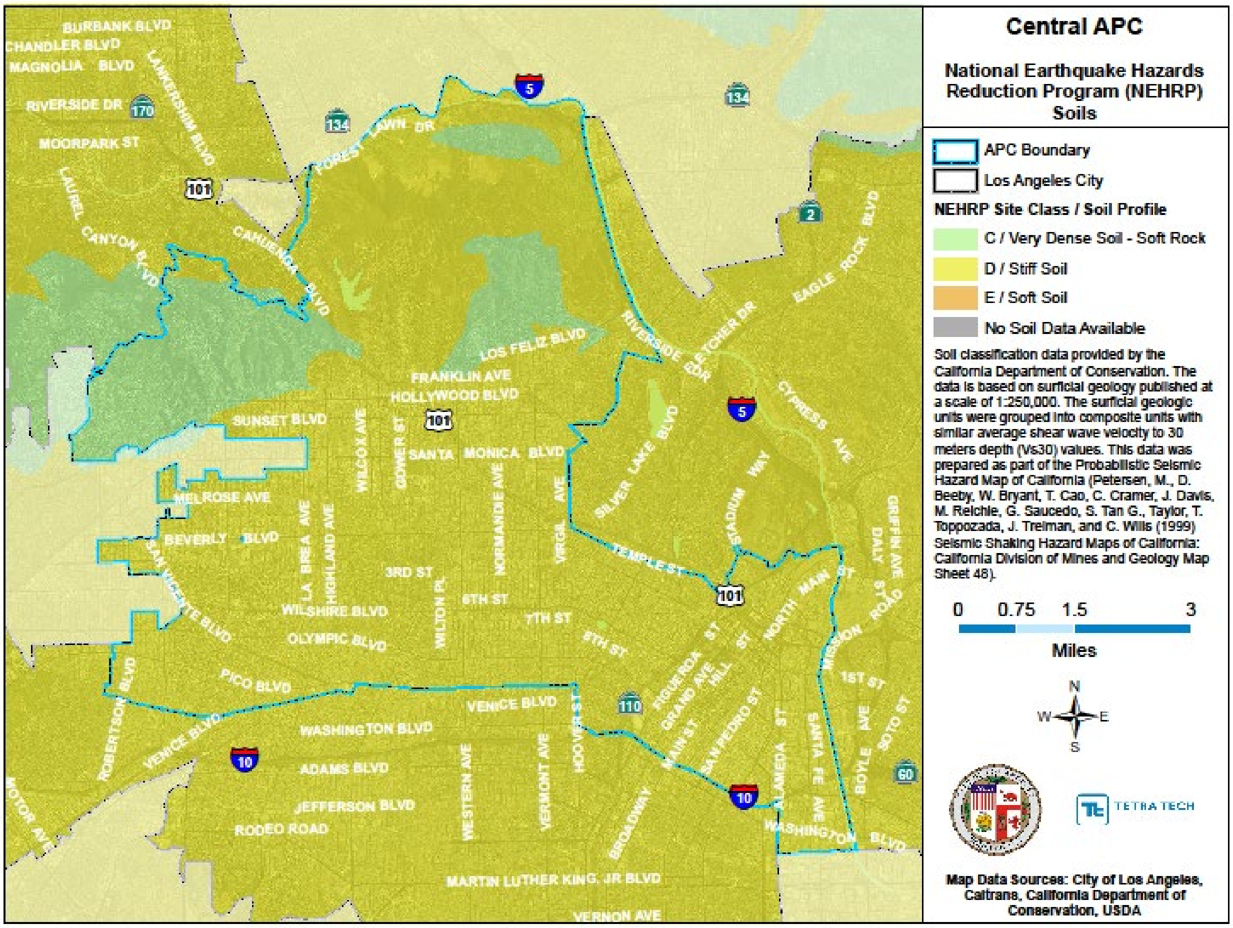


Figure 9-8. Central APC NEHRP Soils

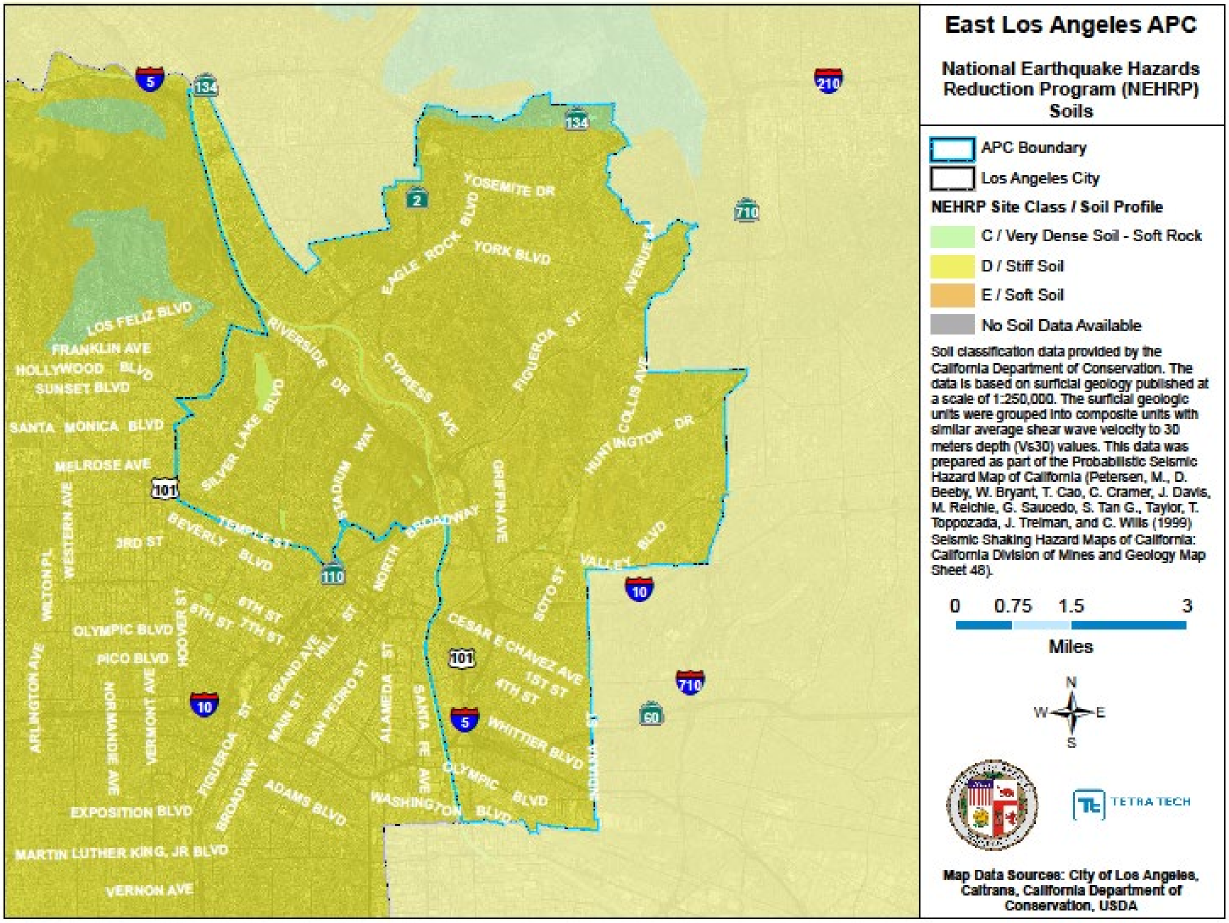


Figure 9-9. East Los Angeles APC NEHRP Soils

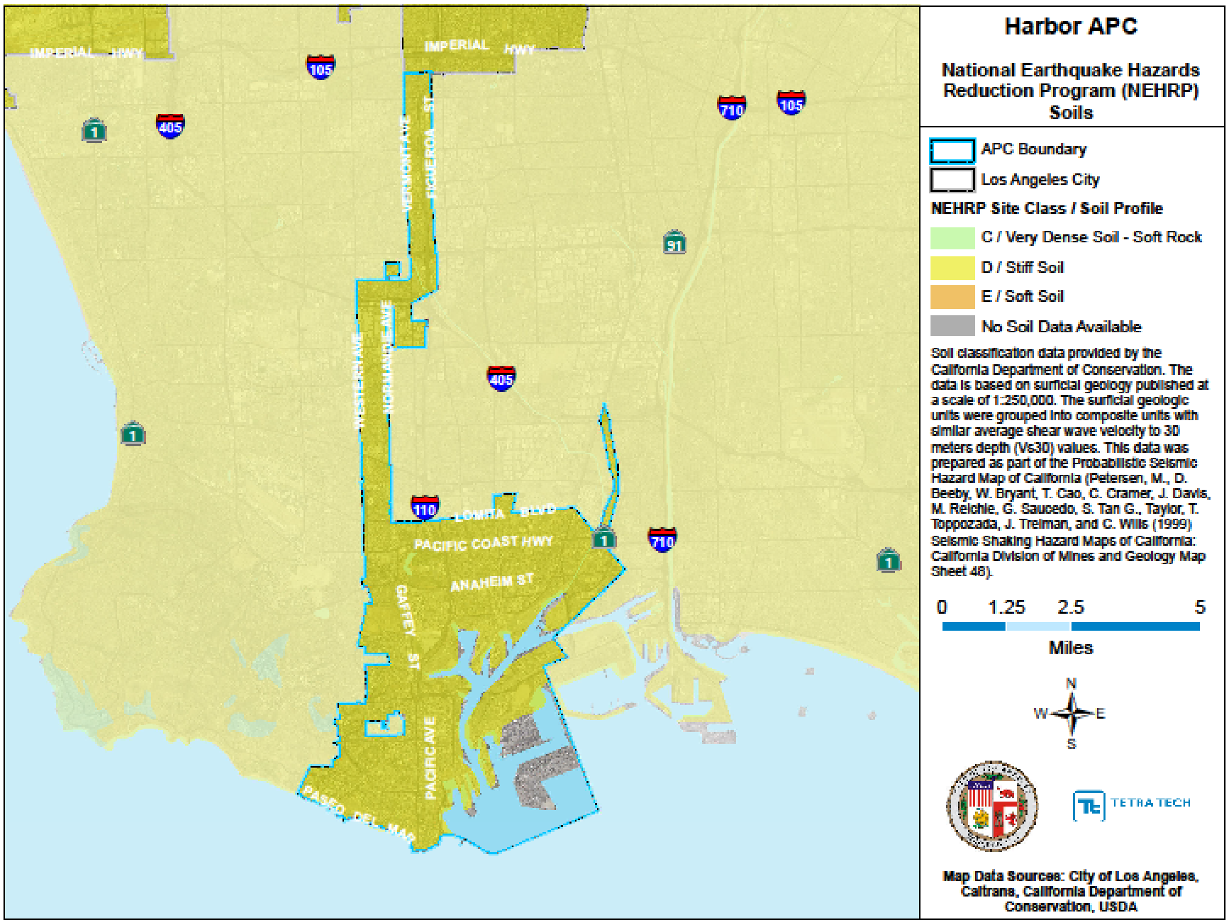


Figure 9-10. Harbor APC NEHRP Soils

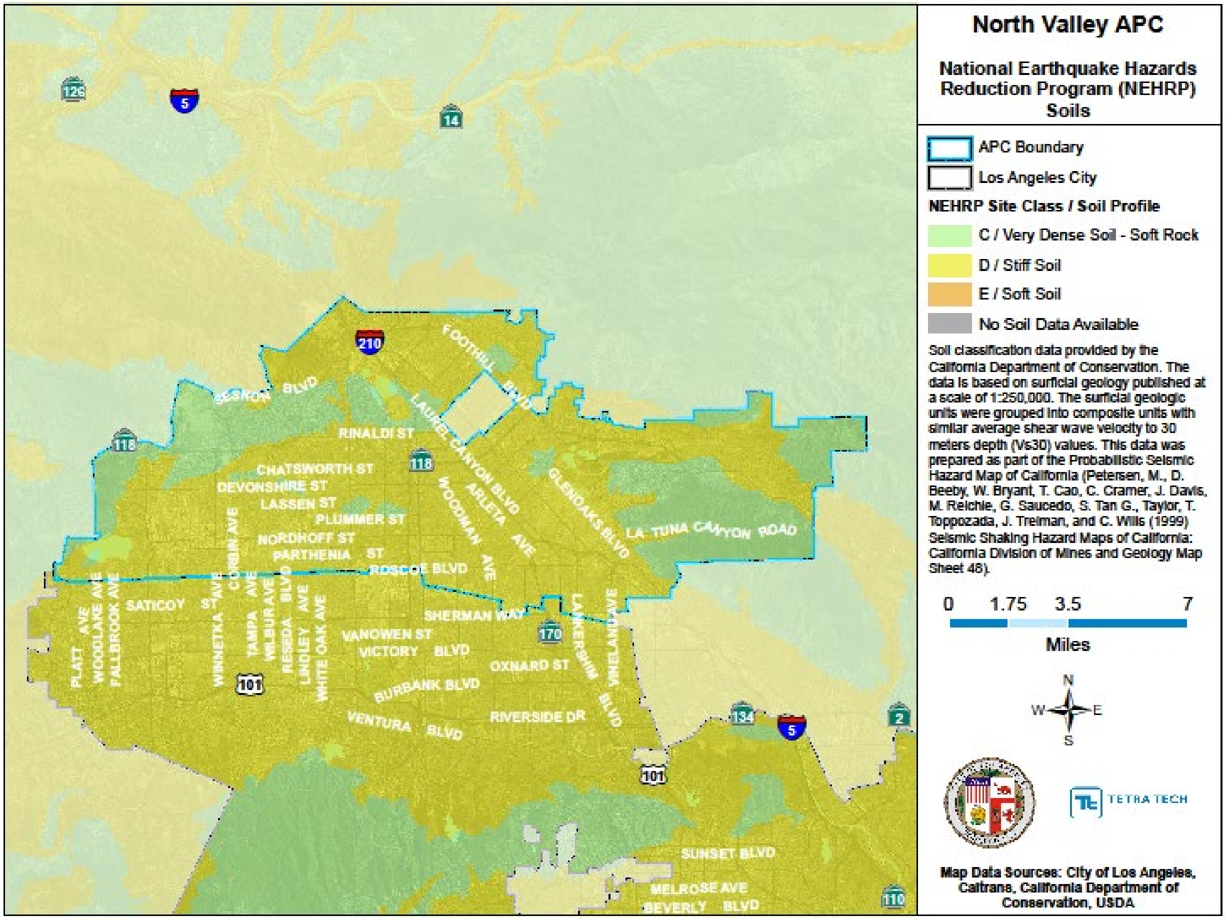


Figure 9-11. North Valley APC NEHRP Soils

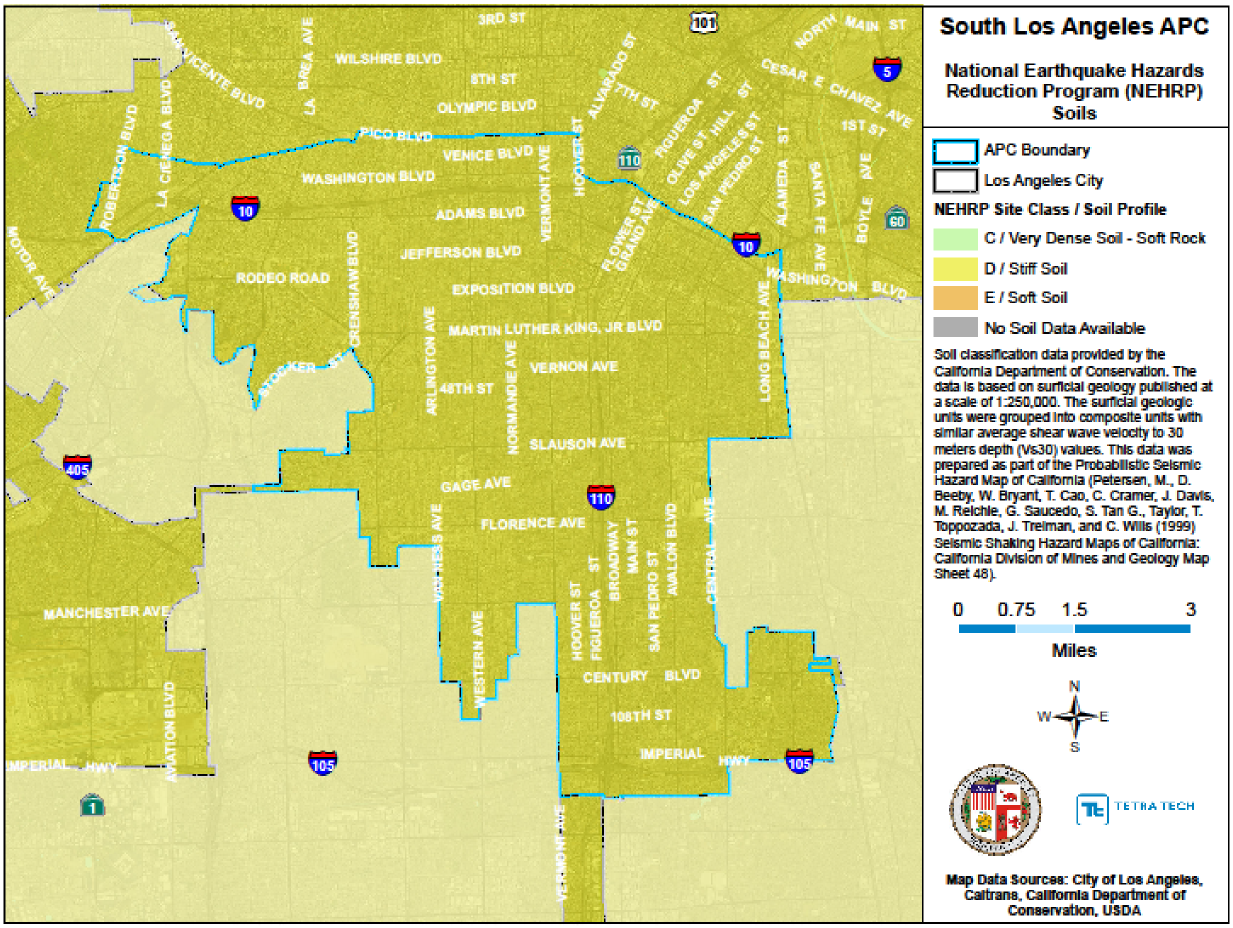


Figure 9-12. South Los Angeles APC NEHRP Soils

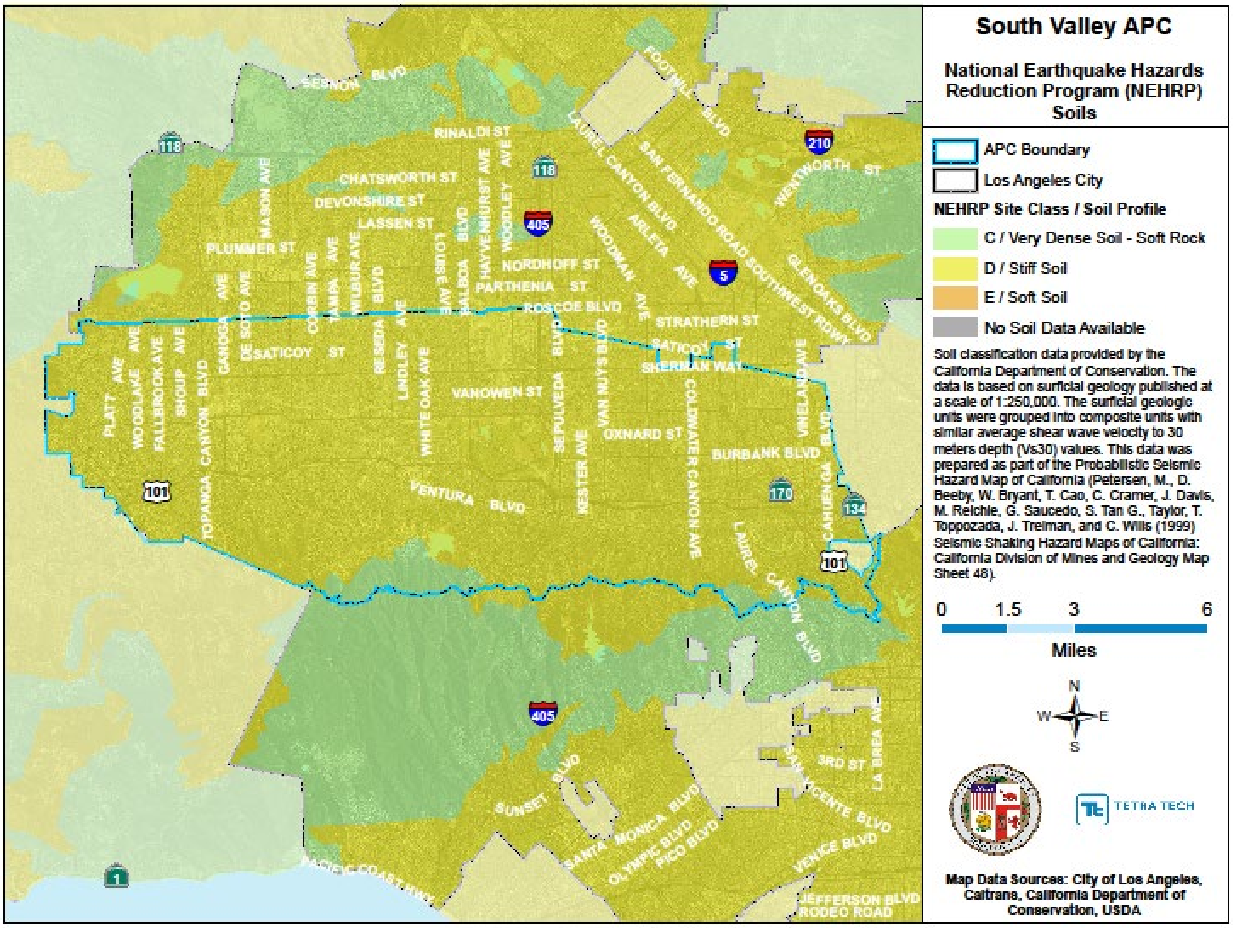


Figure 9-13. South Valley APC NEHRP Soils

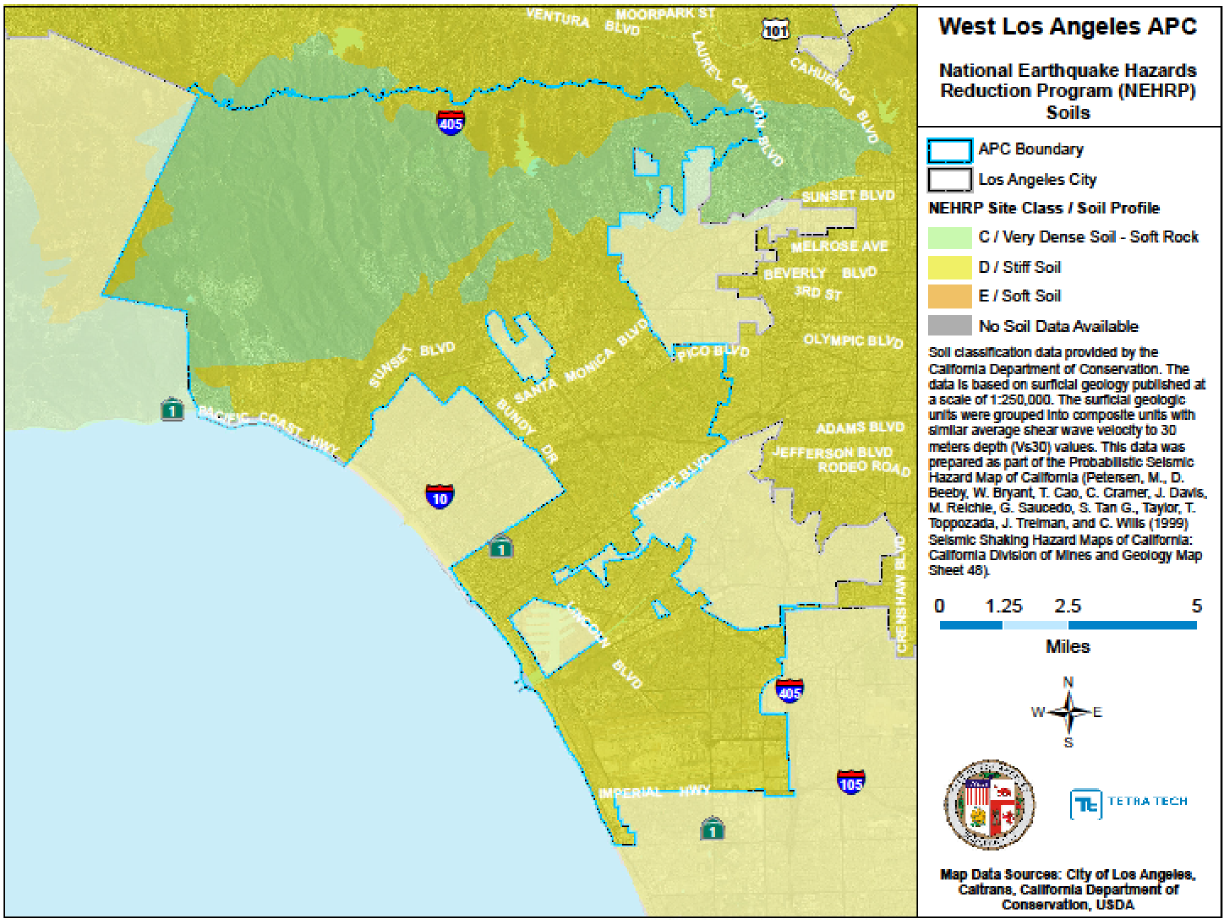


Figure 9-14. West Los Angeles APC NEHRP Soils

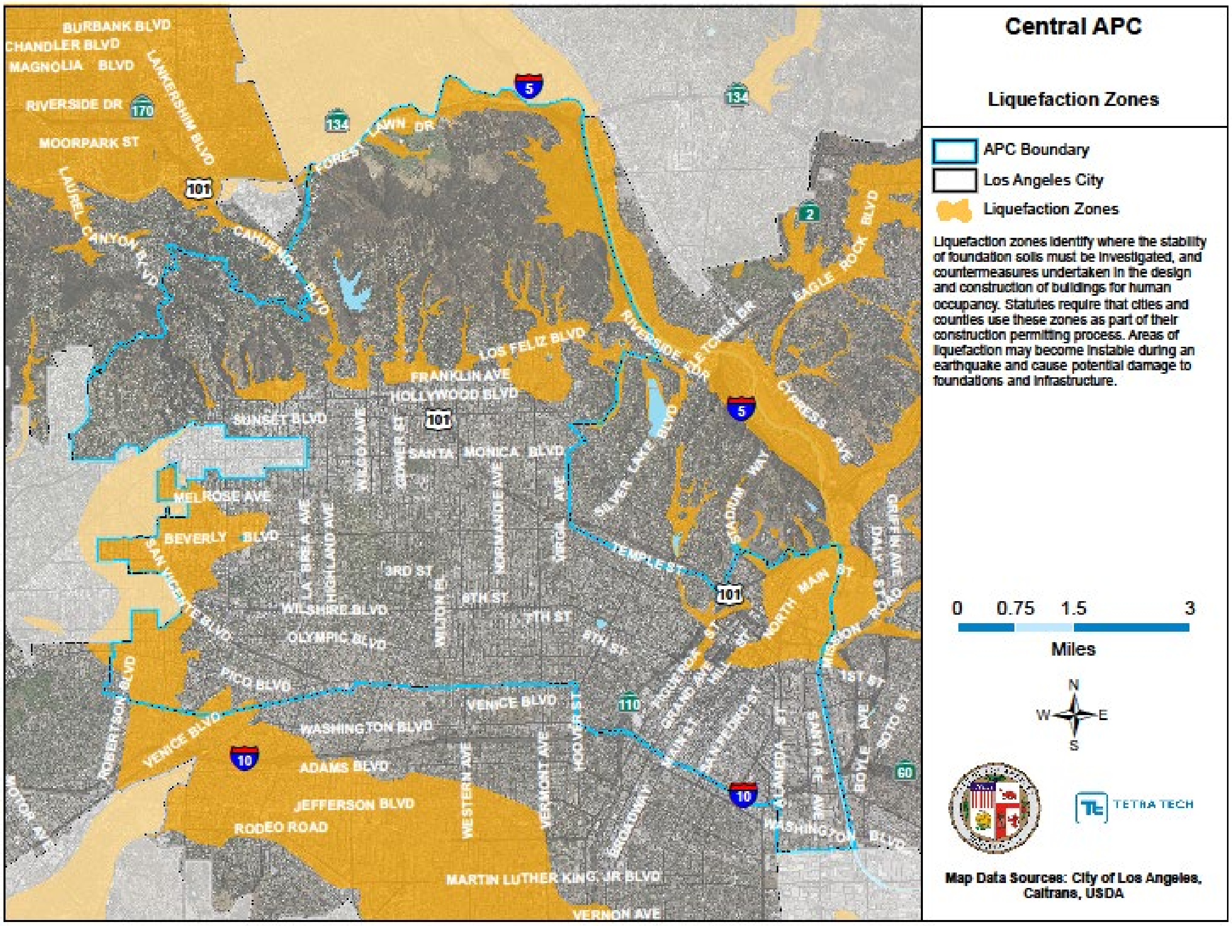


Figure 9-15. Central APC Liquefaction Zones

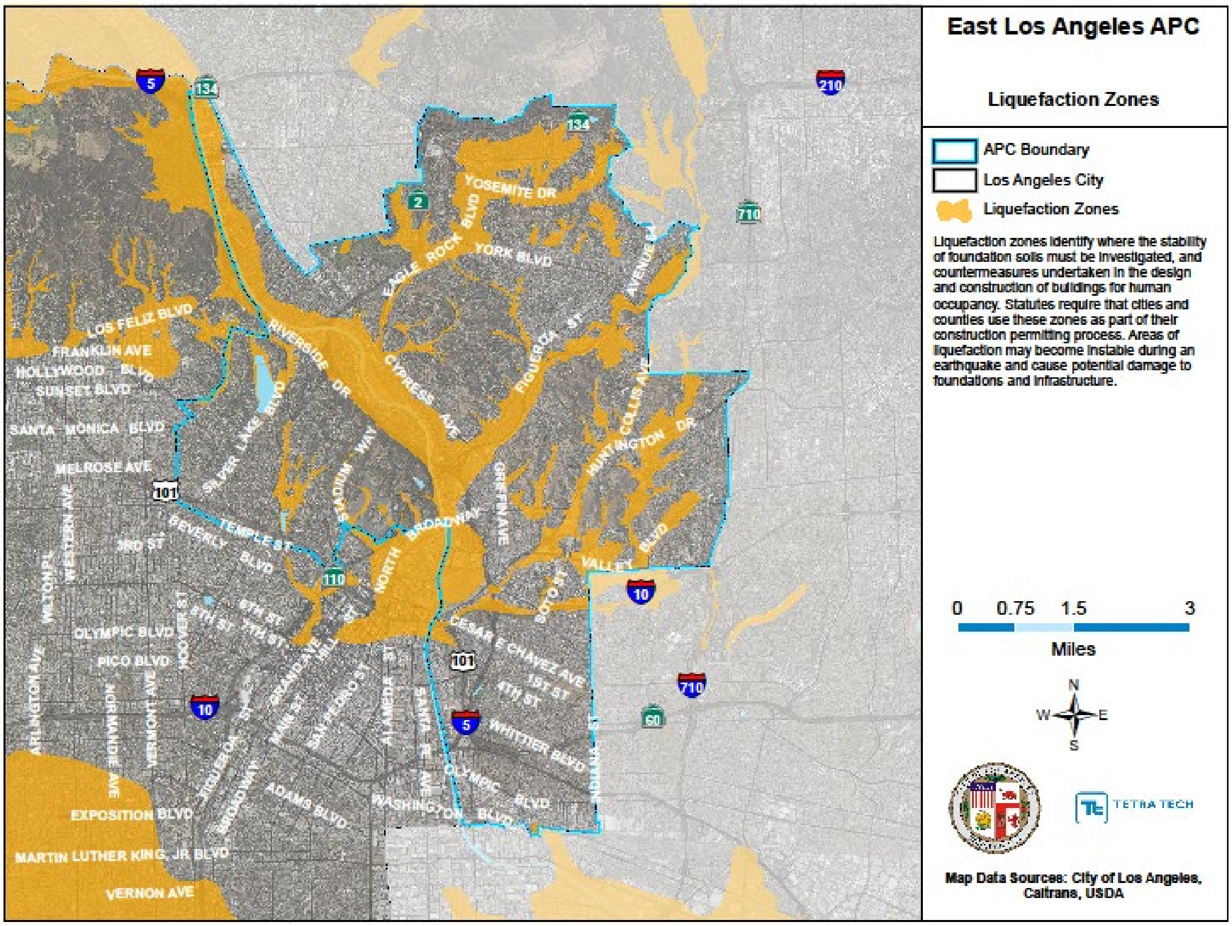


Figure 9-16. East Los Angeles APC Liquefaction Zones

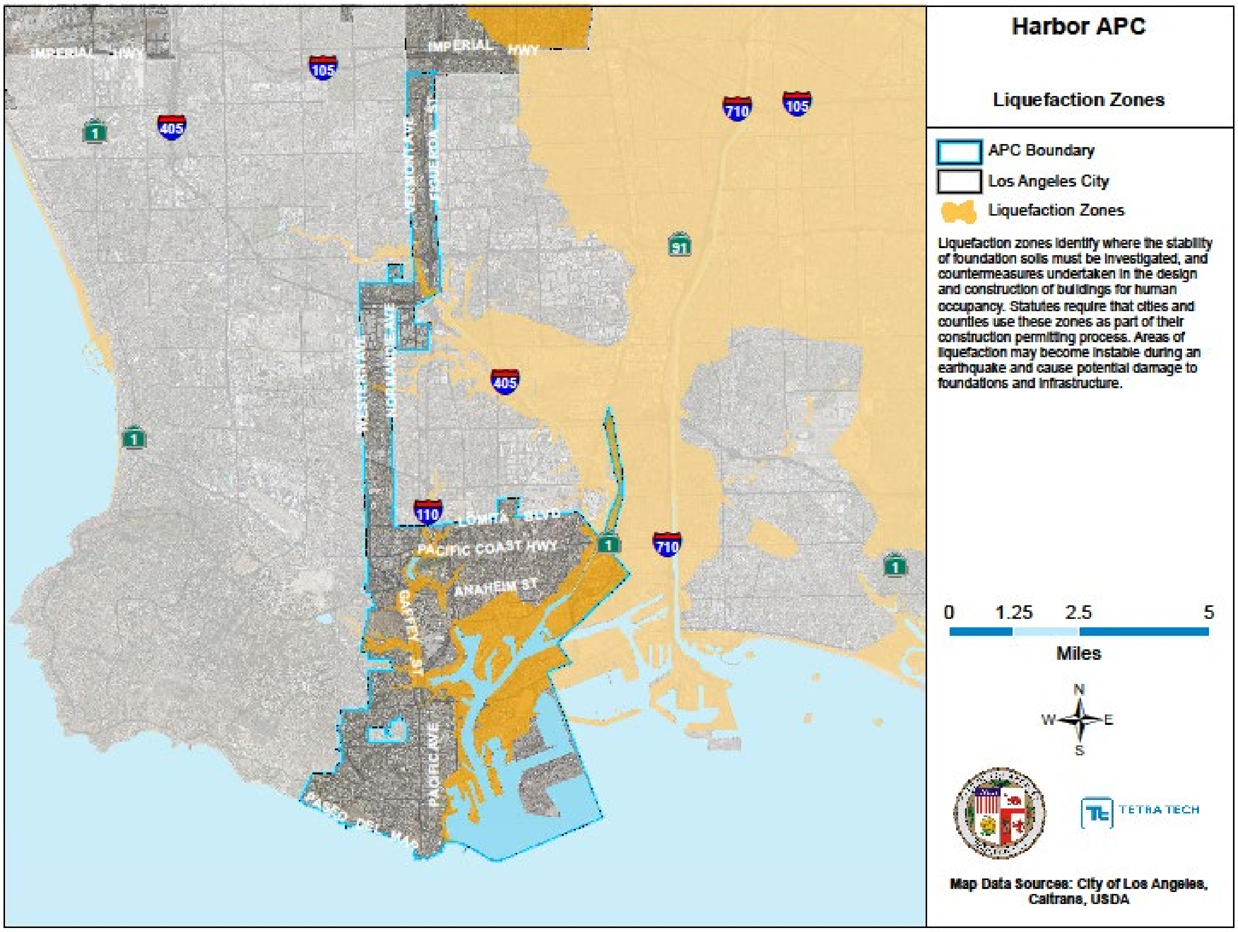


Figure 9-17. Harbor APC Liquefaction Zones

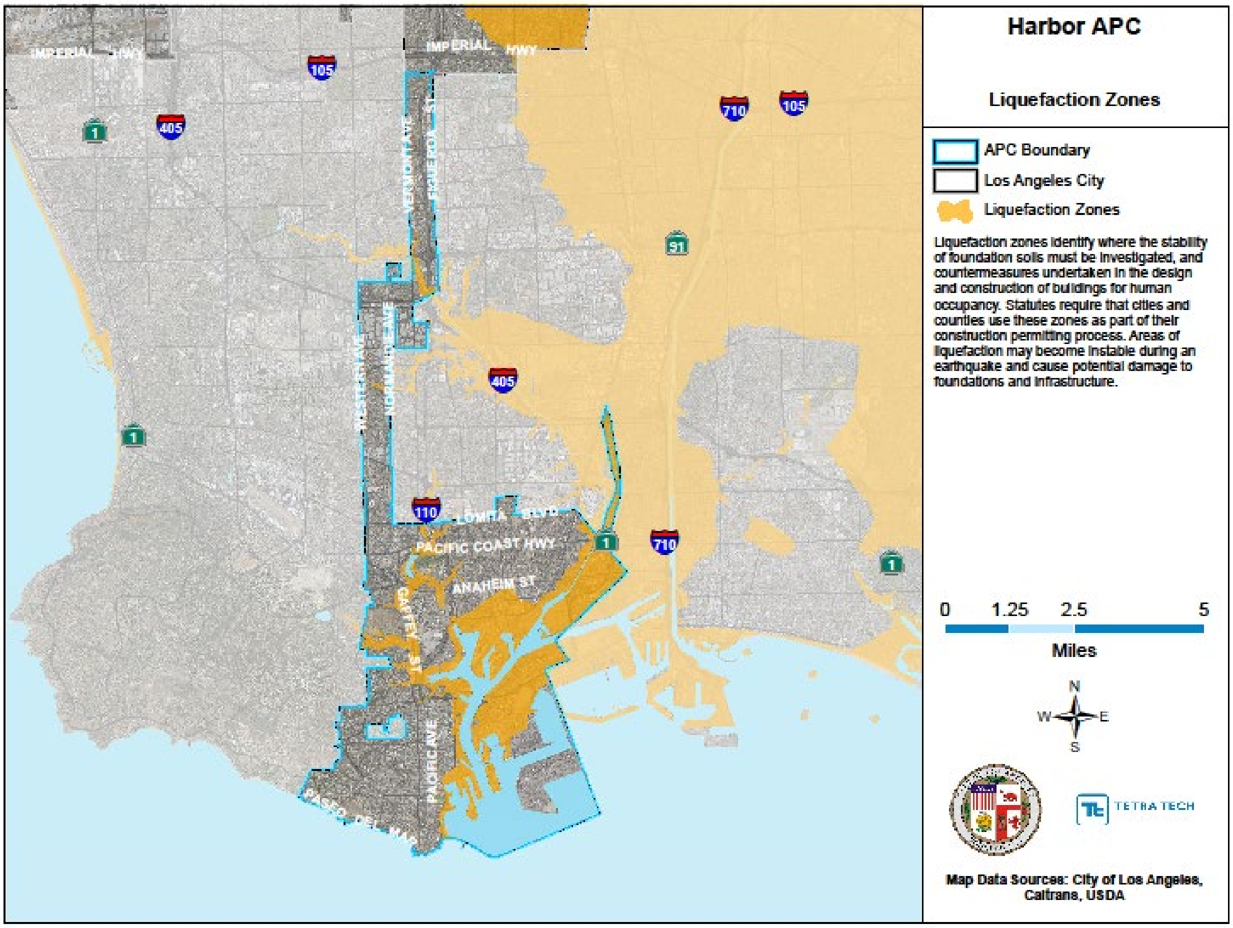


Figure 9-18. North Valley APC Liquefaction Zones

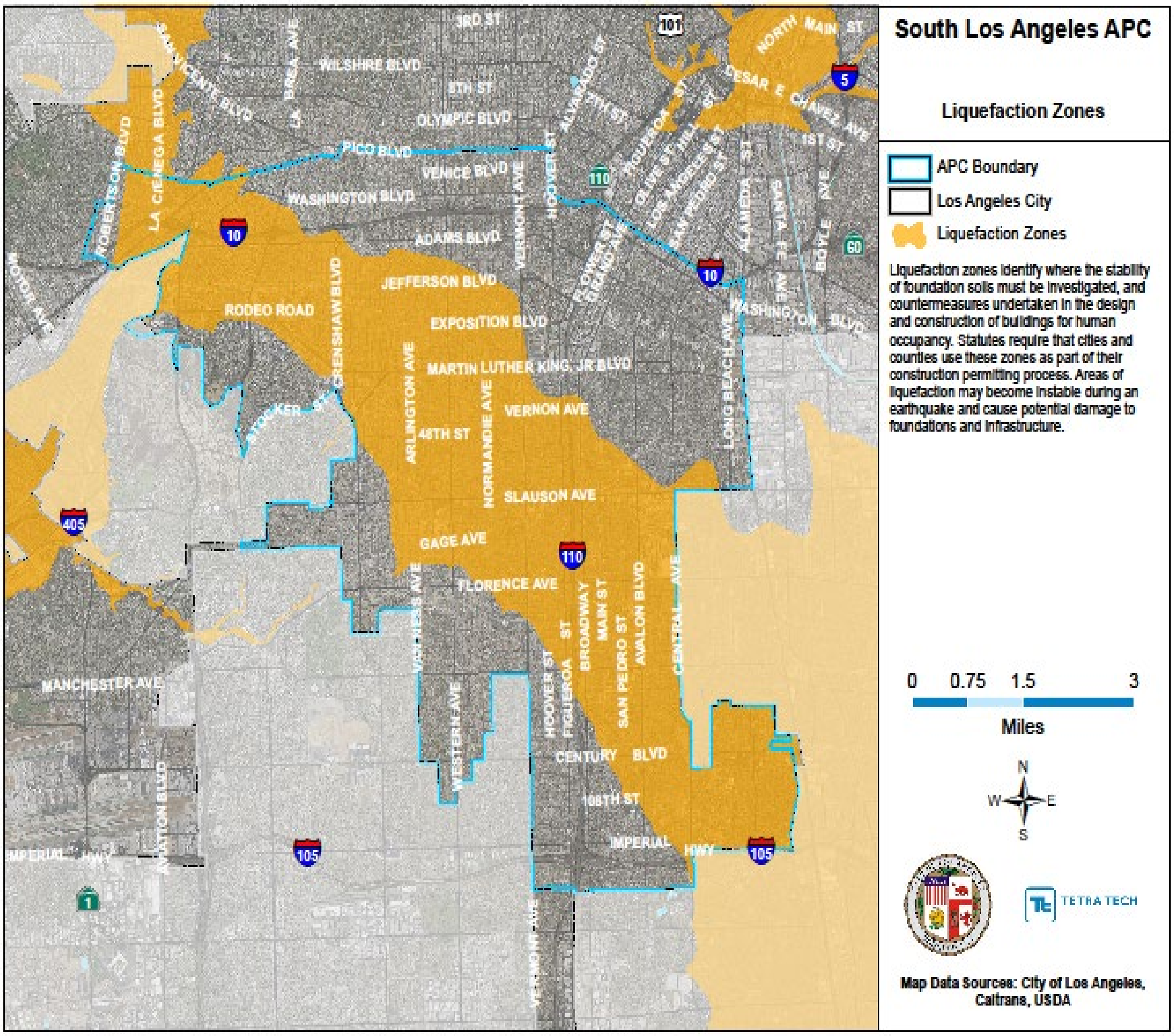


Figure 9-19. South Los Angeles APC Liquefaction Zones

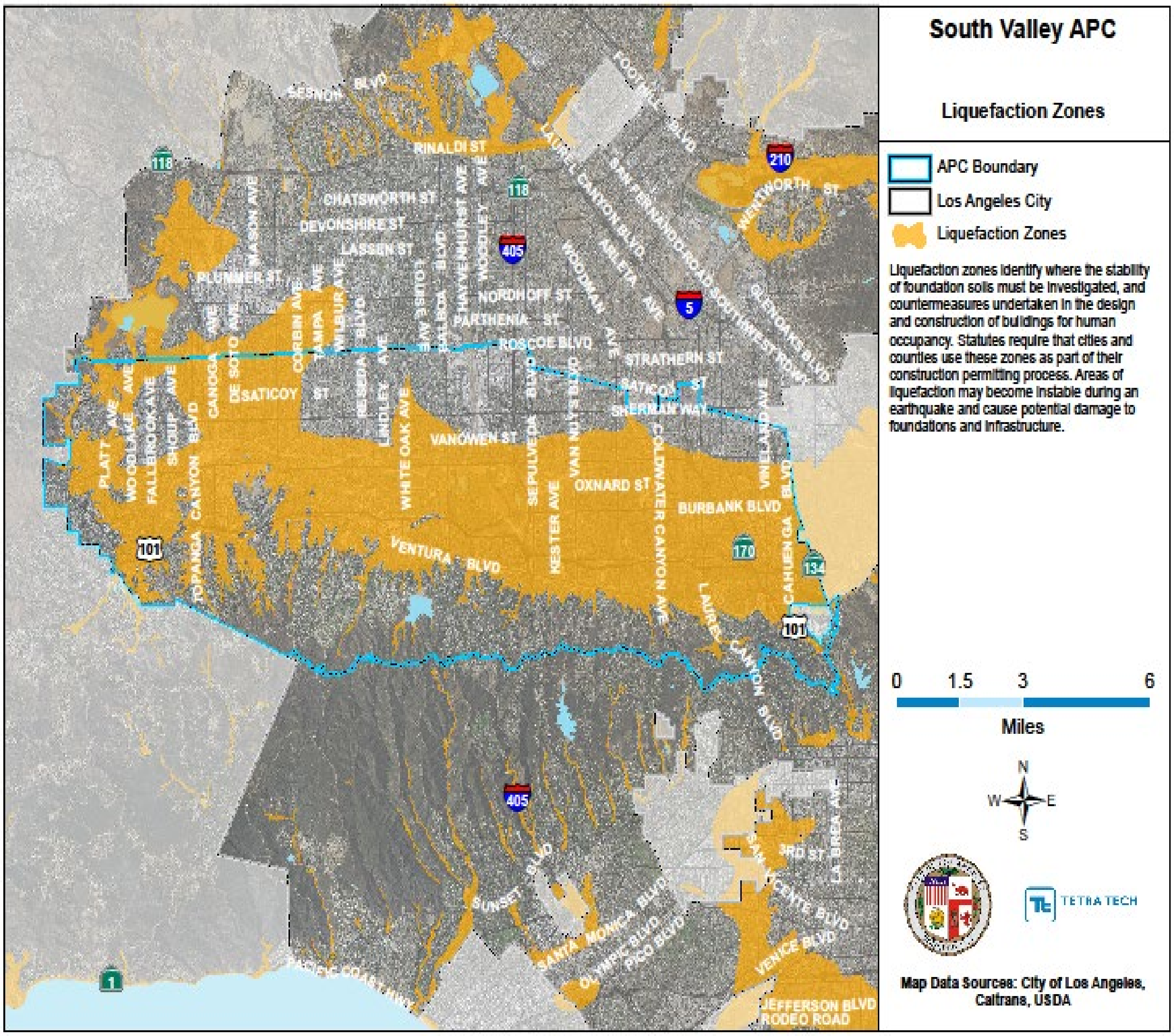


Figure 9-20. South Valley APC Liquefaction Zones

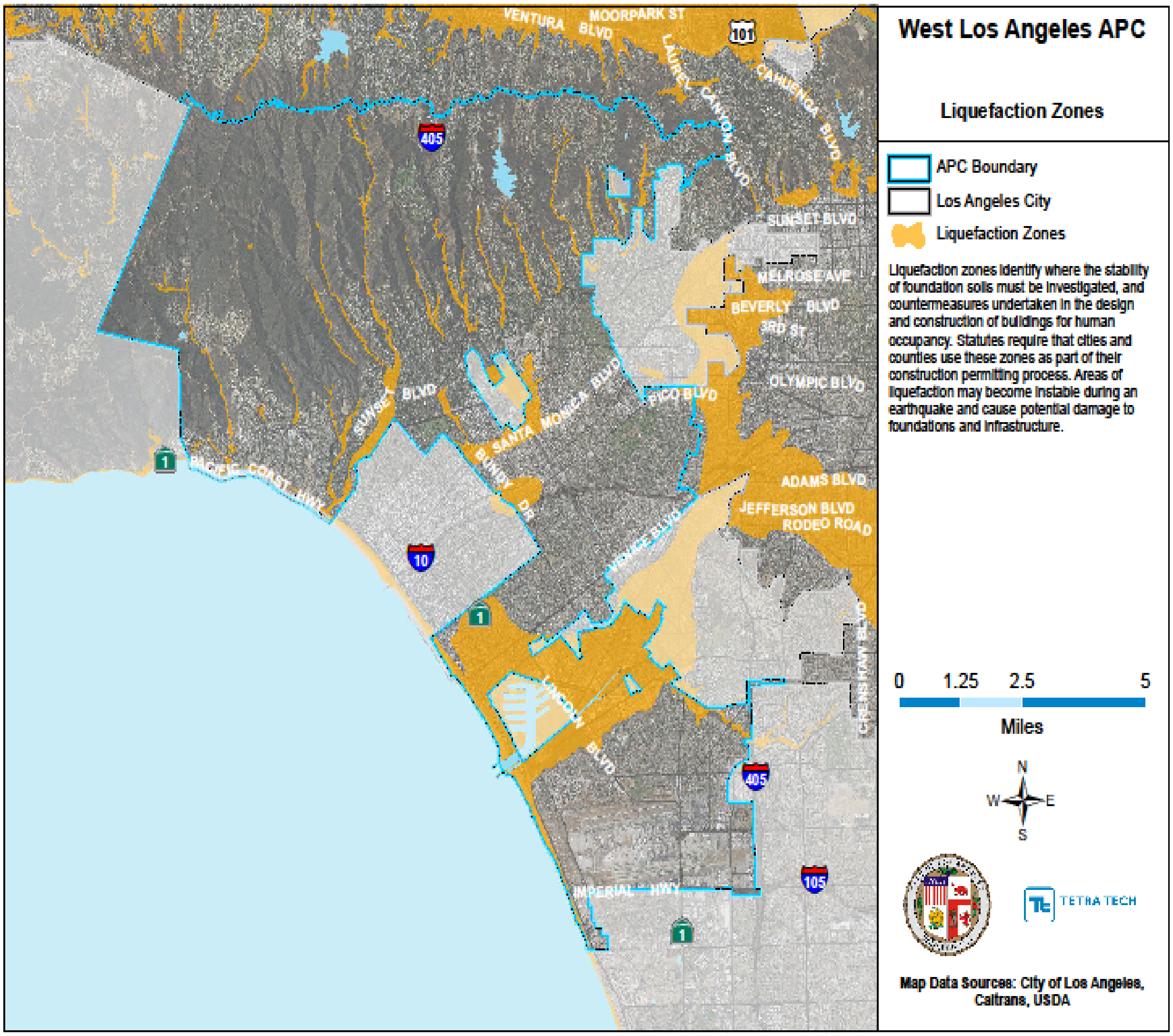
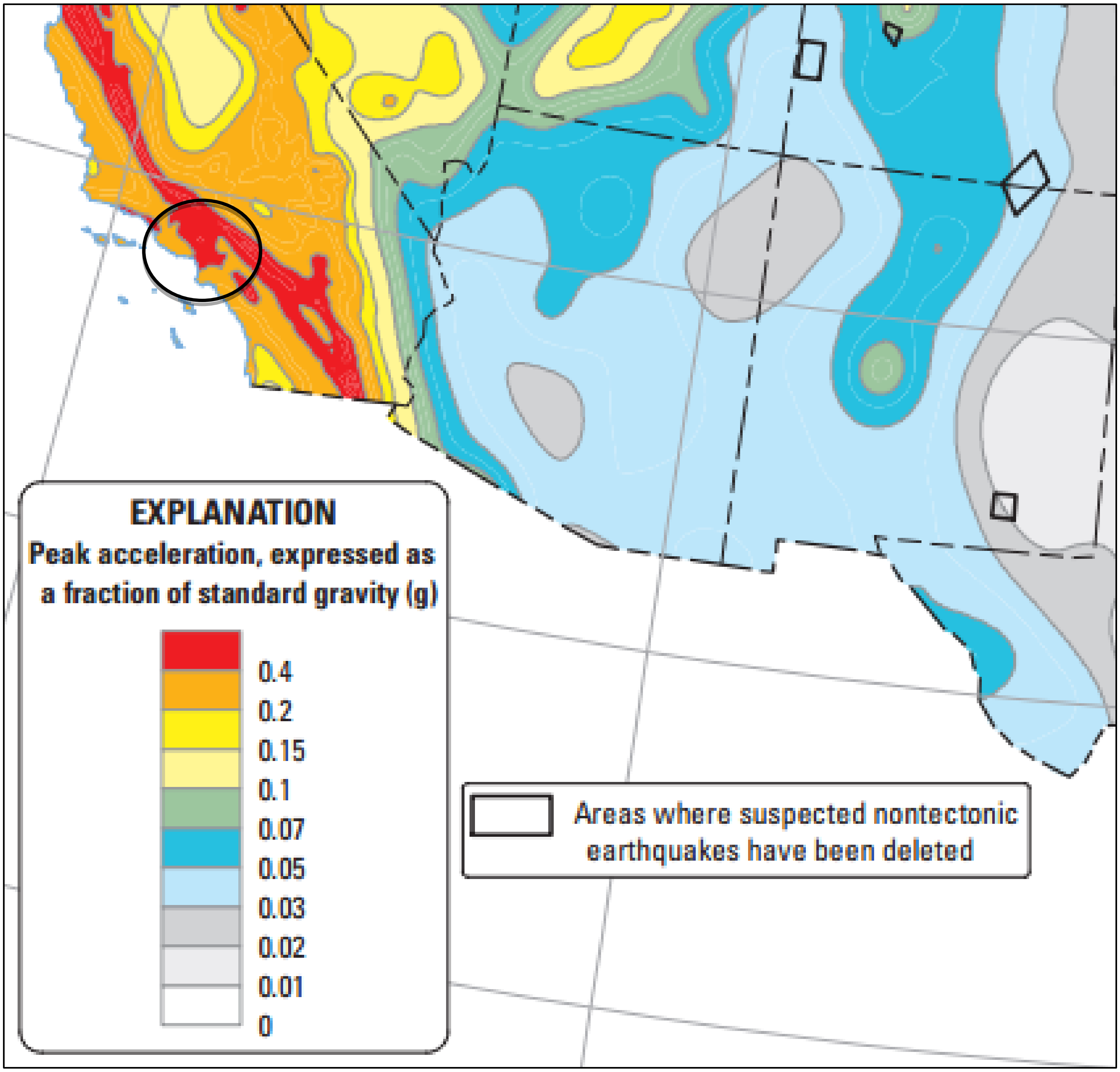


Figure 9-21. West Los Angeles APC Liquefaction Zones

9.2.4 Severity

The USGS has created ground motion maps based on current information about fault zones. These maps show the PGA that has a certain probability (2 percent or 10 percent) of being exceeded in a 50-year period. The maps were most recently updated in 2014 with new seismic, geologic, and geodetic information on earthquake rates and ground shaking, representing the best currently available data. The 2014 map for California shows that for City of Los Angeles, the PGA with a 10-percent probability of exceedance in 50 years is 0.4g and 0.2g (see Figure 9-22).



Oval is approximate location of City of Los Angeles

Figure 9-22. PGA with 2-Percent Probability of Exceedance in 50 Years

9.2.5 Warning Time

There is currently no reliable way to predict the day or month that an earthquake will occur at any given location. Research is being done with warning systems that use the low energy waves that precede major earthquakes. These potential warning systems give approximately 40 seconds notice that a major earthquake is about to occur. The warning time is very short but it could allow for someone to get under a desk, step away from a hazardous material they are working with, or shut down a computer system.

9.3 SECONDARY IMPACTS

Earthquakes can cause large and sometimes disastrous landslides and mudslides. River valleys are vulnerable to slope failure, often as a result of loss of cohesion in clay-rich soils. Soil liquefaction occurs when water-saturated sands, silts or gravelly soils are shaken so violently that the individual grains lose contact with one another and float freely in the water, turning the ground into a pudding-like liquid. Building and road foundations lose load-bearing strength and may sink into what was previously solid ground. Unless properly secured, hazardous materials can be released, causing significant damage to the environment and people. Earthen dams and levees are highly susceptible to seismic events and the impacts of their eventual failures can be considered secondary risks for earthquakes.

Earthquakes can also trigger tsunamis. Tsunamis significantly damage many locations beyond where the earthquake struck. Coastal communities near the earthquake epicenter that are also vulnerable to tsunamis could experience devastating impacts. Additionally, fires can result from gas lines or power lines that are broken or downed during the earthquake. It may be difficult to control a fire, particularly if the water lines feeding fire hydrants are also broken.

9.4 EXPOSURE

9.4.1 Population

The entire population of the planning area is potentially exposed to direct and indirect impacts from earthquakes. Whether directly impacted or indirectly impacted, the entire population will have to deal with the consequences of earthquakes to some degree. Business interruption could keep people from working, road closures could isolate populations, and loss of functions of utilities could impact populations that suffered no direct damage from an event itself.

9.4.2 Property

According to assessor records, there are 746,352 buildings in the planning area, with a total replacement value of $767.9 billion. Since all structures in the planning area are susceptible to earthquake impacts to varying degrees, this total represents the property exposure to seismic events. Table 9-8 shows the exposure value breakdown by Area Planning Commission.

9.4.3 Critical Facilities and Infrastructure

All critical facilities in the planning area are exposed to the earthquake hazard. Table 4-5 lists the number of each type of facility in the planning area. Facilities holding hazardous materials are of particular concern because of possible isolation of neighborhoods surrounding them. Hazardous materials releases can occur during an earthquake from fixed facilities or transportation-related incidents. During an earthquake, structures storing these materials could rupture and leak into the surrounding area or an adjacent waterway, having a disastrous effect on the environment. Transportation corridors can be disrupted during an earthquake, leading to the release of materials to the surrounding environment.

Table 9-8. Earthquake Exposure by Area Planning Commission

Area Planning Commission	Total # of Buildings	Total Building Value—Structure and Contents
Central	84,429	$191,217,052,041
East Los Angeles	72,052	$66,257,497,608
Harbor	39,749	$40,999,775,796
North Valley	151,060	$115,609,300,175
South Los Angeles	112,787	$98,455,728,673
South Valley	173,423	$145,505,548,380
West Los Angeles	112,852	$109,858,703,574
Total	**746,352**	**$767,903,606,246**

9.4.4 Environment

Secondary hazards associated with earthquakes will likely have damaging effects on the environment. Earthquake-induced landslides can significantly impact surrounding habitat. It is also possible for streams to be rerouted after an earthquake. This can change the water quality, possibly damaging habitat and feeding areas. There is a possibility of streams fed by groundwater drying up because of changes in underlying geology.

9.5 VULNERABILITY

Earthquake vulnerability data was generated using a Level 2 Hazus analysis. Once the location and size of a hypothetical earthquake are identified, Hazus estimates the intensity of the ground shaking, the number of buildings damaged, the number of casualties, the damage to transportation systems and utilities, the number of people displaced from their homes, and the estimated cost of repair and clean up.

9.5.1 Population

The degree of vulnerability of people exposed to the earthquake hazard is dependent on many factors, including the age and construction type of the structures they live in, the soil type their homes are constructed on, their proximity to fault location, etc. There are estimated to be 1,189,384 people in over 428,992 households living on soils with liquefaction potential in the planning area. This is about 77 percent of the total population. Three population groups are particularly vulnerable to earthquake hazards:

- **Population Below Poverty Level**—An estimated 209,133 households in areas with liquefaction potential soils have household incomes less than $50,000 per year. This is about 49 percent of all households located on liquefaction potential soils. These households may lack the financial resources to improve their homes to prevent or mitigate earthquake damage. Economically disadvantaged residents are also less likely to have insurance to compensate for losses in earthquakes.
- **Population Over 65 Years Old**—An estimated 123,376 residents in areas with liquefaction potential soils are over 65 years old. This is about 10 percent of all residents in these areas. This population group is vulnerable because they are more likely to need special medical attention, which may not be available due to isolation caused by earthquakes. Elderly residents also have more difficulty leaving their homes during earthquake events and could be stranded in dangerous situations.
- **Linguistically Isolated Populations**——Problems arise when there is an urgent need to inform non-English speaking residents of an earthquake event. They are vulnerable because of difficulties in understanding hazard-related information from predominantly English-speaking media and government agencies. No estimates have been developed of the number of linguistically isolated persons living in areas with liquefaction potential soils.

Impacts on persons and households in the planning area were estimated for the five scenario events through the Level 2 Hazus analysis. Table 9-9 summarizes the results.

Table 9-9. Estimated Earthquake Impact on Persons and Households

Earthquake Scenario	Number of Displaced Households	Number of Persons Requiring Short-Term Shelter
Newport-Inglewood	50,064	34,315
Palos Verde	13,015	9,193
Puente Hills	116,329	92,303
San Andreas	71,428	57,776
Santa Monica	93,572	55,283

9.5.2 Property

Building Age

Table 9-10 identifies significant milestones in building and seismic code requirements that directly affect the structural integrity of development. Using these time periods, the planning team used Hazus to identify the number of structures in the planning area by date of construction.

Table 9-10. Age of Structures in Planning Area

Time Period	Number of Current Planning Area Structures Built in Period	Significance of Time Frame
Pre-1933	120,497	Before 1933, there were no explicit earthquake requirements in building codes. State law did not require local governments to have building officials or issue building permits.
1933-1940	42,566	In 1940, the first strong motion recording was made.
1941-1960	250,943	In 1960, the Structural Engineers Association of California published guidelines on recommended earthquake provisions.
1961-1975	145,368	In 1975, significant improvements were made to lateral force requirements.
1976-1994	127,211	In 1994, the Uniform Building Code was amended to include provisions for seismic safety.
1994 – present	59,773	Seismic code is currently enforced.
Total	**746,358**	

The number of structures does not reflect the number of total housing units, as many multi-family units and attached housing units are reported as one structure. Approximately 8 percent of the planning area's structures were constructed after the Uniform Building Code was amended in 1994 to include seismic safety provisions. Approximately 16 percent were built before 1933 when there were no building permits, inspections, or seismic standards.

Loss Potential

Property losses were estimated through the Level 2 Hazus analysis for the five earthquake fault scenarios. Table 9-11 through Table 9-15 shows the results for damage to structures and damage to building contents.

Table 9-11. Loss Estimates for Newport-Inglewood Fault Scenario

Area Planning Commission	Estimated Loss Associated with Earthquake			% of Total Replacement Value
	Structure	Contents	**Total**	
Central	$8,241,730,263	$1,920,045,166	$10,161,775,428	5.3%
East Los Angeles	$1,305,221,209	$445,761,452	$1,750,982,661	2.6%
Harbor	$1,749,599,309	$531,934,262	$2,281,533,571	5.6%
North Valley	$867,454,730	$348,651,514	$1,216,106,244	1.1%
South Los Angeles	$7,569,043,634	$1,863,552,074	$9,432,595,708	9.6%
South Valley	$1,999,692,385	$636,853,477	$2,636,545,861	1.8%
West Los Angeles	$6,648,152,056	$1,651,233,193	$8,299,385,249	7.6%
Total	**$28,380,893,585**	**$7,398,031,139**	**$35,778,924,723**	**4.7%**

Table 9-12. Loss Estimates for Palos Verde Fault Scenario

Area Planning Commission	Estimated Loss Associated with Earthquake			% of Total Replacement Value
	Structure	Contents	**Total**	
Central	$1,964,015,648	$697,062,972	$2,661,078,620	1.4%
East Los Angeles	$500,900,960	$213,829,877	$714,730,836	1.1%
Harbor	$3,135,433,765	$960,807,399	$4,096,241,164	10.0%
North Valley	$571,011,942	$249,616,280	$820,628,222	0.7%
South Los Angeles	$1,290,293,580	$408,926,868	$1,699,220,448	1.7%
South Valley	$1,177,185,021	$439,600,127	$1,616,785,148	1.1%
West Los Angeles	$2,849,929,987	$779,747,585	$3,629,677,572	3.3%
Total	**$11,488,770,903**	**$3,749,591,107**	**$15,238,362,010**	**2.0%**

Table 9-13. Loss Estimates for Puente Hills Fault Scenario

Area Planning Commission	Estimated Loss Associated with Earthquake			% of Total Replacement Value
	Structure	Contents	**Total**	
Central	$30,232,804,494	$7,858,974,294	$38,091,778,788	19.9%
East Los Angeles	$10,319,509,533	$3,332,567,416	$13,652,076,949	20.6%
Harbor	$399,610,119	$139,106,363	$538,716,483	1.3%
North Valley	$1,503,231,885	$500,450,267	$2,003,682,153	1.7%
South Los Angeles	$13,651,437,366	$3,934,772,239	$17,586,209,605	17.9%
South Valley	$2,326,598,180	$675,458,539	$3,002,056,719	2.1%
West Los Angeles	$3,041,456,855	$784,733,477	$3,826,190,332	3.5%
Total	**$61,474,648,432**	**$17,226,062,595**	**$78,700,711,027**	**10.2%**

Table 9-14. Loss Estimates for San Andreas Fault Scenario

Area Planning Commission	Estimated Loss Associated with Earthquake			% of Total Replacement Value
	Structure	Contents	**Total**	

Area Planning Commission	Estimated Loss Associated with Earthquake			% of Total Replacement Value
	Structure	Contents	Total	
Central	$9,333,230,996	$1,900,962,563	$11,234,193,560	5.9%
East Los Angeles	$3,737,577,115	$1,029,274,178	$4,766,851,293	7.2%
Harbor	$556,079,154	$158,953,374	$715,032,528	1.7%
North Valley	$9,511,961,668	$3,300,449,662	$12,812,411,330	11.1%
South Los Angeles	$8,315,518,426	$2,268,565,184	$10,584,083,611	10.8%
South Valley	$7,524,900,766	$2,045,858,489	$9,570,759,256	6.6%
West Los Angeles	$1,420,912,516	$257,007,998	$1,677,920,514	1.5%
Total	**$40,400,180,642**	**$10,961,071,449**	**$51,361,252,091**	**6.7%**

Table 9-15. Loss Estimates for Santa Monica Fault Scenario

Area Planning Commission	Estimated Loss Associated with Earthquake			% of Total Replacement Value
	Structure	Contents	Total	
Central	$13,967,469,958	$3,164,742,973	$17,132,212,930	9.0%
East Los Angeles	$2,660,404,526	$812,956,065	$3,473,360,591	5.2%
Harbor	$128,768,156	$63,755,338	$192,523,494	0.5%
North Valley	$2,419,071,907	$784,598,527	$3,203,670,434	2.8%
South Los Angeles	$2,728,171,717	$659,059,936	$3,387,231,653	3.4%
South Valley	$8,674,190,206	$2,303,452,116	$10,977,642,322	7.5%
West Los Angeles	$8,811,852,451	$2,234,256,872	$11,046,109,324	10.1%
Total	**$39,389,928,921**	**$10,022,821,827**	**$49,412,750,748**	**6.4%**

A summary of the property-related loss results is as follows:

- For the Newport-Inglewood Fault Scenario, the estimated damage potential is $35.8 billion, or 4.66 percent of the total replacement value for the planning area.
- For the Palos Verde Fault Scenario, the estimated damage potential is $15.3 billion, or 1.98 percent of the total replacement value for the planning area.
- For the Puente Hills Fault Scenario, the estimated damage potential is $78.7 billion, or 10.25 percent of the total replacement value for the planning area.
- For the San Andreas Fault Scenario, the estimated damage potential is $51.4 billion, or 6.69 percent of the total replacement value for the planning area.
- For the Santa Monica Fault Scenario, the estimated damage potential is $49.4 billion, or 6.43 percent of the total replacement value for the planning area.

The Hazus analysis also estimated the amount of earthquake-caused debris in the planning area for the five scenario events, as summarized in Table 9-16.

Table 9-16. Estimated Earthquake-Caused Debris

	Debris to Be Removed (tons)
Newport-Inglewood	12,233
Palos Verde	3,941
Puente Hills	28,158
San Andreas	21,037
Santa Monica	16,181

9.5.3 Critical Facilities and Infrastructure

Level of Damage

Hazus classifies the vulnerability of critical facilities to earthquake as no damage, slight damage, moderate damage, extensive damage, or complete damage. The model was used to assign a category to each critical facility in the planning area for the five earthquake fault scenarios. Table 9-17 through Table 9-21 summarize the results.

Time to Return to Functionality

Hazus estimates the time to restore critical facilities to fully functional use. Results are presented as probability of being functional at specified time increments: 1, 3, 7, 14, 30 and 90 days after the event. For example, Hazus may estimate that a facility has 5 percent chance of being fully functional at Day 3, and a 95-percent chance of being fully functional at Day 90. The analysis of critical facilities in the planning area was performed for the five scenario events assessed. Table 9-22 and Table 9-26 summarize the results.

9.5.4 Environment

The environment vulnerable to earthquake hazard is the same as the environment exposed to the hazard.

Table 9-17. Estimated Number of Critical Facilities Damaged, by Damage Level—Newport/Inglewood Scenario

Category	# of Critical Facilities	Number of Buildings with 50% or Greater Probability of Achieving Damage Level				
		None	Slight	Moderate	Extensive	Complete
Critical Operating Facilities	20	3	11	6	0	0
Critical Response Facilities						
Evacuation Centers / Debris Removal	9	3	4	1	1	0
Fire	73	18	28	15	12	0
Medical	33	29	4	0	0	0
Police	17	3	6	4	4	0
Schools	847	447	97	190	113	0
Critical Infrastructure—Transportation						
Airports	2	2	0	0	0	0
Bridges	841	841	0	0	0	0
Bus Systems	19	5	8	6	0	0
Light Rail	29	4	21	4	0	0
Port / Harbor	20	6	13	1	0	0
Railroads	7	6	1	0	0	0
Critical Infrastructure—Utilities						
Communications	28	1	1	19	5	2
Electric Power	9	2	4	3	0	0
Hazardous Materials	294	77	124	61	32	0
Petroleum & Natural Gas	58	7	19	22	10	0
Potable Water	31	11	7	9	4	0
Waste Water	85	7	48	22	8	0
Overall	**2,422**	**1,472**	**396**	**363**	**189**	**2**

Table 9-18. Estimated Number of Critical Facilities Damaged, by Damage Level—Palos Verdes Scenario

Category	# of Critical Facilities	Number of Buildings with 50% or Greater Probability of Achieving Damage Level				
		None	Slight	Moderate	Extensive	Complete
Critical Operating Facilities	20	12	7	1	0	0
Critical Response Facilities						
Evacuation Centers / Debris Removal	9	3	4	1	1	0
Fire	73	55	11	2	5	0
Medical	33	33	0	0	0	0
Police	17	15	2	0	0	0
Schools	847	748	49	25	25	0
Critical Infrastructure—Transportation						
Airports	2	2	0	0	0	0
Bridges	841	841	0	0	0	0
Bus Systems	19	17	2	0	0	0
Light Rail	29	24	0	5	0	0
Port / Harbor	20	0	0	20	0	0
Railroads	7	7	0	0	0	0
Critical Infrastructure—Utilities						
Communications	28	8	10	7	3	0
Electric Power	9	5	0	1	2	1
Hazardous Materials	294	220	38	25	11	0
Petroleum & Natural Gas	58	16	2	11	28	1
Potable Water	31	17	6	5	3	0
Waste Water	85	18	12	36	19	0
Overall	**2,422**	**2041**	**143**	**139**	**97**	**2**

Table 9-19. Estimated Number of Critical Facilities Damaged, by Damage Level—Puente Hills Scenario

Category	# of Critical Facilities	Number of Buildings with 50% or Greater Probability of Achieving Damage Level				
		None	Slight	Moderate	Extensive	Complete
Critical Operating Facilities	20	4	3	6	7	0
Critical Response Facilities						
Evacuation Centers / Debris Removal	9	2	3	3	1	0
Fire	73	16	13	13	27	4
Medical	33	15	12	6	0	0
Police	17	2	2	3	9	1
Schools	847	311	88	113	334	1
Critical Infrastructure—Transportation						
Airports	2	1	1	0	0	0
Bridges	841	841	0	0	0	0
Bus Systems	19	3	8	6	2	0
Light Rail	29	5	3	15	6	0
Port / Harbor	20	19	1	0	0	0
Railroads	7	3	2	1	1	0
Critical Infrastructure—Utilities						
Communications	28	1	2	9	4	12
Electric Power	9	1	6	1	0	1
Hazardous Materials	294	79	69	33	113	0
Petroleum & Natural Gas	58	25	24	1	8	0
Potable Water	31	11	7	5	8	0
Waste Water	85	32	40	5	8	0
Overall	**2,422**	**1371**	**284**	**220**	**528**	**19**

Table 9-20. Estimated Number of Critical Facilities Damaged, by Damage Level—San Andreas Scenario

Category	# of Critical Facilities	Number of Buildings with 50% or Greater Probability of Achieving Damage Level				
		None	Slight	Moderate	Extensive	Complete
Critical Operating Facilities	20	6	6	7	1	0
Critical Response Facilities						
Evacuation Centers / Debris Removal	9	4	1	2	2	0
Fire	73	22	14	23	5	9
Medical	33	33	0	0	0	0
Police	17	2	3	8	3	1
Schools	847	363	142	166	153	23
Critical Infrastructure—Transportation						
Airports	2	1	1	0	0	0
Bridges	841	841	0	0	0	0
Bus Systems	19	1	8	8	2	0
Light Rail	29	8	9	12	0	0
Port / Harbor	20	19	1	0	0	0
Railroads	7	0	4	2	1	0
Critical Infrastructure—Utilities						
Communications	28	3	1	2	20	2
Electric Power	9	1	3	1	3	1
Hazardous Materials	294	1	2	86	174	31
Petroleum & Natural Gas	58	37	11	6	3	1
Potable Water	31	14	3	9	3	2
Waste Water	85	57	10	15	3	0
Overall	**2,422**	**1413**	**219**	**347**	**373**	**70**

Table 9-21. Estimated Number of Critical Facilities Damaged, by Damage Level—Santa Monica Scenario

Category	# of Critical Facilities	Number of Buildings with 50% or Greater Probability of Achieving Damage Level				
		None	Slight	Moderate	Extensive	Complete
Critical Operating Facilities	20	4	5	11	0	0
Critical Response Facilities						
Evacuation Centers / Debris Removal	9	3	3	3	0	0
Fire	73	10	22	13	28	0
Medical	33	19	14	0	0	0
Police	17	1	5	6	5	0
Schools	847	257	205	209	176	0
Critical Infrastructure—Transportation						
Airports	2	0	1	1	0	0
Bridges	841	841	0	0	0	0
Bus Systems	19	4	9	6	0	0
Light Rail	29	8	13	8	0	0
Port / Harbor	20	20	0	0	0	0
Railroads	7	3	4	0	0	0
Critical Infrastructure—Utilities						
Communications	28	4	0	15	6	3
Electric Power	9	3	1	3	2	0
Hazardous Materials	294	68	113	69	44	0
Petroleum & Natural Gas	58	32	11	11	4	0
Potable Water	31	11	7	3	9	1
Waste Water	85	21	15	15	28	6
Overall	**2,422**	**1309**	**428**	**373**	**302**	**10**

Table 9-22. Functionality of Critical Facilities—Newport/Inglewood Scenario

Category	Probability of Being Fully Functional (%)					
	at Day 1	at Day 3	at Day 7	at Day 14	at Day 30	at Day 90
Critical Operating Facilities	32.9	33.7	66.5	67.4	94.8	95.9
Critical Response Facilities						
Evacuation Centers / Debris Removal	36.0	37.5	66.5	66.6	87.6	96.2
Fire	32.5	32.9	51.8	52.3	80.7	88.4
Medical	71.0	71.5	93.4	94.0	98.0	98.2
Police	28.3	28.8	47.4	47.9	78.3	87.0
Schools	47.0	47.4	62.0	62.4	84.0	90.2
Critical Infrastructure—Transportation						
Airports	79.7	81.8	82.7	83.1	84.1	88.6
Bridges	94.3	96.1	97.3	97.5	97.7	98.6
Bus Systems	76.4	87.8	91.8	92.1	92.8	95.7
Light Rail	80.9	92.1	95.9	96.1	96.4	97.8
Port / Harbor	86.4	92.6	94.8	94.9	95.2	96.4
Railroads	96.2	98.1	98.8	98.8	98.8	99.2
Critical Infrastructure—Utilities						
Communications	50.4	71.7	78.4	87.6	93.2	98.7
Electric Power	44.9	69.6	89.9	96.1	97.8	99.9
Hazardous Materials	32.5	33.5	54.3	54.4	85.3	96.2
Petroleum & Natural Gas	42.7	54.8	64.5	77.8	88.4	98.2
Potable Water	56.2	74.7	83.0	85.6	89.8	97.5
Waste Water	40.7	66.8	81.5	83.4	89.0	98.4
Overall	**57.2**	**65.1**	**77.8**	**79.9**	**90.7**	**95.6**

Table 9-23. Functionality of Critical Facilities—Palos Verdes Scenario

Category	Probability of Being Fully Functional (%)					
	at Day 1	at Day 3	at Day 7	at Day 14	at Day 30	at Day 90
Critical Operating Facilities	58.5	59.1	85.6	86.3	97.0	98.1
Critical Response Facilities						
Evacuation Centers / Debris Removal	65.6	66.7	87.7	87.8	97.7	98.7
Fire	61.9	62.3	79.4	79.9	93.2	95.6
Medical	90.9	91.1	98.8	98.9	99.2	99.2
Police	68.4	68.8	87.2	87.7	98.5	98.9
Schools	76.5	76.8	88.0	88.3	95.9	97.3
Critical Infrastructure—Transportation						
Airports	88.4	89.0	89.3	89.5	89.9	92.1
Bridges	98.8	99.3	99.5	99.6	99.6	99.7
Bus Systems	96.2	97.6	98.2	98.2	98.3	98.7
Light Rail	89.2	94.7	96.5	96.7	96.9	98.1
Port / Harbor	45.4	73.1	82.6	83.2	84.7	91.0
Railroads	99.4	99.7	99.8	99.8	99.8	99.8
Critical Infrastructure—Utilities						
Communications	71.5	87.4	90.7	94.9	97.4	99.5
Electric Power	50.8	64.5	79.5	89.4	94.0	99.9
Hazardous Materials	57.5	58.5	78.4	78.4	95.0	98.7
Petroleum & Natural Gas	39.0	46.7	54.4	65.5	77.5	95.7
Potable Water	68.7	82.0	88.1	90.3	93.6	98.3
Waste Water	31.5	55.4	71.9	75.0	84.4	97.8
Overall	**69.9**	**76.2**	**86.4**	**88.3**	**94.0**	**97.6**

Table 9-24. Functionality of Critical Facilities—Puente Hills Scenario

Category	Probability of Being Fully Functional (%)					
	at Day 1	at Day 3	at Day 7	at Day 14	at Day 30	at Day 90
Critical Operating Facilities	21.5	21.8	34.5	34.9	67.6	79.4
Critical Response Facilities						
Evacuation Centers / Debris Removal	22.4	23.7	50.5	50.6	83.7	94.2
Fire	22.4	22.7	35.2	35.5	56.6	69.3
Medical	42.2	42.9	74.3	75.1	95.6	96.2
Police	13.4	13.6	22.2	22.4	40.6	57.4
Schools	33.5	33.8	44.9	45.2	64.3	76.5
Critical Infrastructure—Transportation						
Airports	75.8	81.1	83.0	83.3	84.2	88.3
Bridges	86.6	89.3	90.8	91.1	91.5	94.0
Bus Systems	62.8	78.5	84.0	84.6	86.3	93.2
Light Rail	47.1	67.6	74.9	76.0	78.8	90.5
Port / Harbor	98.8	99.4	99.6	99.6	99.6	99.7
Railroads	76.5	84.6	87.5	87.9	89.1	93.9
Critical Infrastructure—Utilities						
Communications	37.9	51.6	59.1	70.4	79.7	96.4
Electric Power	48.8	72.6	89.1	93.8	96.5	99.9
Hazardous Materials	26.7	27.5	42.4	42.5	63.3	84.6
Petroleum & Natural Gas	64.1	75.2	80.3	86.7	91.8	97.8
Potable Water	48.9	64.6	73.6	76.8	81.7	92.6
Waste Water	54.2	75.1	84.8	86.1	90.3	98.6
Overall	**49.1**	**57.0**	**67.3**	**69.0**	**80.1**	**89.0**

Table 9-25. Functionality of Critical Facilities—San Andreas Scenario

Category	Probability of Being Fully Functional (%)					
	at Day 1	at Day 3	at Day 7	at Day 14	at Day 30	at Day 90
Critical Operating Facilities	34.4	35.0	59.1	59.8	89.5	93.7
Critical Response Facilities						
Evacuation Centers / Debris Removal	33.0	34.0	53.8	53.8	73.3	93.4
Fire	28.7	29.1	43.8	44.2	71.1	80.7
Medical	80.4	80.9	98.3	98.7	99.8	99.8
Police	16.6	16.9	33.2	33.7	67.8	79.7
Schools	39.5	39.8	54.6	55.0	78.5	86.0
Critical Infrastructure—Transportation						
Airports	88.6	96.8	99.6	99.6	99.6	99.8
Bridges	92.2	94.4	95.5	95.7	95.9	97.4
Bus Systems	62.8	81.0	87.3	87.8	89.2	94.8
Light Rail	75.2	89.6	94.5	94.8	95.4	97.9
Port / Harbor	98.0	99.4	99.9	99.9	99.9	99.9
Railroads	59.7	78.0	84.4	85.1	86.8	93.9
Critical Infrastructure—Utilities						
Communications	40.4	55.8	65.8	80.9	89.9	98.2
Electric Power	36.1	54.0	75.8	89.8	94.4	99.9
Hazardous Materials	1.8	2.0	6.0	6.1	32.7	76.2
Petroleum & Natural Gas	68.2	78.5	83.4	90.0	94.9	99.3
Potable Water	53.3	69.5	78.9	82.9	88.8	96.7
Waste Water	62.0	79.6	89.0	90.6	95.3	99.5
Overall	**53.9**	**61.9**	**72.4**	**74.9**	**85.7**	**93.7**

Table 9-26. Functionality of Critical Facilities—Santa Monica Scenario

Category	Probability of Being Fully Functional (%)					
	at Day 1	at Day 3	at Day 7	at Day 14	at Day 30	at Day 90
Critical Operating Facilities	23.7	24.3	50.8	51.5	89.7	93.0
Critical Response Facilities						
Evacuation Centers / Debris Removal	34.2	35.2	55.8	55.9	87.4	96.5
Fire	21.8	22.1	36.2	36.6	63.6	76.4
Medical	52.7	53.6	88.2	89.1	96.6	96.8
Police	16.3	16.7	33.0	33.4	67.6	79.7
Schools	33.6	34.0	49.6	50.0	76.4	85.2
Critical Infrastructure—Transportation						
Airports	54.6	69.8	75.1	75.6	76.7	82.1
Bridges	92.2	93.9	94.7	94.8	95.0	96.3
Bus Systems	70.6	84.9	89.9	90.2	91.1	94.8
Light Rail	75.7	89.8	94.6	94.8	95.4	97.7
Port / Harbor	99.9	99.9	99.9	99.9	99.9	99.9
Railroads	84.0	94.2	97.6	97.6	97.8	98.4
Critical Infrastructure—Utilities						
Communications	43.8	61.8	70.2	82.6	90.2	98.2
Electric Power	48.2	67.5	87.3	96.2	98.0	99.9
Hazardous Materials	31.8	32.8	51.7	51.8	82.9	96.0
Petroleum & Natural Gas	70.8	79.2	84.0	90.2	95.2	99.3
Potable Water	51.7	68.3	76.7	80.9	87.9	96.6
Waste Water	37.1	53.8	66.4	70.1	81.9	97.7
Overall	**52.4**	**60.1**	**72.3**	**74.5**	**87.4**	**93.6**

9.6 FUTURE TRENDS IN DEVELOPMENT

The City of Los Angeles will strictly enforce all seismic building codes and design standards to prevent loss of life and property from earthquakes. Public education, cooperation with the development community, and individual preparedness are essential.

The City has a General Plan with policies directing land use and dealing with issues of geologic and seismic safety. This plan provides the capability to protect future development from the impacts of earthquakes. Deficiencies identified by development reviews can be identified as mitigation actions to increase the capability to deal with future trends in development.

Since all of the planning area is located within earthquake hazard zones, all future development will, to some extent, be exposed to the earthquake hazard.

9.7 SCENARIO

With the abundance of fault exposure in southern California, the potential scenarios for earthquake activity are many. An earthquake does not have to occur within the planning area to have a significant impact on the people, property and economy of the planning area.

Any seismic activity of 6.0 or greater on faults within the planning area would have significant impacts throughout the planning area. Potential warning systems could give approximately 40 seconds notice that a major earthquake is about to occur. This would not provide adequate time for preparation. Earthquakes of this magnitude or higher would lead to massive structural failure of property on NEHRP C, D, E, and F soils. Levees and revetments built on these poor soils would likely fail, representing a loss of critical infrastructure. These events could cause secondary impacts, including landslides and mudslides that would further damage structures. River valley hydraulic-fill sediment areas are also vulnerable to slope failure, often as a result of loss of cohesion in clay-rich soils. Soil liquefaction would occur in water-saturated sands, silts or gravelly soils.

9.8 ISSUES

Important issues associated with an earthquake include the following:

- More than 74 percent of the planning area’s building stock was built prior to 1975, when seismic provisions became uniformly applied through building code applications.
- Based on the modeling of critical facility performance performed for this plan, a high number of facilities in the planning area are expected to have complete or extensive damage from scenario events. These facilities are prime targets for structural retrofits.
- Critical facility owner should be encouraged to create or enhance continuity of operations plans using the information on risk and vulnerability contained in this plan.
- Geotechnical standards should be established that take into account the probable impacts from earthquakes in the design and construction of new or enhanced facilities.
- There are a large number of earthen dams within the planning area. Dam failure warning and evacuation plans and procedures should be reviewed and updated to reflect the dams’ risk potential associated with earthquake activity in the region.
- Earthquakes could trigger other natural hazard events such as dam failures and landslides, which could severely impact the planning area.
- A worst-case scenario would be the occurrence of a large seismic event during a flood or high-water event. Levee failures would happen at multiple locations, increasing the impacts of the individual events.

10. FLOOD

10.1 GENERAL BACKGROUND

A floodplain is the area adjacent to a river, creek or lake that becomes inundated during a flood. Floodplains may be broad, as when a river crosses an extensive flat landscape, or narrow, as when a river is confined in a canyon.

When floodwaters recede after a flood event, they leave behind layers of rock and mud. These gradually build up to create a new floor of the floodplain. Floodplains generally contain unconsolidated sediments (accumulations of sand, gravel, loam, silt, and/or clay), often extending below the bed of the stream. These sediments provide a natural filtering system, with water percolating back into the ground and replenishing groundwater. These are often important aquifers, the water drawn from them being filtered compared to the water in the stream. Fertile, flat reclaimed floodplain lands are commonly used for agriculture, commerce and residential development.

Connections between a river and its floodplain are most apparent during and after major flood events. These areas form a complex physical and biological system that not only supports a variety of natural resources but also provides natural flood and erosion control. When a river is separated from its floodplain with levees and other flood control facilities, natural, built-in benefits can be lost, altered, or significantly reduced.

DEFINITIONS

Flood—The inundation of normally dry land resulting from the rising and overflowing of a body of water.

Floodplain—The land area along the sides of a river that becomes inundated with water during a flood.

Flood Control System—A system of open channels, flood control basins, storm drains, catch basins, culverts, low-flow diversion structures, pump stations, debris basins, detention basins, and spreading grounds developed to protect the citizens of Los Angeles from flooding.

1-Percent-Annual-Chance (100-Year) Floodplain—The area flooded by the flood that has a 1-percent chance of being equaled or exceeded in a given year. The 1-percent-annual-chance flood is the standard used by most federal and state agencies.

0.2-Percent-Annual-Chance (500-Year) Floodplain—The area flooded by the flood that has a 0.2-percent chance of being equaled or exceeded in a given year.

Regulatory Floodway—Channel of a river or other water course and adjacent land areas that must be reserved for discharge of the base flood without cumulatively increasing water surface elevation more than a designated height. Communities must regulate development in these floodways to ensure no increases in upstream flood elevations.

Return Period—The average number of years between occurrences of a hazard (equal to the inverse of the annual likelihood of occurrence).

Riparian Area—The area along the banks of a natural watercourse.

10.1.1 Measuring Floods and Floodplains

The frequency and severity of flooding are measured using a discharge probability, which is the probability that a certain river discharge (flow) level will be equaled or exceeded in a given year. Flood studies use historical records to determine the probability of occurrence for the different discharge levels. The flood frequency equals 100 divided by the discharge probability. For example, the 100-year discharge has a 1-percent chance of being equaled or exceeded in any given year. The “annual flood” is the greatest flood event expected to occur in a typical year. These measurements reflect statistical averages only; it is possible for two or more floods with a 100-year or higher recurrence interval to occur in a short time period. The same flood can have different recurrence intervals at different points on a river.

The extent of flooding associated with a 1-percent annual probability of occurrence (the base flood or 100-year flood) is used as the regulatory boundary by many agencies. Also referred to as the special flood hazard area (SFHA), this boundary is a convenient tool for assessing vulnerability and risk in flood-prone communities. Many communities have maps that show the extent and likely depth of flooding for the base flood. Corresponding water-surface elevations describe the elevation of water that will result from a given discharge level, which is one of the most important factors used in estimating flood damage.

10.1.2 Floodplain Ecosystems

Floodplains can support ecosystems that are rich in plant and animal species. A floodplain can contain 100 or even 1,000 times as many species as a river. Wetting of the floodplain soil releases an immediate surge of nutrients: those left over from the last flood, and those that result from the rapid decomposition of organic matter that has accumulated since then. Microscopic organisms thrive and larger species enter a rapid breeding cycle. Opportunistic feeders (particularly birds) move in to take advantage. The production of nutrients peaks and falls away quickly, but the surge of new growth endures for some time. This makes floodplains valuable for agriculture. Species growing in floodplains are markedly different from those that grow outside floodplains. For instance, riparian trees (trees that grow in floodplains) tend to be very tolerant of root disturbance and very quick-growing compared to non-riparian trees.

10.1.3 Effects of Human Activities

Because they border water bodies, floodplains have historically been popular sites to establish settlements. Human activities tend to concentrate in floodplains for a number of reasons: water is readily available; land is fertile and suitable for farming; transportation by water is easily accessible; and land is flatter and easier to develop. But human activity in floodplains frequently interferes with the natural function of floodplains. It can affect the distribution and timing of drainage, thereby increasing flood problems. Human development can create local flooding problems by altering or confining drainage channels. This increases flood potential in two ways: it reduces the stream's capacity to contain flows, and it increases flow rates or velocities downstream during all stages of a flood event. Human activities can interface effectively with a floodplain as long as steps are taken to mitigate the activities' adverse impacts on floodplain functions.

10.1.4 Federal Flood Programs

National Flood Insurance Program

The City of Los Angeles participates in the National Flood Insurance Program (NFIP) and has adopted regulations that meet the program's requirements. The City entered the NFIP in 1980; its first Flood Insurance Rate Map (FIRM) was issued February 12, 1980. Structures permitted or built in the City of Los Angeles before then are called "pre-FIRM" structures, and structures built afterwards are called "post-FIRM." The insurance rate is different for the two types of structures. The effective date for the current FIRM is September 26, 2008. Los Angeles is currently in good standing with the provisions of the NFIP. A detailed flood insurance study for the areas subject to flooding was originally completed on September 2, 1980, with updates in 1984, 1987, 1991, 1998, 1999 and 2008.

In California, the DWR is the coordinating agency for floodplain management. CA DWR works with FEMA and local governments by providing grants and technical assistance, evaluating community floodplain management programs, reviewing local floodplain ordinances, participating in statewide flood hazard mitigation planning, and facilitating annual statewide workshops. Compliance is monitored by FEMA regional staff and by CA DWR.

The Community Rating System

The City of Los Angeles has participated in the CRS program since 1991. The City has a Class 7 rating, so residents who live in a 1-percent-annual-chance floodplain can receive a 15-percent discount on their flood insurance; outside the 1-percent-annual-chance floodplain they receive a 5-percent discount. This equates to a savings ranging from $58 to $475 per policy, for a total citywide premium savings of almost $770,000 (CA DWR, 2013). To maintain or improve its rating, the City goes through an annual recertification and a re-verification every five years.

10.2 HAZARD PROFILE

10.2.1 Flood Types and Areas in City of Los Angeles

Flooding results from a diversity of factors; there is no single type of flood or single area most susceptible to flooding. The following sections describe the primary flood types and flood hazard areas in Los Angeles.

FEMA Special Flood Hazard Areas

SFHAs are defined in the September 26, 2008 DFIRM for Los Angeles County. These areas include the following:

- **Areas of Shallow Flooding—**Shallow flooding occurs in flat areas when there are depressions in the ground that collect ponds of water, areas of sloping land and areas of sheet flow where flood depths range from 1 to 3 feet.
- **Regulated Floodways—**The regulated floodway consists of a stream channel plus the portion of the overbanks that must be kept free from encroachment in order to convey the 1-percent annual chance flood without increasing flood levels.
- **Alluvial Fan Flooding—**An alluvial fan is a sedimentary deposit at a point where ground surface slope changes suddenly, such as the base of a mountain front, escarpment, or valley side. Sediments at these locations are deposited in the shape of a fan. Alluvial fan flooding occurs on the surface of these deposits and is characterized by uncertain flow paths.
- **Coastal Areas—**SFHAs along coasts are subject to inundation by the 1-percent annual chance flood with the additional hazards associated with storm waves.

Non-SFHA Hillside Areas

The City of Los Angeles has hillside areas (slopes of 6 percent or greater) that have not been mapped as SFHAs but are subject to flood hazards. These include water courses that may appropriately belong among the City's regulated water courses, as well as mud and debris flow areas that have yet to be mapped.

Non-SFHA Shallow Flooding Areas

Flooding records indicate non-hillside areas across the City that have experienced multiple occasions of shallow flooding. Such flooding may be caused by clogged or undersized drains, catch basins or water courses, or poor surface drainage patterns on streets or property.

Non-SFHA Urban Drainage Flood Areas

Pipes, roadside ditches, channels and roadways serve as drainage facilities in urbanized areas. Urban drainage flooding occurs when these conveyance systems lack the capacity to convey runoff to nearby creeks, streams and rivers. The key factors that contribute to urban drainage flooding are rainfall intensity and duration and the design and maintenance of drainage facilities. Topography, soil conditions, urbanization and groundcover also play important roles. Many portions of the City are subject to this type of flooding. This type of flooding is the predominant contributor to repetitive flood loss in the City.

Flash Flooding

Flash flooding is characterized by a quick rise and fall of water level. Flash floods generally result from intense storms dropping large amounts of rain within a short period of time onto watersheds that cannot absorb or slow the flow. Natural terrain and vegetation help to reduce the potential for flash floods, but flash flooding can occur when vegetation is lost due to wildfires and the ground becomes impervious due to extreme heat. Such events usually include deposition of large amounts of sediment transported from the denuded hillsides.

Non-SFHA Coast Areas

Coastal areas are susceptible to several flood hazards, regardless of whether they are within the SFHA:

- **Storm Surge Areas—**A storm surge occurs when the ocean level increases above the normal astronomical high tide due to wind, low barometric pressure, storms coinciding with astronomical high tide, or the configuration of the shoreline.
- **Coastal Erosion Areas—**Coastal erosion is generally associated with storm surges, hurricanes, windstorms, and flooding. It may be exacerbated by construction of seawalls, groins, jetties or navigation inlets, boat wakes, dredging and other interruption of physical processes.
- **Tsunami Hazard Areas—**Earthquakes, landslides on the ocean floor, and volcanic activity all have the potential to create large sea waves that can inundate coastal areas. The California coast has experienced about 80 tsunamis over the past 150 years, and four of these have caused fatalities.

Geologic Hazard Areas

Flooding is associated with geologic hazards in two ways:

- **Subsidence Areas—**Human activities such as underground mining, groundwater or oil withdrawal, or soil drainage can cause the ground to subside. This may occur gradually, resulting in greater flood potential due to lower land elevation, or suddenly, resulting in sinkholes and collapses that may damage buildings, roads and utilities.
- **Landslide Areas—**Floods and earthquakes can trigger landslides. The landslide risk can be exacerbated by human activities such as mining or the cut-and-fill construction of highways, buildings and railroads.

System-Failure-Related Flood Hazard Areas

Dam and Storage Tank Inundation Areas

The failure of water-holding dams and storage tanks can cause inundation of downstream properties. Dam owners submit inundation maps to California’s Office of Emergency Services that represent the best estimate of where water would flow if a dam failed completely and suddenly with a full reservoir.

Power-Failure-Induced Flooding Areas

Power-failure-induced flooding would result from a loss of power at the City’s stormwater pump stations that drain low-lying areas. The City operates and maintains 18 stormwater pumping plants. The Bureau of Sanitation maintains an updated inventory of the pumping plants with emergency generators. Most of the pumping plants have permanent backup power generators installed. For pumping plants that do not have permanent backup generators, portable generators located at the nearest District yards can be brought into service rapidly. Portable generators are strategically located at the six District yards (South, Harbor, North, Venice, West Los Angeles, and North Hollywood Districts).

Levee Failures

Levees are a basic means of providing flood protection along waterways in regions where development exists or is planned and in agricultural areas. Levees confine floodwaters to the main river channel or protect inland areas from high tides. Failure of a levee can lead to inundation of surrounding areas.

The causes of levee failures are structural failures, foundation failures of underlying soils, and overtopping by flood flows, tides and waves. Contributing factors include poor construction materials, erosion by current and wave action, seepage through or under the levee, burrowing rodents, and improper repairs. Seismic activity can impact levees as well, especially those constructed on the softer soils that are typical of floodplains. Lack of adequate and regular maintenance to correct these problems also contributes to levee failure. Most failures are composites of several of these factors.

There are 7.82 miles of levees in the City of Los Angeles that provide protection against floods of 25-year or greater magnitude. Fewer than half of these levee systems have been certified as meeting FEMA levee accreditation criteria. The Army Corps of Engineers has jurisdiction over 83 percent of the levee systems; the remainder are under the jurisdiction of the Los Angeles County Flood Control District.

10.2.2 Principal Flooding Sources

In southern California, most flooding is the result of heavy precipitation over one or two days. Short streams and steep watersheds emptying onto lowlands that may be heavily populated produce large volumes of water in short periods, and damage is often severe. The problem is sometimes compounded by the denuding of large areas of watershed by fire during the previous season (WRCC, 2014).

Four primary watersheds cover the City of Los Angeles: the Los Angeles River, the Santa Monica Bay, Ballona Creek and the Dominguez Channel. The Los Angeles River is the major watercourse that drains the San Gabriel Mountains. Its watershed covers a land area of over 834 square miles, including the eastern portions of the Santa Monica Mountains and portions of the San Gabriel Mountains in the west. The Los Angeles River is 51 miles long from its headwaters to its mouth, and 32 miles of the river is within the City of Los Angeles.

The Los Angeles River originates at the west end of the San Fernando Valley in the northwest corner of Los Angeles County. The river channel extends east to Glendale, where it turns and flows south to the Pacific Ocean. The Los Angeles River is part of a network of dams, reservoirs, debris collection basins, and spreading grounds built by the Los Angeles County Flood Control District and the U.S. Army Corps of Engineers to minimize flooding. The floodplain starts in the northeast part of the City of Los Angeles at the Arroyo Seco confluence and then passes through the cities of Los Angeles, Bell, Bell Gardens, South Gate, Lynwood, Lakewood, Paramount, Compton, Bellflower, Carson, Gardena and Long Beach on the way to its terminus at the Pacific Ocean.

10.2.3 Past Events

Federal Disaster Declarations

Los Angeles County has experienced 14 flooding events since 1969 for which federal disaster declarations were issued, as summarized in Table 10-1. Review of these events helps identify targets for risk reduction and ways to increase a community’s capability to avoid large-scale events in the future. Many flood events do not trigger federal disaster declaration protocol but have significant impacts on their communities. These events are also important to consider in establishing recurrence intervals for flooding. The sections below describe significant recent flood events in Los Angeles.

Table 10-1. History of Flood Events

Date	Declaration #	Type of event
1/18 – 1/23/2017	DR-4305	Severe winter storms, flooding, and mudslides
1/17 – 2/6/2010	DR-1884	Severe winter storms, flooding, and debris and mud flows
2/16 – 23/2005	DR-1585	Severe storms, flooding, landslides, and mud and debris flows
12/27/2004 – 1/11/2005	DR-1577	Severe storms, flooding, debris flows, and mudslides
2/2 – 4/30/1998	DR-1203	Severe winter storms, and flooding
2/13 – 4/19/1995	DR-1046	Severe winter storms, flooding landslides, mud flow
1/3 – 2/10/1995	DR-1044	Severe winter storms, flooding, landslides, mud flows
1/5 – 3/20/1993	DR-979	Severe winter storm, mud and landslides, and flooding
2/10-18/1992	DR-935	Rain/snow/wind storms, flooding, mudslides
1/17-22/1988	DR-812	Severe storms, high tides and flooding
1/21 – 3/30/1983	DR-677	Coastal storms, floods, slides and tornadoes
1/8/1980	DR-615	Severe storms, mudslides and flooding
2/15/1978	DR-547	Coastal storms, mudslides and flooding
1/26/1969	DR-253	Severe storms and flooding

Source: FEMA, 2017

January 18-23, 2017 Winter Storms

A series of storms pounded Southern California, including one that dropped nearly 2.5 inches of rain in 3 hours. It caused roads to be flooded, homes to be threatened by mudslides, and traffic to become clogged on many freeways and surface streets. According to the Los Angeles Department of Water and Power, at least 10,000 customers were without power.

January 18-22, 2010 Winter Storms

A series of storms brought heavy rain, gusty winds and flash flooding to Southern California. Rainfall totals ranged from 4 to 8 inches over coastal areas. Water was chest high in places, which stranded many vehicles and flooded numerous businesses.

2004-2005 Flooding Events

National Weather Service records show a total of 37.25 inches of rain at the downtown Los Angeles Civic Center during the rainy season of 2004-2005—the second highest recorded seasonal rainfall (the highest was 38.18 inches in 1883-1884). FEMA records indicate over 70 flood insurance claims filed by owners of structures within the city limits. The storms of January 7 – 11, 2005 and February 17 – 23, 2005 prompted state and federal disaster declarations, with flooding throughout southern California. Widespread mud and debris flows, rock slides, and small stream and urban flooding caused considerable damage to roads and homes. Significant damage was reported by the Bureau of Engineering, included the following:

- 25th Street was filled with debris. Cars were trapped when drivers misjudged the level of the water.
- Approximately 20,000 cubic yards from Tujunga Avenue north of Strathern Street washed out into an adjacent gravel pit, resulting in a hole about 200 feet long, 100 feet wide, and 30 feet deep.
- Homeowners were evacuated when Laurel Canyon and Coldwater Canyon experienced debris slides.

Approximately 80 homes in Los Angeles were red-tagged (no one was allowed back in). According to local newspaper accounts, nine people died, including two deaths caused by mud and rock slides and a City of Los Angeles employee who died responding to the Tujunga Avenue sinkhole.

2003-2004 Flooding Events

On November 12, 2003, 5.6 inches of rain fell during a 4-hour period over the Watts area of Los Angeles and portions of the City of Carson. According to the County of Los Angeles, the storm represented a 0.2-percent-annual-chance storm event. Runoff far exceeded the design capacity of the storm drain system. The Watts area is not a FEMA-designated 1-percent-annual-chance floodplain, so most property owners did not have flood insurance. According to the Los Angeles Department of Building and Safety, 496 buildings were affected and 57 were damaged—one building had structural damage and the others had content damage. Eight FEMA flood claims were reported within the City for other events during the 2003-2004 wet season, mostly along hillsides.

1997-1998 El Niño

Noteworthy storm incidents that occurred in Los Angeles due to the 1997-1998 El Niño include the following:

- October 1997—Hurricane Nora caused three deaths and caused extensive damage due to mudslides.
- February 6, 1998—Mud crashed into an apartment building in the Westlake area; more than 100 residents were evacuated.
- February 8, 1998—An ocean-eroded cliff in Malibu buckled, causing one home to collapse and threatening two others.
- February 13, 1998—A rain-soaked hillside collapsed in the Canoga Park area, forcing the evacuation of five homes and threatening several others.

10.2.4 Location

The September 26, 2008, Los Angeles County Digital Flood Insurance Rate Maps (DFIRMs) are FEMA's official delineation of SFHAs for the City of Los Angeles (see Figure 10-1 through Figure 10-7). Identified SFHAs include shallow flooding areas, floodways, alluvial fans, and coastal areas. They were determined using statistical analysis of records of river flow, storm tides, and rainfall; information obtained through consultation with the City of Los Angeles and the County of Los Angeles; floodplain topographic surveys; and hydrologic and hydraulic analyses. These maps are the basis for the exposure and vulnerability analyses presented in this chapter. They represent the best data available at the time of this analysis, but they are not representative of all identified sources of flood risk in Los Angeles. Extent and location mapping is not currently available for all flood hazard areas identified. Errors in the FEMA mapping were identified during the course of this project.

10.2.5 Frequency

The City of Los Angeles experienced significant flooding in 1914, 1916, 1927, 1934, 1938, 1941, 1943, 1952, 1956, 1969, 1978, 1980, 1983, 1993, 1995, 1998, 2005, 2010, and 2017. Large floods occur approximately every 5 to 6 years in the City. U.S. Geological Survey records indicate that 1-percent-annual-chance flood flow in the Los Angeles River Basin was exceeded at the Tujunga Canyon in March 1938 and Topanga and Malibu Creeks in January 1969. The January-February 1980 flooding was a 10- to 50- year recurrence event.

10.2.6 Severity

The magnitude of destruction from flooding in Los Angeles is enormous, especially as development in the floodplain has increased dramatically. The principal factors affecting flood damage are flood depth and velocity. The deeper and faster flood flows become, the more damage they can cause. Shallow flooding with high velocities can cause as much damage as deep flooding with slow velocity. This is especially true when a channel migrates over a broad floodplain, redirecting high velocity flows and transporting debris and sediment.

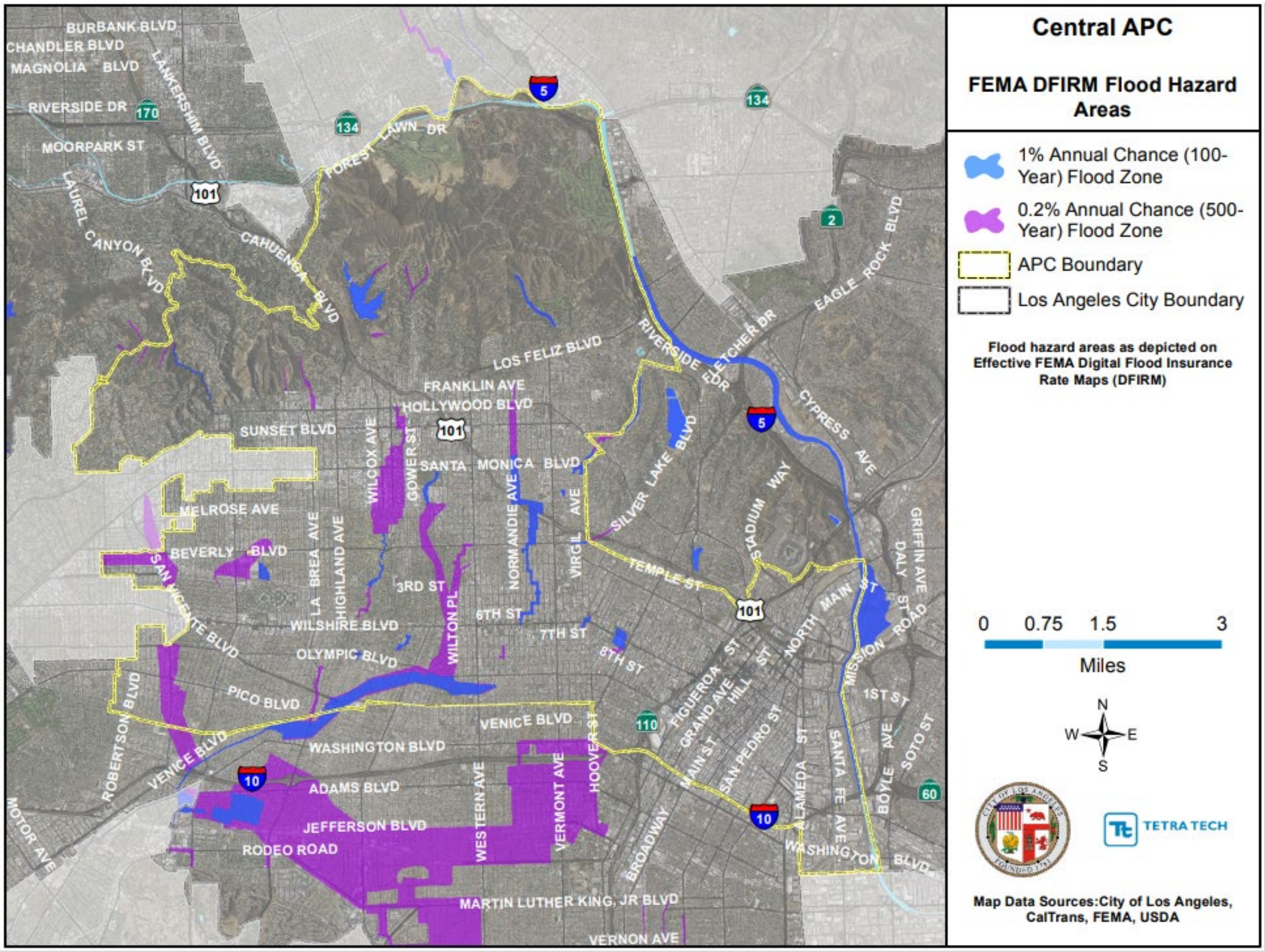


Figure 10-1. Mapped Flood Hazard Areas in Central APC

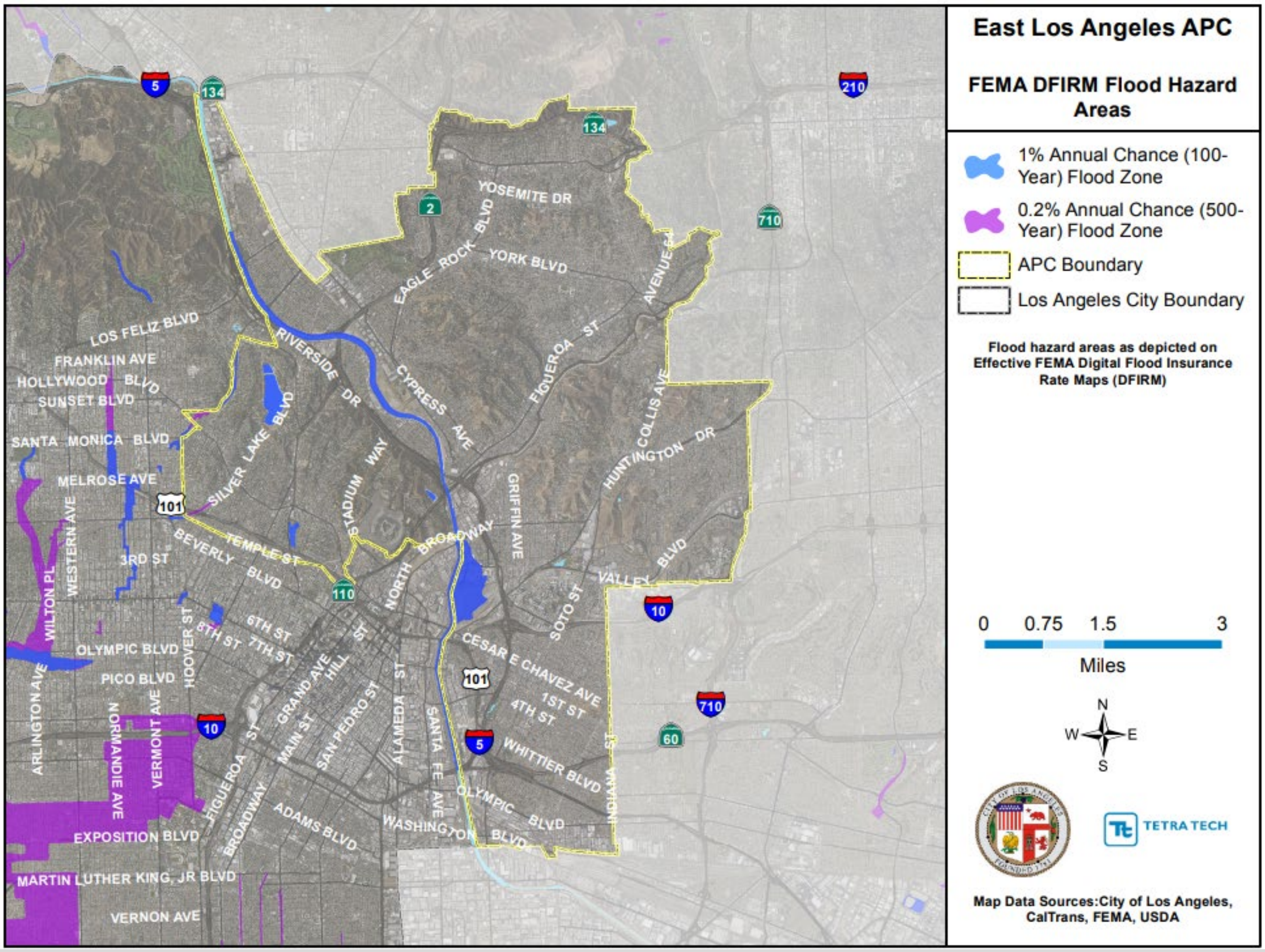


Figure 10-2. Mapped Flood Hazard Areas in East Los Angeles APC

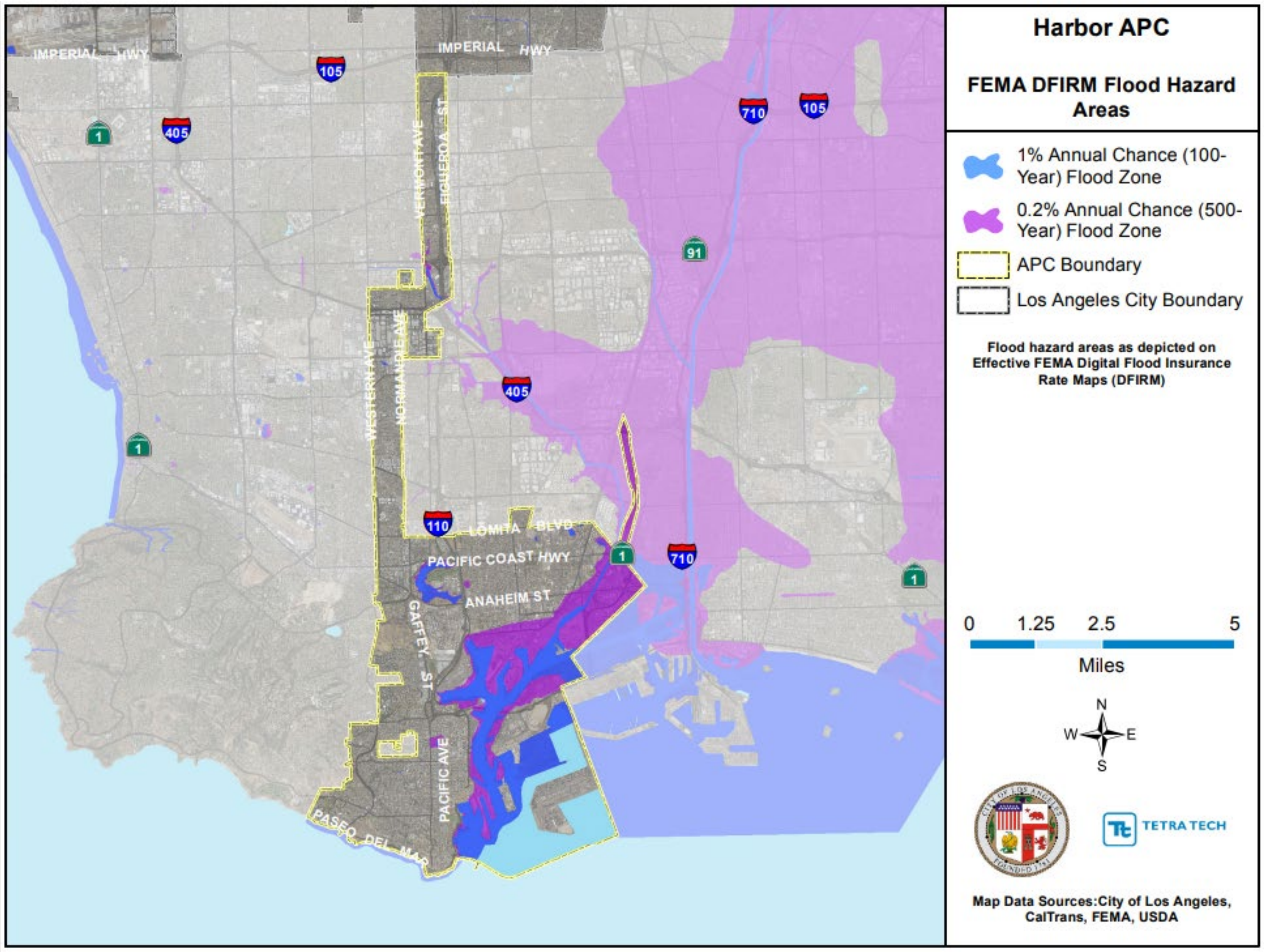


Figure 10-3. Mapped Flood Hazard Areas in Harbor APC

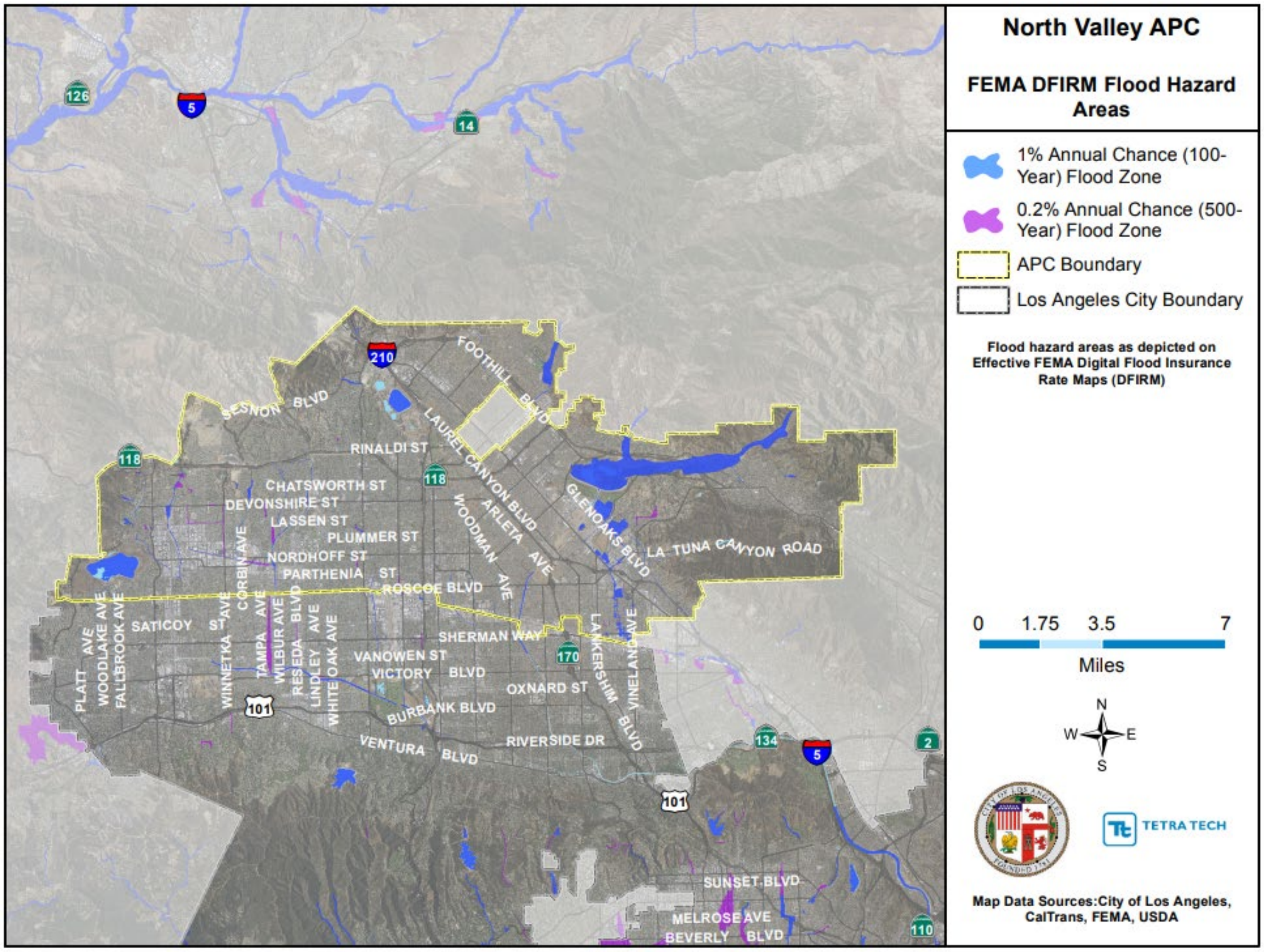


Figure 10-4. Mapped Flood Hazard Areas in North Valley APC

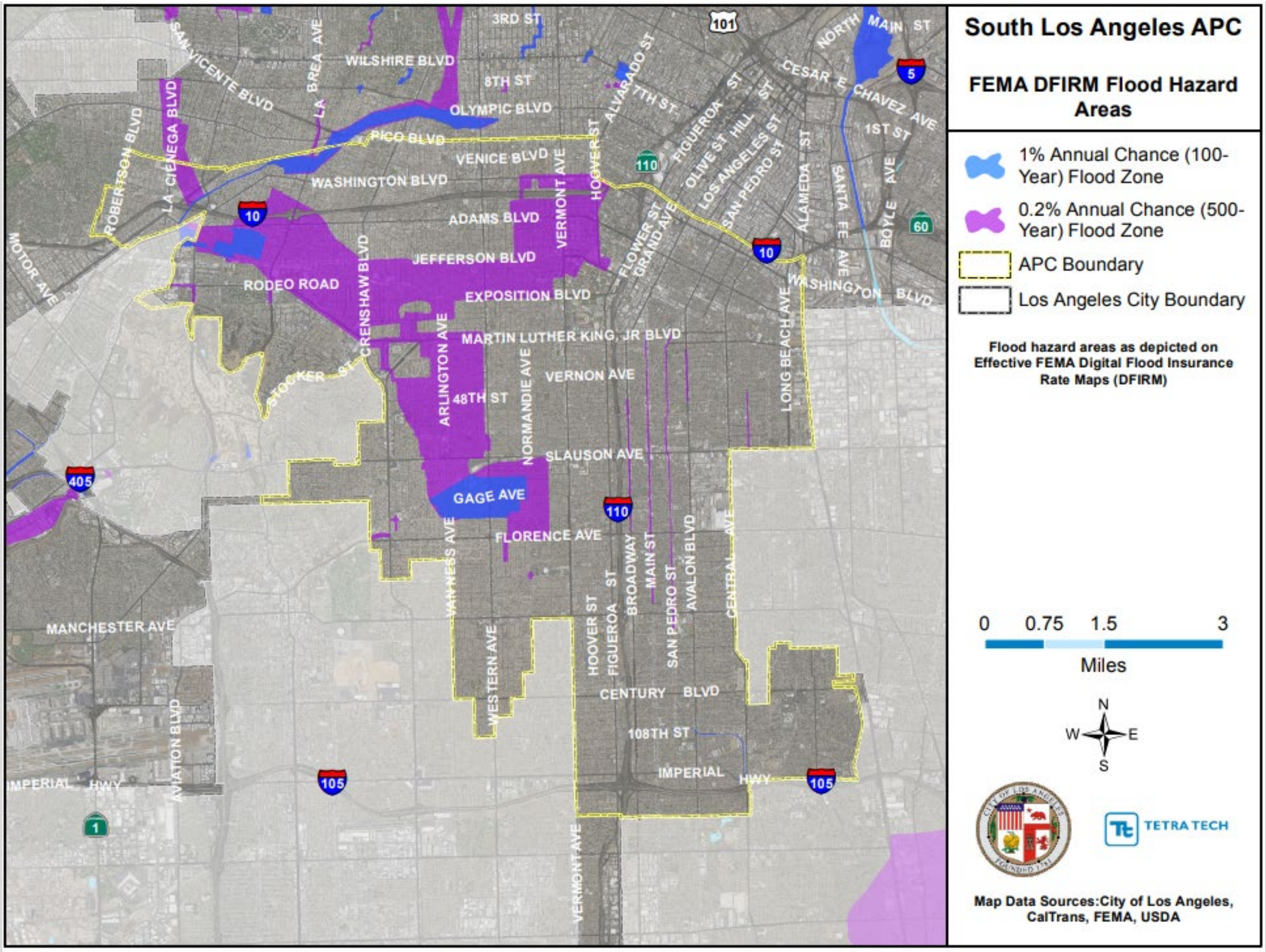


Figure 10-5. Mapped Flood Hazard Areas in South Los Angeles APC

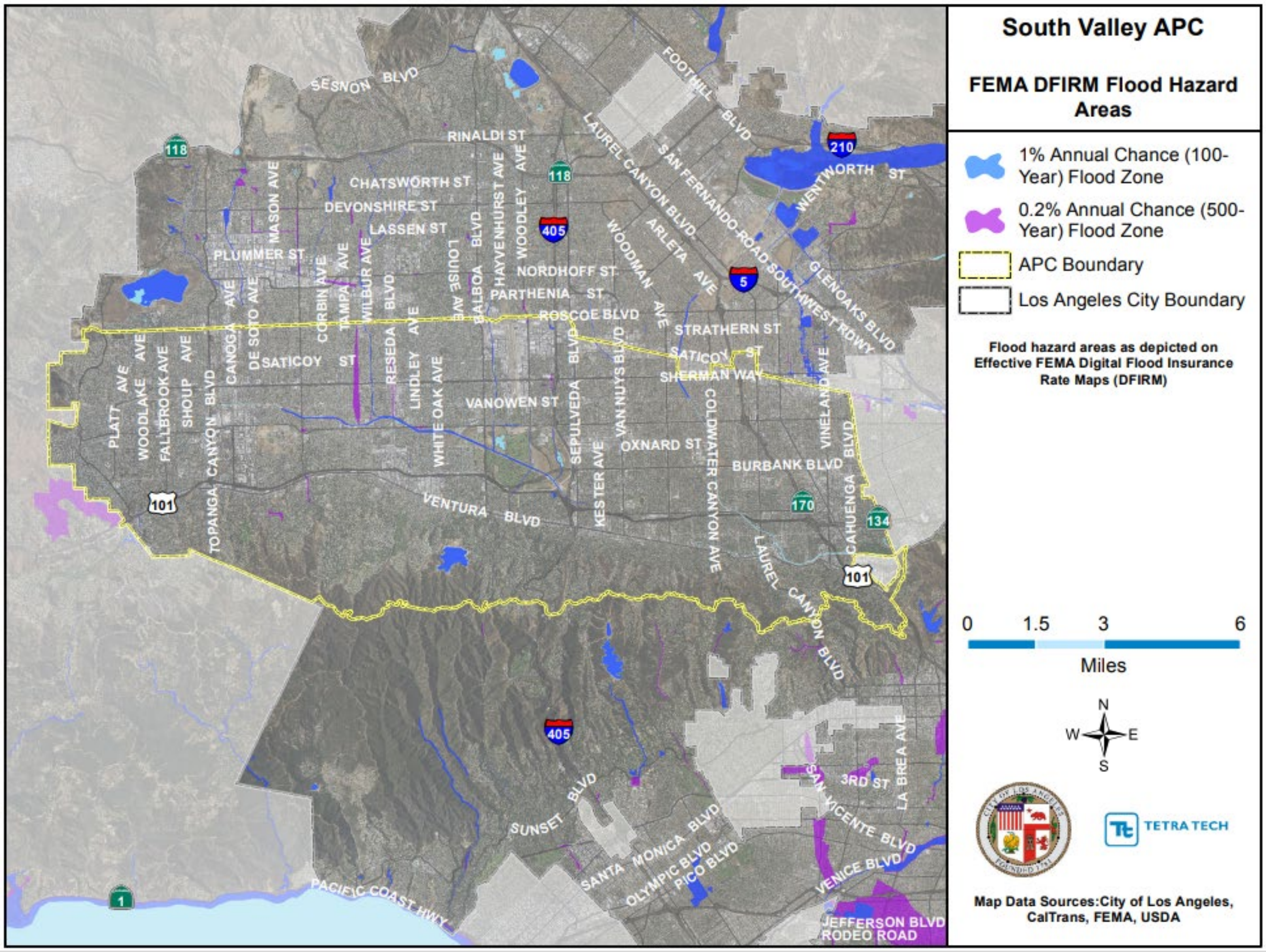


Figure 10-6. Mapped Flood Hazard Areas in South Valley APC

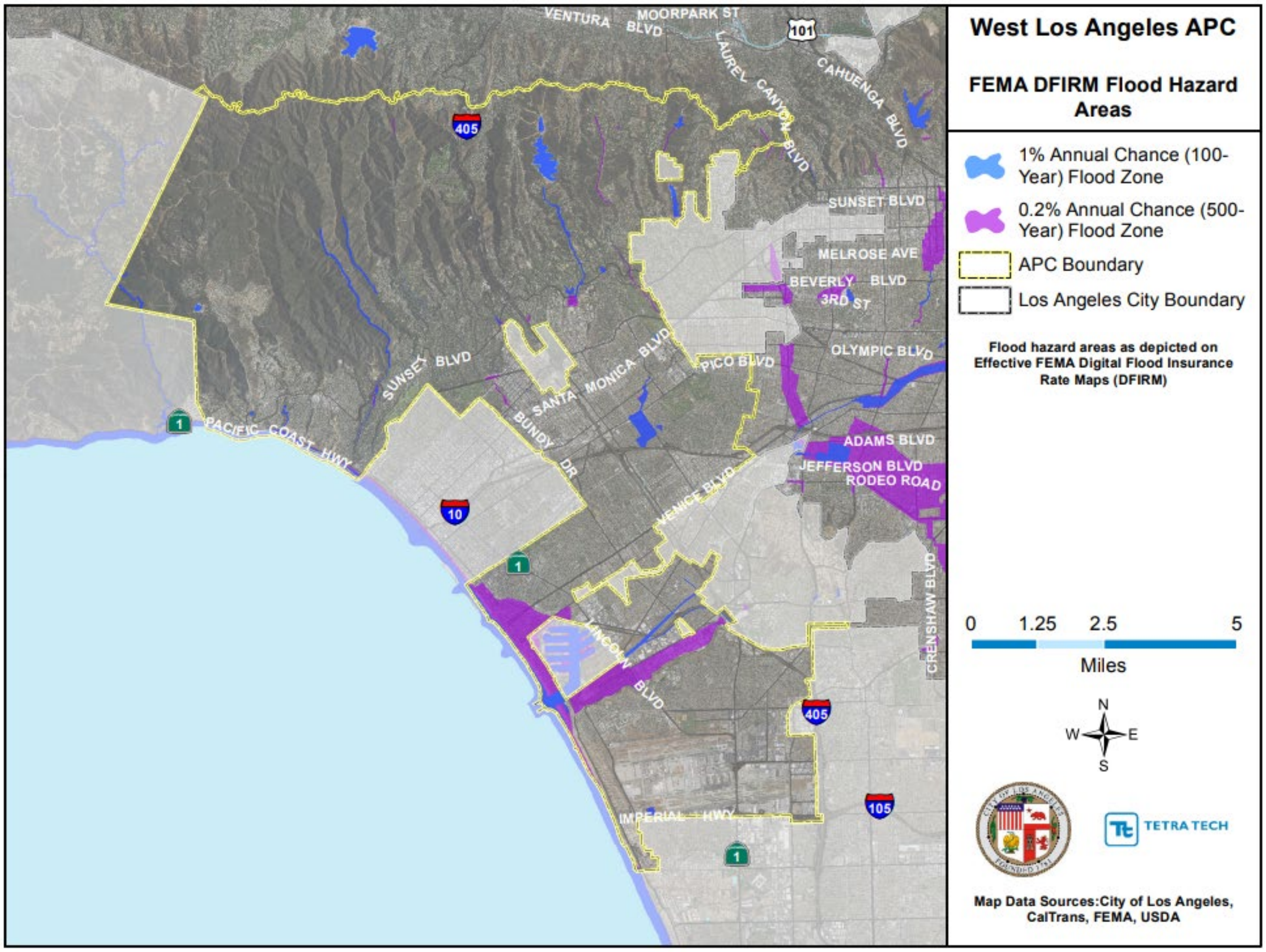


Figure 10-7. Mapped Flood Hazard Areas in West Los Angeles APC

Although jurisdictions can implement mitigation and take preventative actions to significantly reduce severity and threat of flood events, some residual risk will always exist (i.e., risk of a hazard event occurring despite technical and scientific measures applied to reduce/prevent it). Threats associated with residual risk could include failure of a reservoir, a dam breach, or other infrastructure failure, or a severe flood event that exceeds flood design standards or drainage capacity.

Flood severity is often evaluated by examining peak discharges; Table 10-2 lists peak flows used by FEMA's Flood Insurance Study, revised January 2016 to map the floodplains of the planning area.

Table 10-2. Summary of Peak Discharges Within the Planning Area

Source/Location	Drainage Area (sq. mi.)	Discharge (cubic feet/second)			
		10-Year	50-Year	100-Year	500-Year
Los Angeles River					
At Compton Creek	808	92,900	133,000	142,000	143,000
At Imperial Highway	752	89,400	126,000	140,000	156,000
@ Fernwood Ave.	--	--	--	57,000	--
Left Overbank	--	--	--	18,200	--
Right Overbank	--	--	--	45,400	--
@ Wardlow Rd	--	--	--	14,200	--
Left Overbank	--	--	--	31,200	--
Right Overbank	--	--	--	75,200	--
Rio Honda					
At Stuart and Gray Rd	132	35,600	41,000	39,300	40,200
At Beverly Blvd.	113	33,800	37,500	38,000	38,400
Outflow from Whittier Narrows Dam	110	33,500	36,500	36,500	36,500
@ Beverley Blvd., Left overbank	--	--	--	13,700	--
Stewart/Gray Rd.	--	--	--	2,790	--
Left Overbank	--	--	--	1,395	--
Right Overbank	--	--	--	1,395	--
West Los Angeles					
Balsam Ave./Olympic Blvd.	1.19	290	550	660	940
Manning Ave./Tennessee	3.4	530	1,300	1,700	2,600
Westwood Blvd. and Overland @ Exposition Blvd.	4.00	190	1,200	1,500	2,700
Roundtree Rd/ Manning Ave.	0.72	500	740	840	1,100
Harbor District					
Harbor Lake, SE of Vermont Ave.	18.97	3,200	7,000	8,900	14,000
Denker Ave./204th St.	0.28	60	130	170	260
Little Tujunga Wash					
3,000 feet upstream of Los Angeles City Limits	17.9	2,273	5,019	6,405	10,022
Hancock Park					
6th St. / Alexandria Ave.	8.09	2,100	4,600	5,900	9,200
Lucerne Blvd./Francis Ave.	0.26	70	160	200	320
Olympic Blvd./Hudson	0.56	130	290	370	570
Western Ave./11th St.	3.48	670	1,300	1,600	2,500
Bronson Ave./Country Club Dr.	18.07	3,700	7,900	9,600	14,000
West Blvd. / Dockweiler St.	18.76	3,600	7,600	9,300	13,600
San Vicente / Pico Blvd.	18.91	3,500	7,400	9,000	13,100
Highland Ave. / St. Elmo Dr.	20.21	3,600	7,700	9,300	13,700

Source/Location	Drainage Area (sq. mi.)	Discharge (cubic feet/second)			
		10-Year	50-Year	100-Year	500-Year
Arlington Ave. / 37th Place	0.73	440	990	1,400	2,500
Victoria Ave. / Jefferson Blvd.	1.17	320	1,100	1,400	2,600
Chesapeake Ave. / Exposition Blvd.	7.97	1,100	2,400	3,000	3,700
Harcourt Ave./ Westhaven St.	0.53	160	350	450	700
Lakeview Terrace					
Little Tujunga Canyon upstream of Foothill Blvd.	20.29	2,700	6,000	7,700	12,200
Kagel Canyon, upstream of Osborne Ave.	2.04	490	1,100	1,400	12,200
Park La Brea					
Wilshire Blvd./Crescent Heights Ave.	6.62	1,500	3,300	4,200	6,600
Orange Dr./Pickford St.	24.67	4,400	9,500	11,800	17,700
Whitworth Dr./La Cienega Blvd.	17.13	3,400	7,600	9,700	15,200
Venice Blvd. / Fairfax Ave.	18.44	3,400	7,500	9,500	14,900
Redondo Blvd./Santa Monica Freeway	1.16	300	670	860	1,300
Redondo Blvd./Roseland St.	14.53	2,000	4,400	5,700	9,100
Houser Blvd./ La Cienega Blvd.	14.76	1,900	4,300	5,500	8,800
Fairfax Ave./La Cienega Blvd.	16.67	2,100	4,700	6,000	9,600
Century City					
Santa Monic Blvd./ Avenue of the Stars	0.49	400	590	700	900
Bel Air Estates					
Stone Canyon Rd south of Somma Way	0.66	480	710	800	1,100
Stone Canyon Rd south of Bellagio Rd	1.02	630	940	1,100	1,400
Beverly Glen Blvd. north of Sunset Blvd.	1.18	700	1,000	1,200	1,600
Brentwood					
North of San Vicente, west of Westgate Ave.	0.21	60	140	180	280
Sunset Blvd./Barrington Ave.	0.24	230	340	390	520
Pacific Palisades					
Rustic Canyon, downstream of Sunset Blvd.	5.67	700	1,500	2,000	3,100
Westchester					
Sepulveda Blvd, north of 74th St	1.39	310	690	880	1,400
Sepulveda Blvd., south of the San Diego Freeway	1.39	310	690	880	1,400
Arizona Ave. north of Arizona Circle	1.65	340	740	950	1,500
Hyde Park					
Halldale Ave./65th St.	1.20	300	660	850	1,300
Wilton Pl/Gage Ave.	3.29	770	1,600	1,900	3,000
Southwest Dr./Van Ness Ave.	4.15	730	1,600	2,100	3,200
Sunland					
Big Tujunga Canyon, upstream of Foothill Blvd.	34.57	8,100	24,700	36,500	62,600
Big Tujunga Canyon, upstream of Wheatland Ave.	43.25	9,300	26,800	38,900	66,000
Sylmar					
East side of Golden State Freeway, south of Sierra Hwy	0.22	50	120	150	240
Weldon Canyon, downstream of Sierra Hwy	1.47	410	900	1,150	1,800
Van Nuys					
Victory Blvd./Hayvenhurst Ave.	0.73	90	200	250	390
Porter Ranch					
Mayerling St./Shoshone Ave.	0.19	40	100	120	190
Vicinity of Senson Blvd.	0.10	30	60	70	120

Source/Location	Drainage Area (sq. mi.)	Discharge (cubic feet/second)			
		10-Year	50-Year	100-Year	500-Year
Granada Hills					
Superior St./Paso Robles Ave.	0.53	90	200	260	400
Balboa Blvd. / Citronia St.	0.53	90	200	260	400
Sepulveda					
Roscoe Blvd. / Haskell Ave	0.84	160	360	460	720
Haskell Ave., north of Union Pacific Railroad	1.0	230	500	640	1,000
Chatsworth					
Chatsworth St./Corbin Ave.	0.85	220	480	610	960
Variel Ave./ Chatsworth Ave.	13.43	2,100	4,700	6,000	9,300
Canoga Ave./ Devonshire St.	0.77	230	510	650	1,000
Valley Circle/Lassen St.	0.75	220	480	600	950
Topanga Canyon Blvd. / Lassen St	0.25	50	120	150	230
Farrolone Ave. / Lassen St.	0.42	100	220	280	440
Topanga Canyon Blvd./Lassen St.	0.25	50	120	150	230
Santa Susana Pass Rd/Santa Susana Ave.	1.46	450	990	1,300	2,000
Woodland Hills					
Mulholland Dr./Ventura Freeway	2.27	490	1,100	1,400	2,200
Saltillo St./Canoga Ave.	0.32	100	250	300	500
Sherman Oaks					
Magnolia Blvd./Haskell Ave.	1.23	360	800	1,000	1,600

Source: FEMA, 2016

10.2.7 Warning Time

The warning time that a community has to take action to protect lives and property from a flooding threat is a function of the time between the first predictions of heavy rainfall, the first rainfall, and the first occurrence of flooding. Each watershed has unique qualities that affect its response to rainfall. A hydrograph, which is a graph or chart of stream flow in relation to time (see Figure 10-8), is a useful tool for examining a stream’s response to rainfall. Once rainfall starts falling over a watershed, runoff begins and the stream begins to rise. Water depth in the stream channel (stage of flow) will continue to rise in response to runoff even after rainfall ends. Eventually, the runoff will reach a peak and the stage of flow will crest. At this peak, the stream stage remains at a constant level until it begins to fall and eventually subside to a level below flooding stage. The length of time that floodwaters remain above flood stage is an important characteristic of the flood hazard.

Due to the sequential pattern of meteorological conditions needed to cause serious flooding, it is unusual for a flood to occur without warning. Warning times for river and stream floods can be between 24 and 48 hours. Flash flooding can be less predictable, but communities can be warned in advance of the potential for flash flooding to occur.

The Los Angeles County flood threat system consists of a network of precipitation gages throughout the watershed and stream gages at strategic locations in the county that constantly monitor and report stream levels. This information is fed into a U.S. Geological Survey forecasting program, which assesses the flood threat based on the amount of flow in the stream (measured in cubic feet per second). In addition to this program, data and flood warning information is provided by the National Weather Service (NWS). All of this information is analyzed to evaluate the flood threat and possible evacuation needs. Los Angeles County is responsible for dissemination of flood warnings to all municipalities within the County.

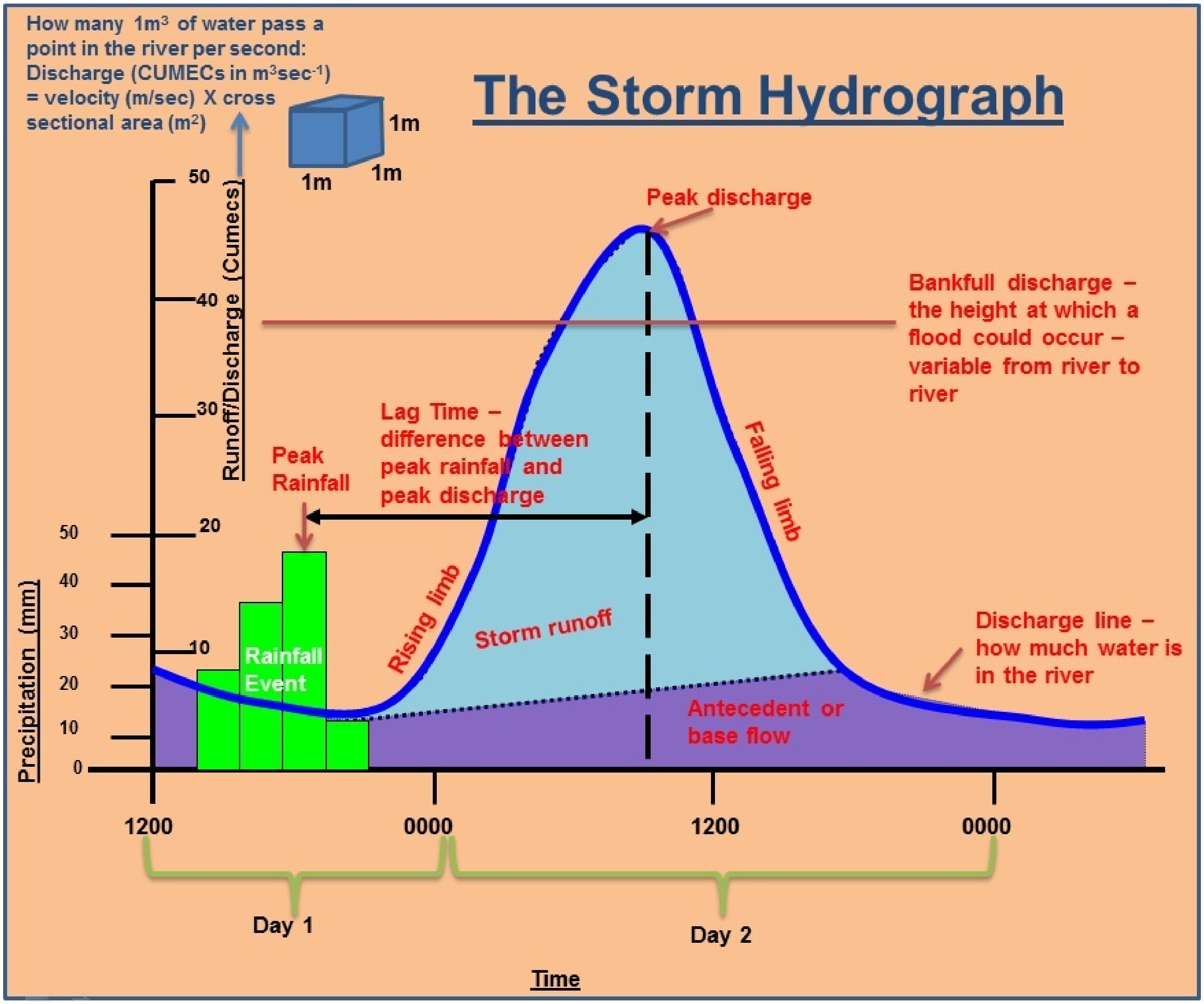


Figure 10-8. Example Hydrograph

The NWS issues watches and warnings when forecasts indicate rivers may approach bank-full levels. When a watch is issued, the public should prepare for the possibility of a flood. When a warning is issued, the public is advised to stay tuned to a local radio station for further information and be prepared to take quick action if needed. A warning means a flood is imminent, generally within 12 hours, or is occurring. Local media broadcast NWS warnings.

10.3 FLOOD CONTROL SYSTEM

As the City of Los Angeles began to grow rapidly in the 1920s and 1930s, rainwater that was once absorbed by miles of undeveloped land began to run off newly paved and developed areas, leading to an increased amount of water flowing into local rivers and creeks. These waterways could not contain the increased amount of water and the region experienced extensive flooding. In response, the U.S. Army Corps of Engineers lined the Los Angeles River and Ballona Creek with concrete and initiated the development of an underground urban drainage system. As the City continued to grow, a complex drainage system developed.

The City of Los Angeles today has an extensive drainage system to protect its residents and property from flood damage. The primary agencies responsible for flood control in the City are the U.S. Army Corps of Engineers, the Los Angeles County Flood Control District, the City of Los Angeles, and Caltrans. Each agency exercises jurisdiction over its own flood control facilities, which include open flood control channels, flood control basins, storm drains, debris basins, detention basins and spreading grounds.

Typically, City and County storm drains are designed according to criteria identified in a design criteria manual to carry flow from design storms. The combination of storm drain pipe and street conveyance of stormwater typically strives to provide capacity for up to a 25-year storm. Army Corps facilities are typically designed for a 1-percent-annual-chance storm (City of Los Angeles, 2010).

10.3.1 Los Angeles County Drainage Area Project

In 1915, the State Legislature created the Los Angeles County Flood Control District to control floods and conserve water. Early bond issues financed construction of 14 dams in the San Gabriel Mountain, flood channel modifications, and construction of debris basins to trap sediment. In 1936, federal legislation made the Army Corps a participant in Los Angeles County's flood protection program. The Army Corps' Los Angeles River, San Gabriel River and Ballona Creek projects included the construction of five flood storage reservoirs or basins, 24 debris basins, 95 miles of main channels, 191 miles of tributary channels and two jetties.

These two agencies are responsible for all the major flood control facilities that protect the City of Los Angeles. This regional flood control system is described in the Los Angeles County Drainage Area (LACDA) study. It includes the Los Angeles River, San Gabriel River, Rio Hondo Channel and Ballona Creek. Flood control facilities in the LACDA system fall into four general categories:

- Debris basins, found at the mouth of canyons, trap debris carried by floodwaters, leaving relatively clean water to flow unimpeded in downstream channels.
- Flood control reservoirs control and reduce stream flow so that downstream main channel capacities are not exceeded. The Army Corps operates five major reservoirs:

  - Hansen Dam—25,446 acre-feet
  - Lopez Dam—441 acre-feet
  - Santa Fe Dam—30,887 acre-feet
  - Sepulveda Dam—17,425 acre-feet
  - Whittier Narrows Dam—34,947 acre-feet

  Locally operated facilities include 15 flood control and water supply reservoirs in the upper watershed areas of the LACDA basin. Combined, these local reservoirs have a maximum combined capacity of 109,146 acre-feet. The City of Los Angeles has built recreational facilities at the Hansen Dam and Sepulveda Dam (including golf courses, riding and hiking trails, picnic etc.).

- Improved channels speed the passage of flood flows through local communities and into the main stem river system. Improved tributary channels include Arroyo Seco and Compton Creek.
- Main channel improvements pass the controlled or partially controlled flows to the ocean. The Los Angeles River is improved along most of the reach below Sepulveda Dam; its sides and bottom are generally lined with concrete or grouted rock. Sepulveda and Hansen Dams regulate flows to the main channel of the Los Angeles River.

In total, the LACDA system has over 100 miles of main stem channel, over 370 miles of tributary channels, 129 debris basins, 15 flood control and water conservation dams, and five flood control dams.

10.3.2 City Drainage System

The City of Los Angeles has complemented the LACDA drainage system with a comprehensive network of underground pipes and open channels to prevent local flooding. These local drains collect runoff and carry it rapidly to the main stem river channels. Most of the storm drain system receives no treatment or filtering and is completely separate from Los Angeles' sewer system.

Runoff drains from streets to gutters and enters the system through catch basins. From there, it flows into underground tunnels that empty into flood control channels that are not under the City's jurisdiction such as Ballona Creek or the Los Angeles River.

10.3.3 Summary

The City's storm drain system comprises 67,777 catch basins, with 1,900 miles of underground pipes and 220 miles of open channels. Table 10-3 provides an inventory of all flood control facilities in the City. Runoff from 1,060 square miles of developed land reaches Santa Monica and San Pedro Bays through the storm drain outfalls. Approximately 100 million gallons of water flows through Los Angeles' storm drain system on an average dry day. When it rains, the amount of water flowing through the channels can increase to 10 billion gallons per day, with speeds up to 35 mph and depths up to 25 feet.

Table 10-3. Flood Control System Features in the City of Los Angeles

Flood Control Facility	Description	Jurisdictional Responsibility					
		City	County	Corps	Caltrans	Private	Total
Open Channel	Larger visible concrete lined drainage system	31 mi	110 mi	30 mi	49 mi	—	**220 mi**
Storm Drain Pipe	Underground pipe or box varying in diameter from 12" to greater than 10'	1,200 mi	700 mi	—	—	—	**1,900 mi**
Debris Basin	Basin that collects debris (sand, mud, rock, vegetation) at the point where natural areas connect with development. Size varies	164	10	—	1	41	**216**
Catch Basin	Curb inlet structure for directing runoff into the storm drain system	39,389	23,078	—	4,813	497	**67,777**
Pump Station	Collects runoff in low lying areas and pumps it to an acceptable discharge location	18	1	—	—	—	**19**
Culvert	Open channel crossing at bridges or other locations where a short pipe or box structure conveys runoff	3,374	547	—	132	75	**4,128**
Corrugated Metal Pipe	Storm drains constructed of corrugated metal pipe. Typically, less desirable and prone to require excessive maintenance	30 mi	—	—	—	—	**30 mi**
Low Flow Drain	Conveys low or nuisance runoff short distances to alleviate minor problem areas	1,078	37	—	4	17	**1,136**

Source: City of Los Angeles, 2010

10.4 SECONDARY IMPACTS

The most problematic secondary impact for flooding is bank erosion, which in some cases can be more harmful than actual flooding. This is especially true in the upper courses of rivers with steep gradients, where floodwaters may pass quickly and without much property damage, but scour the banks, edging properties closer to the floodplain or causing them to fall in. Flooding is also responsible for hazards such as landslides when high flows over-saturate soils on steep slopes, causing them to fail. Hazardous materials spills are also a secondary impact of flooding if storage tanks rupture and spill into streams, rivers or storm drains.

Other secondary impacts of a flood include the following:

- Disruption of services:
  - Drinking water supplies may become polluted, especially if sewage treatment plants are flooded. This may result in disease and other health effects.
  - Gas and electrical service may be disrupted.
  - Transportation systems may be disrupted, resulting in shortages of food and clean-up supplies.
- Long-term effects (tertiary effects):
  - Location of river channels may change as the result of flooding. New channels develop, leaving the old channels dry.
  - Sediment deposited by flooding may destroy farm land (although silt deposited by floodwaters could also help to increase agricultural productivity).
  - Jobs may be lost due to the disruption of services, destruction of business, etc. (although jobs may be gained in the construction industry to help rebuild or repair flood damage).
  - Insurance rates may increase.
  - Corruption may result from misuse of relief funds.
- Destruction of wildlife habitat.

10.5 EXPOSURE

The Level 2 Hazus protocol was used to assess exposure and vulnerability to flooding in the planning area. The model used census data at the block level and FEMA floodplain data, which has a level of accuracy acceptable for planning purposes. Where possible, the Hazus default data was enhanced using local GIS data from local, state and federal sources.

10.5.1 Population

Population counts of those living in the floodplain were generated for each APC by estimating the percent of residential buildings located in the 1-percent-annual chance and 0.2-percent-annual-chance hazard areas in that APC and multiplying the total estimated population for the APC by this percentage. Using this approach, it was estimated that the exposed population for the entire planning area is 35,268 within the 1-percent-annual-chance floodplain (0.9 percent of the total planning area population) and 231,888 within the 0.2-percent-annual-chance floodplain (5.9 percent of the total).

10.5.2 Property

Structures in the Floodplain

Table 10-4 summarizes the total area and number of structures in the 1-percent-annual-chance floodplain. The Hazus model identified 5,628 structures in the 1-percent-annual-chance floodplain—88 percent of them residential and 10 percent commercial or industrial. Table 10-5 summarizes the total area and number of structures in the 0.2-percent-annual-chance floodplain, where Hazus identified 38,927 structures—89 percent residential, and 9 percent commercial or industrial.

Table 10-4. Area and Structures in the 1-Percent-Annual-Chance Floodplain

Area Planning Commissions	Area in Floodplain (acres)	Structures in 1-Percent-Annual-Chance Floodplain							
		Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Total

Area Planning Commissions	Area in Floodplain (acres)	Structures in 1-Percent-Annual-Chance Floodplain							
		Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Total
Central	635	1187	142	5	0	10	4	3	**1,351**
East Los Angeles	519	117	50	38	0	1	6	1	**213**
Harbor	2,600	27	4	15	0	0	5	0	**51**
North Valley	3,460	227	62	63	0	2	5	1	**360**
South Los Angeles	574	2760	86	62	0	3	3	1	**2,915**
South Valley	450	23	8	0	0	0	1	0	**32**
West Los Angeles	1,188	652	49	0	0	0	5	0	**706**
Total	**9,426**	**4,993**	**401**	**183**	**0**	**16**	**29**	**6**	**5,628**

Table 10-5. Area and Structures in the 0.2-Percent-Annual-Chance Floodplain

Area Planning Commissions	Area in Floodplain (acres)	Structures in 0.2-Percent-Annual-Chance Floodplain							
		Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Total
Central	1,733	5,254	665	48	0	27	35	20	**6,049**
East Los Angeles	537	173	61	41	0	1	6	1	**283**
Harbor	5,266	218	233	269	0	1	13	0	**734**
North Valley	3,688	497	73	67	0	2	6	1	**646**
South Los Angeles	5,048	20,436	1,441	301	3	133	65	76	**22,455**
South Valley	647	622	101	3	1	0	2	0	**729**
West Los Angeles	2,737	7,617	372	19	0	5	16	2	**8,031**
Total	**19,656**	**34,817**	**2,946**	**748**	**4**	**169**	**143**	**100**	**38,927**

Exposed Value

Table 10-6 summarizes the estimated value of exposed buildings in the 1-percent-annual-chance floodplain in the planning area. This methodology estimated $7.9 billion worth of building-and-contents exposure to the 1-percent-annual-chance flood, representing about 1.0 percent of the total replacement value of the planning area.
Table 10-7 summarizes the estimated value of exposed buildings in the 0.2-percent-annual-chance floodplain planning area. This methodology estimated $47.8 billion worth of building-and-contents exposure to the 0.2-percent-annual-chance flood, representing 6.2 percent of the total replacement value of the planning area.

Table 10-6. Value of Structures in the 1-Percent-Annual-Chance Floodplain

Area Planning Commission	Estimated Value within the Floodplain			% of Total Replacement Value
	Structure	Contents	**Total**	
Central	$1,533,409,751	$1,018,554,878	$2,551,964,629	1.3%
East Los Angeles	$482,706,667	$496,452,301	$979,158,968	1.5%
Harbor	$177,433,227	$204,037,579	$381,470,806	0.9%
North Valley	$506,294,268	$544,014,427	$1,050,308,695	0.9%
South Los Angeles	$1,109,918,894	$818,822,844	$1,928,741,739	2.0%
South Valley	$111,886,580	$91,243,194	$203,129,774	0.1%
West Los Angeles	$476,696,758	$373,919,048	$850,615,806	0.8%
Total	**$4,398,346,146**	**$3,547,044,271**	**$7,945,390,417**	**1.0%**

Table 10-7. Value of Structures in the 0.2-Percent-Annual-Chance Floodplain

Area Planning Commission	Estimated Value within the Floodplain			% of Total Replacement Value
	Structure	Contents	**Total**	
Central	$7,256,841,251	$5,801,301,583	$13,058,142,833	6.8%
East Los Angeles	$522,338,738	$522,389,657	$1,044,728,394	1.6%
Harbor	$2,891,775,292	$3,214,293,902	$6,106,069,195	14.9%
North Valley	$697,979,298	$688,273,981	$1,386,253,279	1.2%
South Los Angeles	$11,030,789,295	$7,962,129,307	$18,992,918,601	19.3%
South Valley	$405,320,176	$284,117,540	$689,437,716	0.5%
West Los Angeles	$3,951,972,817	$2,653,844,344	$6,605,817,161	6.0%
Total	**$26,757,016,867**	**$21,126,350,314**	**$47,883,367,181**	**6.2%**

Land Use in the Floodplain

Some land uses are more vulnerable to flooding, such as single-family homes, while others are less vulnerable, such as agricultural land or parks. Table 10-8 shows the existing land use of all parcels in the 1-percent-annual-chance and 0.2-percent-annual-chance floodplain, including vacant parcels and those in public/open space uses, broken down for the planning area. Open space uses make up about two-thirds of the 1-percent-annual-chance floodplain. These are favorable, lower-risk uses for the floodplain. The amount of the floodplain that contains vacant, developable land is not known. This would be valuable information for gauging the future development potential of the floodplain.

Table 10-8. Land Use Within the Floodplain

Land Use	1% Annual Chance Flood		0.2% Annual Chance Flood	
	Area (acres)	% of total	Area (acres)	% of total
Agriculture	3.2	0.04%	4.9	0.03%
Commercial	146.1	2.04%	1,223.4	8.12%
Government	191.8	2.68%	502.5	3.34%
Industrial	1,184.3	16.57%	3,513.0	23.32%
Multi-Family Residential	287.3	4.02%	2,259.0	14.99%
Open Space	4,778.0	66.87%	5,304.6	35.21%
Parking	0.0	0.00%	0.0	0.00%
Single Family Residential	554.3	7.76%	2,259.0	14.99%
Total	**7,145.1**	**100.00%**	**15,066.3**	**100.00%**

10.5.3 Critical Facilities and Infrastructure

Table 10-9 summarizes the critical facilities and infrastructure in the 10-percent, 2-percent, 1-percent and 0.2-percent-annual-chance flood hazard areas. Details are provided in the following sections.

Hazardous Materials Facilities

Hazardous materials facilities are those that use or store materials that can harm the environment if damaged by a flood. During a flood event, containers holding these materials can rupture and leak into the surrounding area, having a disastrous effect on the environment as well as residents. Fourteen businesses in the 1-percent-annual-chance floodplain in the City of Los Angeles report having hazardous materials under the Environmental Protection Agency's Toxic Release Inventory program.

Table 10-9. Critical Facilities in the Floodplain

APC	Critical Operating Facilities	Critical Response Facilities	Critical Infrastructure—Transportation	Critical Infrastructure—Utilities	Total
10% Annual Chance Flood Hazard Area					
Central	0	0	0	0	**0**
East Los Angeles	0	0	0	0	**0**
Harbor	0	0	0	0	**0**
North Valley	0	0	3	0	**3**
South Los Angeles	0	0	0	0	**0**
South Valley	0	0	0	0	**0**
West Los Angeles	0	0	1	0	**1**
Total	**0**	**0**	**4**	**0**	**4**
2% Annual Chance Flood Hazard Area					
Central	0	0	0	0	**0**
East Los Angeles	0	0	0	0	**0**
Harbor	0	0	0	0	**0**
North Valley	0	0	3	0	**3**
South Los Angeles	0	0	0	0	**0**
South Valley	0	0	0	0	**0**
West Los Angeles	0	0	1	0	**1**
Total	**0**	**0**	**4**	**0**	**4**
1% Annual Chance Flood Hazard Area					
Central	0	3	8	1	**12**
East Los Angeles	0	3	6	3	**12**
Harbor	0	4	16	3	**23**
North Valley	0	1	30	11	**42**
South Los Angeles	0	0	11	2	**13**
South Valley	0	0	9	1	**10**
West Los Angeles	0	1	3	1	**5**
Total	**0**	**12**	**83**	**22**	**117**
0.2% Annual Chance Flood Hazard Area					
Central	0	12	9	1	**22**
East Los Angeles	0	3	8	3	**14**
Harbor	0	4	50	48	**102**
North Valley	0	4	34	12	**50**
South Los Angeles	0	25	15	12	**52**
South Valley	0	0	9	1	**10**
West Los Angeles	0	2	8	14	**24**
Total	**0**	**50**	**133**	**91**	**274**

Utilities and Infrastructure

It is important to determine who may be at risk if infrastructure is damaged by flooding. Roads or railroads that are blocked or damaged can isolate residents and can prevent access throughout the planning area, including for emergency service providers needing to get to vulnerable populations or to make repairs. Bridges washed out or blocked by floods or debris also can cause isolation. Water and sewer systems can be flooded or backed up, causing health problems. Underground utilities can be damaged. Dikes can fail or be overtopped, inundating the land that they protect. The following sections describe specific types of critical infrastructure.

Bridges

Flooding can significantly impact road bridges, which provide the only ingress and egress to some areas. There are 70 bridges that are in or cross over the 1-percent-annual-chance floodplain and 98 bridges that intersect the 0.2-percent-annual-chance floodplain within the City of Los Angeles.

Roads

The following major roads in the planning area pass through the 1-percent-annual-chance floodplain and thus are exposed to flooding:

- E Sepulveda Blvd
- N Balboa Blvd
- N Glendale Blvd
- N Glenoaks Blvd
- N Reseda Blvd
- N Sepulveda Blvd
- N Sunland Blvd
- N Topanga Canyon Blvd
- N Van Nuys Blvd
- S Avalon Blvd
- S Crenshaw Blvd
- S La Cienega Blvd
- S Lincoln Blvd
- W Beverly Blvd
- W Burbank Blvd
- W Foothill Blvd
- W Jefferson Blvd
- W Los Feliz Blvd
- W Olympic Blvd
- W Pico Blvd
- W Roscoe Blvd
- W San Vicente Blvd
- W Santa Monica Blvd
- W Sesnon Blvd
- W Sunset Blvd
- W Venice Blvd
- W Victory Blvd
- W Washington Blvd
- W Wilshire Blvd
- E Pacific Coast Hwy
- W Pacific Coast Hwy

Some of these roads are built above the flood level, and others function as levees to prevent flooding. Still, in severe flood events these roads can be blocked or damaged, preventing access to some areas.

Water and Sewer Infrastructure

Water and sewer systems can be affected by flooding. Floodwaters can back up drainage systems, causing localized flooding. Culverts can be blocked by debris from flood events, also causing localized urban flooding. Floodwaters can get into drinking water supplies, causing contamination. Sewer systems can be backed up, causing wastewater to spill into homes, neighborhoods, rivers and streams.

10.5.4 Environment

Flooding, combined with human development, can have negative impact on the environment. Fish can wash into roads or over dikes into flooded fields, with no possibility of escape. Pollution from roads, such as oil, and hazardous materials can wash into streams. During floods, these can settle onto normally dry soils, polluting them for agricultural uses. Human development such as bridge abutments, levees, or logjams from timber harvesting can increase stream bank erosion, causing rivers and streams to migrate into non-natural courses. Floodwaters can add pollution to the Pacific Ocean, impacting tourism and reducing uses of the shoreline.

10.6 VULNERABILITY

Many of the areas exposed to flooding may not experience serious flooding or flood damage. This section describes vulnerabilities in terms of population, property, infrastructure and environment.

10.6.1 Population

Vulnerable Populations

A geographic analysis of demographics using the Hazus model identified populations vulnerable to the flood hazard as follows:

- **Economically Disadvantaged Populations**—It is estimated that 58 percent of the households within the 1-percent-annual-chance floodplain are economically disadvantaged, defined as having household incomes of $50,000 or less.
- **Population over 65 Years Old**—It is estimated that 10 percent of the population in the census blocks that intersect the 1-percent-annual-chance floodplain are over 65 years old.
- **Population under 16 Years Old**—It is estimated that 26 percent of the population within census blocks located in or near the 1-percent-annual-chance floodplain are under 16 years of age.

Impacts on Persons and Households

Impacts on persons and households in the planning area were estimated for the 1-percent-annual-chance and 0.2-percent-annual-chance flood events through the Level 2 Hazus analysis. Table 10-10 and Table 10-11 summarize the results.

Table 10-10. Estimated 1-Percent-Annual-Chance Flood Impact on Persons and Households

APC	Number of Displaced Persons	Number of Persons Requiring Short-Term Shelter
Central	2,717	2,600
East Los Angeles	98	63
Harbor	11	7
North Valley	94	69
South Los Angeles	11,118	10,950
South Valley	6	5
West Los Angeles	516	405
Total	**14,559**	**14,099**

Table 10-11. Estimated 0.2-Percent-Annual-Chance Flood Impact on Persons and Households

APC	Number of Displaced Persons	Number of Persons Requiring Short-Term Shelter
Central	13,779	13,043
East Los Angeles	170	121
Harbor	186	155
North Valley	203	143
South Los Angeles	57,238	54,314
South Valley	247	178
West Los Angeles	10,955	9,080
Total	**82,778**	**77,034**

Public Health and Safety

Floods present threats to public health and safety. Floodwater is generally contaminated by pollutants such as sewage, human and animal feces, pesticides and insecticides, fertilizers, oil, asbestos, and rusting building materials. The following health and safety risks are commonly associated with flood events:

- **Unsafe food—**Floodwaters contain disease-causing bacteria, dirt, oil, human and animal wastes, and farm and industrial chemicals. They carry away whatever lies on the ground and upstream. Their contact with food items, including food crops in agricultural lands, can make that food unsafe to eat and hazardous to human health. Power failures caused by floods damage stored food. Refrigerated and frozen foods are affected during the outage periods, and thus must be carefully monitored and examined prior to consumption. Foods kept inside cardboard, plastic bags, jars, bottles, and paper packaging are subject to disposal if contaminated by floodwaters. Even though the packages do not appear to be wet, they may be unhygienic with mold contamination and deteriorate rapidly.
- **Contaminated drinking and washing water and poor sanitation—**Flooding impairs clean water sources with pollutants and affects sanitary toilets. Direct and indirect contact with the contaminants—whether through direct food intake, vector insects such as flies, unclean hands, or dirty plates and utensils—can result in waterborne infectious disease. Wastewater treatment plants, if flooded and caused to malfunction, can be overloaded with polluted runoff waters and sewage beyond their disposal capacity, resulting in backflows of raw sewage to homes and low-lying grounds. Private wells can be contaminated or damaged severely by floodwaters, while private sewage disposal systems can become a cause of infection and illnesses if they are broken or overflow. Unclean drinking and washing water and sanitation, coupled with lack of adequate sewage treatment, can lead to disease outbreaks, including life-threatening cholera, typhoid, dysentery and some forms of hepatitis.
- **Mosquitoes and animals—**Prolonged rainfall and floods provide new breeding grounds for mosquitoes—wet areas and stagnant pools—and can lead to an increase in the number of mosquito-borne diseases such as malaria and dengue and West Nile fevers. Rats and other rodents and wild animals also can carry viruses and diseases. The public should avoid such animals and should dispose of dead animals in accordance with guidelines issued by local animal control authorities.
- **Molds and mildews—**Excessive exposure to molds and mildews can cause flood victims—especially those with allergies and asthma—to contract upper respiratory diseases and to trigger cold-like symptoms such as sore throat, watery eyes, wheezing and dizziness. Molds grow in as short a period as 24 to 48 hours in wet and damp areas of buildings and homes that have not been cleaned after flooding, such as water-infiltrated walls, floors, carpets, toilets and bathrooms. Very small mold spores can be easily inhaled by human bodies and, in large enough quantities, cause allergic reactions, asthma episodes, and other respiratory problems. Infants, children, elderly people and pregnant women are considered most vulnerable to mold-induced health problems.
- **Carbon monoxide poisoning—**Carbon monoxide poisoning is as a potential hazard after major floods. Carbon monoxide can be found in combustion fumes, such as those generated by small gasoline engines, stoves, generators, lanterns and gas ranges, or by burning charcoal or wood. In the event of power outages following floods, flood victims tend to use alternative sources of fuels for heating, cooling, or cooking inside enclosed or partly enclosed houses, garages or buildings without an adequate level of air ventilation. Carbon monoxide builds up from these sources and poisons the people and animals inside.
- **Hazards when reentering and cleaning flooded homes and buildings—**Flooded buildings can pose health hazards after floodwaters recede. Electrical power systems can become hazardous. People should avoid turning on or off the main power while standing in floodwater. Gas leaks from pipelines or propane tanks can trigger explosion when entering and cleaning damaged buildings or working to restore utility service. Flood debris—such as broken bottles, wood, stones and walls—may cause wounds and injuries when cleaning damaged buildings. Containers of hazardous chemicals, including pesticides, insecticides, fertilizers, car batteries, propane tanks and other industrial chemicals, may be hidden or buried under

flood debris. A health hazard can also occur when hazardous dust and mold in ducts, fans and ventilators of air-conditioning and heating equipment are circulated through a building and inhaled by those engaged in cleanup.

- **Mental stress and fatigue**—Exposure to extreme disaster events can cause psychological distress. Having experienced a devastating flood, seen loved ones lost or injured, and homes damaged or destroyed, flood victims can experience long-term psychological impact. The expense and effort required to repair flood-damaged homes places severe financial and psychological burdens on the people affected, in particular the unprepared and uninsured. Post-flood recovery—especially when prolonged—can cause anxiety, anger, depression, lethargy, hyperactivity, sleeplessness, and, in an extreme case, suicide. Behavior changes may also occur in children. There is also a long-term concern among the affected that their homes can be flooded again in the future.

Current loss estimation models such as Hazus are not equipped to measure public health impacts. The best level of mitigation for these impacts is to be aware that they can occur, educate the public on prevention, and be prepared to deal with these vulnerabilities in responding to flood events.

10.6.2 Property

Loss Estimates

Hazus calculates losses to structures from flooding by looking at depth of flooding and type of structure. Using historical flood insurance claim data, Hazus estimates the percentage of damage to structures and their contents by applying established damage functions to an inventory. For this analysis, local data on facilities was used instead of the default inventory data provided with Hazus.

The analysis is summarized in Table 10-12 for the 1-percent-annual-chance flood event and Table 10-13 for the 0.2-percent-annual-chance flood event. It is estimated that there would be up to $369 million of flood loss from a 1-percent-annual-chance flood event in the planning area. This represents about 1 percent of the total exposure to the 1-percent-annual-chance flood and a negligible percentage of the total replacement value for the planning area. It is estimated that there would be $3.4 billion of flood loss from a 0.2-percent-annual-chance flood event, representing 6.2 percent of the total exposure to a 0.2-percent-annual-chance flood event and 0.5 percent of the total replacement value.

Table 10-12. Loss Estimates for 1-Percent-Annual-Chance Flood

Area Planning Commission	Structures Impacted[a]	Estimated Loss Associated with Flood			% of Total Replacement Value
		Structure	Contents	**Total**	
Central	977	$80,626,613	$59,567,772	$140,194,384	0.1%
East Los Angeles	66	$5,905,621	$12,990,777	$18,896,398	0.0%
Harbor	20	$2,518,094	$7,295,958	$9,814,051	0.0%
North Valley	146	$25,381,793	$34,439,985	$59,821,778	0.1%
South Los Angeles	2,197	$46,575,352	$30,985,149	$77,560,501	0.1%
South Valley	13	$1,853,431	$1,564,877	$3,418,309	0.0%
West Los Angeles	606	$28,083,067	$31,938,037	$60,021,103	0.1%
Total	4,025	$190,943,969	$178,782,555	$369,726,525	0.0%

a. Impacted structures are those structures with finished floor elevations below the flood event water surface elevation. These structures are the most likely to receive significant damage in a flood event.

Table 10-13. Loss Estimates for 0.2-Percent-Annual-Chance Flood

Area Planning Commission	Structures Impacted[a]	Estimated Loss Associated with Flood			% of Total Replacement Value
		Structure	Contents	Total	
Central	3,287	$386,426,595	$340,458,927	$726,885,523	0.4%
East Los Angeles	115	$7,595,582	$14,679,082	$22,274,664	0.0%
Harbor	362	$180,045,060	$381,913,207	$561,958,268	1.4%
North Valley	247	$28,117,124	$36,152,982	$64,270,107	0.1%
South Los Angeles	12,577	$442,398,355	$476,284,351	$918,682,707	0.9%
South Valley	207	$2,868,582	$2,660,644	$5,529,226	0.0%
West Los Angeles	3,931	$602,512,612	$556,108,479	$1,158,621,091	1.1%
Total	20,726	$1,649,963,911	$1,808,257,673	$3,458,221,584	0.5%

a. Impacted structures are those structures with finished floor elevations below the flood event water surface elevation. These structures are the most likely to receive significant damage in a flood event.

Flood-Caused Debris

Hazus debris estimates for the 1-percent-annual-chance and 0.2-percent-annual-chance flood events for the planning area are shown in Table 10-14.

Table 10-14. Estimated Flood-Caused Debris

Area Planning Commission	Debris to Be Removed Because of Flood Event (tons)	
	1-Percent-Annual-Chance Event	0.2-Percent-Annual-Chance Event
Central	7,558	32,995
East Los Angeles	477	901
Harbor	1,122	5,925
North Valley	24,558	25,669
South Los Angeles	9,326	72,501
South Valley	557	1,124
West Los Angeles	4,474	77,588
Total	**48,072**	**216,702**

National Flood Insurance Program

The City of Los Angeles participates in the NFIP, with 7,864 flood insurance policies providing $2.17 billion in coverage at a combined annual premium of $6.9 million. According to FEMA statistics, 1,809 flood insurance claims were paid between January 1, 1978 and January 31, 2017, for a total of $19 million, an average of $10,503 per claim. Properties constructed after a FIRM has been adopted are eligible for reduced flood insurance rates. Such structures are less vulnerable to flooding since they were constructed after regulations and codes were adopted to decrease vulnerability. Properties built before a FIRM is adopted are more vulnerable to flooding because they do not meet code or are located in hazardous areas. The first FIRM for Los Angeles was available in 1980.

The following observations are based on a review of City of Los Angeles flood insurance statistics performed as part of this risk assessment:

- The use of flood insurance in the City of Los Angeles is similar to the national average, with 46.8 percent of insurable buildings in the City covered by flood insurance. According to an NFIP study, about 49 percent of single-family homes in SFHAs are covered by flood insurance nationwide.
- The average cost of a flood insurance policy within the SFHA is $1,430 per year.

- The average cost of a policy outside the SFHA is $763.
- 78 percent of the policies in force are for residences.
- 81.5 percent of the policies are for pre-FIRM construction.
- The amount of insurance in force represents 41.9 percent of the total value of exposed assets in the SFHA.
- Over 30 percent of flood insurance claims paid were for policies outside the SFHA.
- The high percentage of flood insurance policies in force outside the SFHA (roughly 60 percent of the policies) suggests that the currently effective mapping does not reflect the total flood risk.

Flood Insurance Reform

The NFIP is currently $24 billion in debt and taxpayers will be forced to pay for any additional payouts until that situation is solved. The Biggert-Waters Flood Insurance Reform Act of 2012 changed the NFIP to make it more sustainable. It requires the NFIP to raise rates to reflect true flood risk, make the program more financially stable, and change how FIRM updates impact policyholders. The new law eliminates some artificially low rates and discounts, as well as subsidies to certain pre-FIRM policyholders. Most flood insurance rates will move to reflect full risk, and flood insurance rates will rise on some policies. There are investments property owners and communities can make to reduce the impact of rate changes.

The Homeowner Flood Insurance Affordability Act of 2014 delays the increases in flood insurance premiums mandated under the Biggert–Waters Flood Insurance Reform Act of 2012 for four years. During that time, FEMA is supposed to come up with a plan to make the premiums less expensive and reassess its maps of areas that are likely to flood and therefore require flood insurance. The 2014 law also allows those who sell their homes to pass lower flood insurance premiums on to the next homeowner.

These laws will have profound impacts on the costs of flood insurance and implementation of the NFIP. How changes will impact local communities is not yet known. However, 81 percent of current policies in force in the City of Los Angeles are the pre-FIRM subsidized policies that the legislation is targeting.

Repetitive Loss

A repetitive loss property is defined by FEMA as an NFIP-insured property that has experienced any of the following since 1978, regardless of any changes in ownership:

- Four or more paid losses in excess of $1,000
- Two paid losses in excess of $1,000 within any rolling 10-year period
- Three or more paid losses that equal or exceed the current value of the insured property.

Repetitive loss properties make up only 1 to 2 percent of flood insurance policies in force nationally, yet they account for 40 percent of the nation’s flood insurance claim payments. The government has instituted programs encouraging communities to identify and mitigate the causes of repetitive losses. A report on repetitive losses by the National Wildlife Federation found that 20 percent of these properties are outside any mapped 1-percent-annual-chance floodplain. The key identifiers for repetitive loss properties are the existence of flood insurance policies and claims paid by the policies.

The CRS requires participating communities to identify repetitive loss areas. A repetitive loss area is the portion of a floodplain holding structures that FEMA has identified as meeting the definition of repetitive loss. Identifying repetitive loss areas helps to identify structures that are at risk but are not on FEMA’s list of repetitive loss structures because no flood insurance policy was in force at the time of loss. This information for Los Angeles is provided in the 2015 *Floodplain Management Plan*. Repetitive loss areas in each APC are shown in Figure 10-9 through Figure 10-15.

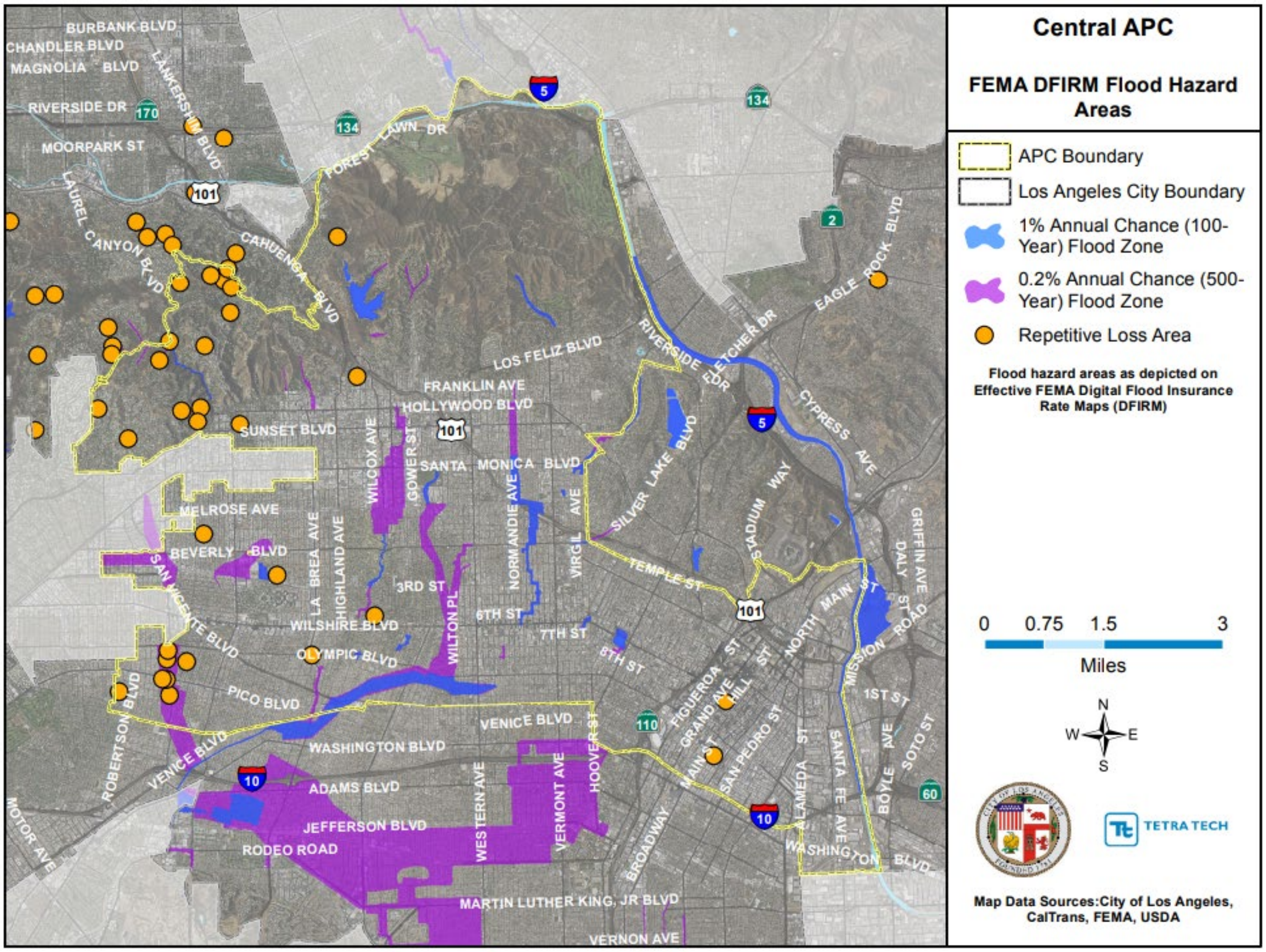


Figure 10-9. Repetitive Loss Areas in the Central APC

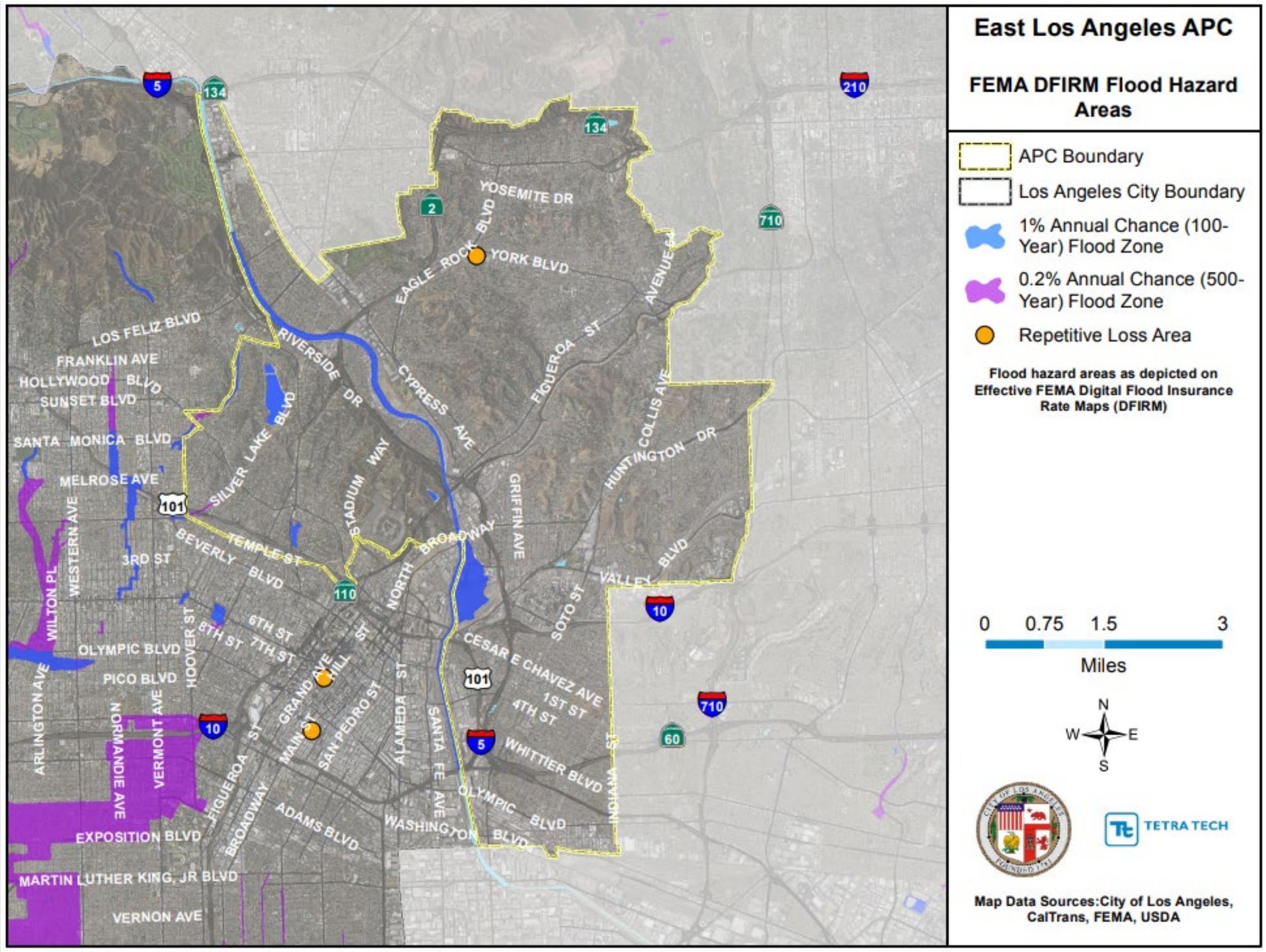


Figure 10-10. Repetitive Loss Areas in the East Los Angeles APC

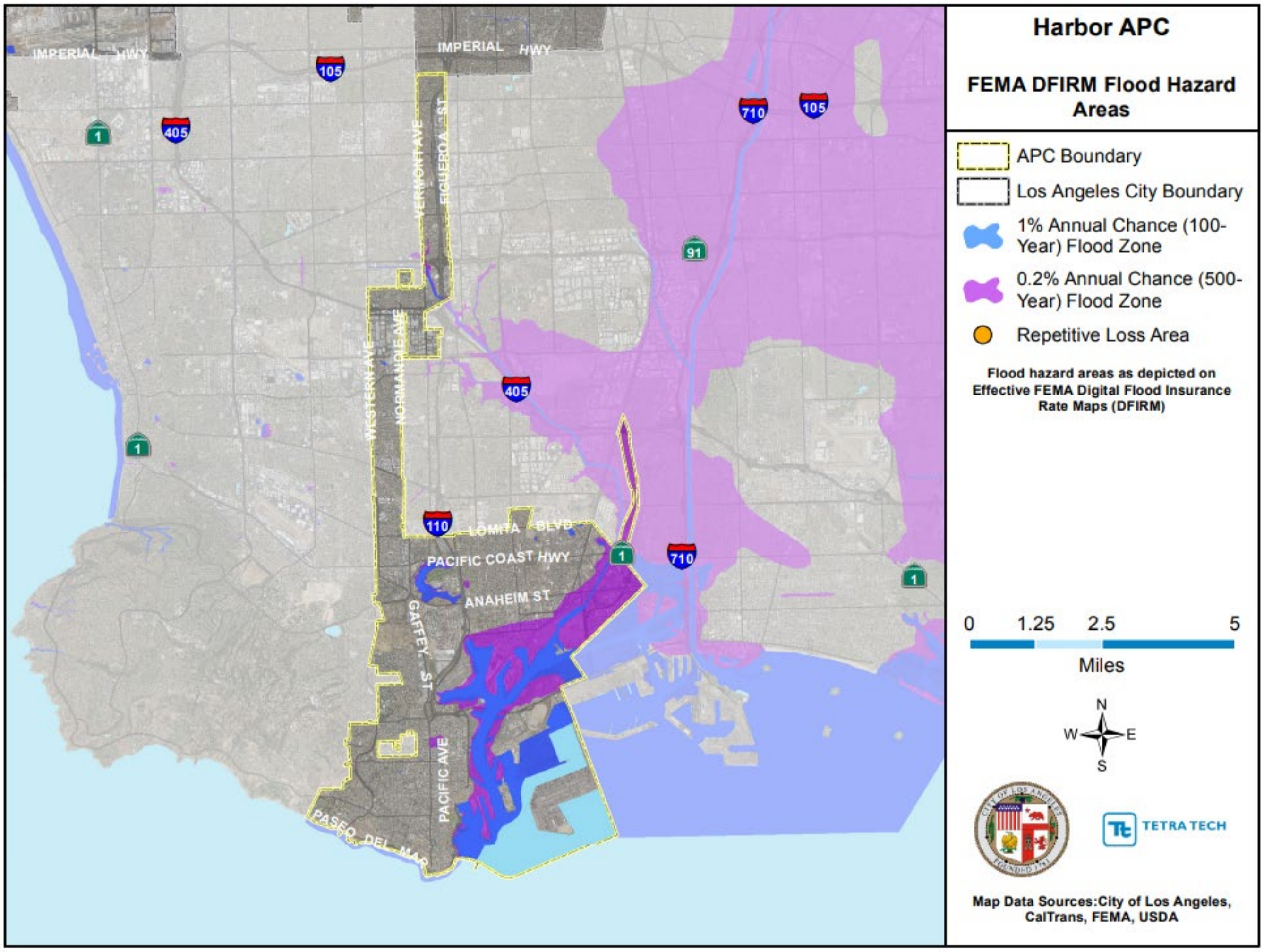


Figure 10-11. Repetitive Loss Areas in the Harbor APC

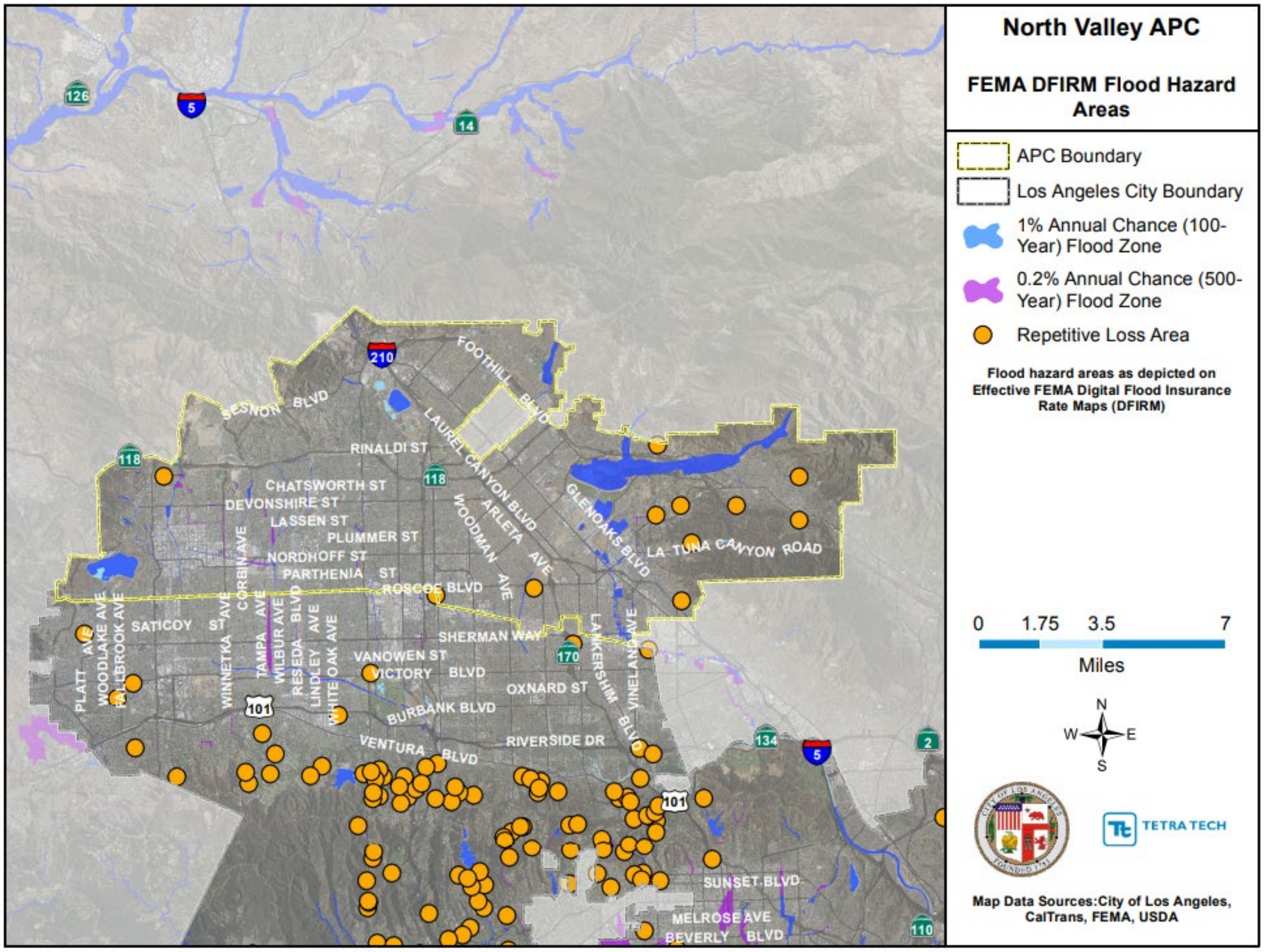


Figure 10-12. Repetitive Loss Areas in the North Valley APC

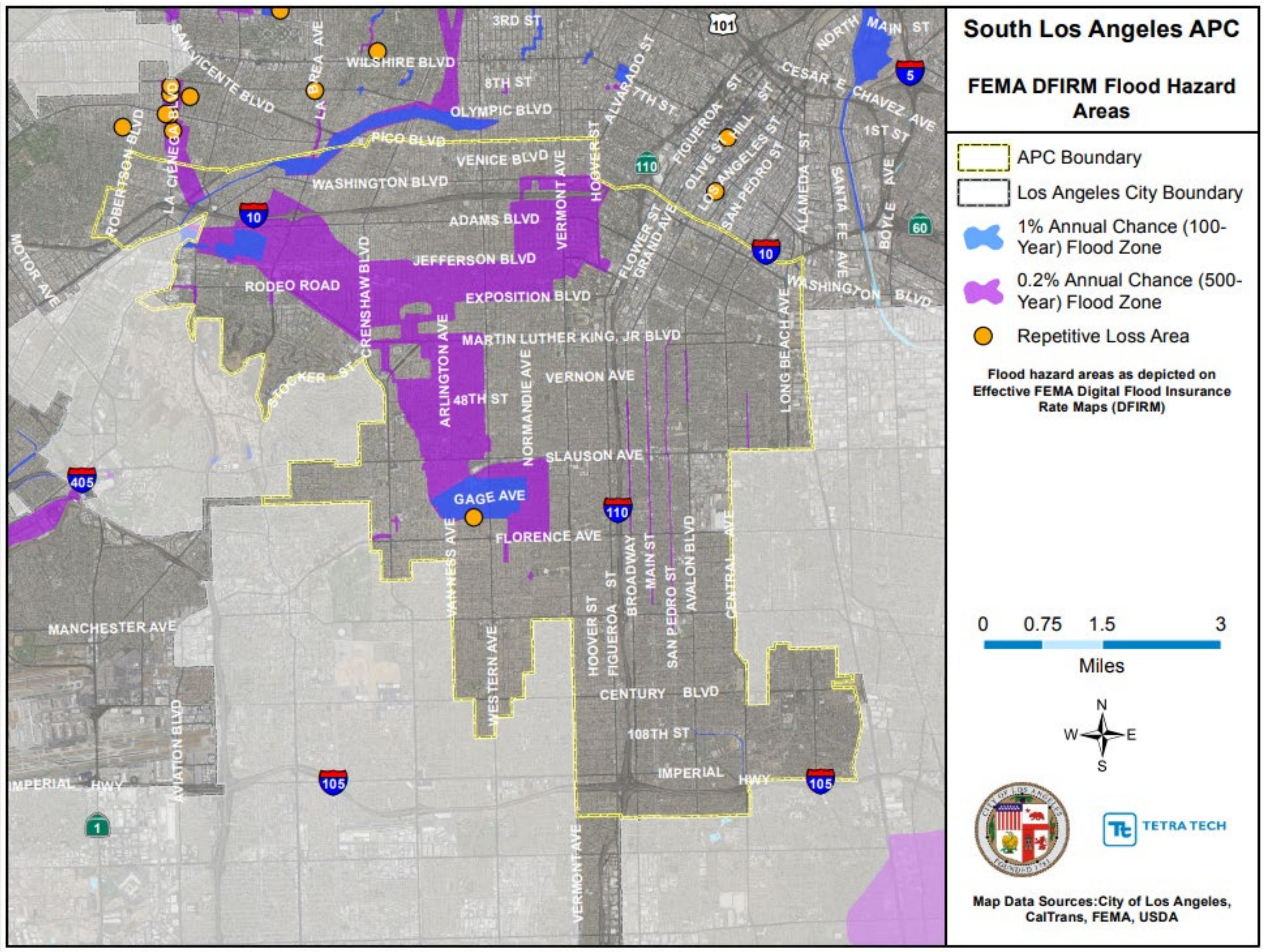


Figure 10-13. Repetitive Loss Areas in the South Los Angeles APC

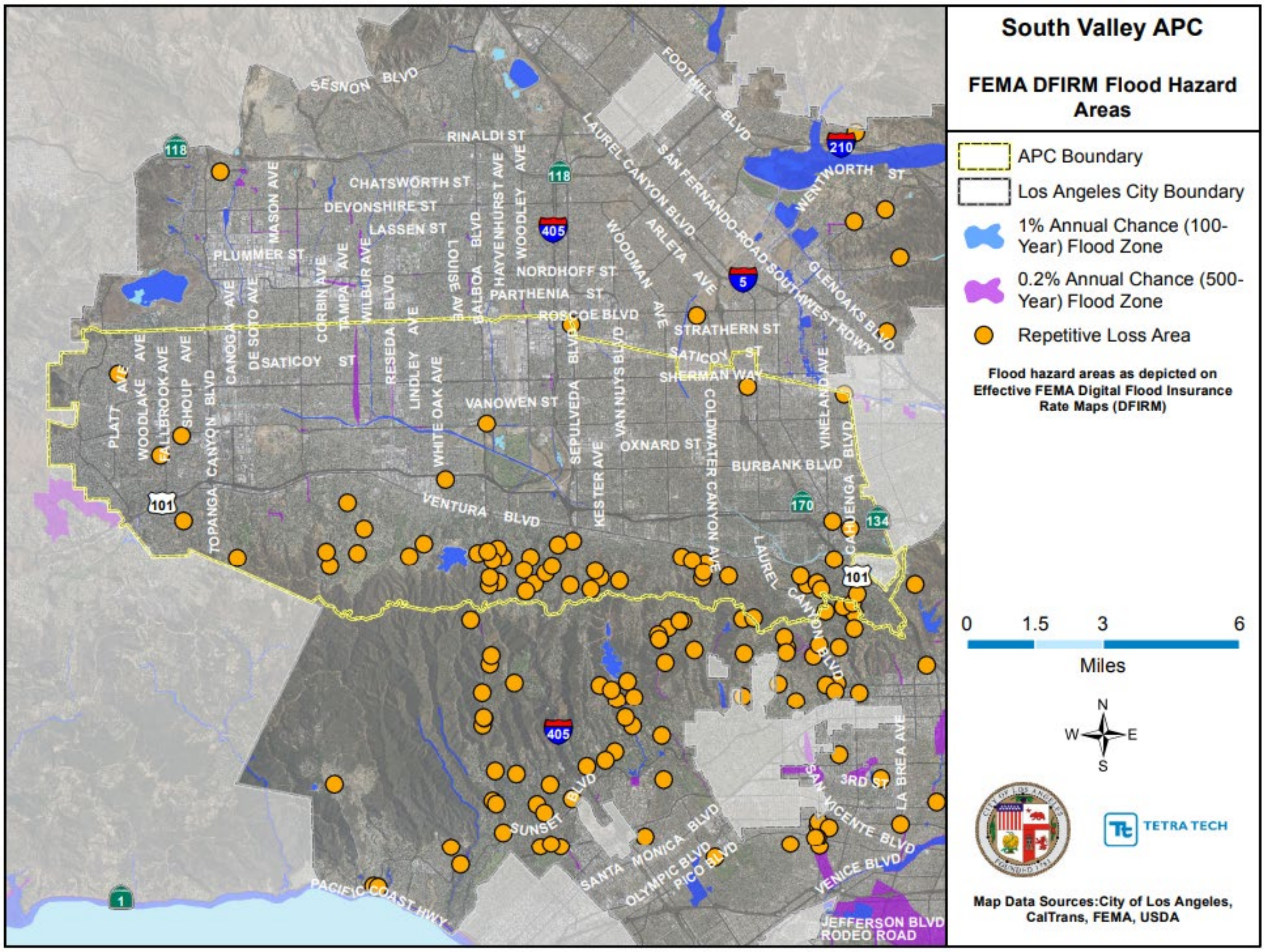


Figure 10-14. Repetitive Loss Areas in the South Valley APC

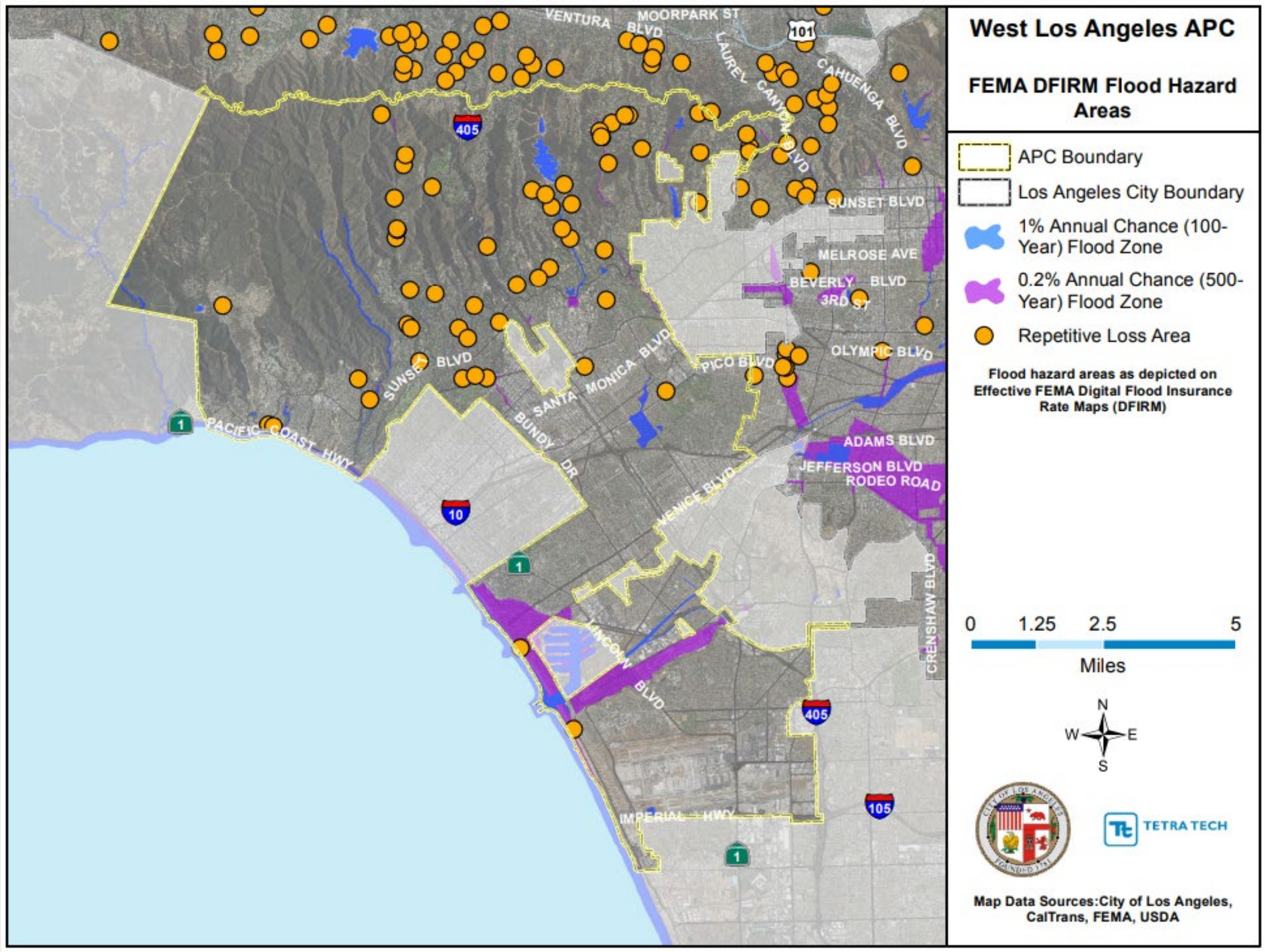


Figure 10-15. Repetitive Loss Areas in the West Los Angeles APC

FEMA's list of repetitive loss properties identifies 145 such properties in the planning area as of February 28, 2011. Based on FEMA Report of Repetitive Losses, 25 of the 145 have been mitigated. A review of the repetitive loss list indicated that 118 of the properties are outside the planning area's special flood hazard area. Causes of flood damage to repetitive loss properties were analyzed in 2010 based on field investigation, data review, interviews with homeowners, and hydrologic/hydraulic calculations. Causes were classified into the following types:

- **Hillside Drainage Problem**—These properties are located at the bottom of a steep hill, which can be impacted by hillside runoff. Flooding occurs due to deficiency of private on-site drainage system to carry the hillside runoff that enters the property. Mudslide hazards from slope failure are also common. This was identified as the cause of damage for 76 properties, 52 percent of the properties for which a cause was assigned.
- **Street Drainage Problem**—These properties are located lower than the street level or the driveway is sloped downward toward the house and garage. Street runoff can enter the private property, particularly if the property is located at the street sump area (lowest point of the nearby streets), where street flow can pond, and no drainage network is available. Storm drain problems may include undersized or broken storm drain and debris-clogged catch basins. This was identified as the cause of damage for 27 properties, 19 percent of the properties for which a cause was assigned.
- **Others**—This was identified as the cause of damage for 15 properties, 10 percent of the properties for which a cause was assigned. This includes sump pump inlet issues, retaining wall problems, storm drain broke, and remodeling a house issues.

10.6.3 Critical Facilities and Infrastructure

Hazus was used to estimate the level of potential damage to critical facilities exposed to the flood risk, using depth/damage function curves to estimate the percent of damage to the building and contents of critical facilities. Table 10-15 summarizes the Hazus critical facility results.

10.6.4 Environment

The environment vulnerable to flood hazard is the same as the environment exposed to the hazard. Loss estimation platforms such as Hazus are not currently equipped to measure environmental impacts of flood hazards. The best gauge of vulnerability of the environment would be a review of damage from past flood events. Loss data that segregates damage to the environment was not available at the time of this plan. Capturing this data from future events could be beneficial in measuring the vulnerability of the environment for future updates.

10.7 FUTURE TRENDS

According to the California Department of Finance, the population of the greater Los Angeles region is expected to increase the most over the next 45 years. The City of Los Angeles has limited potential for expansion through annexation, as it is surrounded by other incorporated cities. It is anticipated that future growth in the City will be managed through redevelopment, which creates an opportunity to correct past land use decisions, especially with regards to development within floodplains.

The City will be well-equipped to manage growth in floodplains with its flood damage prevention ordinance, its building code, and the safety element of its General Plan. Proper application of these tools requires accurate hazard mapping. It is the conclusion of this planning effort that currently effective flood hazard mapping does not accurately reflect the true flood risk for the City of Los Angeles. This should be taken into account as future land use decisions are made for areas impacted by flooding.

Table 10-15. Potential Flood Damage to Critical Facilities in Flood Hazard Areas

	Number of Facilities Affected	Average % of Total Value Damaged	
		Structure	Content
10% Annual Chance Flood Hazard Area			
Critical Operating Facilities	0	N/A	N/A
Critical Response Facilities	0	N/A	N/A
Critical Infrastructure—Transportation	2	0.03	N/A
Critical Infrastructure—Utilities	0	N/A	N/A
Total/Average	**2**	**0.03**	**N/A**
2% Annual Chance Flood Hazard Area			
Critical Operating Facilities	0	N/A	N/A
Critical Response Facilities	0	N/A	N/A
Critical Infrastructure—Transportation	2	0.16	N/A
Critical Infrastructure—Utilities	0	N/A	N/A
Total/Average	**2**	**0.16**	**N/A**
1% Annual Chance Flood Hazard Area			
Critical Operating Facilities	0	N/A	N/A
Critical Response Facilities	4	4.10	10.00
Critical Infrastructure—Transportation	22	2.22	17.43
Critical Infrastructure—Utilities	13	3.04	5.45
Total/Average	**39**	**3.12**	**10.96**
0.2% Annual Chance Flood Hazard Area			
Critical Operating Facilities	0	N/A	N/A
Critical Response Facilities	9	4.47	13.91
Critical Infrastructure—Transportation	43	6.12	26.04
Critical Infrastructure—Utilities	28	10.73	5.45
Total/Average	**80**	**7.11**	**15.13**

10.8 SCENARIO

The major flooding causes in the City of Los Angeles are short-duration, high-intensity storms. Water courses in the City can flood in response to a succession of intense winter rainstorms, usually between early November and late March. A series of such weather events can cause severe flooding in the City due to the large percentage of impervious area and the age and capacity of the drainage system.

The worst-case scenario is a series of storms that flood numerous drainage basins in a short time such as those projected by USGS in the CA ARkStorm Scenario (USGS, 2013). This could overwhelm response and floodplain management capabilities within the City. Major roads could be blocked, preventing critical access for many residents and critical functions. High in-channel flows could cause water courses to scour, possibly washing out roads and creating more isolation problems. In the case of multi-basin flooding, floodplain management resources would not be able to make repairs quickly enough to restore critical facilities and infrastructure. Additionally, as the grounds become saturated, groundwater flooding issues typical for the City would be significantly enhanced.

10.9 ISSUES

The planning team has identified the following flood-related issues relevant to the planning area:

- The currently effective flood hazard mapping does not accurately reflect the true flood risk in the City.
- The stormwater/urban drainage flooding risk is not mapped, which makes it difficult to assess this hazard, other than looking at historical loss data.
- Planning tools whose use depends on flood hazard mapping are less effective due to the deficiencies in the currently available mapping.
- There needs to be a sustained effort to gather historical damage data, such as high water marks on structures and damage reports, to measure the cost-effectiveness of future mitigation projects.
- Some City codes, such as the zoning ordinance and safety element of the General Plan, are old and in need of updating.
- Ongoing flood hazard mitigation will require funding from multiple sources.
- There needs to be a coordinated hazard mitigation effort between jurisdictions affected by flood hazards across Los Angeles County.
- Floodplain residents need to continue to be educated about flood preparedness and the resources available during and after floods.
- A lack of concern regarding flood risk by property owners can translate to the lack of political will to make changes.
- The potential impact of climate change on flood conditions needs to be better understood.
- The capability for flood threat recognition and warning needs to be enhanced.
- Flood warning capability should be tied to flood phases.
- There needs to be enhanced modeling to better understand the true flood risk.
- Floodplain restoration/reconnection opportunities should be identified as a means to reduce flood risk.
- Post-flood disaster response and recovery actions need to be solidified.
- Staff capacity is required to maintain the City's existing level of floodplain management.
- Floodplain management actions require interagency coordination.
- With the large percentage of pre-FIRM flood insurance policies in force, the City can expect to see significant increases in the costs of flood insurance within the City. This will create challenges in the promotion of flood insurance.
- Open spaces (infiltration) have decreased substantially, with no plans to reverse this trend. More impervious surface leads to more runoff.

11. LANDSLIDE / DEBRIS FLOW

11.1 GENERAL BACKGROUND

Ground saturation by water, steepening of slopes by erosion or construction, alternate freezing and thawing, and earthquake shaking are all factors that contribute to landslides. Landslides are typically associated with periods of heavy rainfall or rapid snow melt. Rain-saturated hill slopes and increased groundwater pressure on porous hillsides are triggering agents of slope failure. In areas burned by forest and brushfires, a lower threshold of precipitation may initiate landslides.

DEFINITIONS

Debris Flow—A river of rock, earth, organic matter and other materials saturated with water. Debris flows develop in the soil overlying bedrock on sloping surfaces when water rapidly accumulates in the ground, such as during heavy rainfall or rapid snowmelt. Water pressure in the pore spaces of the material increases to the point that the internal strength of the soil is drastically weakened. The soil's reduced resistance can then easily be overcome by gravity, changing the earth into a flowing river of mud or "slurry."

Landslide—The movement of masses of loosened rock and soil down a hillside or slope. Slope failures occur when the strength of the soils forming the slope is exceeded by the pressure, such as weight or saturation, acting upon them.

Mass Movement—A collective term for landslides, debris flows, falls and sinkholes.

11.1.1 Landslide Types

Landslides are commonly categorized by the type of initial ground failure. Common types of slides are shown on Figure 11-1 through Figure 11-4. The most common is the shallow colluvial slide, occurring particularly in response to intense, short-duration storms. The largest and most destructive are deep-seated slides, although they are less common than other types.

Source: Ecology, 2026

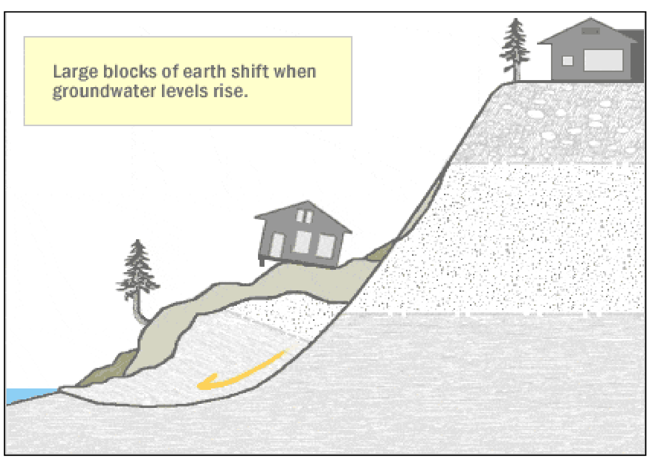


Figure 11-1. Deep Seated Slide

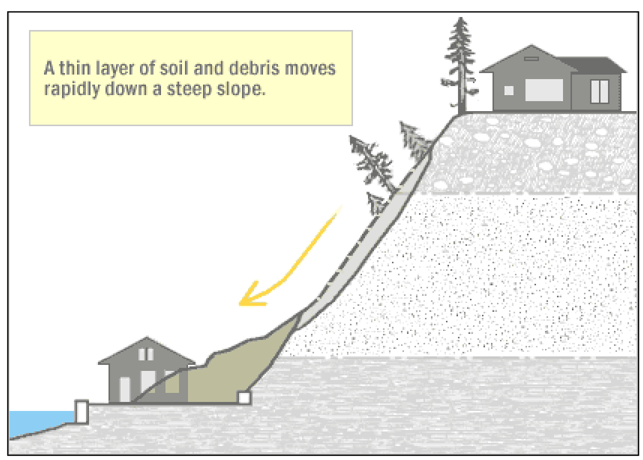


Figure 11-2. Shallow Colluvial Slide

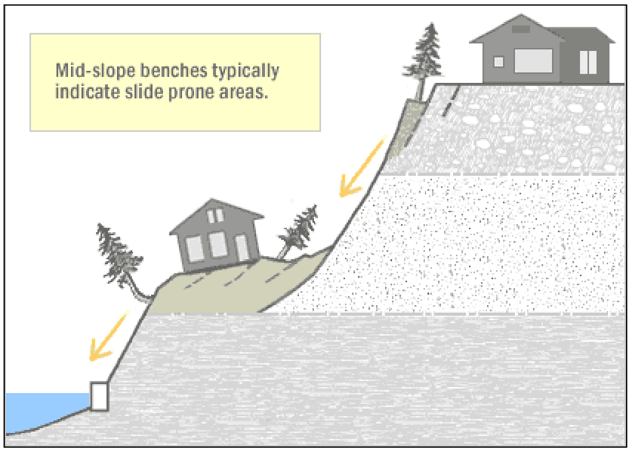


Figure 11-3. Bench Slide

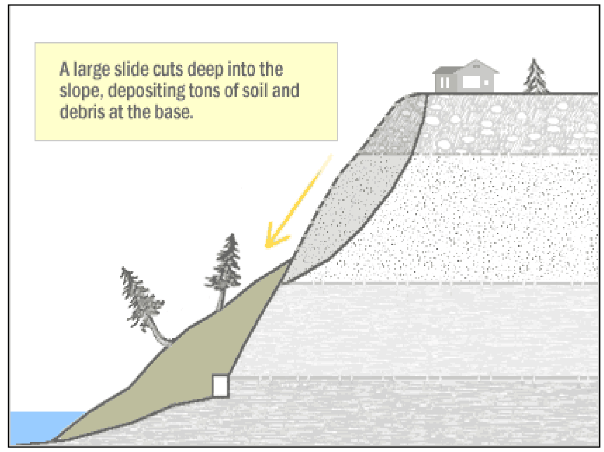


Figure 11-4. Large Slide

Debris flows—sometimes referred to as mudslides or mud flows—are rivers of rock, earth, organic matter and other soil materials saturated with water. Debris flows develop in the soil overlying bedrock on sloping surfaces when water rapidly accumulates in the ground, such as during heavy rainfall or rapid snowmelt. Water pressure in the pore spaces of the material increases to the point that the internal strength of the soil is drastically weakened. The soil's reduced resistance can then easily be overcome by gravity, changing the earth into a flowing river of mud. The consistency of debris flows ranges from watery mud to thick sludge that can carry large items such as boulders, trees, and cars. Debris flows from many sources can combine into channels that, with the addition of water, sand, mud, boulders, trees and other materials, can become greatly more destructive. The debris carried by a debris flow has the potential to spread over a broad area, wreaking havoc in developed communities.

A debris avalanche (Figure 11-5) is a fast-moving debris flow that travels faster than about 10 miles per hour (mph). Speeds in excess of 20 mph are not uncommon, and speeds in excess of 100 mph, although rare, can occur. Debris avalanches can travel many miles from their source, picking up large objects in their path and they can have many times the hydraulic force of water due to the mass of material included in them. They can be among the most destructive events in nature.

Landslides also include the following:

- Rock Falls—Blocks of rock that fall away from a bedrock unit without a rotational component
- Rock Topples—Blocks of rock that fall away from a bedrock unit with a rotational component
- Rotational Slumps—Blocks of fine-grained sediment that rotate and move down slope
- Transitional Slides—Sediments that move along a flat surface without a rotational component
- Earth Flows—Fine-grained sediments that flow downhill and typically form a fan structure
- Creep—A slow-moving landslide often only noticed through crooked trees and disturbed structures
- Block Slides—Blocks of rock that slide along a slip plane as a unit down a slope.

11.1.2 Landslide Modeling

Two characteristics are essential to conducting an accurate risk assessment of the landslide hazard:

- The type of initial ground failure that occurs, as described above
- The post-failure movement of the loosened material ("run-out"), including travel distance and velocity.

Source: California Department of Conservation 2016a

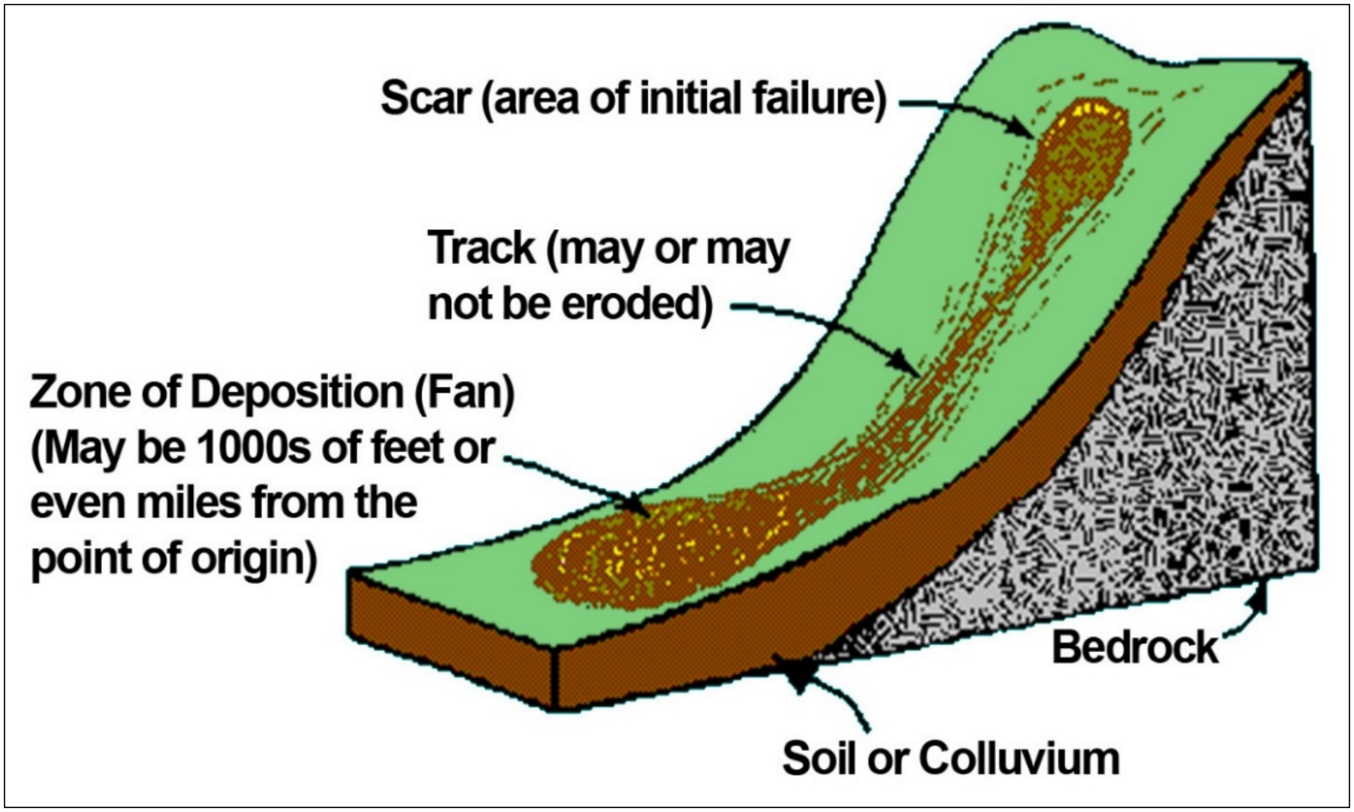


Figure 11-5. Typical Debris Avalanche Scar and Track

All current landslide models—those in practical applications and those more recently developed—use simplified hypothetical descriptions of mass movement to simulate the complex behavior of actual flow. The models attempt to reproduce the general features of the moving mass of material through measurable factors, such as base shear, that define a system and determine its behavior. Due to the lack of experimental data and the limited current knowledge about the behavior of the moving flows, landslide models use simplified parameters to account for complex aspects that may not be defined. These simplified parameters are not related to specific physical processes that can be directly measured, and there is a great deal of uncertainty in their definition. Some, but not all, models provide estimates of the level of uncertainty associated with the modeling approach.

Run-out modeling is further complicated because the movement of materials may change over the course of a landslide event, depending on the initial composition, the extent of saturation by water, the ground shape of the path traveled and whether there is additional material incorporated during the event (Savage and Hutter 1991; Rickenmann & Weber, 2000; Iverson, 2004).

11.1.3 Landslide Causes

Mass movements are caused by a combination of geological and climate conditions, as well as the encroaching influence of urbanization. Vulnerable natural conditions are affected by human residential, agricultural, commercial and industrial development and the infrastructure that supports it. The following factors can contribute to landslide: change in slope of the terrain, increased load on the land, shocks and vibrations, change in water content, groundwater movement, frost action, weathering of rocks, and removing or changing the type of vegetation covering slopes.

Excavation and Grading

Slope excavation is common in the development of home sites or roads on sloping terrain. Grading can result in some slopes that are steeper than the pre-existing natural slopes. Since slope steepness is a major factor in landslides, these steeper slopes can be at an increased risk for landslides. The added weight of fill placed on slopes can also result in an increased landslide hazard. Small landslides can be fairly common along roads, in either the road cut or the road fill. Landslides occurring below new construction sites are indicators of the potential impacts stemming from excavation.

Drainage and Groundwater Alterations

Watershed protection is a primary concern of the City of Los Angeles, especially in hillside areas. While permeable soils soak up rain and irrigation water, proper grading and drainage systems can collect water to protect slopes from oversaturation and slippage. Water flowing through or above ground is often the trigger for landslides. Any activity that increases the amount of water flowing into landslide-prone slopes can increase landslide hazards. Broken or leaking water or sewer lines can be especially problematic, as can water retention facilities that direct water onto slopes. However, even lawn irrigation and minor alterations to small streams in landslide prone locations can result in damaging landslides. Ineffective stormwater management and excess runoff can also cause erosion and increase the risk of landslide hazards. Drainage can be affected naturally by the geology and topography of an area. Development that results in an increase in impervious surface impairs the ability of the land to absorb water and may redirect water to other areas. Channels, streams, flooding, and erosion on slopes all indicate potential slope problems.

Road and driveway drains, gutters, downspouts, and other constructed drainage facilities can concentrate and accelerate flow. Ground saturation and concentrated velocity flow are major causes of slope problems and may trigger landslides.

Changes in Vegetation

The Los Angeles Bureau of Engineering, Department of Building and Safety, Department of City Planning and Fire Department coordinate on development project permit reviews to guarantee that proper grading, drainage, irrigation and landscaping are implemented to preserve slope stability, control erosion and reduce the potential for flooding and fires. Following major brushfires, federal or state agencies typically seed denuded areas with wild plant seeds. This encourages vegetation growth, thereby stabilizing the barren soil and protecting the watershed from erosion. Areas that have experienced wildfire and land clearing for development may have long periods of increased landslide hazard. To reduce fire hazards and protect slopes, Los Angeles presently mandates vegetation clearance and encourages hillside property owners to plant appropriate vegetation.

11.1.4 Landslide Management

While small landslides are often a result of human activity, the largest landslides are often naturally occurring phenomena with little or no human contribution. The sites of large landslides are typically areas of previous landslide movement that are periodically reactivated by significant precipitation or seismic events. Such naturally occurring landslides can disrupt roadways and other infrastructure lifelines, destroy private property, and cause flooding, stream bank erosion and rapid stream channel migration.

Landslides can create immediate, critical threats to public safety. Engineering solutions to protect structures on or adjacent to large active landslides are often extremely or prohibitively expensive. In spite of their destructive potential, landslides can serve beneficial functions to the natural environment. They supply sediment and large wood to stream channel networks and can contribute to stream complexity and dynamic channel behavior critical for aquatic and riparian ecological diversity. Effective landslide management should include the following elements:

- Continuing investigation to identify natural landslides, understand their mechanics, assess their risk to public health and welfare, and understand their role in ecological systems
- Regulation of development in or near existing landslides or areas of natural instability through codes and ordinances.
- Preparation for emergency response to landslides to facilitate rapid, coordinated action among local, state and federal agencies, and to provide emergency assistance to affected or at-risk residents
- Evaluation of options including landslide stabilization or structure relocation where landslides are identified as a threat to critical public structures or infrastructure

11.2 HAZARD PROFILE

11.2.1 Past Events

Table 11-1 lists known landslide events that impacted the planning area between 1978 and February 2017.

11.2.2 Location

The best available predictor of where movement of slides and earth flows might occur is the location of past movements. Past landslides can be recognized by their distinctive topographic shapes, which can remain in place for thousands of years. Most landslides recognizable in this fashion range from a few acres to several square miles. Most show no evidence of recent movement and are not currently active. A small proportion of them may become active in any given year, with movements concentrated within all or part of the landslide masses or around their edges.

The recognition of ancient dormant mass movement sites is important in the identification of areas susceptible to flows and slides because they can be reactivated by earthquakes or by exceptionally wet weather. Also, because they consist of broken materials and frequently involve disruption of groundwater flow, these dormant sites are vulnerable to construction-triggered sliding.

Landslide hazard areas are scattered throughout Los Angeles. As development has spread into the hillsides, unstable soil and erosion often contributes to landslides and mudslides. Factors that characterize landslide hazard areas include significant slope, weak rocks, and heavy rains.

The Santa Susana Mountains and the mountains north of the Santa Clara River valley are extremely susceptible to landslides during seismic shaking. In the Santa Susana Mountains, more than 75 percent of the slope area has been denuded by landslides triggered by strong shaking. Characteristic landslides in this area were anywhere from several inches to several feet deep. These slides consisted of dry, highly disaggregated material that cascaded to flatter areas near the bases of nearby slopes. In the San Gabriel Mountains to the northeast, rock falls have been fewer and more widely scattered. This has been attributed to the mountain range's Mesozoic granite and Precambrian metamorphic rock that, although deeply weathered, is more competent than the weak sediment of the Santa Susana Mountains.

The California Landslide Hazard Identification Act directs the state geologist to identify and map hazardous landslide areas for use by municipalities in planning and decision-making on grading and building permits. This program focuses on urban areas and growth areas experience heavy rainfall and that exhibit significant slopes and weak rocks. The California Geological Survey provides access to many of these maps through its California Landslide Inventory (DOC 2016b). Landslide hazard areas in each APC are shown in Figure 11-6 through Figure 11-12.

Table 11-1. Landslide Events in and near the City of Los Angeles Planning Area

Event Date	Event Type	FEMA Number	Location	Description
1/18 – 1/23/2017	Severe winter storms, flooding, and mudslides	4305	Hollywood Hills	A hillside collapsed, affecting five homes. Hundreds of residents were without power immediately after the collapse.
10/17/2015	Mudslide	—	State Route 58 east of Bakersfield	In northern Los Angeles County's Antelope Valley, a river of mud covered a section of the highway and cars after high rains.
3/21/2013	Landslide	—	Pacific Coast Highway near Santa Monica	A landslide closed northbound Pacific Coast Highway for a day.
11/04/2011	Landslide	—	San Pedro	A major landslide along a seaside cliff in San Pedro was triggered by a heavy rainstorm The landslide took out 600 feet of the scenic road and carved a chasm into the 12-foot-high coastal bluff.
1/17- 2/6/2010	Severe Winter Storms, Flooding, and Debris And Mud Flows	1884	Regional storm	A slow moving rainstorm triggered a mudslide along Ocean View Boulevard in the La Canada Flintridge burn area, flooded freeways, and caused traffic problems and mudslides throughout the region.
10/21/2007 – 3/31/2008	Wildfires, Flooding, Mud Flows, and Debris Flows	1731	Regional storm	
2/16 – 2/23/2005	Severe Storms, Flooding, Landslides, Mud & Debris Flows	1585	Regional storm	
12/27/2004 – 1/11/2005	Severe Storms, Flooding, Debris Flows, and Mudslides	1577	La Conchita	Major landslide killed 10 people and destroyed or damaged dozens of homes.
10/21/2003 – 3/31/2004	Wildfires, Flooding, Mud Flow and Debris Flow	1498	Regional storm	
2/13 – 4/19/1995	Severe Winter Storms, Flooding Landslides, Mud Flow	1046	Regional storm	
1/3 – 2/10/1995	Severe Winter Storms, Flooding, Landslides, Mud Flows	1044	Los Angeles and Ventura Counties	A year of above-average rainfall caused landslides in Los Angeles and Ventura counties, including the La Conchita landslide, in which 12 homes were severely damaged or destroyed.
1/17/1994	Northridge Earthquake	1008	Regional event	The earthquake caused more than 11,000 landslides throughout the region. The landslides released a spore, known as "valley fever" leading to several deaths.
10/26/1993 – 4/22/1994	Fires, Mud/Landslides, Flooding, Soil Erosion	1005	Orange County	Landslides in Orange County's San Clemente and Big Rock Mesa cost over $700 million in damage and litigation costs.
1/5 – 3/20/1993	Severe Winter Storm, Mud and Land Slides, and Flooding	979	Regional storm	
2/10 – 2/18/1992	Rain/Snow/Wind Storms, Flooding, Mudslides	935	Regional storm	
10/1 – 11/20/1987	Earthquake and Aftershocks	799	Regional event	
1/21 – 3/30/1983	Coastal Storms, Floods, Slides and Tornadoes	677	Regional storm	
1/8/1980	Severe Storms, Mudslides and Flooding	615	Los Angeles County	Damage in Monterey Park, in Los Angeles County.
2/15/1978	Coastal Storms, Mudslides and Flooding	547	Regional storm	Intense rainfall caused water and debris down canyons in the City, leading to 21 deaths and $50 million in damage.

Sources: FEMA 2017; California Department of Conservation, Division of Mines and Geology 1979, USGS 1988, and 1998; NOAA 2017

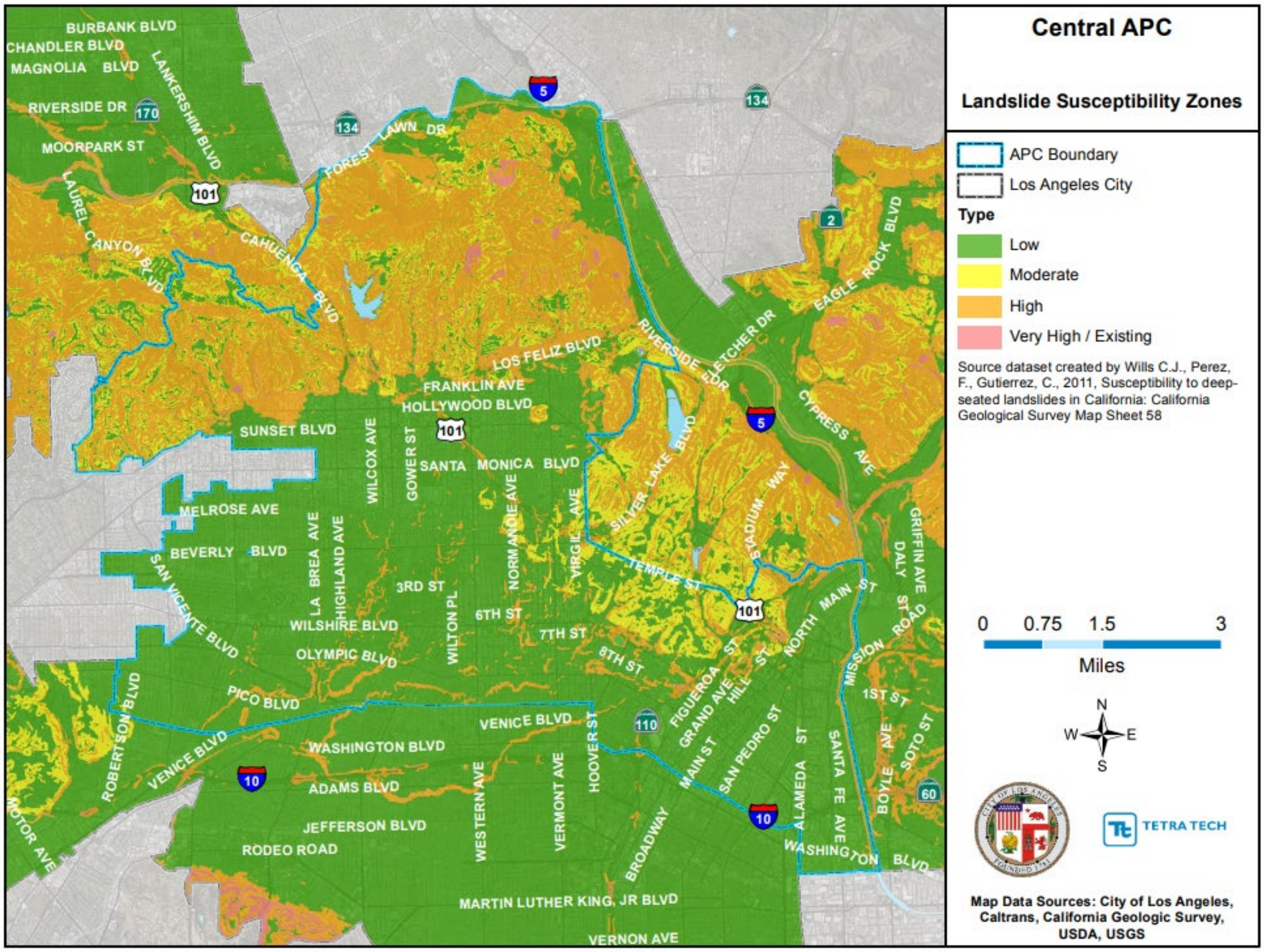


Figure 11-6. Landslide Hazard Areas in the Central APC

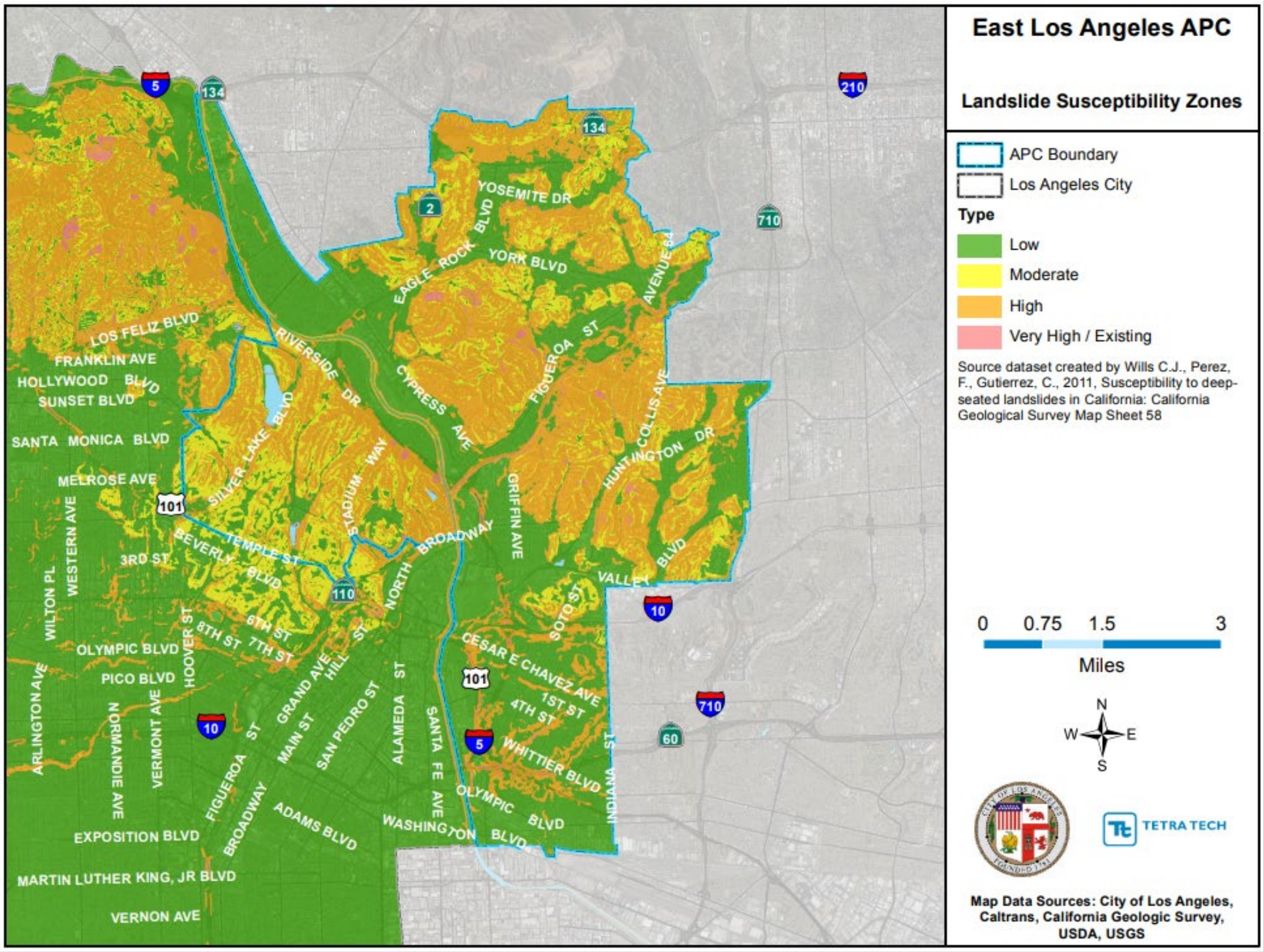


Figure 11-7. Landslide Hazard Areas in the East Los Angeles APC

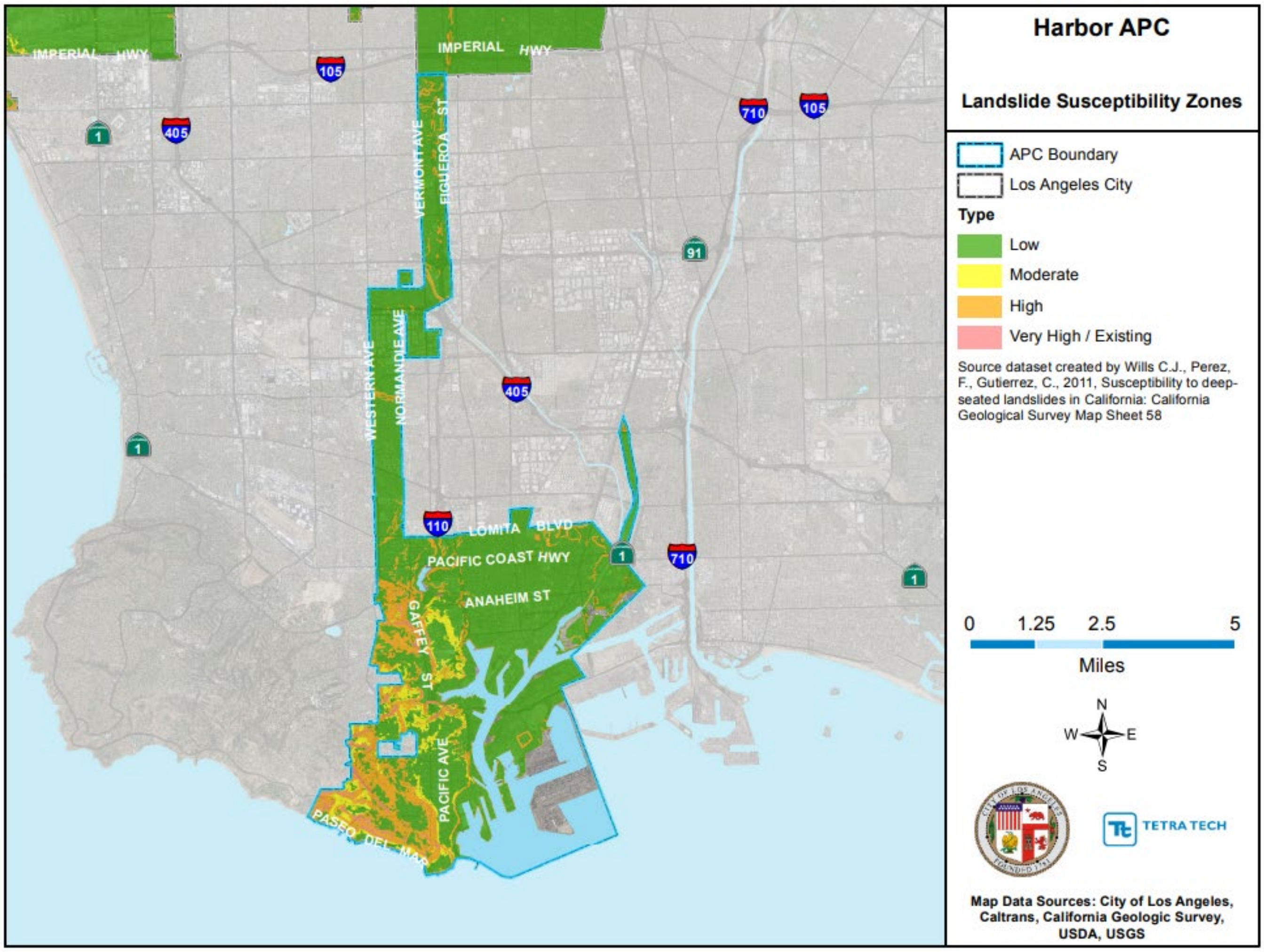


Figure 11-8. Landslide Hazard Areas in the Harbor APC

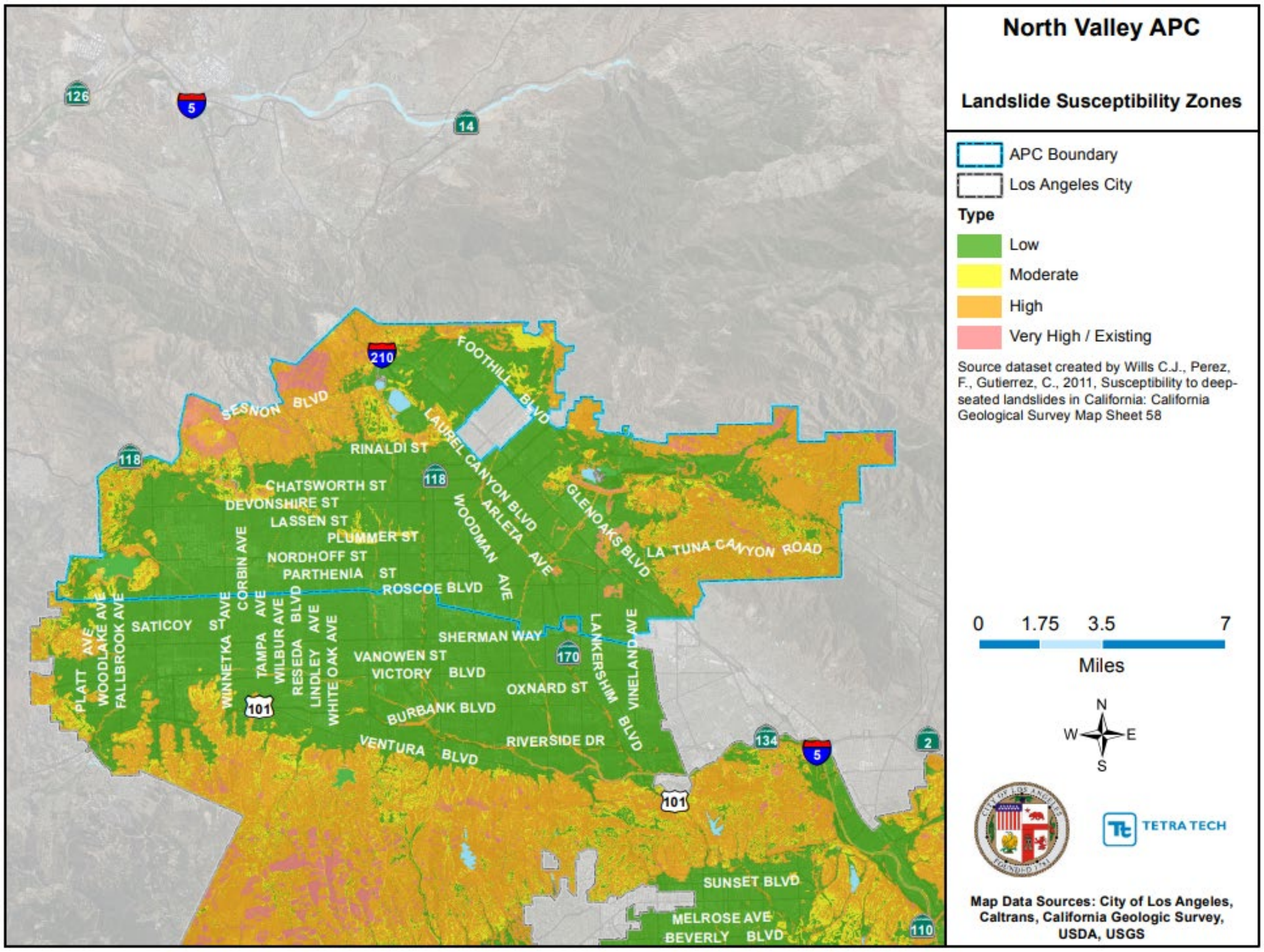


Figure 11-9. Landslide Hazard Areas in the North Valley APC

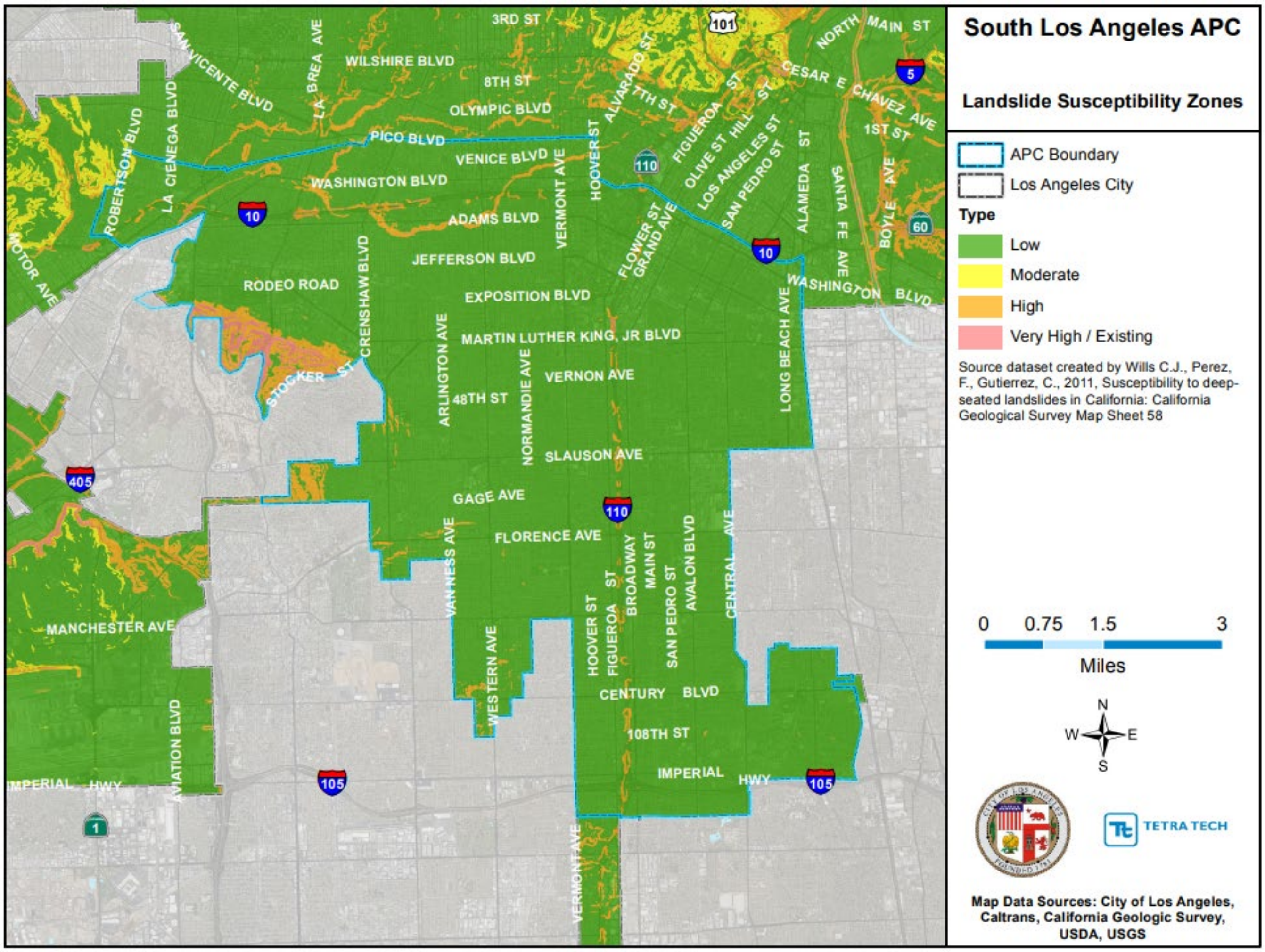


Figure 11-10. Landslide Hazard Areas in the South Los Angeles APC

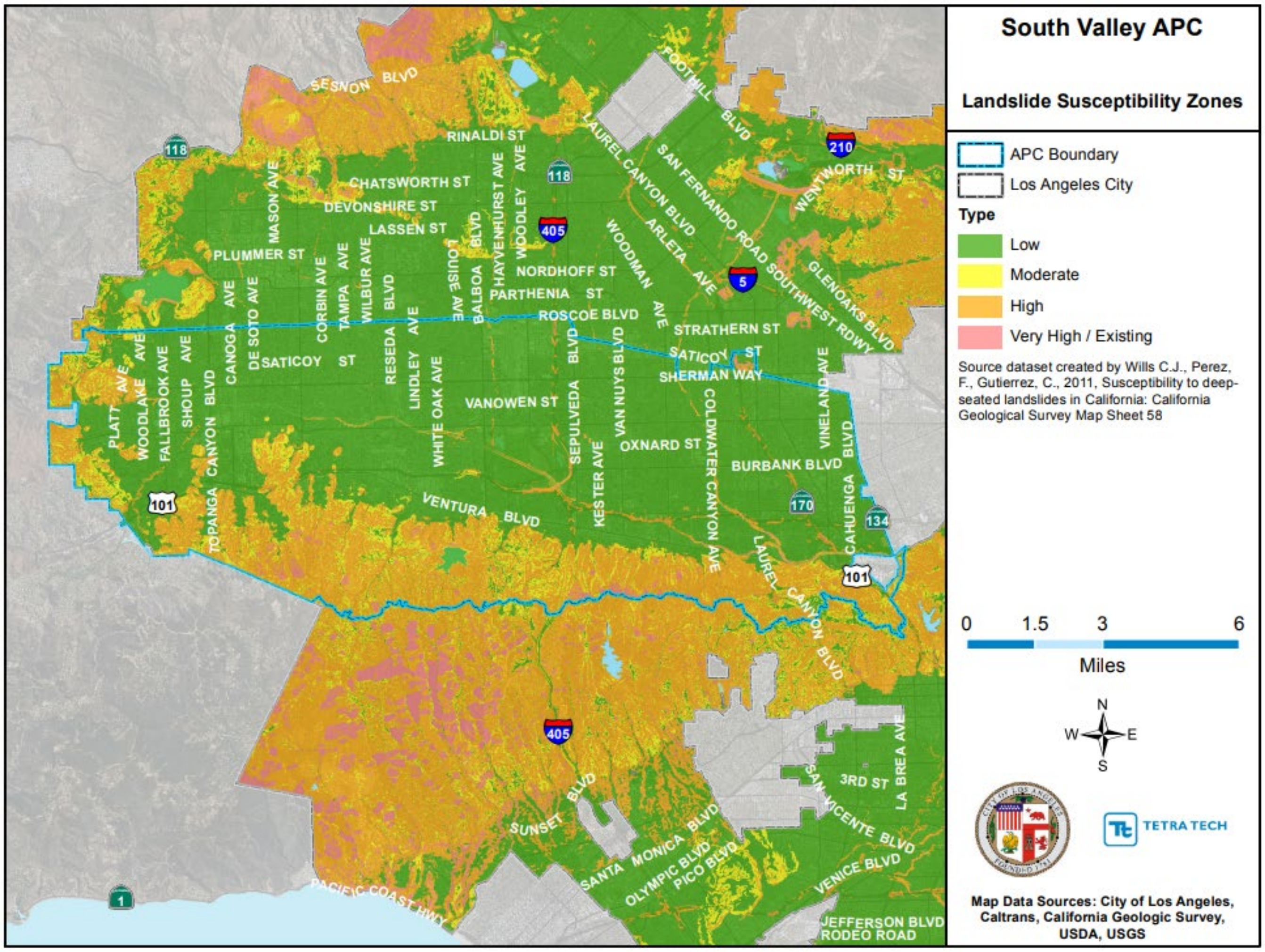


Figure 11-11. Landslide Hazard Areas in the South Valley APC

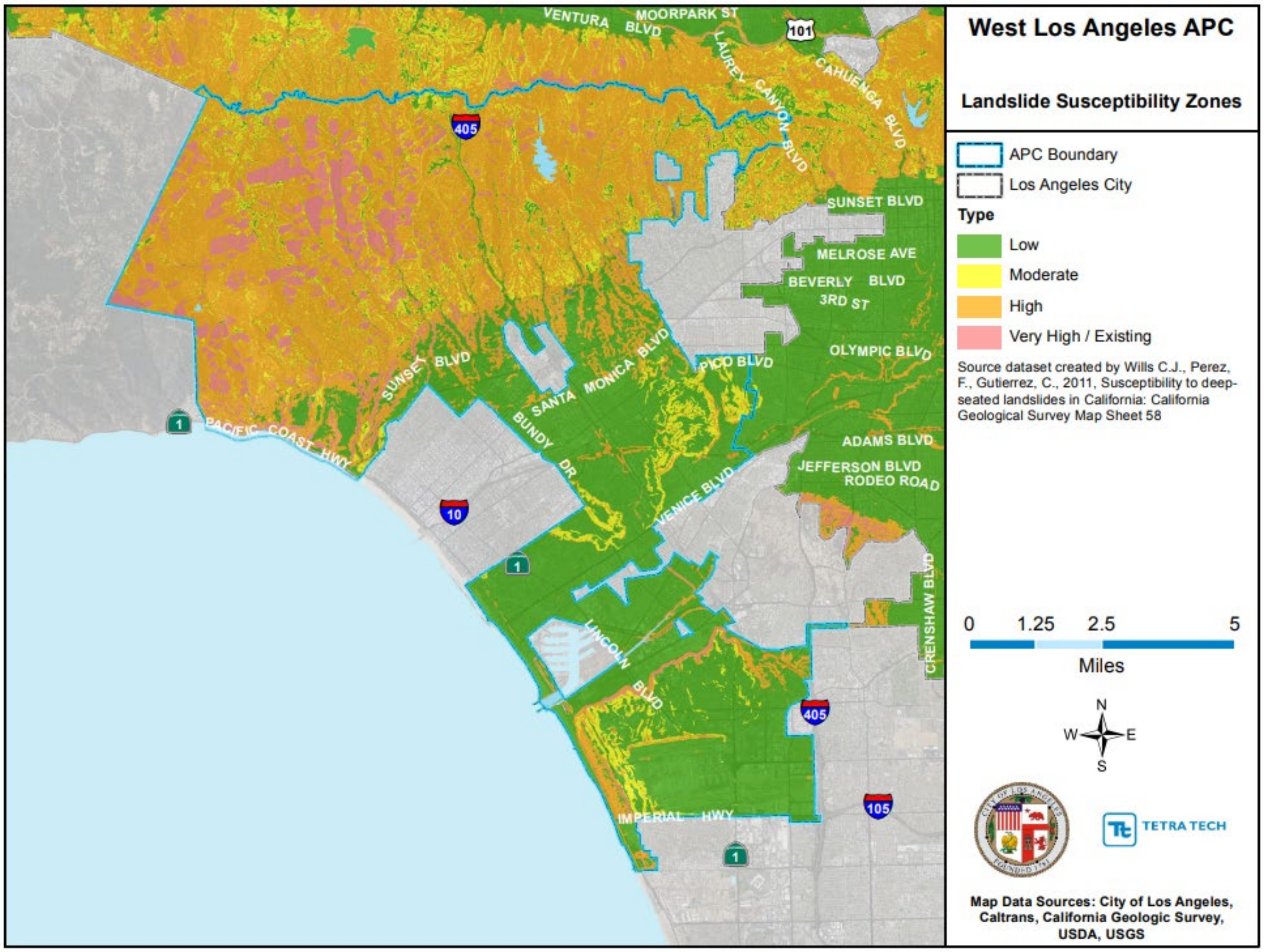


Figure 11-12. Landslide Hazard Areas in the West Los Angeles APC

11.2.3 Frequency

Landslides are often triggered by other natural hazards such as earthquakes, heavy rain, floods or wildfires, so landslide frequency is often related to the frequency of these other hazards. In the planning area, landslides typically occur during and after earthquakes, wildland fires, and severe storms, so the potential for landslides largely coincides with the potential for sequential severe storms that saturate steep and vulnerable soils from earthquakes and wildland fires. According to NCEI storm events database, the planning area has been impacted by earthquakes, wildland fires, and severe storms at least once every other year since 1960, representing an annual probability of 50 percent. Given the preponderance of steep slopes and the frequency of contributory sources to landslides in Los Angeles, the probability of future occurrence can be considered equal to this 50-percent annual probability. Until better data is generated specifically for landslide hazards, this severe storm frequency is appropriate for the purpose of ranking risk associated with the landslide hazard.

In general, landslides are most likely during periods of higher than average rainfall. The ground must be saturated prior to the onset of a major storm for significant landslide to occur. Most local landslides occur in January after the water table has risen during the wet months of November and December. Water is involved in nearly all cases; and human influence has been identified in more than 80 percent of reported slides.

11.2.4 Severity

Landslides destroy property and infrastructure and can take the lives of people. They can pose a serious hazard to properties on or below hillsides. Landslides directly damage structures in two ways: disruption of structural foundations caused by differential movement/deformation of the ground upon which the structure sits, and the physical impact of debris moving down-slope against structures located in the debris flow's path. As a landslide breaks away from a slope, it deforms the ground into an undulating surface broken up by fissures and scarps. This deformation distresses foundations and structures situated on top of a landslide by settlement, cracking, and tilting. This can occur slowly, over years, or rapidly within days or hours. A water-saturated, fast-moving debris flow can destroy all in its path, collapsing walls and shifting structures off their foundations.

Slope failures in the United States result in an average of 25 lives lost per year and an annual cost to society of about $1.5 billion. Landslides and debris flows cause millions of dollars in cumulative damage to Southern California's homes, businesses, and infrastructure every year.

11.2.5 Warning Time

Mass movements can occur suddenly or slowly. The velocity of movement may range from a slow creep of inches per year to many feet per second, depending on slope angle, material and water content. Landslides and debris flows can be initiated by severe storms, earthquakes, wildland fires, or human modification of the land. They can move rapidly down slopes or through channels, and can strike with little or no warning at avalanche speeds.

Some methods used to monitor mass movements can provide an idea of the type of movement and the amount of time prior to failure. It is also possible to determine what areas are at risk during general time periods. Assessing the geology, vegetation and amount of predicted precipitation for an area can help in these predictions. However, there is no practical warning system for individual landslides. The current standard operating procedure is to monitor situations on a case-by-case basis, and respond after the event has occurred.

When atmospheric river weather patterns reach Los Angeles, the risk and dangers of landslides and debris flows increase. Improved forecasting of such events could allow advanced warning to better prepare for and respond to potential slope failures and flood events. Generally accepted warning signs for landslide activity include the following:

- Springs, seeps, or saturated ground in areas that have not typically been wet before

- New cracks or unusual bulges in the ground, street pavements or sidewalks
- Soil moving away from foundations
- Ancillary structures such as decks and patios tilting and/or moving relative to the main house
- Tilting or cracking of concrete floors and foundations
- Broken water lines and other underground utilities
- Leaning telephone poles, trees, retaining walls or fences
- Offset fence lines
- Sunken or down-dropped road beds
- Rapid increase in creek water levels, possibly accompanied by increased turbidity (soil content)
- Sudden decrease in creek water levels though rain is still falling or just recently stopped
- Sticking doors and windows, and visible open spaces indicating jambs and frames out of plumb
- A faint rumbling sound that increases in volume as the landslide nears
- Unusual sounds, such as trees cracking or boulders knocking together.

11.3 SECONDARY IMPACTS

Landslides can cause secondary impacts such as blocking roads, which can isolate residents and businesses and delay commercial, public and private transportation. This could result in economic losses for businesses. Other potential problems resulting from landslides are power and communication failures. Vegetation or poles on slopes can be knocked over, resulting in possible losses to power and communication lines. Landslides also have the potential of destabilizing the foundation of structures, which may result in monetary loss for residents. They also can damage rivers or streams, potentially harming water quality, fisheries and spawning habitat.

11.4 EXPOSURE

11.4.1 Population

Population counts of those living in landslide hazard areas were generated for each APC by estimating the percent of residential buildings in each landslide susceptibility zone and multiplying the total estimated population for the APC by this percentage. Using this approach, the estimated residential population is 246,184 in the moderate landslide risk area, 643,161 in the high landslide risk area, and 25,562 in the very high landslide risk area.

11.4.2 Property

Structures

Table 11-2, Table 11-3, and Table 11-4 show the number of buildings in the landslide susceptibility risk areas and replacement value of structures and contents. There are 118,314 structures on parcels in the high landslide risk areas, with an estimated value of $88 billion. Over 99 percent of the exposed structures are dwellings.

Land Use

Table 11-5 shows the general land use of parcels exposed to moderate, high and very high landslide hazard in the City of Los Angeles.

Table 11-2. Exposure and Value of Structures in Moderate Landslide Risk Areas

Area Planning Commission	Buildings Exposed	Estimated Value within the Landslide Risk Area			% of Total Replacement Value
		Structure	Contents	Total	
Central	5,497	$5,792,058,648	$3,927,936,838	$9,719,995,486	5.08%
East Los Angeles	12,612	$4,770,835,868	$3,134,157,139	$7,904,993,007	11.93%
Harbor	3,065	$943,206,960	$550,289,562	$1,493,496,522	3.64%
North Valley	6,989	$2,514,613,734	$1,617,152,259	$4,131,765,994	3.57%
South Los Angeles	65	$25,575,004	$15,153,908	$40,728,912	0.04%
South Valley	8,847	$4,017,690,103	$2,217,434,986	$6,235,125,089	4.29%
West Los Angeles	8,608	$4,004,685,947	$2,245,155,861	$6,249,841,809	5.69%
Total	**45,683**	**$22,068,666,264**	**$13,707,280,553**	**$35,775,946,817**	**4.66%**

Table 11-3. Exposure and Value of Structures in High Landslide Risk Areas

Area Planning Commission	Buildings Exposed	Estimated Value within the Landslide Risk Area			% of Total Replacement Value
		Structure	Contents	Total	
Central	14,198	$11,727,874,741	$7,324,325,876	$19,052,200,616	9.96%
East Los Angeles	28,632	$9,871,746,469	$6,410,710,828	$16,282,457,298	24.57%
Harbor	7,522	$2,946,382,674	$2,016,873,113	$4,963,255,787	12.11%
North Valley	23,115	$8,192,394,373	$4,986,838,184	$13,179,232,557	11.40%
South Los Angeles	3,760	$1,876,528,381	$1,107,241,961	$2,983,770,342	3.03%
South Valley	18,984	$8,407,646,455	$4,676,015,080	$13,083,661,535	8.99%
West Los Angeles	22,103	$12,079,420,360	$7,361,969,941	$19,441,390,301	17.70%
Total	**118,314**	**$55,101,993,453**	**$33,883,974,983**	**$88,985,968,436**	**11.59%**

Table 11-4. Exposure and Value of Structures in Very High Landslide Risk Areas

Area Planning Commission	Buildings Exposed	Estimated Value within the Landslide Risk Area			% of Total Replacement Value
		Structure	Contents	Total	
Central	175	$110,603,489	$80,392,445	$190,995,933	0.10%
East Los Angeles	356	$198,929,462	$163,024,470	$361,953,932	0.55%
Harbor	609	$138,007,665	$73,947,119	$211,954,784	0.52%
North Valley	1,606	$635,835,920	$338,050,043	$973,885,963	0.84%
South Los Angeles	349	$116,893,386	$60,089,012	$176,982,398	0.18%
South Valley	358	$150,690,013	$81,659,096	$232,349,109	0.16%
West Los Angeles	1,717	$1,079,123,406	$729,274,106	$1,808,397,512	1.65%
Total	**5,170**	**$2,430,083,340**	**$1,526,436,291**	**$3,956,519,631**	**0.52%**

Table 11-5. Land Use in Landslide Risk Areas

Land Use	Area in Landslide Risk Area (acres)	% of total
Moderate Landslide Risk Area		
Agriculture	0.0	0.00%
Commercial	758.8	4.44%
Government	866.2	5.06%
Industrial	299.5	1.75%
Multi-Family Residential	1,637.2	9.57%
Open Space	3,822.7	22.35%
Parking	0.9	0.01%
Single Family Residential	9,721.4	56.83%
Total	17,106.6	100.00%
High Landslide Risk Area		
Agriculture	1.5	0.00%
Commercial	1,309.9	1.74%
Government	3,550.4	4.71%
Industrial	1,401.8	1.86%
Multi-Family Residential	3,902.6	5.18%
Open Space	26,634.2	35.36%
Parking	0.3	0.00%
Single Family Residential	38,528.1	51.15%
Total	75,328.8	100.00%
Very High Landslide Risk Area		
Agriculture	0.0	0.00%
Commercial	102.5	1.14%
Government	327.4	3.63%
Industrial	197.7	2.19%
Multi-Family Residential	145.5	1.61%
Open Space	4,935.8	54.74%
Parking	0.2	0.00%
Single Family Residential	3,307.0	36.68%
Total	9,016.2	100.00%

11.4.3 Critical Facilities and Infrastructure

Landslide and debris flow damage to buildings, roads, utilities, and transportation lines can have catastrophic repercussions, such as loss of power to critical facilities (hospitals, schools, fire departments, etc.), impaired disposal of sewage, contamination of water supplies, disruption of transportation infrastructure, release of flammable fuels, etc. The overall impact of such lifeline failures, including secondary failure of systems that depend on lifelines, can be much greater than the impact of individual building failures. A significant amount of infrastructure can be exposed to mass movements:

- **Roads**—Access to major roads is crucial to life-safety after a disaster event and to response and recovery operations. Landslides can block egress and ingress on roads, causing isolation for neighborhoods, traffic problems and delays for public and private transportation. This can result in economic losses for businesses.

- **Bridges**—Landslides can significantly impact road bridges. Mass movements can knock out bridge abutments or significantly weaken the soil supporting them, making them hazardous for use. **Transportation Lines**— Once broken, transmission of electricity, water and other essentials through utility and transportation lines cease. Such sudden elimination of these services can have catastrophic repercussions such as loss of power to critical facilities (hospitals, schools, fire departments, etc.) impaired disposal of sewage, contamination of water supplies, disruption of transportation infrastructure, release of flammable fuels, etc.

Table 11-6 summarizes the critical facilities exposed to the landslide hazard. No loss estimation of these facilities was performed due to the lack of established damage functions for the landslide hazard.

Table 11-6. Critical Facilities and Infrastructure in Landslide Risk Areas

APC	Critical Operating Facilities	Critical Response Facilities	Critical Infrastructure—Transportation	Critical Infrastructure—Utilities	Total
Moderate Landslide Risk Areas					
Central	0	6	19	2	**27**
East Los Angeles	0	16	12	3	**31**
Harbor	0	3	2	2	**7**
North Valley	0	2	11	3	**16**
South Los Angeles	0	0	0	0	**0**
South Valley	0	6	6	0	**12**
West Los Angeles	0	4	9	4	**17**
Total	**0**	**37**	**59**	**14**	**110**
High Landslide Risk Areas					
Central	1	17	45	3	**66**
East Los Angeles	0	32	98	9	**139**
Harbor	0	8	15	9	**32**
North Valley	0	21	71	19	**111**
South Los Angeles	0	3	20	2	**25**
South Valley	0	7	40	5	**52**
West Los Angeles	0	22	26	23	**71**
Total	**1**	**110**	**315**	**70**	**496**
Very High Landslide Risk Areas					
Central	0	0	7	0	**7**
East Los Angeles	0	1	3	0	**4**
Harbor	0	0	1	1	**2**
North Valley	0	0	4	1	**5**
South Los Angeles	0	0	0	0	**0**
South Valley	0	0	2	0	**2**
West Los Angeles	0	0	4	10	**14**
Total	**0**	**1**	**21**	**12**	**34**

11.4.4 Environment

Environmental problems as a result of mass movements can be numerous. Landslides that fall into streams may significantly impact fish and wildlife habitat, as well as affecting water quality. Hillsides that provide wildlife habitat can be lost for prolong periods of time due to landslides.

11.5 VULNERABILITY

11.5.1 Population

All of people exposed to landslide risk are considered to be vulnerable. Increasing population and the fact that many homes are built on view property atop or below bluffs and on steep slopes subject to mass movement increases the number of lives endangered by this hazard.

11.5.2 Property

Loss estimations for the landslide hazard are not based on modeling utilizing damage functions, because no such damage functions have been generated. Instead, loss estimates were developed representing 10 percent, 30 percent and 50 percent of the replacement value of exposed structures. This allows emergency managers to select a range of economic impact based on an estimate of the percent of damage to the general building stock. Damage in excess of 50 percent is considered to be substantial by most building codes and typically requires total reconstruction of the structure. Table 11-7 shows the aggregate general building stock loss estimates from the Very High and High landslide risk areas.

Table 11-7. Loss Potential for Landslide (Aggregate from Very High and High Risk Areas)

Area Planning Commission	Total Building Value (Structure and contents in $)	10% of Total Building Value	30% of Total Building Value	50% of Total Building Value
Central	$19,243,196,549	$1,924,319,655	$5,772,958,965	$9,621,598,275
East Los Angeles	$16,644,411,230	$1,664,441,123	$4,993,323,369	$8,322,205,615
Harbor	$5,175,210,571	$517,521,057	$1,552,563,171	$2,587,605,286
North Valley	$14,153,118,519	$1,415,311,852	$4,245,935,556	$7,076,559,260
South Los Angeles	$3,160,752,740	$316,075,274	$948,225,822	$1,580,376,370
South Valley	$13,316,010,644	$1,331,601,064	$3,994,803,193	$6,658,005,322
West Los Angeles	$21,249,787,813	$2,124,978,781	$6,374,936,344	$10,624,893,906
Total	**$92,942,488,067**	**$9,294,248,807**	**$27,882,746,420**	**$46,471,244,033**

Although complete historical documentation of the landslide threat in the planning area is lacking, the available history of landslides and mudslides in the region suggests a significant vulnerability to such hazards. The millions of dollars in damage attributable to mass movement has affected private property and public infrastructure and facilities.

11.5.3 Critical Facilities and Infrastructure

There are 640 critical facilities exposed to the landslide hazard in the moderate to very high risk areas. A more in-depth analysis of the mitigation measures taken by these facilities to prevent damage from mass movements should be done to determine if they could withstand impacts of a mass movement.

Several types of infrastructure are exposed to mass movements, including transportation, water and sewer and power infrastructure. Highly susceptible areas of the planning area include mountain and coastal roads and transportation infrastructure. At this time all infrastructure and transportation corridors identified as exposed to the landslide hazard are considered vulnerable until more information becomes available.

11.5.4 Environment

The environment vulnerable to landslide hazard is the same as the environment exposed to the hazard.

11.6 FUTURE TRENDS IN DEVELOPMENT

The planning area has experienced moderate growth over the past seven years, averaging a 0.90 percent increase in population every year from 2010 through 2016.

The City of Los Angeles is equipped to handle future growth within landslide hazard areas. In July 2016, the City updated the Baseline Mansionization Ordinance and the Baseline Hillside Ordinance that includes limiting the grading quantities of lots in designated “Hillside Areas.” In addition, the City’s General Plan addresses landslide risk areas in its Safety Element. The City of Los Angeles has committed to linking its General Plan to this hazard mitigation plan update. This will create an opportunity for wise land use decisions as future growth impacts landslide hazard areas.

The State of California has adopted the International Building Code (IBC) by reference in its California Building Standards Code. The IBC includes provisions for geotechnical analyses in steep slope areas that have soil types considered susceptible to landslide hazards. These provisions ensure that new construction is built to standards that reduce the vulnerability to landslide risk.

11.7 SCENARIO

Major landslides in the planning area occur as a result of soil conditions that have been affected by severe storms, groundwater or human development. The worst-case scenario for landslide hazards in the planning area would generally correspond to a severe storm that had heavy rain and caused flooding. Landslides are most likely during late winter when the water table is high. After heavy rains from November to December, soils become saturated with water. As water seeps downward through upper soils that may consist of permeable sands and gravels and accumulates on impermeable silt, it will cause weakness and destabilization in the slope. A short intense storm could cause saturated soil to move, resulting in landslides. As rains continue, the groundwater table rises, adding to the weakening of the slope. Gravity, poor drainage, a rising groundwater table and poor soil exacerbate hazardous conditions.

Mass movements are becoming more of a concern as development moves outside of urban centers and into areas less developed in terms of infrastructure. Most mass movements would be isolated events affecting specific areas. It is probable that private and public property, including infrastructure, will be affected. Mass movements could affect bridges that pass over landslide prone ravines and knock out rail service through the planning area. Road obstructions caused by mass movements would create isolation problems for residents and businesses in sparsely developed areas. Property owners exposed to steep slopes may suffer damage to property or structures. Landslides carrying vegetation such as shrubs and trees may cause a break in utility lines, cutting off power and communication access to residents.

Continued heavy rains and flooding will complicate the problem further. As emergency response resources are applied to problems with flooding, it is possible they will be unavailable to assist with landslides occurring all over the planning area.

11.8 ISSUES

Important issues associated with landslides in the planning area include the following:

- There are existing homes in landslide risk areas throughout the planning area. The degree of vulnerability of these structures depends on the codes and standards the structures were constructed to. Information to this level of detail is not currently available.
- Future development could lead to more homes in landslide risk areas.
- Mapping and assessment of landslide hazards are constantly evolving. As new data and science become available, assessments of landslide risk should be reevaluated.
- The impact of climate change on landslides is uncertain. If climate change impacts atmospheric conditions, then exposure to landslide risks is likely to increase.
- Landslides may cause negative environmental consequences, including water quality degradation.
- The risk associated with the landslide hazard overlaps the risk associated with other hazards such as earthquake, flood and wildfire. This provides an opportunity to seek mitigation alternatives with multiple objectives that can reduce risk for multiple hazards.

12. TSUNAMI

12.1 GENERAL BACKGROUND

12.1.1 Tsunami Behavior

A tsunami consists of a series of high-energy waves that radiate outward like pond ripples from an area where a generating event occurs. The waves arrive at shorelines over an extended period.

Tsunamis are typically classified as local or distant. Locally generated tsunamis have minimal warning times, leaving few options except to run to high ground. They may be accompanied by damage resulting from the triggering earthquake due to ground shaking, surface faulting, liquefaction or landslides.

DEFINITIONS

Tsunami—A series of traveling ocean waves of extremely long wavelength usually caused by displacement of the ocean floor and typically generated by seismic or volcanic activity or by underwater landslides.

Distant tsunamis may travel for hours before striking a coastline, giving a community a chance to implement evacuation plans. In the open ocean, a tsunami may be only a few inches or feet high, but it can travel with speeds approaching 600 miles per hour. Tsunami waves arrive at shorelines over an extended period.

As a tsunami enters the shoaling waters near a coastline, its speed diminishes, its wavelength decreases, and its height increases greatly. The first wave usually is not the largest. Several larger and more destructive waves often follow the first one. As tsunamis reach the shoreline, they may take the form of a fast-rising tide, a cresting wave, or a bore (a large, turbulent wall-like wave). The bore phenomenon resembles a step-like change in the water level that advances rapidly (from 10 to 60 miles per hour).

The configuration of the coastline, the shape of the ocean floor, and the characteristics of advancing waves play important roles in the destructiveness of the waves. Offshore canyons can focus tsunami wave energy and islands can filter the energy. The orientation of the coastline determines whether the waves strike head-on or are refracted from other parts of the coastline. A wave may be small at one point on a coast and much larger at other points. Bays, sounds, inlets, rivers, streams, offshore canyons, islands, and flood control channels may cause various effects that alter the level of damage. It has been estimated, for example, that a tsunami wave entering a flood control channel could reach a mile or more inland, especially if it enters at high tide.

The first visible indication of an approaching tsunami may be recession of water (draw down) caused by the trough preceding the advancing, large inbound wave crest. Rapid draw down can create strong currents in harbor inlets and channels that can severely damage coastal structures due to erosive scour around piers and pilings. As the water’s surface drops, piers can be damaged by boats or ships straining at or breaking their mooring lines. The vessels can overturn or sink due to strong currents, collisions with other objects, or impact with the harbor bottom.

Conversely, the first indication of a tsunami may be a rise in water level. The advancing tsunami may initially resemble a strong surge increasing the sea level like the rising tide, but the tsunami surge rises faster and does not stop at the shoreline. Even if the wave height appears to be small, 3 to 6 feet for example, the strength of the accompanying surge can be deadly. Waist-high surges can cause strong currents that float cars, small structures, and other debris. Boats and debris are often carried inland by the surge and left stranded when the water recedes.

At some locations, the advancing turbulent wave front will be the most destructive part of the wave. In other situations, the greatest damage will be caused by the outflow of water back to the sea between crests, sweeping all before it and undermining roads, buildings, bulkheads, and other structures. This outflow action can carry enormous amounts of highly damaging debris with it, resulting in further destruction. Ships and boats, unless moved away from shore, may be dashed against breakwaters, wharves, and other craft, or be washed ashore and left grounded after the withdrawal of the seawater.

12.1.2 Tsunami Causes

Earthquakes can create large sea waves that can inundate coastal areas. The earth's surface is made up of crustal plates that contain large sections of continents and ocean basins. These plates may pull apart from, slide past, override, or under-ride (i.e., "subduct") one another. Plate boundaries coincide with faults that produce earthquakes as stress accumulated from the relative movement of the plates is relieved. The earthquakes, in turn, may produce displacements of the sea floor that can set the overlying column of water in motion, initiating a tsunami. However, not all submarine earthquakes produce tsunamis. It depends on the magnitude of the earthquake and type of faulting that has occurred.

The most active plate boundaries rim the Pacific Ocean and the Caribbean Sea. Consequently, this is where most tsunami activity is expected. Most tsunamis originate in the Pacific "Ring of Fire," which is the most active seismic region on earth. An estimated 489 cities in Alaska, California, Hawaii, Oregon, and Washington are susceptible to tsunamis. As many as 900,000 residents of these cities could be inundated by a 50-foot tsunami. In addition, millions of tourist that visit these regions each year could be impacted by tsunami events along the Pacific coast.

Landslides on the ocean floor and volcanic activity also have the potential to create large sea waves that can inundate coastal areas.

12.2 HAZARD PROFILE

12.2.1 Past Events

Eighty-two possible or confirmed tsunamis have been observed or recorded in California in the past 150 years. Statewide, most recorded tsunami events were small and detected only by tide gages. Eleven events were large enough to cause damage, and four caused deaths. The following is a summary of major tsunami events that have affected Los Angeles County (Los Angeles County, 2015 and National Geophysical Data Center, 2017)

- September 16, 2015—A magnitude 8.3 earthquake in Chile caused the National Tsunami Warning Center to issue a tsunami advisory for Southern California including Los Angeles County. No damage was reported in Los Angeles County.
- March 11, 2011—A magnitude 9.0 earthquake in Japan generated tsunami waves that caused extensive damage in Japan. The tsunami reached Los Angeles County, where waves capsized vessels berthed near the Santa Catalina Island and caused minor damage in Marina del Rey, Redondo Beach and Santa Monica. This was the most damaging tsunami to hit California since 1964. The California coastal counties of Del Norte, Monterey, and Santa Cruz were included in FEMA-1968-DR-CA declaration.
- February 27, 2010—A tsunami originating off Chile created rapid water level fluctuations and strong currents in harbors and along beaches in California.

- September 29, 2009—Following a magnitude 8.0 to 8.3 earthquake 120 miles from America Samoa, a tsunami brought strong currents and dangerous waves to the San Pedro area and the Santa Monica Bay area.
- November 29, 1975—A magnitude 7.2 earthquake in Hawaii caused a tsunami that reached Santa Catalina Island.
- March 27, 1964—A magnitude 9.2 earthquake in Prince William Sound, Alaska triggered a tsunami that caused damage in Alaska, British Columbia, Washington, California and Hawaii. The hardest hit was Crescent City, California, where waves destroyed half of the waterfront business district. There was also extensive damage in San Francisco Bay, marinas in Marin County and the Los Angeles and Long Beach harbors.
- May 22-24, 1960—A magnitude 8.5 earthquake in Chile caused a tsunami that contributed to a scuba diver death and $1 million in damage.
- April 1, 1946—A magnitude 7.8 earthquake in Alaska's Aleutian Island chain caused a tsunami whose effects were felt along the United States coastline, especially in Los Angeles and Long Beach harbor areas.
- 1927—A tsunami hit Southern California, raising the ocean by 6 feet.

Nearly two-thirds of California's tsunami events and all but one damaging event were generated by distant sources. Most tsunamis affecting California have originated in the Gulf of Alaska in the Aleutian Subduction Zone. The worst event was the 1964 tsunami generated by the Magnitude-9.2 Alaska earthquake, which killed 12 in Northern California and caused over $15 million in damage. The 1960 Chilean earthquake produced a great tsunami that impacted the entire Pacific basin. Damage was reported in California ports and harbors from San Diego to Crescent City and losses exceeded $1 million.

Local tsunamis have the potential to cause locally greater wave heights. The largest historical local-source tsunami on the west coast was caused by the 1927 Point Arguello, California, earthquake (Magnitude 7.1), which produced 7-foot waves in the nearby coastal area. There is geological evidence of significant impacts from tsunamis originating along the Cascadia subduction zone, which extends from Cape Mendocino in California to the Queen Charlotte Islands, British Columbia, and lies only a short distance off the coast.

12.2.2 Location

Depending upon the magnitude of the tsunami, coastal areas of the City could be inundated, most notably in the San Pedro and Los Angeles Harbor areas, and in neighboring Santa Monica. Continued development in areas exposed to coastal inundation has increased the risk of property damage and loss of life from future tsunamis. While historic and geologic evidence suggests a threat of tsunami is greater in Alaska, Hawaii and the northern coastal areas of California, some evidence indicates a potential for events impacting Southern California.

Figure 12-1 and Figure 12-2 show tsunami inundations areas mapped by the California Office of Emergency Services (Cal OES). These are the only two Area Planning Commissions in the City that have structures exposed to tsunamis. The modeling used for this map allows for wave evolution over a variable seabed and accounts for topography in its inundation mapping. The map does not represent inundation from a single scenario. It was created by combining inundation results for multiple source events affecting a given region, representing realistic local and distant earthquakes and hypothetical extreme undersea and near-shore landslides.

12.2.3 Frequency

The frequency of tsunamis is related to the frequency of the events that cause them, so it is similar to the frequency of seismic or volcanic activities or landslides. Generally four or five tsunamis occur every year in the Pacific Basin, and those that are most damaging are generated in the Pacific waters off South America rather than in the northern Pacific.

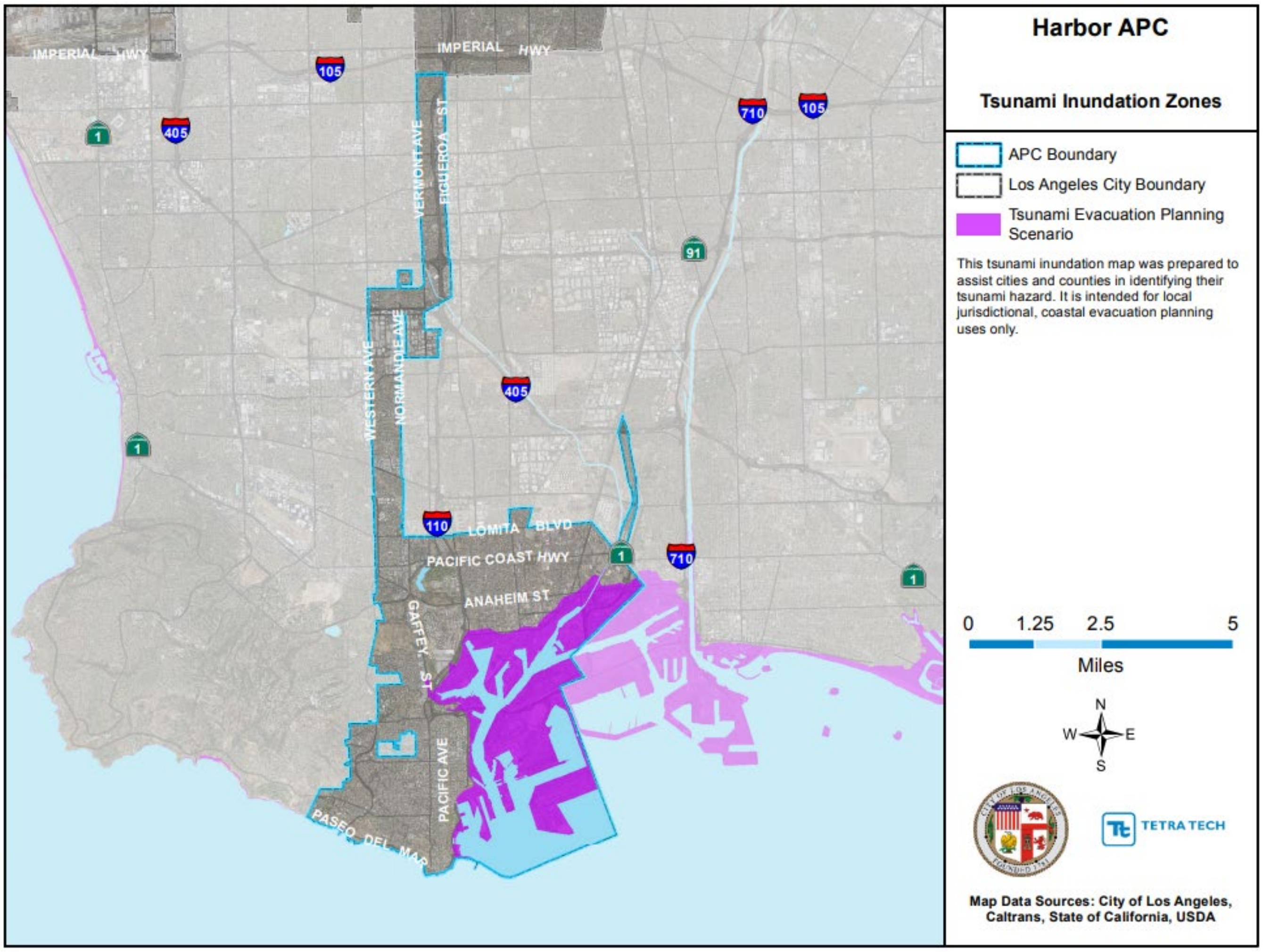


Figure 12-1. Mapped Tsunami Inundation Area in the Harbor APC

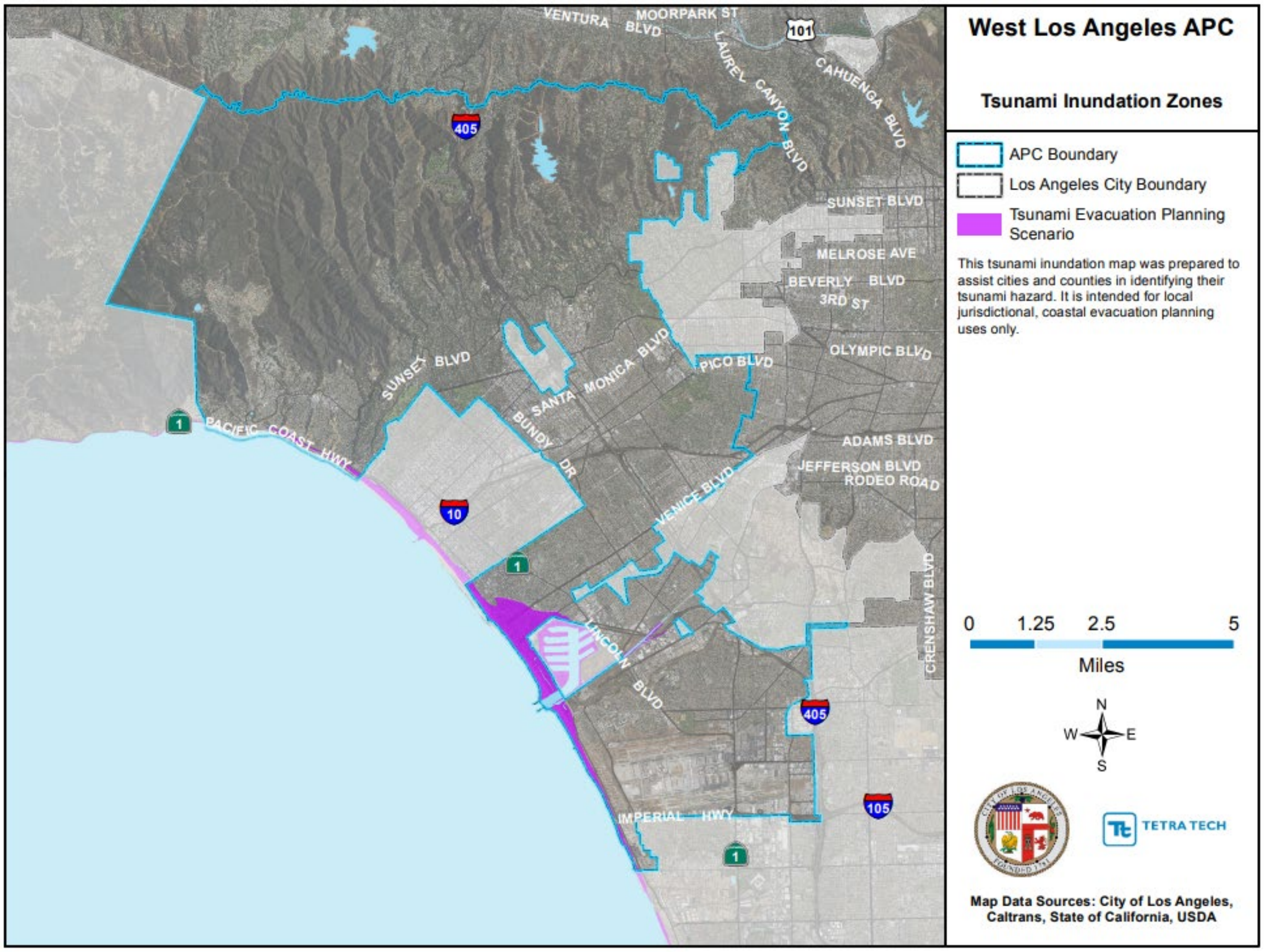


Figure 12-2. Mapped Tsunami Inundation Area in the West Los Angeles APC

12.2.4 Severity

Tsunamis are a threat to life and property to anyone living near the ocean. From 1970 to 2016, 375 tsunamis and tsunami effects were recorded globally. The overwhelming majority of these events occurred in the Pacific basin. Recent tsunamis have struck in Chile, Alaska Peninsula, New Guinea, Indonesia, and Japan. Historically, tsunamis originating in the northern Pacific and along the west coast of South America have caused more damage on the west coast of the United States than tsunamis originating in Japan and the Southwest Pacific.

The Cascadia subduction zone, which runs from Northern Vancouver Island to Cape Mendocino California, will produce California's largest tsunami. The Cascadia subduction zone is similar to the Alaska-Aleutian trench that generated the magnitude 9.2 1964 Alaska earthquake and the Sunda trench in Indonesia that produced the magnitude 9.3 December 2004 Sumatra earthquake. Native American accounts of past Cascadia earthquakes suggest tsunami wave heights on the order of 60 feet, comparable to water levels in Aceh Province Indonesia during the December 2004 tsunami there. Water heights in Japan produced by the 1700 Cascadia earthquake were over 15 feet, comparable to tsunami heights observed on the African coast after the Sumatra earthquake. The Cascadia subduction zone last ruptured on January 26, 1700, creating a tsunami that left markers in the geologic record from Humboldt County, California, to Vancouver Island in Canada and is noted in written records in Japan. At least seven ruptures of the Cascadia subduction zone have been observed in the geologic record.

12.2.5 Warning Time

Typical signs of a tsunami hazard are earthquakes and/or sudden and unexpected rise or fall in coastal water. The large waves are often preceded by coastal flooding and followed by a quick recession of the water. Tsunamis are difficult to detect in the open ocean; with waves less than 3 feet high. The tsunami's size and speed, as well as the coastal area's form and depth, affect the impact of a tsunami; wave heights of 50 feet are not uncommon. In general, scientists believe it requires an earthquake of at least a magnitude 7 to produce a tsunami. Figure 12-3 shows likely travel times across the Pacific Ocean for a tsunami.

Pacific Tsunami Warning System

The Pacific tsunami warning system evolved from a program initiated in 1946. It is a cooperative effort involving 26 countries along with numerous seismic stations, water level stations and information distribution centers. The National Weather Service operates two regional information distribution centers. One is located in Ewa Beach, Hawaii, and the other is in Palmer, Alaska. The Ewa Beach center also serves as an administrative hub for the Pacific warning system.

The warning system only begins to function when a Pacific basin earthquake of magnitude 6.5 or greater triggers an earthquake alarm. When this occurs, the following sequence of actions occurs:

- Data is interpolated to determine epicenter and magnitude of the event.
- If the event is magnitude 7.5 or greater and located at sea, a TSUNAMI WATCH is issued.
- Participating tide stations in the earthquake area are requested to monitor their gages. If unusual tide levels are noted, the tsunami watch is upgraded to a TSUNAMI WARNING.
- Tsunami travel times are calculated, and the warning is transmitted to the disseminating agencies and thus relayed to the public.
- The Ewa Beach center will cancel the watch or warning if reports from the stations indicate that no tsunami was generated or that the tsunami was inconsequential.

This system is not considered to be effective for communities located close to the tsunami because the first wave would arrive before the data were processed and analyzed. In this case, strong ground shaking would provide the first warning of a potential tsunami.

NOAA, 2017

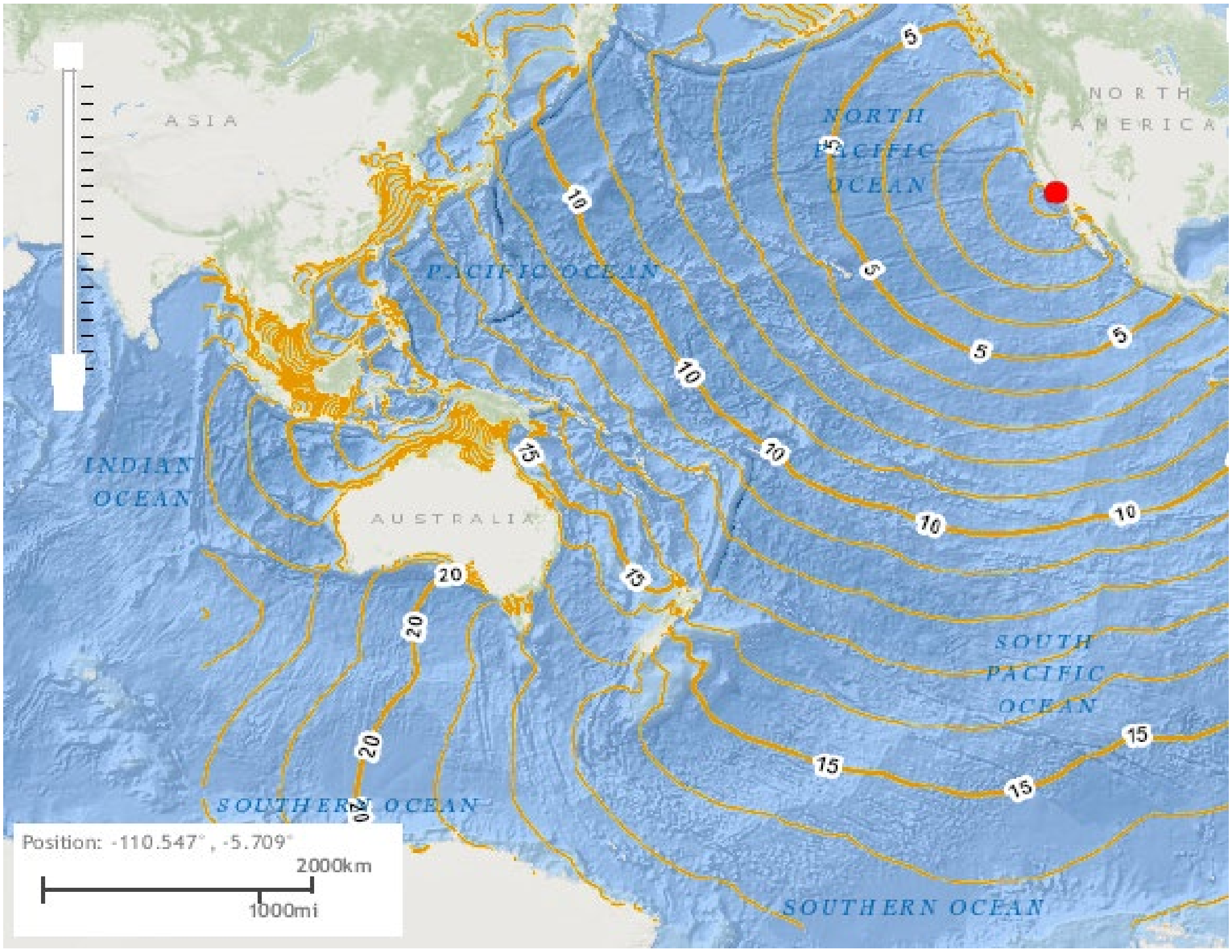


Figure 12-3. Potential Tsunami Travel Times in the Pacific Ocean, in Hours

Information provided by this system is monitored and evaluated by NOAA scientists who assess the risk and issue a tsunami warning if indicated by the data. Warnings are transmitted to state agencies via the National Warning System. In California, the California Office of Emergency Services (Cal OES) Warning Center receives the information from the National Warning System and immediately transmits it to local operational areas using the California Law Enforcement Telecommunications System, California Warning System, and Emergency Digital Information System. The information is simultaneously transmitted to designated local response agencies such as the Los Angeles Police Department, Los Angeles Fire Department, and Harbor Department.

12.3 SECONDARY IMPACTS

Aside from the tremendous hydraulic force of the tsunami waves themselves, floating debris carried by a tsunami can endanger human lives and batter inland structures. Ships moored at piers and in harbors often are swamped and sunk or are left battered and stranded high on the shore. Breakwaters and piers collapse, sometimes because of scouring actions that sweep away their foundation material and sometimes because of the sheer impact of the waves. Railroad yards and oil tanks situated near the waterfront are particularly vulnerable. Oil fires frequently result and are spread by the waves.

Port facilities, naval facilities, fishing fleets and public utilities are often the backbone of the economy of the affected areas, and these are the resources that generally receive the most severe damage. Until debris can be cleared, wharves and piers rebuilt, utilities restored, and fishing fleets reconstituted, communities may find themselves without fuel, food and employment. Wherever water transport is a vital means of supply, disruption of coastal systems caused by tsunamis can have far-reaching economic effects.

12.4 EXPOSURE

12.4.1 Population

The population living in tsunami hazard zones was estimated based on the number of residential structures in each APC located in the tsunami hazard area. The populations that would be most exposed to this type of hazard are those along beaches, low-lying coastal areas, tidal flats and river deltas that empty into ocean-going waters. The methodology estimated the percent of APC residential buildings located in the tsunami hazard zone and multiplying the total estimated population for the APC by this percentage.

Using this approach, it is estimated that exposed population is 18,149 people (0.5 percent of the planning area total): 18,093 in the West Los Angeles APC and 56 in the Harbor APC.

12.4.2 Property

Structures

The value of exposed buildings in the tsunami hazard zone within the planning area was generated using Hazus at the user-defined level and is summarized in Table 12-1. The estimates include the value of both the buildings and their contents. This methodology estimates that that there are 5,337 structures exposed to the tsunami hazard within the planning area, with a replacement value of $8.9 billion.

Table 12-1. Exposure and Value of Structures in Tsunami Inundation Zone

Area Planning Commission	Buildings Exposed	Estimated Value within the Tsunami Inundation Zone			% of Total Replacement Value
		Structure	Contents	Total	
Central	0	$0	$0	$0	0.0%
East Los Angeles	0	$0	$0	$0	0.0%
Harbor	445	$2,530,847,432	$2,964,627,474	$5,495,474,907	13.4%
North Valley	0	$0	$0	$0	0.0%
South Los Angeles	0	$0	$0	$0	0.0%
South Valley	0	$0	$0	$0	0.0%
West Los Angeles	4,892	$2,177,194,005	$1,316,241,705	$3,493,435,710	3.2%
Total	**5,337**	**$4,708,041,437**	**$4,280,869,180**	**$8,988,910,617**	**1.2%**

Land Use

Some land uses are more vulnerable to damage from inundation, such as single-family homes, while others are less vulnerable, such as agricultural land or parks. Table 12-2 shows the existing land use of all parcels in the tsunami inundation areas, including those in public/open space uses for the planning area. Industrial uses make up about 73 percent of the tsunami inundation areas. This is a high risk use for this hazard area. The amount of the tsunami inundation area that contains vacant, developable land is not known. This would be valuable information for gauging the future development potential of tsunami hazard areas.

Table 12-2. General Plan Land Use within the Tsunami Inundation Area

Land Use	Tsunami Inundation Area	
	Area (acres)	% of total
Agriculture	76.5	1.47%
Commercial	203.6	3.91%
Government	91.5	1.76%
Industrial	3,813.6	73.25%
Multi-Family Residential	209.3	4.02%
Open Space	723.1	13.89%
Parking	0.0	0.00%
Single Family Residential	88.9	1.71%
Total	**5,206.5**	**100.00%**

12.4.3 Critical Facilities and Infrastructure

Roads or railroads that are blocked or damaged can prevent access and can isolate residents and emergency service providers needing to get to vulnerable populations or to make repairs. Bridges washed out or blocked by tsunami inundation or debris from flood flows also can cause isolation. Water and sewer systems can be flooded or backed up, causing further health problems. Underground utilities can also be damaged during flood events. Table 12-3 provides an estimate of the number and types of critical facilities exposed to the tsunami hazard.

Table 12-3. Critical Facilities and Infrastructure in Tsunami Inundation Zone

APC	Critical Operating Facilities	Critical Response Facilities	Critical Infrastructure—Transportation	Critical Infrastructure—Utilities	Total
Central	0	0	0	0	**0**
East Los Angeles	0	0	0	0	**0**
Harbor	0	5	44	54	**103**
North Valley	0	0	0	0	**0**
South Los Angeles	0	0	0	0	**0**
South Valley	0	0	0	0	**0**
West Los Angeles	0	2	5	11	**18**
Total	**0**	**7**	**49**	**65**	**121**

Roads

Roads are an important component in the management of tsunami emergencies as they are the primary resource for evacuation to higher ground before and during the course of a tsunami event. Roads often act as flood control facilities in low depth, low velocity flood events by acting as levees or berms and diverting or containing flood flows. Hazus identified the following major road facilities that may be impacted by tsunami events:

- Interstate 110
- State Highway 1
- State Highway 103
- State Highway 47
- State Highway 90
- Lincoln Blvd
- Marina Freeway
- Pacific Coast Highway.

This is a list of major roads that may be impacted by a tsunami, based solely on exposure; it should not be misinterpreted as possible evacuation routes for tsunami events. Evacuation routes are identified in emergency response plans.

Bridges

Bridges exposed to tsunami events can be extremely vulnerable due to the forces transmitted by the wave run-up and by the impact of debris carried by the wave action. Hazus identified 14 bridges within the tsunami inundation areas.

Water/Sewer/Utilities

Water and sewer systems can be affected by the flooding associated with tsunami events. Floodwaters can back up drainage systems, causing localized flooding. Culverts can be blocked by debris from flood events, also causing localized urban flooding. Floodwaters can get into drinking water supplies, causing contamination. Sewer systems can be backed up, causing wastes to spill into homes, neighborhoods, rivers and streams. The forces of tsunami waves can impact above-ground utilities by knocking down power lines and radio/cellular communication towers. Power generation facilities can be severely impacted by both the impact of the wave action and the inundation of floodwaters.

12.4.4 Environment

All waterways would be exposed to the effects of a tsunami; inundation of water and introduction of foreign debris could be hazardous to the environment. All wildlife inhabiting the area also is exposed.

12.5 VULNERABILITY

12.5.1 Population

The populations most vulnerable to the tsunami hazard are those who reside near beaches, low-lying coastal areas, tidal flats and river deltas that empty into ocean-going waters and are elderly or very young, or are individuals with disabilities or others with access and functional needs. In the event of a local tsunami generated in or near the planning area, there would be little warning time, so more of the population would be vulnerable. The degree of vulnerability of the population exposed to the tsunami hazard event is based on a number of factors:

- Is there a warning system?
- What is the lead time of the warning?
- What is the method of warning dissemination?
- Where are the evacuation areas and routes?
- Will the people evacuate when warned?

A geographic analysis of demographics using the Hazus model identified populations vulnerable to the tsunami hazard as follows:

- **Economically Disadvantaged Populations**—It is estimated that 31 percent of the households within the tsunami inundation area are economically disadvantaged, defined as having household incomes of $50,000 or less.
- **Population over 65 Years Old**—It is estimated that 13 percent of the population in the census blocks that intersect the tsunami inundation area are over 65 years old.
- **Population under 16 Years Old**—It is estimated that 8 percent of the population within census blocks located in or near the tsunami inundation area are under 16 years of age.

The Hazus modeling estimated that as many as 8,569 people would be displaced by the tsunami events depicted by the inundation mapping and an additional 6,868 people would need short-term shelter.

12.5.2 Property

All structures along beaches, low-lying coastal areas, tidal flats and river deltas would be vulnerable to a tsunami, especially in an event with little or no warning time. The impact of the waves and the scouring associated with debris that may be carried in the water could be damaging to structures in the tsunami's path. Those that would be most vulnerable are those located in the front line of tsunami impact and those that are structurally unsound. Hazus generated loss estimates for the estimated tsunami hazard areas, as reflected in Table 12-4. It is estimated that there would be up to $1 billon of losses from a scenario tsunami hazard event.

Table 12-4. Loss Estimates for Tsunami

Area Planning Commission	Structures Impacted[a]	Estimated Loss Associated with Flood			% of Total Replacement Value
		Structure	Contents	Total	
Central	0	$0	$0	$0	0.0%
East Los Angeles	0	$0	$0	$0	0.0%
Harbor	284	$249,045,396	$453,248,020	$702,293,416	1.7%
North Valley	0	$0	$0	$0	0.0%
South Los Angeles	0	$0	$0	$0	0.0%
South Valley	0	$0	$0	$0	0.0%
West Los Angeles	1,943	$185,236,583	$179,145,925	$364,382,508	0.3%
Total	**2,227**	**$434,281,979**	**$632,393,945**	**$1,066,675,924**	**0.1%**

a. Impacted structures are those structures with finished floor elevations below the flood event water surface elevation. These structures are the most likely to receive significant damage in a flood event.

The Hazus modeling for this hazard estimated that no debris would be generated by the tsunami events depicted in the inundation mapping for the City of Los Angeles.

12.5.3 Critical Facilities and Infrastructure

Hazus uses damage function curves to estimate the percent of damage to critical buildings and their contents. Table 12-5 summarizes the results for potential damage to critical facilities in the tsunami inundation area.

Table 12-5. Potential Damage to Critical Facilities in Tsunami Inundation Area

	Number of Facilities Affected	Average % of Total Value Damaged	
		Structure	Content
Critical Operating Facilities	0	N/A	N/A
Critical Response Facilities	0	N/A	N/A
Critical Infrastructure—Transportation	14	3.96	6.05
Critical Infrastructure—Utilities	17	6.15	3.16
Total/Average	**31**	**5.05**	**4.60**

12.5.4 Environment

The vulnerability of aquatic habit and associated ecosystems would be highest in low-lying areas close to the coastline. Areas near gas stations, industrial areas and Tier II facilities would be vulnerable due to potential contamination from hazardous materials.

Tsunami waves can carry destructive debris and pollutants that can have devastating impacts on all facets of the environment. Millions of dollars spent on habitat restoration and conservation in the planning area could be wiped out by one significant tsunami. There are currently no tools available to measure these impacts. However, it is conceivable that the potential financial impact of a tsunami event on the environment could equal or exceed the impact on property. Community planners and emergency managers should take this into account when preparing for the tsunami hazard.

12.6 FUTURE TRENDS IN DEVELOPMENT

According to the California Department of Finance, the population of Los Angeles County is expected to increase 13 percent by 2060, a growth rate of 0.28 percent per year over the next 45 years. The City of Los Angeles has limited potential for expansion through annexation, as it is surrounded by other incorporated cities. It is anticipated that future growth in the City will be managed through redevelopment, which creates an opportunity to correct past land use decisions, especially with regards to development within tsunami inundation zones. Los Angeles is subject to state general planning laws and the California Coastal Act. The City has adopted critical areas and resources lands regulations pursuant to these laws.

12.7 SCENARIO

The 2007 report *Tsunami Hazard Assessment for the Ports of Long Beach and Los Angeles* analyzed recent studies suggesting tsunami sources in southern California that could have a greater impact on the Ports of Los Angeles and Long Beach due to short travel distance and high amplitude waves. The report concluded that local tsunamis may cause worse impact than remote ones; however, based on seismicity and geology, a large tsunami generated from local seismic activity or a local submarine landslide would likely not occur more than once every 10,000 years. A worst-case-scenario for the City of Los Angeles would be a near shore tsunami caused by a significant off-shore seismic event. While history has shown that these type events are not likely, should one occur, damages for this type of event would exceed those estimated in this risk assessment.

12.8 ISSUES

The planning team has identified the following issues related to the tsunami hazard for the planning area:

- Present building codes and guidelines do not adequately address the impacts of tsunamis on structures, and current tsunami hazard mapping is not appropriate for code enforcement.
- There is a high degree of risk in the tsunami inundation areas due to the high percentage of industrial occupancy.
- As tsunami warning technologies evolve, tsunami warning capability in the City will need to be enhanced to provide the highest degree of warning to areas with tsunami risk exposure.
- With the possibility of climate change, sea level rise may become an important consideration as probable tsunami inundation areas are identified through future studies.
- Resources in the City of Los Angeles, such as the Tsunami Research Center at the University of Southern California, have done excellent work in implementing and supporting public information and awareness programs. These programs need to be continued, supported and enhanced to promote the concepts of mitigation and preparedness for the impacts of tsunamis.
- Special attention will need to be focused on vulnerable neighborhoods in the tsunami zone and on hazard mitigation through public education and outreach.

13. URBAN / WILDLAND INTERFACE FIRE

13.1 GENERAL BACKGROUND

A wildfire is any uncontrolled fire occurring on undeveloped land that requires fire suppression. Wildfires can be ignited by lightning or by human activity such as smoking, campfires, equipment use, and arson.

Fire hazards present a considerable risk to vegetation and wildlife habitats. Short-term loss caused by a wildfire can include the destruction of timber, wildlife habitat, scenic vistas, and watersheds. Long-term effects include smaller timber harvests, reduced access to affected recreational areas, and destruction of cultural and economic resources and community infrastructure. Vulnerability to flooding increases due to the destruction of watersheds. The potential for significant damage to life and property exists in areas designated as "wildland-urban interface areas," where development is adjacent to densely vegetated areas.

DEFINITIONS

Interface Area—An area susceptible to wildfires and where wildland vegetation and urban or suburban development occur together. An example would be smaller urban areas and dispersed rural housing in forested areas.

Wildfire—Fires that result in uncontrolled destruction of forests, brush, field crops, grasslands, and real and personal property in non-urban areas. Because of their distance from firefighting resources, they can be difficult to contain and can cause a great deal of destruction.

Devastating urban-wildland interface fires have resulted in establishment of more fire stations and facilities in hillside areas of Los Angeles, and in more stringent requirements for fire hydrant installation, hillside brush clearance, fire access road systems, home sprinklers, fire resistant construction and landscaping materials, and development of improved firefighting strategies and equipment. The Los Angeles Fire Department currently has responsibility for enforcing brush clearance on vacant lots.

13.2 HAZARD PROFILE

13.2.1 Past Events

Incident information from the California Department of Forestry and Fire Protection (CAL FIRE) identifies over 50 wildfires in Los Angeles County since 2005, but most of them have been outside the City of Los Angeles. Los Angeles County has been included in seven federal wildfire disaster declarations and another 26 federal fire management declaration events, for a total of 33 federal declaration since 1978. The City of Los Angeles Fire Department has used its resources to respond to numerous large wildfires in Los Angeles County beyond the city. The following are recent major urban-wildland interface fires that have affected Los Angeles (as reported by CAL FIRE unless otherwise noted):

- **November 14, 2016, Marek Fire**—Burned 4,824 acres in Angeles National Forest.
- **July 9 – 16, 2016, Sage Fire**—Burned 1,109 acres off Calgrove Boulevard, southwest of Santa Clarita.
- **June 20 – November 8, 2016, San Gabriel Complex**—Burned 5,399 acres in San Gabriel Complex.
- **June 24, 2015, Calgrove Fire**—Burned 415 acres along southbound Interstate 5, north of Calgrove.
- **January 16 – 27, 2014, Colby Fire—**Burned 1,915 acres, damaged seven homes, destroyed 5 homes near Morris Reservoir, north of Glendora.

- **August 26 – October 16, 2009, Station Fire** (see Figure 13-1)—Burned 160,000 acres and resulted in the death of two firefighters, the injury of 22 persons, and the burning of 89 homes and more than 110 other structures. The Los Angeles Times reported costs exceeding $100 million. The Station Fire was the largest fire in the recorded history of Angeles National Forest, the 12th largest in California and the largest in Los Angeles County. It threatened Mount Wilson Observatory and communication towers with transmitters for every major television station in Los Angeles. Cooperating agencies included: Forest Service, Los Angeles County Fire Department, Los Angeles County Sheriff's Department, California State Highway Patrol, Cal Trans, and Los Angeles City Fire Department. The fire threatened the Sunland and Tujunga neighborhoods of the City of Los Angeles (City of Los Angeles, 2011)
- **October 13, 2008, Sesnon Fire**—Burned 14,700 acres in the Porter Ranch Community, Twin Lakes and Indian Hills areas of Los Angeles County. The fire destroyed 15 residences and 63 outbuildings; 11 residences were damaged. Costs were reported around $12.6 million (City of Los Angeles, 2011).
- **September 28 – October 6, 2005, Topanga Fire**—Burned 24,175 acres in the Chatsworth area. Numerous residential and commercial properties were damaged and destroyed. Costs were reported around $15.8 million.

Source: City of Los Angeles, 2011

Figure 13-1. Station Fire, October 2009

13.2.2 Location

CAL FIRE's Fire and Resource Assessment Program has modeled and mapped wildfire hazard zones using a science-based and field-tested computer model that assigns a fire hazard severity zone (FHSZ) of moderate, high or very high. The FHSZ model is built from existing CAL FIRE data and hazard information based on factors such as the following:

- **Fuel**—Fuel may include living and dead vegetation on the ground, along the surface as brush and small trees, and above the ground in tree canopies. Lighter fuels such as grasses, leaves and needles quickly expel moisture and burn rapidly, while heavier fuels such as tree branches, logs and trunks take longer to warm and ignite. Trees killed or defoliated by forest insects and diseases are more susceptible to wildfire.
- **Weather**—Relevant weather conditions include temperature, relative humidity, wind speed and direction, cloud cover, precipitation amount and duration, and the stability of the atmosphere. Of particular importance for wildfire activity are wind and thunderstorms:

  - Strong, dry winds produce extreme fire conditions. Such winds generally reach peak velocities during the night and early morning hours.
  - The thunderstorm season typically begins in June with wet storms, and turns dry with little or no precipitation reaching the ground as the season progresses into July and August.

- **Terrain**—Topography includes slope and elevation. The topography of a region influences the amount and moisture of fuel; the impact of weather conditions such as temperature and wind; potential barriers to fire spread, such as highways and lakes; and elevation and slope of land forms (fire spreads more easily uphill than downhill).
- **Probability of Future Occurrence**—The likelihood of an area burning over a 30- to 50-year time period, based on history and other factors.

The model also is based on frequency of fire weather, ignition patterns, and expected rate-of spread. It accounts for flying ember production, which is the principal driver of the wildfire hazard in densely developed areas. A related concern in built-out areas is the relative density of vegetative fuels that can serve as sites for new spot fires within the urban core and spread to adjacent structures. The model refines the zones to characterize fire exposure mechanisms that cause ignitions to structures. Significant land-use changes need to be accounted for through periodic model updates. FHSZ mapping for each APC is shown in Figure 13-2 through Figure 13-8

13.2.3 Frequency

Wildfire frequency can be assessed through review of the number of previous wildfire events and the area burned over a defined time period. CAL FIRE records of fires indicate that, from 1878 to 2016, 53.5 percent of the total area within the very-high FHSZ was burned by wildfire (50,782 acres out of 94,904 acres). This averages 0.4 percent of the very-high FHSZ area burned per year over that 139-year period. However, those records are incomplete prior to 1950, so the annual average is likely higher than that. The total number of fires affecting the planning area from 1950 to 2016 is 358, an average of more than five per year.

13.2.4 Severity

Potential losses from wildfire include human life, structures and other improvements, and natural resources. There are no recorded incidents of loss of life from wildfires in the planning area. Wildfire can lead to ancillary impacts such as landslides in steep ravine areas and flooding due to the impacts of silt in local watersheds.

13.2.5 Warning Time

Wildfires are often caused by humans, intentionally or accidentally. There is no way to predict when one might break out. Since fireworks often cause brush fires, extra diligence is warranted around the Fourth of July when the use of fireworks is highest. Dry seasons and droughts are factors that greatly increase fire likelihood. Dry lightning may trigger wildfires. Adverse weather can be predicted, so special attention can be paid during weather events that may include lightning. Reliable National Weather Service lightning warnings are available on average 24 to 48 hours prior to a significant electrical storm.

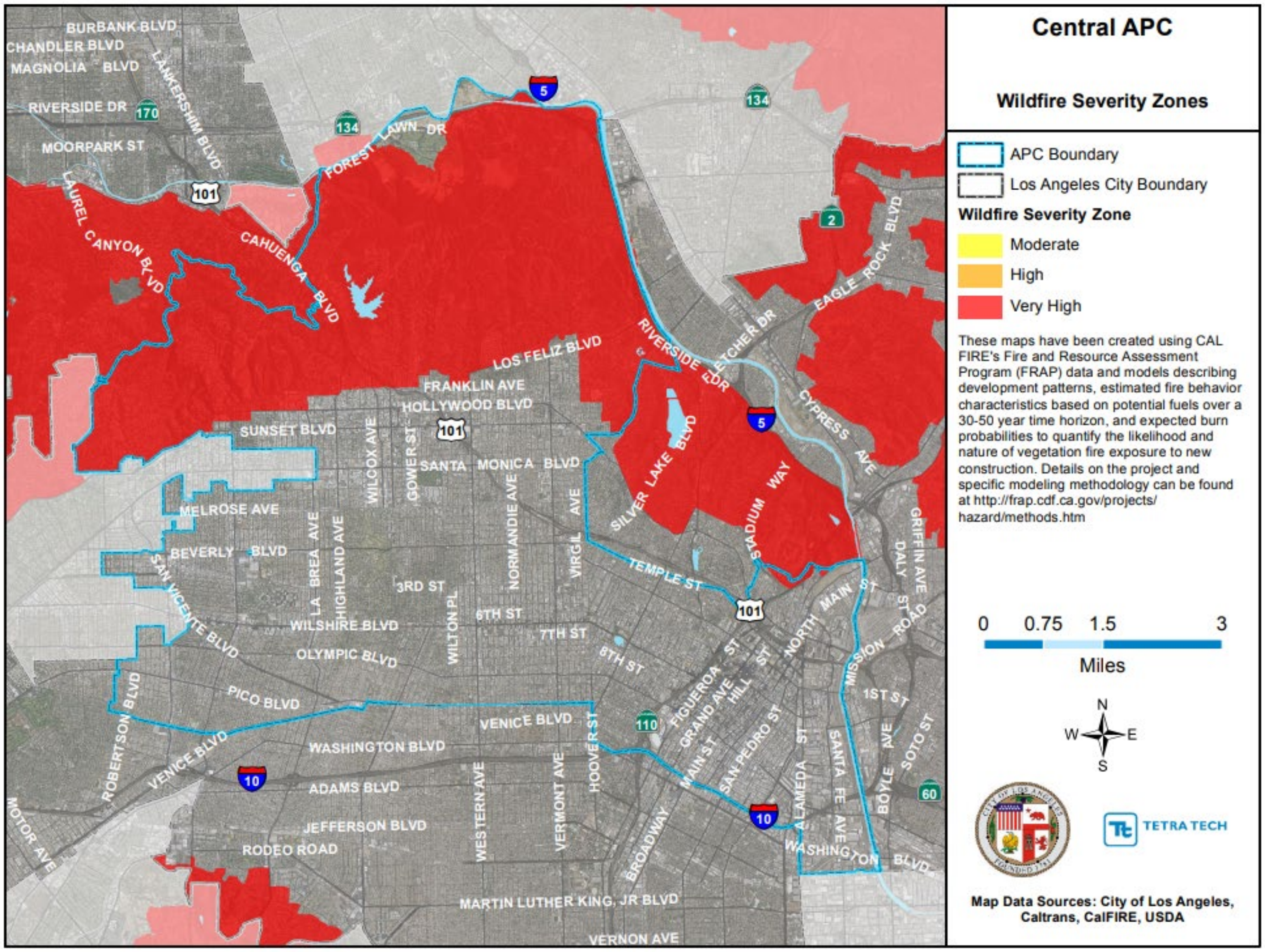


Figure 13-2. Wildfire Severity Zones in the Central APC

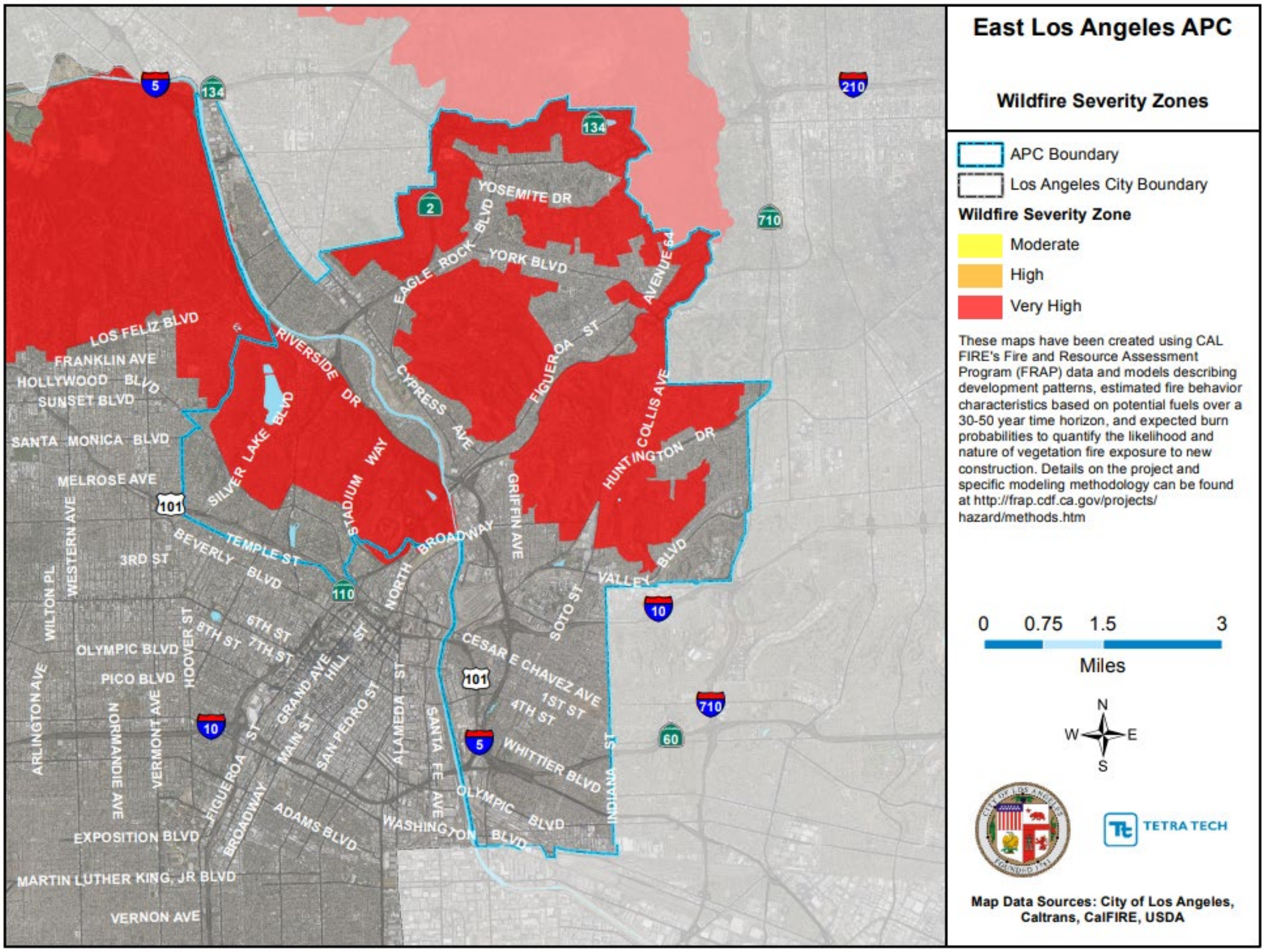


Figure 13-3. Wildfire Severity Zones in the East Los Angeles APC

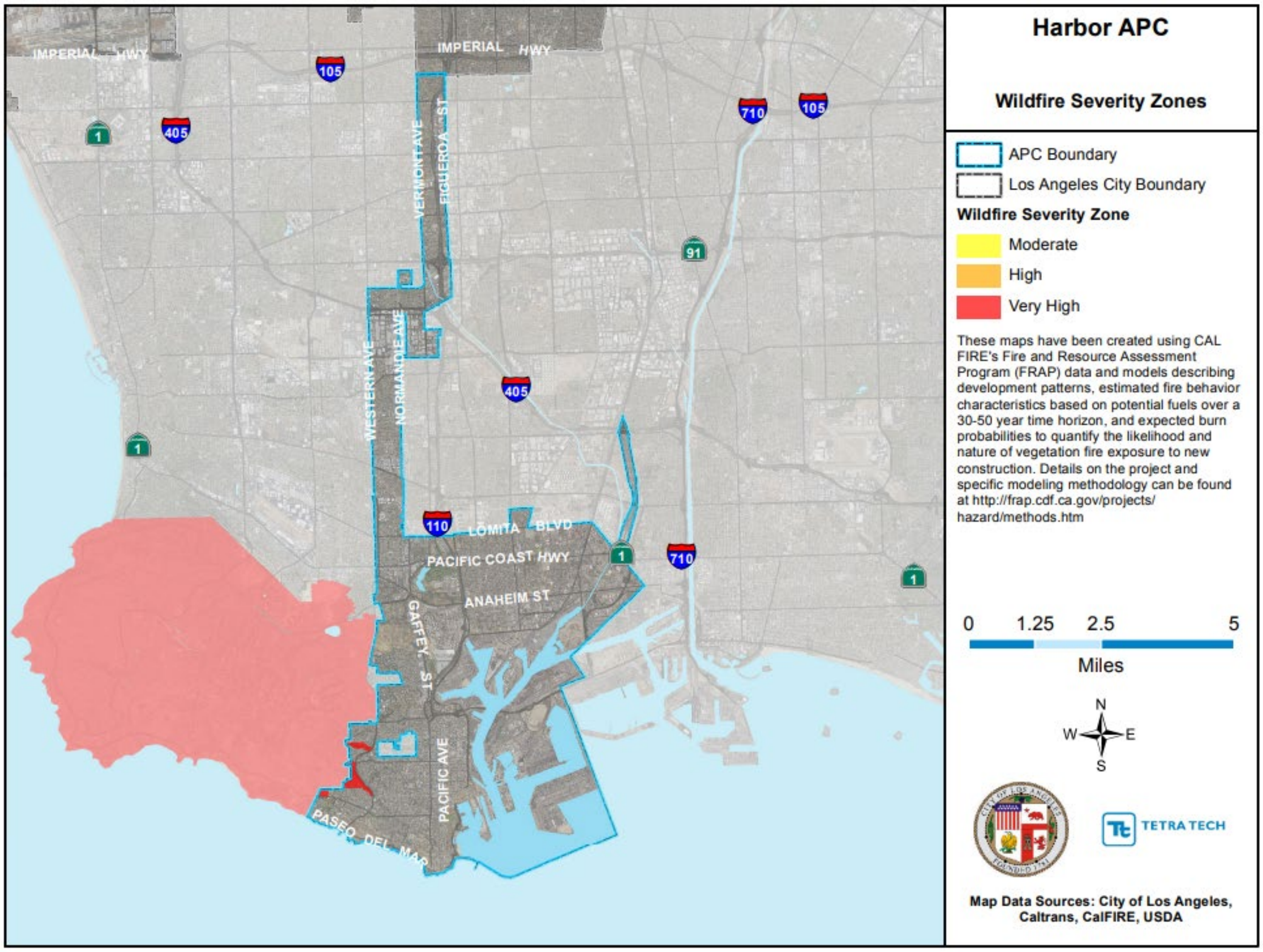


Figure 13-4. Wildfire Severity Zones in the Harbor APC

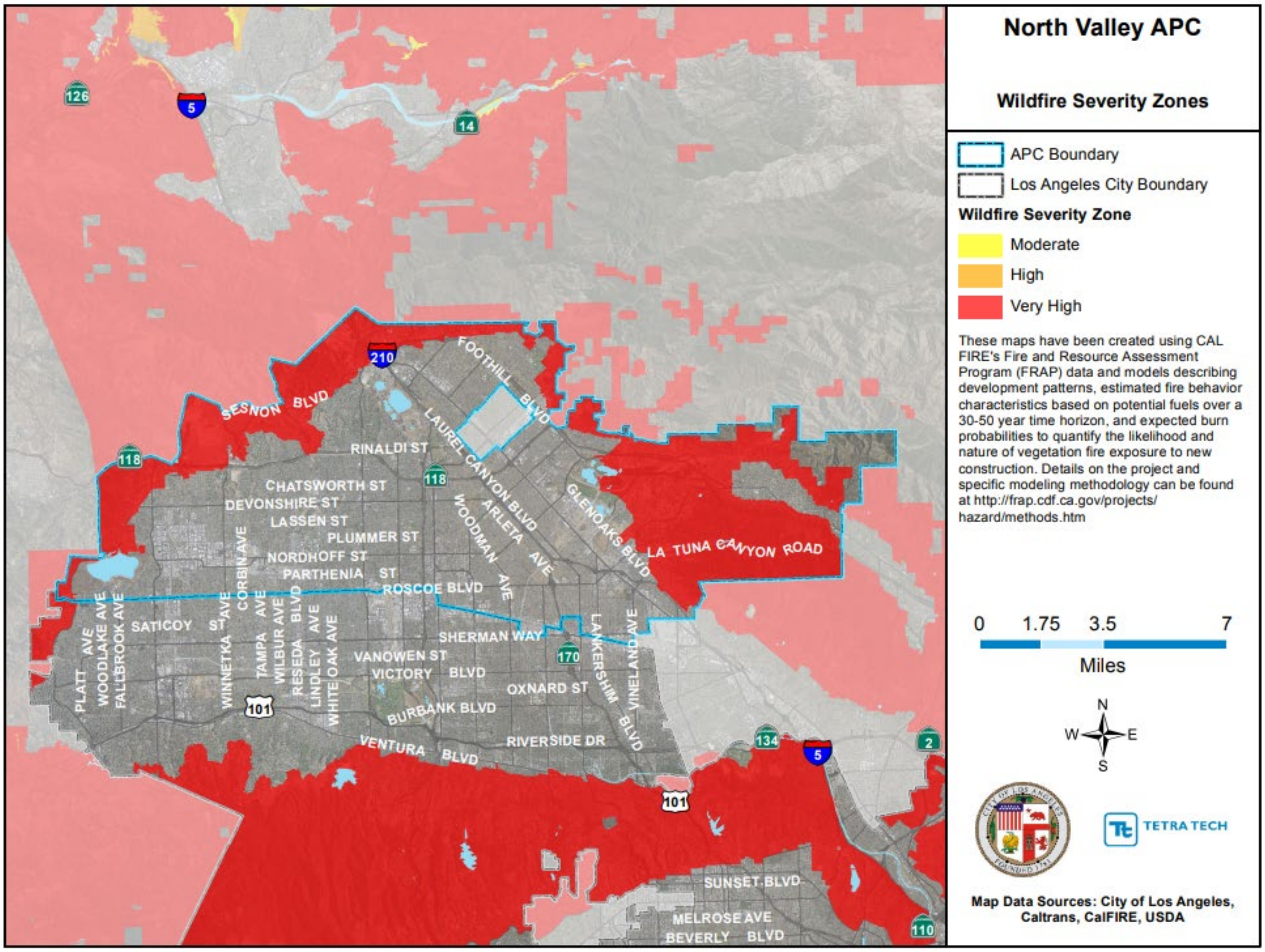


Figure 13-5. Wildfire Severity Zones in the North Valley APC

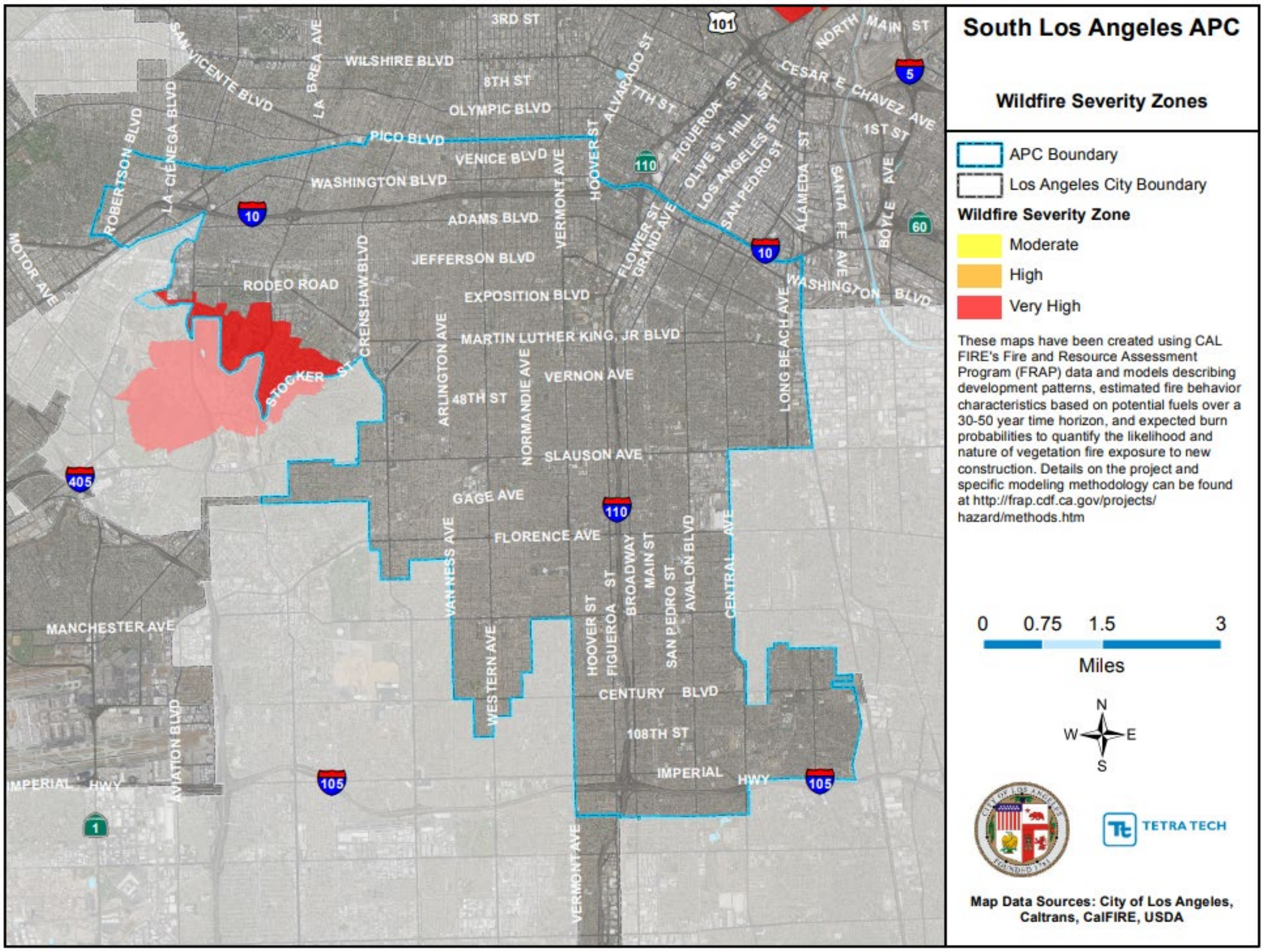


Figure 13-6. Wildfire Severity Zones in the South Los Angeles APC

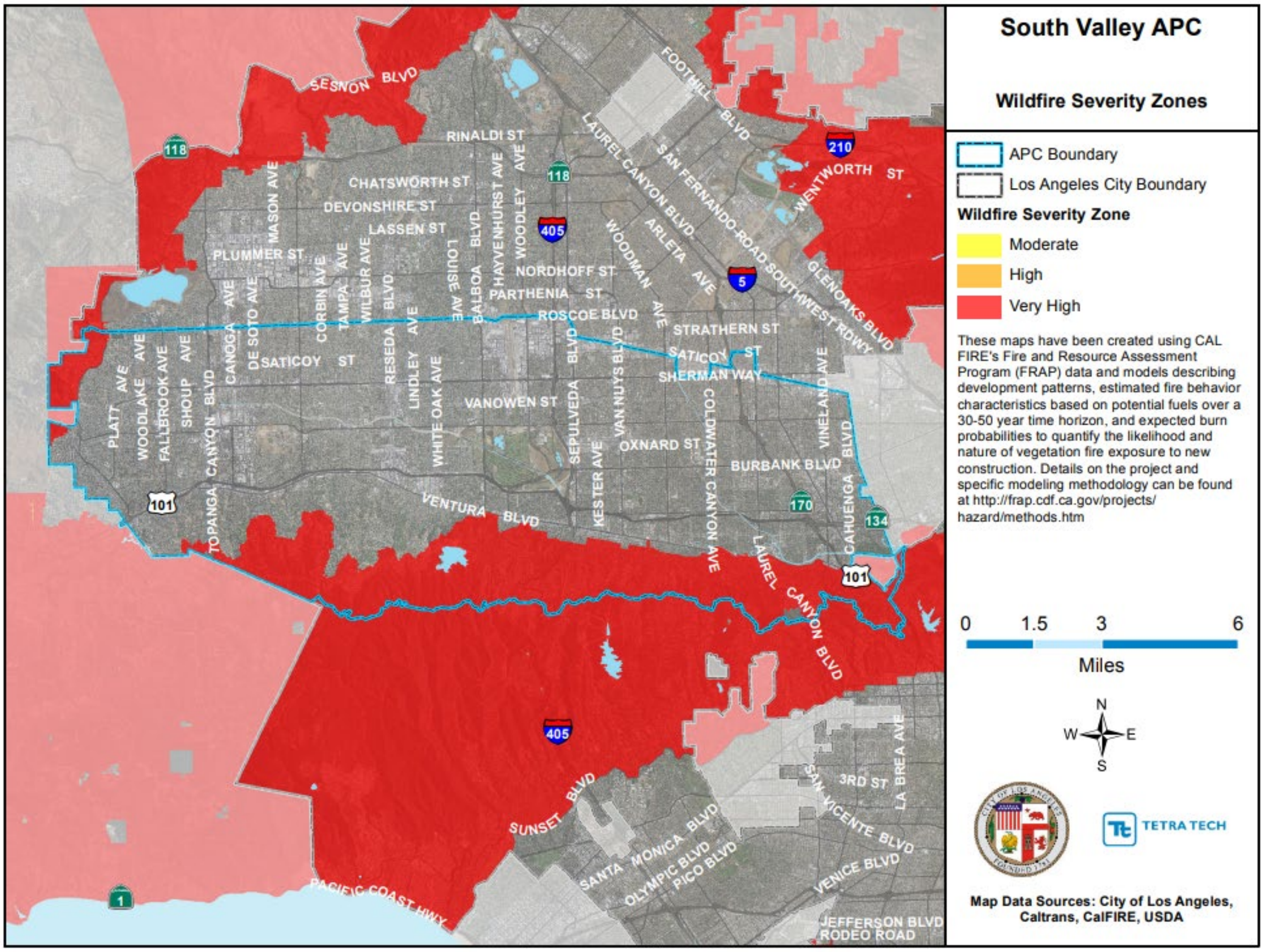


Figure 13-7. Wildfire Severity Zones in the South Valley APC

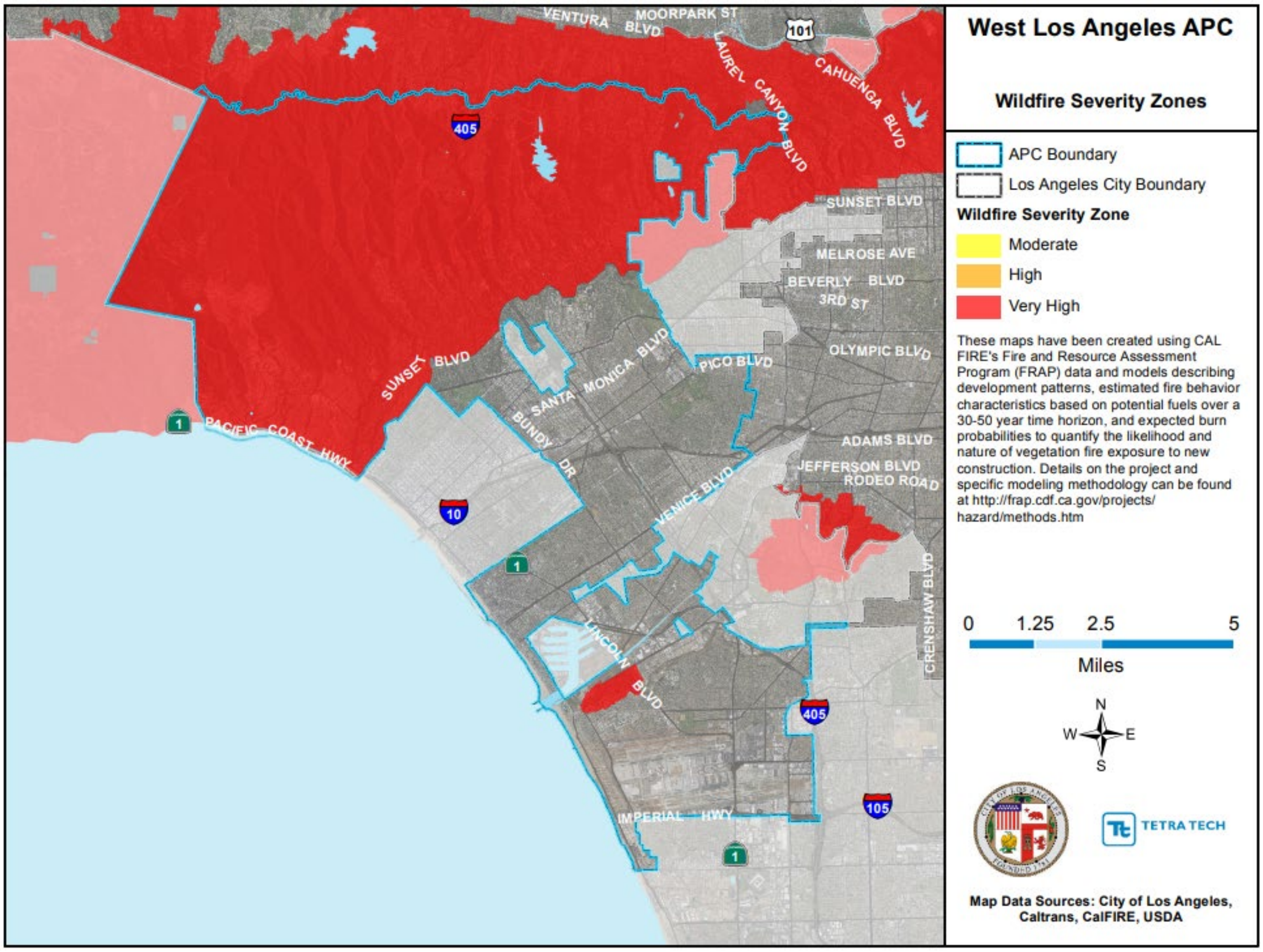


Figure 13-8. Wildfire Severity Zones in the West Los Angeles APC

If a fire does break out and spread rapidly, residents may need to evacuate within days or hours. A fire's peak burning period generally is between 1 p.m. and 6 p.m. Once a fire has started, fire alerting is reasonably rapid in most cases. The rapid spread of cellular and two-way radio communications in recent years has further contributed to a significant improvement in warning time.

13.3 SECONDARY IMPACTS

Wildfires can generate a range of secondary impacts, which in some cases may cause more widespread and prolonged damage than the fire itself. Fires can cause direct economic losses in the reduction of harvestable timber and indirect economic losses in reduced tourism. Wildfires can have a significant impact on air quality, especially with prolonged periods of burning combined with climatic conditions. Wildfires cause the contamination of reservoirs, destroy transmission lines and contribute to flooding. They strip slopes of vegetation, exposing them to greater amounts of runoff. This in turn can weaken soils and cause failures on slopes. Major landslides can occur several years after a wildfire. Most wildfires burn hot and for long durations that can bake soils, especially those high in clay content, thus increasing the imperviousness of the ground. This increases the runoff generated by storm events, thus increasing the chance of flooding.

13.4 EXPOSURE

13.4.1 Population

Population counts of those living in wildfire hazard areas were generated for each APC by estimating the percent of APC residential buildings located in each wildfire severity zone and multiplying the total estimated population for the APC by this percentage. Table 13-1 presents the results.

Table 13-1. Population Within Very High Wildfire Hazard Area

Area Planning Commission	Number of Buildings	Population	
		Number	% of Total
Central	16,007	144,346	21.8%
East Los Angeles	31,600	186,195	46.7%
Harbor	262	1,455	0.7%
North Valley	22,751	110,661	15.5%
South Los Angeles	2,002	14,208	1.9%
South Valley	17,715	80,087	10.5%
West Los Angeles	23,908	92,316	21.8%
Total	**114,245**	**629,267**	**16.1%**

13.4.2 Property

Structures

Property damage from wildfires can be severe and can significantly alter entire communities. Table 13-2 displays the number of structures in the Very High FHSZ within the planning area and their value.

Land Use

Table 13-3 shows the general land use of parcels exposed to the wildfire hazard in the planning area.

Table 13-2. Exposure and Value of Structures in Very High Wildfire Hazard Area

Area Planning Commission	Buildings Exposed	Estimated Value in Very High Wildfire Hazard Area			% of Total Replacement Value
		Structure	Contents	Total	
Central	16,007	$7,393,594,289	$3,932,969,760	$11,326,564,049	5.9%
East Los Angeles	31,600	$9,389,683,550	$5,764,257,110	$15,153,940,660	22.9%
Harbor	262	$61,196,924	$36,309,958	$97,506,882	0.2%
North Valley	22,751	$8,552,367,907	$5,501,356,432	$14,053,724,339	12.2%
South Los Angeles	2,002	$822,704,789	$455,409,293	$1,278,114,082	1.3%
South Valley	17,715	$8,007,389,253	$4,442,879,414	$12,450,268,667	8.6%
West Los Angeles	23,908	$12,081,482,209	$6,836,704,931	$18,918,187,140	17.2%
Total	**114,245**	**$46,308,418,921**	**$26,969,886,898**	**$73,278,305,819**	**9.5%**

Table 13-3. Land Use Within the Very High Wildfire Hazard Area

Land Use	Very High FHSZ	
	Area (acres)	% of total
Agriculture	0.0	0.00%
Commercial	908.2	1.04%
Government	2,802.9	3.20%
Industrial	614.6	0.70%
Multi-Family Residential	2,650.0	3.03%
Open Space	34,113.3	39.00%
Parking	0.7	0.00%
Single Family Residential	46,369.2	53.02%
Total	**87,458.9**	**100.00%**

13.4.3 Critical Facilities and Infrastructure

Table 13-4 identifies critical facilities exposed to the wildfire hazard in the planning area. In the event of wildfire, there would likely be little damage to the majority of infrastructure. Most road and railroads would be without damage except in the worst scenarios. Power lines are the most at risk to wildfire because most are made of wood and susceptible to burning. In the event of a wildfire, pipelines could provide a source of fuel and lead to a catastrophic explosion.

Table 13-4. Critical Facilities and Infrastructure in Wildfire Hazard Areas

APC	Critical Operating Facilities	Critical Response Facilities	Critical Infrastructure—Transportation	Critical Infrastructure—Utilities	Total
Central	0	13	34	3	**50**
East Los Angeles	0	33	55	10	**98**
Harbor	0	1	0	0	**1**
North Valley	0	14	63	15	**92**
South Los Angeles	0	0	0	1	**1**
South Valley	0	12	6	3	**21**
West Los Angeles	0	39	25	31	**95**
Total	**0**	**112**	**183**	**63**	**358**

13.4.4 Environment

Fire is a natural and critical ecosystem process in most terrestrial ecosystems, dictating in part the types, structure, and spatial extent of native vegetation. However, wildfires can cause severe environmental impacts:

- **Damaged Fisheries**—Critical fisheries can suffer from increased water temperatures, sedimentation, and changes in water quality.
- **Soil Erosion**—The protective covering provided by foliage and dead organic matter is removed, leaving the soil fully exposed to wind and water erosion. Accelerated soil erosion occurs, causing landslides and threatening aquatic habitats.
- **Spread of Invasive Plant Species**—Non-native woody plant species frequently invade burned areas. When weeds become established, they can dominate the plant cover over broad landscapes, and become difficult and costly to control.
- **Disease and Insect Infestations**—Unless diseased or insect-infested trees are swiftly removed, infestations and disease can spread to healthy forests and private lands. Timely active management actions are needed to remove diseased or infested trees.
- **Destroyed Endangered Species Habitat**—Catastrophic fires can have devastating consequences for endangered species.
- **Soil Sterilization**—Topsoil exposed to extreme heat can become water repellant, and soil nutrients may be lost. It can take decades or even centuries for ecosystems to recover from a fire. Some fires burn so hot that they can sterilize the soil.

Many ecosystems are adapted to historical patterns of fire occurrence. These patterns, called “fire regimes,” include temporal attributes (e.g., frequency and seasonality), spatial attributes (e.g., size and spatial complexity), and magnitude attributes (e.g., intensity and severity), each of which have ranges of natural variability. Ecosystem stability is threatened when any of the attributes for a given fire regime diverge from its range of natural variability.

13.5 VULNERABILITY

Structures, above-ground infrastructure, critical facilities and natural environments are all vulnerable to the wildfire hazard. There is currently no validated damage function available to support wildfire mitigation planning. Except as discussed in this section, vulnerable populations, property, infrastructure and environment are assumed to be the same as described in the section on exposure.

13.5.1 Population

There are no recorded incidents of loss of life from wildfires within the planning area. Given the immediate response times to reported fires, the likelihood of injuries and casualties is minimal; therefore, injuries and casualties were not estimated for the wildfire hazard.

Smoke and air pollution from wildfires can be a severe health hazard, especially for sensitive populations, including children, the elderly and those with respiratory and cardiovascular diseases. Smoke generated by wildfire consists of visible and invisible emissions that contain particulate matter (soot, tar, water vapor, and minerals), gases (carbon monoxide, carbon dioxide, nitrogen oxides), and toxics (formaldehyde, benzene). Emissions from wildfires depend on the type of fuel, the moisture content of the fuel, the efficiency (or temperature) of combustion, and the weather. Public health impacts associated with wildfire include difficulty in breathing, odor, and reduction in visibility.

Wildfire may also threaten the health and safety of those fighting the fires. First responders are exposed to the dangers from the initial incident and after-effects from smoke inhalation and heat stroke.

13.5.2 Property

Loss estimations for the wildfire hazard are not based on damage functions, because no such damage functions have been generated. Instead, loss estimates were developed representing 10 percent, 30 percent and 50 percent of the replacement value of exposed structures. This allows emergency managers to select a range of economic impact based on an estimate of the percent of damage to the general building stock. Damage in excess of 50 percent is considered to be substantial by most building codes and typically requires total reconstruction of the structure. Table 13-5 lists the loss estimates for the general building stock exposed to a very high fire hazard severity zone.

Table 13-5. Loss Estimates for Very High Wildfire Zone

Area Planning Commission	Total Building Value (Structure and Contents in $)	10% of Total Building Value	30% of Total Building Value	50% of Total Building Value
Central	$11,326,564,049	$1,132,656,405	3,397,969,215	5,663,282,024
East Los Angeles	$15,153,940,660	$1,515,394,066	4,546,182,198	7,576,970,330
Harbor	$97,506,882	$9,750,688	29,252,065	48,753,441
North Valley	$14,053,724,339	$1,405,372,434	4,216,117,302	7,026,862,170
South Los Angeles	$1,278,114,082	$127,811,408	383,434,225	639,057,041
South Valley	$12,450,268,667	$1,245,026,867	3,735,080,600	6,225,134,334
West Los Angeles	$18,918,187,140	$1,891,818,714	5,675,456,142	9,459,093,570
Total	**$73,278,305,819**	**$7,327,830,582**	**21,983,491,746**	**36,639,152,909**

13.5.3 Critical Facilities and Infrastructure

Critical facilities of wood frame construction are especially vulnerable during wildfire events. In the event of wildfire, there would likely be little damage to most infrastructure. Most roads and railroads would be without damage except in the worst scenarios. Power lines are the most at risk from wildfire because most poles are made of wood and susceptible to burning. Fires can create conditions that block or prevent access and can isolate residents and emergency service providers. Wildfire typically does not have a major direct impact on bridges, but it can create conditions in which bridges are obstructed. Many bridges in areas of high to moderate fire risk are important because they provide the only ingress and egress to large areas and in some cases to isolated neighborhoods.

13.6 FUTURE TRENDS IN DEVELOPMENT

The highly urbanized planning area has little wildfire risk exposure. Urbanization tends to alter the natural fire regime, and can create the potential for expansion of urbanized areas into wildland areas. Expansion of the wildland urban interface can be managed with strong land use and building codes. The planning area is well equipped with these tools and this planning process has assessed capabilities with regards to the tools. As the planning area experiences future growth, it is anticipated that the exposure to this hazard will remain as assessed or even decrease over time due to these capabilities.

13.7 SCENARIO

A major wildfire in the planning area might begin with a wet spring, adding to fuels already present on the forest floor. Flashy fuels would build throughout the spring. The summer could see the onset of insect infestation. A dry summer could follow the wet spring, exacerbated by dry hot winds. Carelessness with combustible materials or a tossed lit cigarette, or a sudden lighting storm could trigger a multitude of small isolated fires.

The embers from these smaller fires could be carried miles by hot, dry winds. The deposition zone for these embers would be deep in the forests and interface zones. Fires that start in flat areas move slower, but wind still pushes them. It is not unusual for a wildfire pushed by wind to burn the ground fuel and later climb into the crown and reverse its track. This is one of many ways that fires can escape containment, typically during periods when response capabilities are overwhelmed. These new small fires would most likely merge. Suppression resources would be redirected from protecting the natural resources to saving more remote subdivisions.

The worst-case scenario would include an active fire season throughout the American west, spreading resources thin. Firefighting teams would be exhausted or unavailable. Many federal assets would be responding to other fires that started earlier in the season. While local fire districts would be extremely useful in the urban interface areas, they have limited wildfire capabilities or experience, and they would have a difficult time responding to the ignition zones. Even though the existence and spread of the fire is known, it may not be possible to respond to it adequately, so an initially manageable fire can become out of control before resources are dispatched.

To further complicate the problem, heavy rains could follow, causing flooding and landslides and releasing tons of sediment into rivers, permanently changing floodplains and damaging sensitive habitat and riparian areas. Such a fire followed by rain could release millions of cubic yards of sediment into streams for years, creating new floodplains and changing existing ones. With the forests removed from the watershed, stream flows could easily double. Floods that could be expected every 50 years may occur every couple of years. With the streambeds unable to carry the increased discharge because of increased sediment, the floodplains and floodplain elevations would increase.

13.8 ISSUES

The major issues for wildfire are the following:

- Public education and outreach to people living in or near the fire hazard zones should include information about and assistance with mitigation activities such as defensible space, and advance identification of evacuation routes and safe zones.
- Wildfires could cause landslides as a secondary natural hazard.
- Climate change could affect the wildfire hazard.
- Future growth into the foothills interface areas should continue to be managed.
- The City fire department needs to continue to train on wildland-urban interface events.
- Vegetation management activities. This would include enhancement through expansion of the target areas as well as additional resources.
- Regional consistency of higher building code standards such as residential sprinkler requirements and prohibitive combustible roof standards.

14. CLIMATE CHANGE AND SEA LEVEL RISE

14.1 GENERAL BACKGROUND

DEFINITIONS

Climate Change—A long-term change in the earth's climate, especially a change due to an increase in the average atmospheric temperature.

Sea Level Rise—An increase of the volume of water in the world's oceans, resulting in an increase in global mean sea level.

14.1.1 What is Climate Change?

Climate, consisting of patterns of temperature, precipitation, humidity, wind and seasons, plays a fundamental role in shaping natural ecosystems and the human economies and cultures that depend on them. "Climate change" refers to changes over a long period of time. Worldwide, average temperatures have increased 1.78ºF since 1880 (NASA, 2017). Although this change may seem small, it can lead to large changes in climate and weather.

The warming trend and its related impacts are caused by increasing concentrations of carbon dioxide and other greenhouse gases in the earth's atmosphere. Greenhouse gases are gases that trap heat in the atmosphere, resulting in a warming effect. Carbon dioxide is the most commonly known greenhouse gas; however, methane, nitrous oxide and fluorinated gases also contribute to warming. Emissions of these gases come from a variety of sources, such as the combustion of fossil fuels, agricultural production, changes in land use and volcanic eruptions.

According to the U.S. Environmental Protection Agency (EPA), carbon dioxide concentrations measured about 280 parts per million before the industrial era began in the late 1700s and reached 401 parts per million in 2015 (EPA, 2016) (see Figure 14-1). In addition, the concentration of methane has almost doubled, and nitrous oxide is being measured at a record high of 328 parts per billion (EPA, 2016a). In the United States, electricity generation is the largest source of these emissions, followed by transportation (EPA, 2016b).

Scientists are able to place the rise in carbon dioxide in a longer historical context through the measurement of carbon dioxide in ice cores. According to these records, carbon dioxide concentrations in the atmosphere are the highest that they have been in 650,000 years (NASA, 2016). According to NASA, most of this trend is very likely human-induced and it is proceeding at an unprecedented rate (NASA, 2016). There is broad scientific consensus (97 percent of scientists) that climate-warming trends are very likely due to human activities (NASA, 2016). Unless emissions of greenhouse gases are substantially reduced, this warming trend is expected to continue.

Climate change will affect the people, property, economy and ecosystems of the City of Los Angeles in a variety of ways. Climate change impacts are most frequently associated with negative consequences, such as increased flood vulnerability or increased heat-related illnesses/public health concerns; however, other changes may present opportunities. The most important effect for the development of this plan is that climate change will have a measurable impact on the occurrence and severity of natural hazards.

14.1.2 How Climate Change Affects Hazard Mitigation

An essential aspect of hazard mitigation is predicting the likelihood of hazard events. Typically, predictions are based on statistical projections from records of past events. This approach assumes that the likelihood of hazard events remains essentially unchanged over time. Thus, averages based on the past frequencies of, for example, floods are used to estimate future frequencies: if a river has flooded an average of once every 5 years for the past 100 years, then it can be expected to continue to flood an average of once every 5 years.

Source: EPA, 2016

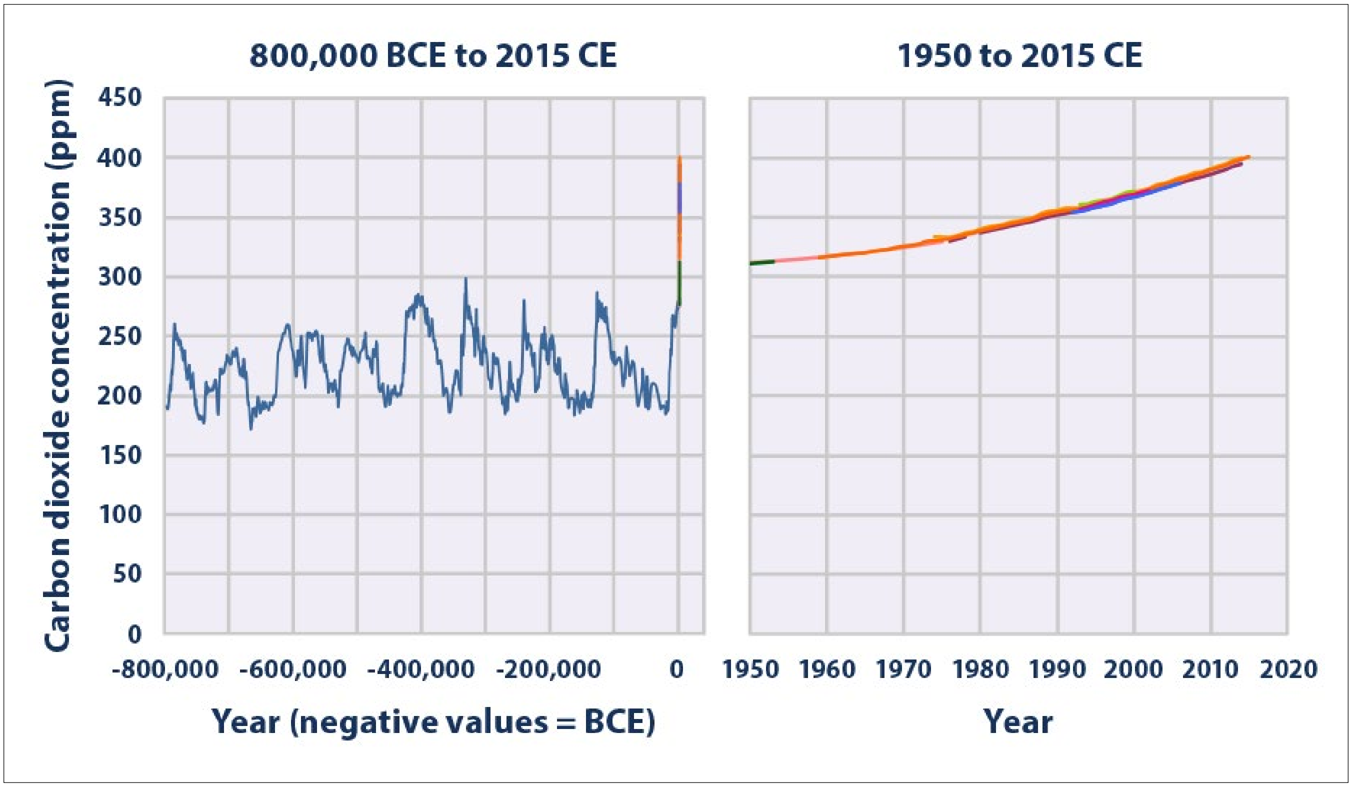


Figure 14-1. Global Carbon Dioxide Concentrations Over Time

For hazards that are affected by climate conditions, the assumption that future behavior will be equivalent to past behavior is not valid if climate conditions are changing. As flooding is generally associated with precipitation frequency and quantity, for example, the frequency of flooding will not remain constant if broad precipitation patterns change over time. As hydrology changes, storms currently considered to be a 1-percent-annual-chance event (100-year flood) might strike more often, leaving many communities at greater risk. The risks of landslide, severe storms, extreme heat and wildfire are all affected by climate patterns as well. For this reason, an understanding of climate change is pertinent to efforts to mitigate natural hazards. Information about how climate patterns are changing provides insight on the reliability of future hazard projections used in mitigation analysis. This chapter summarizes current understandings about climate change in order to provide a context for the recommendation and implementation of hazard mitigation measures.

14.1.3 Current Indicators of Climate Change

The major scientific agencies of the United States and the world—including NASA, NOAA and the Intergovernmental Panel on Climate Change (IPCC)—agree that climate change is occurring. Multiple temperature records from all over the world have shown a warming trend. The IPCC has stated that the warming of the climate system is unequivocal (IPCC, 2014). Sixteen of the 17 warmest years on record occurred since 2001, and 2016 was the warmest year on record (NASA, 2017).

Rising global temperatures have been accompanied by other changes in weather and climate. Many places have experienced changes in rainfall resulting in more intense rain, as well as more frequent and severe heat waves (IPCC, 2014). The planet's oceans and glaciers have also experienced changes: oceans are warming and becoming more acidic, ice caps are melting, and sea levels are rising (NASA, 2016). Global sea level has risen 6.7 inches in the last 100 years (NASA, 2016). This has already put some coastal homes, beaches, roads, bridges, and wildlife at risk (USGCRP, 2009). At the time of the development of this plan, NASA reports the following trends (NASA, 2016):

- Carbon Dioxide—Increasing trend, currently at 405.92 parts per million.
- Global Temperature—Increasing trend, increase of 1.7ºF since 1880.
- Arctic Ice Minimum—Decreasing trend, 13.3 percent per decade.
- Land Ice—Decreasing trend, 281.0 giga-tonnes per year.
- Sea Level—Increasing trend, 3.4 millimeters (0.04 inches) per year.

14.1.4 Projected Future Impacts

The *Third National Climate Assessment Report for the United States* indicates that impacts resulting from climate change will continue through the 21st century and beyond. Although not all changes are understood at this time and the impacts of those changes will depend on global emissions of greenhouse gases and sensitivity in human and natural systems, the following impacts are expected in the United States (NASA, 2016):

- Temperatures will continue to rise.
- Growing seasons will lengthen.
- Precipitation patterns will change.
- Droughts and heat waves will increase.
- Hurricanes will become stronger and more intense.
- Sea level will rise 1 to 4 feet by 2100.
- The Arctic may become ice free.

The *California Climate Adaptation Planning Guide* outlines the following climate change impact concerns for the South Coast climate impact region, which includes Los Angeles (Cal EMA et al., 2012):

- Increased temperatures
- Reduced overall precipitation
- Sea level rise
- Public health (heat and air quality)
- Reduced water supply
- Reduced tourism
- Coastal erosion
- Wildfire risk.

Some of these changes are direct or primary climatic changes, such as increased temperature, while others are indirect or secondary impacts resulting from the direct changes, such as heat and air pollution. Some direct changes may interact with one another to create unique secondary impacts. These primary and secondary impacts may then result in impacts on human and natural systems. The primary and secondary impacts likely to affect the planning area are summarized in Table 14-1.

Climate change projections contain inherent uncertainty, largely because they depend on future greenhouse gas emission scenarios. Generally, the uncertainty in greenhouse gas emissions is addressed by the assessment of differing scenarios: low-emissions scenarios and high-emissions scenarios. In low-emissions scenarios, greenhouse gas emissions are reduced substantially from current levels. In high-emissions scenarios, greenhouse gas emissions generally increase or continue at current levels. Uncertainty in outcomes is generally addressed by averaging a variety of model outcomes.

Table 14-1. Summary of Primary and Secondary Impacts Likely to Affect the City of Los Angeles

Primary Impact	Secondary Impact	Example Human and Natural System Impacts
Increased Temperature	Heat wave and high carbon emissions	• Increased frequency of illness and death • Increased high alert ozone days, urban heat islands • Increased stress on mechanical systems, such as HVAC systems • Increased stress on electricity supply and demand
Reduced Precipitation	Changed seasonal patterns	• Reduced water supply • Reduced tourism
	Increased wildfires	• More people, wildlife, land, and structures impacted by fires. • Summer dryness will begin earlier, last longer, and become more intense.
Sea Level Rise	Permanent inundation of previously dry land	• Loss of assets and tax base • Loss of coastal habitat • Loss of tourism
	Larger area impacted by extreme high tide	• More people and structures impacted by storms
	Increased coastal erosion	• Loss of assets and tax base
Reduced Mountain Snowpack	Reduced water supply	• Primary sources of water are State Water Project and the Colorado River, both originating in mountain snowpack; change may reduce water supply. • Increased costs for water

Adapted and expanded from California Adaptation Planning Guide: Planning for Adaptive Communities

Despite this uncertainty, climate change projections present valuable information to help guide decision-making for possible future conditions. The following sections summarize information developed for the City of Los Angeles by Cal-Adapt, a resource for public information on how climate change might impact local communities, based on the most current data available.

Temperature

The historical (1981-2010) average temperature in City of Los Angeles was 66.6ºF. By 2090, the average temperature is expected to increase above this baseline by 3.5ºF and 6.0ºF in the low- and high-emissions scenarios, respectively (see Figure 14-2). By 2100, if temperatures rise to the higher warning range, there could be up to 100 more days per year with temperatures above 90 ºF in Los Angeles.

Extreme Heat

The extreme heat day temperature threshold for the planning area is 91°F. The historical average number of extreme heat days is four. The number of extreme heat days, the number of warm nights (62°F threshold), the number of heat waves and the duration of heat waves are all expected to increase over the next century (see Figure 14-3).

Precipitation

Precipitation projections for California remain uncertain. Models show differing impacts from slightly wetter winters to slightly drier winters, with the potential for a 10- to 20-percent decrease in total annual precipitation. Changes in precipitation patterns, coupled with warmer temperatures, may lead to significant changes in hydrology. In high-emissions scenarios, more precipitation may fall as rain rather than snow and this snow may melt earlier in the season, thus impacting the timing of changes in stream flow and flooding (Cal-Adapt, 2016).

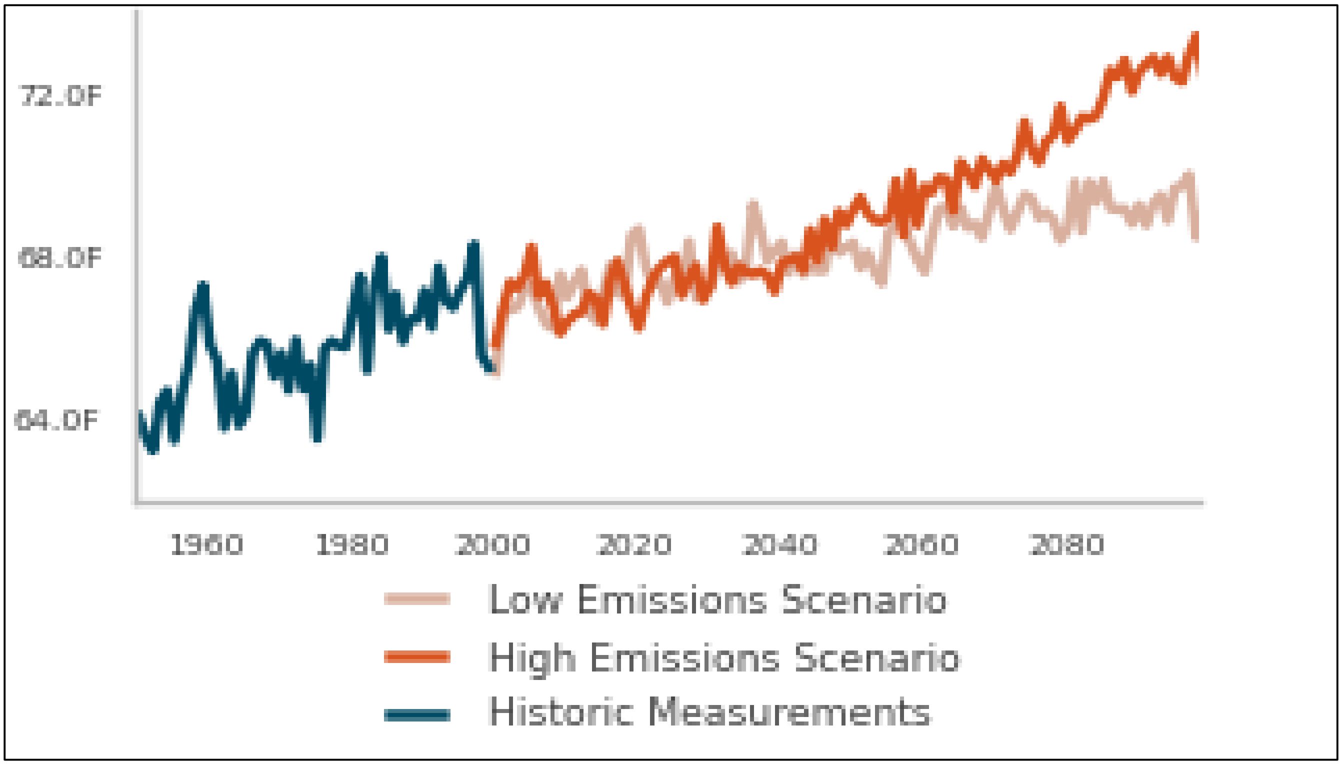


Figure 14-2. Observed and Projected Average Temperatures for City of Los Angeles

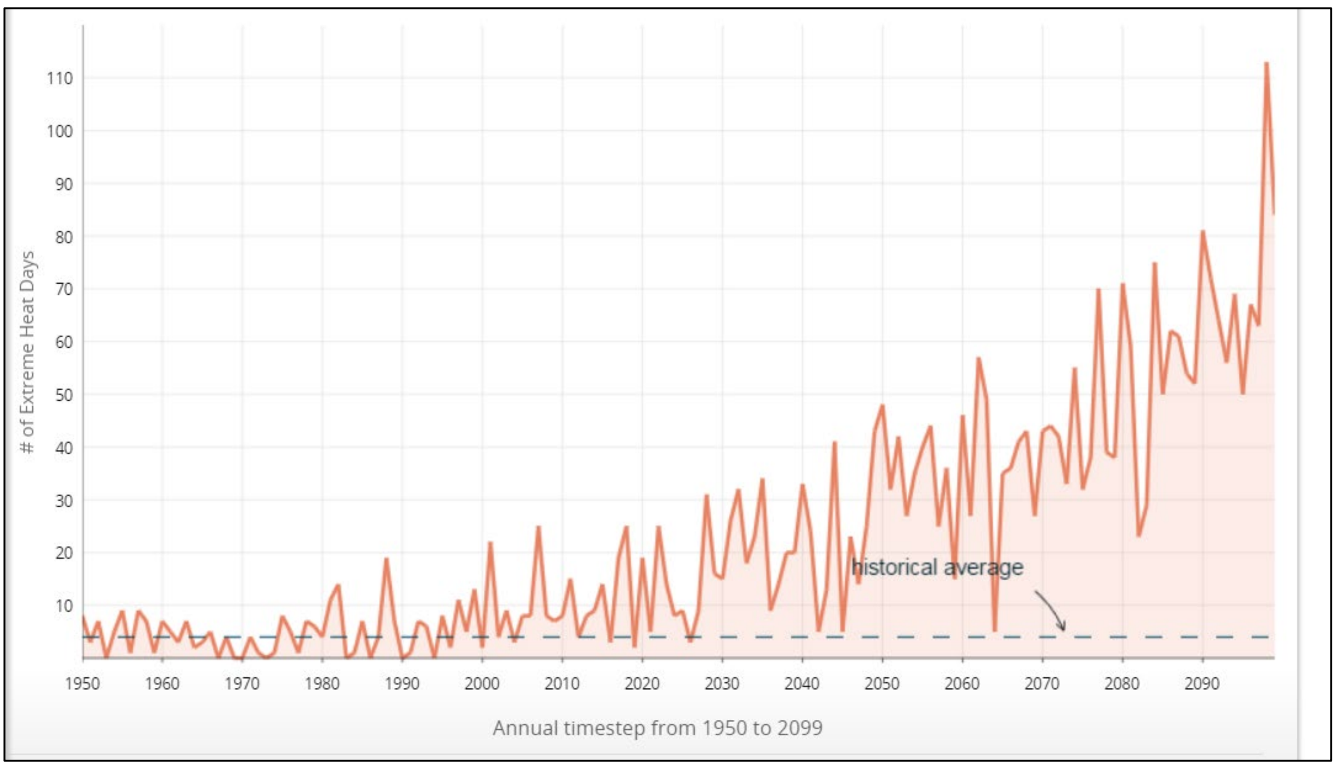


Figure 14-3. Projected Number of Extreme Heat Days by Year for City of Los Angeles

Snow Pack

While there are no snow water equivalency measurements for the planning area, Cal-Adapt indicates that parts of California should expect snow pack levels to be reduced by up to 25 inches from the baseline (1961-1990) by 2090.

Wildfire

Wildfire risk is expected to change in the coming decades (see Figure 14-4). Under both high- and low-emissions scenarios, the change in area burned may slightly increase until 2020 and then decrease by 10 to 20 percent by 2085.

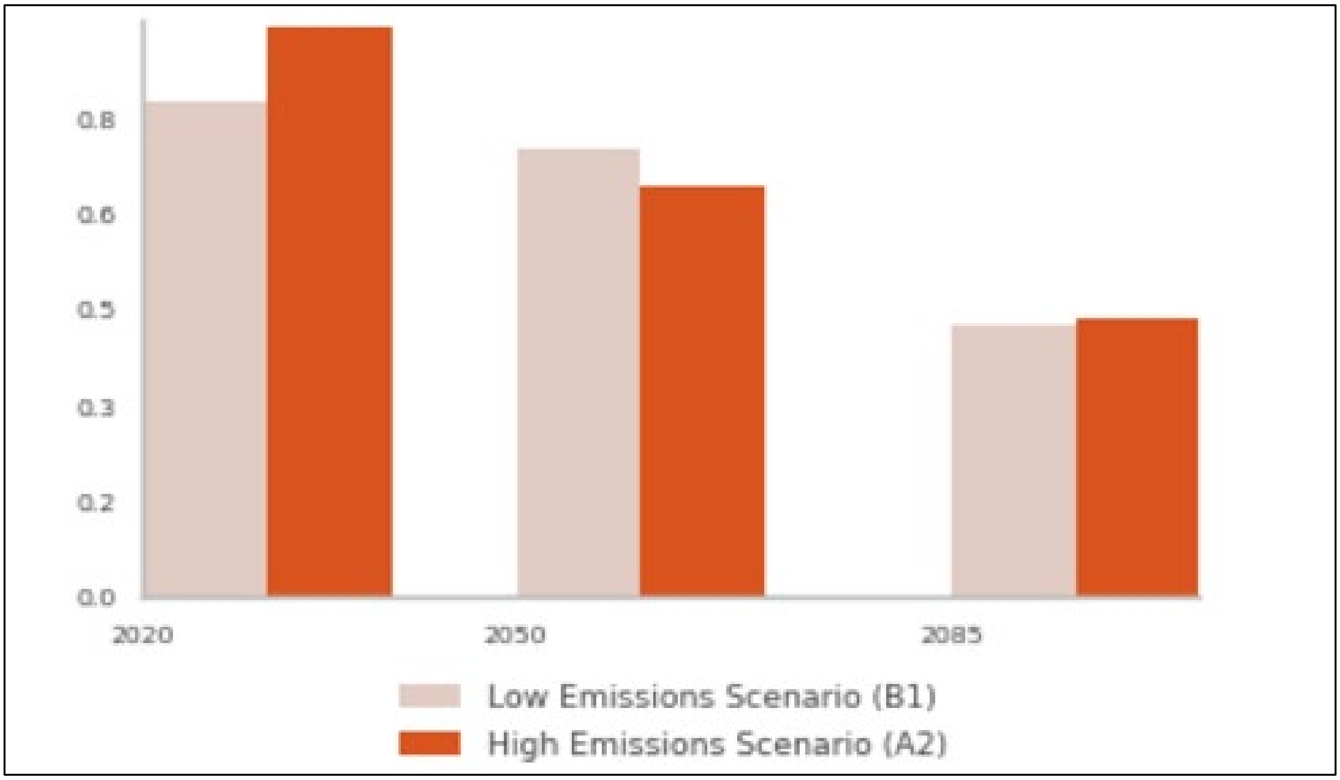


Figure 14-4. Projected Changes in Fire Risk for City of Los Angeles, Relative to 2010 Levels

14.1.5 Responses to Climate Change

Communities and governments worldwide are working to address, evaluate and prepare for climate changes that are likely to impact communities in coming decades. Generally, climate change discussions encompass two separate but inter-related considerations: mitigation and adaptation. The term "mitigation" can be confusing, because its meaning changes across disciplines:

- Mitigation in restoration ecology and related fields generally refers to policies, programs or actions that are intended to reduce or to offset the negative impacts of human activities on natural systems. Generally, mitigation can be understood as avoiding, minimizing, rectifying, reducing or eliminating, or compensating for known impacts (CEQ, 1978).
- Mitigation in climate change discussions is defined as "a human intervention to reduce the impact on the climate system." It includes strategies to reduce greenhouse gas sources and emissions and enhance greenhouse gas sinks (EPA, 2013).

- Mitigation in emergency management is typically defined as the effort to reduce loss of life and property by lessening the impact of disasters (FEMA, 2013).

In this chapter, mitigation is used as defined by the climate change community. In the other chapters of this plan, mitigation is primarily used in an emergency management context.

The IPCC defines adaptation as "the process of adjustment to actual or expected climate and its effects." Mitigation and adaptation are related, as the world's ability to reduce greenhouse gas emissions will affect the degree of adaptation that will be necessary. Moreover, some initiatives and actions can both reduce greenhouse gas emissions and support adaptation to likely future conditions. The ability to adapt to changing conditions is often referred to as adaptive capacity, which is "the ability of systems, institutions, humans and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences" (IPCC, 2014).

Societies across the world are facing the need to adapt to changing conditions and to identify ways to increase their adaptive capacity. Some efforts are already underway. Farmers are altering crops and agricultural methods to deal with changing rainfall and rising temperature; architects and engineers are redesigning buildings; planners are looking at managing water supplies to deal with droughts or flooding.

Adaptive capacity goes beyond human systems, as some ecosystems show a remarkable ability to adapt to change and to buffer surrounding areas from the impacts of change. Forests can bind soils and hold large volumes of water during times of plenty, releasing it through the year; floodplains can absorb vast volumes of water during peak flows; coastal ecosystems can hold out against storms, attenuating waves and reducing erosion. Other ecosystem services—such as food provision, timber, materials, medicines and recreation—can provide a buffer to societies in the face of changing conditions. Ecosystem-based adaptation is the use of biodiversity and ecosystem services as part of an overall strategy to help people adapt to the adverse effects of climate change. This includes the sustainable management, conservation and restoration of specific ecosystems that provide key services.

14.2 VULNERABILITY ASSESSMENT— HAZARDS OF CONCERN

The following sections provide information on how each identified natural hazard of concern for this planning process may be impacted by climate change and how these impacts may alter current exposure and vulnerability to these hazards for the people, property, critical facilities and the environment in the planning area.

14.2.1 Adverse Weather

Climate Change Impacts on the Hazard

Climate change presents a challenge for risk management associated with adverse weather. The number of weather-related disasters during the 1990s was four times that of the 1950s and led to 14 times as much in economic losses. The science for linking the severity of specific adverse weather events to climate change is still evolving; however, some trends provide an indication of how climate change may be impacting these events.

The increase in average surface temperatures can lead to more intense heat waves that can be exacerbated in the City of Los Angeles by its urban heat island effect. Evidence suggests that heat waves are already increasing, especially in western states. Extreme heat days in the planning area are likely to increase. Climate change impacts on other adverse weather events, such as high winds and thunderstorms, are still not well understood.

Exposure, Sensitivity and Vulnerability

Population and Property

Population and property exposure and vulnerability would be unlikely to increase as a direct result of climate change impacts on the adverse weather hazard. Adverse weather events may occur more frequently, but exposure and vulnerability will remain the same. Secondary impacts, such as the extent of localized flooding, may increase, impacting greater numbers of people and structures. Exposure of the population to higher heat stress and lower air quality could lead to lower quality of health in the City.

Critical Facilities

Critical facility exposure and vulnerability would be unlikely to increase as a result of climate change impacts on the adverse weather hazard; however, critical facility owners and operators may experience more frequent disruption to service. For example, more frequent and intense storms may cause more frequent disruptions in power service.

Environment

Exposure and vulnerability of the environment would be unlikely to increase; however, more frequent storms and heat events and more intense rainfall may place additional stressors on already stressed systems.

Economy

Climate change impacts on the adverse weather hazard may impact the local economy through more frequent disruption to services, such as power outages.

14.2.2 Dam Failure

Climate Change Impacts on the Hazard

On average, changes in California's annual precipitation levels are not expected to be dramatic; however, small changes may have significant impacts for water resource systems, including dams. Dams are designed partly based on assumptions about a river's flow behavior, expressed as hydrographs. Changes in weather patterns can have significant effects on the hydrograph used for the design of a dam. If the hygrograph changes, it is conceivable that the dam can lose some or all of its designed margin of safety, also known as freeboard.

If the freeboard of a dam is reduced, dam operators may be forced to release increased volumes earlier in a storm cycle in order to maintain the required margins of safety. Such early releases of increased volumes can increase flood potential downstream. According to the California Department of Water Resources, flood flows on many California rivers have been record-setting since the 1950s. This means that dams and other water infrastructure have been forced to manage flows for which they were not designed (DWR, 2007). The California Division of Safety of Dams has indicated that climate change may result in the need for increased safety precautions to address higher winter runoff, frequent fluctuations of water levels, and increased potential for sedimentation and debris accumulation from changing erosion patterns and increases in wildfires. According to the DSOD, climate change also will impact the ability of dam operators to estimate extreme flood events (DWR, 2008).

Dams are constructed with safety features known as "spillways." Spillways are put in place on dams as a safety measure in the event of the reservoir filling too quickly. Spillway overflow events, often referred to as "design failures," result in increased discharges downstream and increased flooding potential. Although climate change will not increase the probability of catastrophic dam failure, it may increase the probability of design failures.

Exposure, Sensitivity and Vulnerability

Population

Population exposure and vulnerability to the dam failure hazard are unlikely to change as a result of climate change.

Property

Property exposure and vulnerability to the dam failure hazard are unlikely to change as a result of climate change.

Critical facilities

The exposure and vulnerability of critical facilities are unlikely to change as result of climate change. Dam owners and operators are sensitive to the risk and may need to alter maintenance and operations to account for changes in the hydrograph and increased sedimentation.

Environment

The exposure and vulnerability of the environment to dam failure are unlikely to change as a result of climate change. Ecosystem services may be used to mitigate some factors that could increase the risk of design failures, such as increasing the natural water storage capacity in watersheds above dams.

Economy

Changes in the dam failure hazard related to climate change are unlikely to affect the local economy.

14.2.3 Drought

Climate Change Impacts on the Hazard

The long-term effects of climate change on regional water resources are unknown, but global water resources are already experiencing the following stresses without climate change:

- Growing populations.
- Increased competition for available water.
- Poor water quality.
- Environmental claims.
- Uncertain reserved water rights.
- Groundwater overdraft.
- Aging urban water infrastructure.

With a warmer climate, droughts could become more frequent, more severe, and longer-lasting. The *Third National Climate Assessment Report for the United States* indicates that “higher surface temperatures brought about by global warming increase the potential for drought. Evaporation and the higher rate at which plants lose moisture through their leaves both increase with temperature. Unless higher evapotranspiration rates are matched by increases in precipitation, environments will tend to dry, promoting drought conditions” (Globalchange.gov, 2014).

Because expected changes in precipitation patterns are still uncertain, the potential impacts and likelihood of drought are uncertain. DWR has noted impacts of climate change on statewide water resources by charting changes in snowpack, sea level, and river flow. As temperatures rise and more precipitation comes in the form of rain instead of snow, these changes will likely continue or grow even more significant. DWR estimates that the

Sierra Nevada snowpack, which provides a large amount of the water supply for the planning area and other parts of the state, will experience a 48- to 65-percent loss by the end of the century compared to historical averages (DWR, 2016b). Increasing temperatures may also increase net evaporation from reservoirs by 15 to 37 percent (DWR, 2013). In addition to snowpack resources, the planning area's water supply is derived from groundwater and surface water resources. Increased incidence of drought may cause a drawdown in groundwater resources without allowing for the opportunity for aquifer recharge.

Exposure, Sensitivity and Vulnerability

Population

Population exposure and vulnerability to drought are unlikely to increase as a result of climate change. While greater numbers of people may need to engage in behavior change, such as water saving efforts, significant life or health impacts are unlikely.

Property

Property exposure and vulnerability may increase as a result of increased drought resulting from climate change, although this would most likely occur in non-structural property such as crops and landscaping. It is unlikely that structure exposure and vulnerability would increase as a direct result of drought, although secondary impacts of drought, such as wildfire, may increase and threaten structures.

Critical facilities

Critical facility exposure and vulnerability are unlikely to increase as a result of increased drought resulting from climate change; however, critical facility operators may be sensitive to changes and need to alter standard management practices and actively manage resources, particularly in water-related service sectors.

Environment

The vulnerability of the environment may increase as a result of increased drought resulting from climate change. Ecosystems and biodiversity are already under stress from development and water diversion activities. Prolonged or more frequent drought resulting from climate change may further stress the ecosystems in the region, which include many special status species.

Economy

Increased incidence of drought could increase the potential for impacts on the local economy. Increased drought may impact tourism activities as well as the landscaping industry.

14.2.4 Earthquake

Climate Change Impacts on the Hazard

The impacts of global climate change on earthquake probability are unknown. Some scientists say that melting glaciers could induce tectonic activity. As ice melts and water runs off, tremendous amounts of weight are shifted on the earth's crust. As newly freed crust returns to its original, pre-glacier shape, it could cause seismic plates to slip and stimulate volcanic activity, according to research into prehistoric earthquakes and volcanic activity. NASA and USGS scientists found that retreating glaciers in southern Alaska may be opening the way for future earthquakes (NASA, 2004).

Secondary impacts of earthquakes could be magnified by climate change. Soils saturated by repetitive storms or heavy precipitation could experience liquefaction or an increased propensity for slides during seismic activity due to the increased saturation. Dams storing increased volumes of water due to changes in the hydrograph could fail during seismic events.

Exposure, Sensitivity and Vulnerability

Because impacts of climate change on the earthquake hazard are not well understood, increases in exposure and vulnerability of the local resources are not able to be determined.

14.2.5 Flood

Climate Change Impacts on the Hazard

Use of historical hydrologic data has long been the standard of practice for designing and operating water supply and flood protection projects. For example, historical data are used for flood forecasting models and to forecast snowmelt runoff for water supply. This method of forecasting assumes that the climate of the future will be similar to that of the period of historical record. However, scientists project greater storm intensity with climate change, resulting in more direct runoff and flooding. High frequency flood events (e.g. 10-year floods) in particular will likely increase with a changing climate. What is currently considered a 1-percent-annual-chance (100-year flood) also may strike more often, leaving many communities at greater risk. Going forward, model calibration must happen more frequently, new forecast-based tools must be developed, and a standard of practice that explicitly considers climate change must be adopted.

Climate change is already impacting water resources, and resource managers have observed the following:

- Historical hydrologic patterns can no longer be solely relied upon to forecast the water future.
- Precipitation and runoff patterns are changing, increasing the uncertainty for water supply and quality, flood management and ecosystem functions.
- Extreme climatic events will become more frequent, necessitating improvement in flood protection, drought preparedness and emergency response.

The amount of snow is critical for water supply and environmental needs, but so is the timing of snowmelt runoff into rivers and streams. Rising snowlines caused by climate change will allow more mountain areas, such as the Sierra Nevada watersheds, to contribute to peak storm runoff. Changes in watershed vegetation and soil moisture conditions will likewise change runoff and recharge patterns. As stream flows and velocities change, erosion patterns will also change, altering channel shapes and depths, possibly increasing sedimentation behind dams, and affecting habitat and water quality. With potential increases in the frequency and intensity of wildfires due to climate change, there is potential for more floods following fire, which increase sediment loads and water quality impacts.

In addition to riverine system flood impacts, climate change will also alter coastal flooding through sea level rise. These impacts are described in a separate section below.

Exposure, Sensitivity and Vulnerability

Population and Property

Population and property exposure and vulnerability may increase as a result of climate change impacts on the flood hazard. Runoff patterns may change, resulting in flooding in areas where it has not previously occurred.

Critical Facilities

Critical facility exposure and vulnerability may increase as a result of climate change impacts on the flood hazard. Runoff patterns may change, resulting in risk to facilities that have not historically been at risk from flooding.

Additionally, changes in the management and design of flood protection critical facilities may be needed as additional stress is placed on these systems. Planners will need to factor a new level of safety into the design, operation, and regulation of flood protection facilities such as dams, bypass channels and levees, as well as the design of local sewers and storm drains.

Environment

The exposure and vulnerability of the environment may increase as a result of climate change impacts on the flood hazard. Changes in the timing and frequency of flood events may have broader ecosystem impacts that alter the ability of already stressed species to survive.

Economy

If flooding becomes more frequent, there may be impacts on the local economy. More resources may need to be directed to response and recovery efforts, and businesses may need to close more frequently due to loss of service or access during flood events.

14.2.6 Landslide

Climate Change Impacts on the Hazard

Climate change may impact storm patterns, increasing the probability of more frequent, intense storms with varying duration. Increase in global temperature is likely to affect the snowpack and its ability to hold and store water. Warming temperatures also could increase the occurrence and duration of droughts, which would increase the probability of wildfire, reducing the vegetation that helps to support steep slopes. All of these factors would increase the probability for landslide occurrences.

Exposure, Sensitivity and Vulnerability

Population and Property

Population and property exposure and vulnerability would be unlikely to increase as a result of climate change impacts on the landslide hazard. Landslide events may occur more frequently, but the extent and location should be contained within mapped hazard areas or recently burned areas.

Critical facilities

Critical facility exposure and vulnerability would be unlikely to increase as a result of climate change impacts on the landslide hazard; however, critical facility owners and operators may experience more frequent disruption to service provision as a result of landslide hazards. For example, transportation systems may experience more frequent delays if slides blocking these systems occur more frequently. In addition, increased sedimentation resulting from landslides may negatively impact flood control facilities, such as dams.

Environment

Exposure and vulnerability of the environment would be unlikely to increase as a result of climate change, but more frequent slides in river systems may impact water quality and have negative impacts on stressed species.

Economy

Changes to the landslide hazard resulting from climate change are unlikely to result in impacts on the local economy.

14.2.7 Tsunami

Climate Change Impacts on the Hazard

The impacts of global climate change on tsunami probability are unknown. Some scientists say that melting glaciers could induce tectonic activity, inducing earthquakes. Other scientists have indicated that underwater avalanches (also caused by melting glaciers), may also result in tsunamis. Even if climate change does not increase the frequency with which tsunamis occur, it may result in more destructive waves. As sea levels continue to rise, tsunami inundation areas would likely reach further into communities than current mapping indicates.

Exposure, Sensitivity and Vulnerability

As land area likely to be inundated by tsunami waves increases, exposure and vulnerability to the tsunami hazard may increase for population, property, critical facilities and the environment. Changes to the tsunami hazard from climate change may result in more direct economic impacts on a greater number of businesses and economic centers, as well as the infrastructure systems that support those businesses.

14.2.8 Wildfire

Climate Change Impacts on the Hazard

Wildfire is determined by climate variability, local topography, and human intervention. Climate change has the potential to affect multiple elements of the wildfire system: fire behavior, ignitions, fire management, and vegetation fuels. Hot dry spells create the highest fire risk. Increased temperatures may intensify wildfire danger by warming and drying out vegetation.

Changes in climate patterns may impact the distribution and perseverance of insect outbreaks that create dead trees (increase fuel). When climate alters fuel loads and fuel moisture, forest susceptibility to wildfires changes. Climate change also may increase winds that spread fires. Faster fires are harder to contain, and thus are more likely to expand into residential neighborhoods.

Exposure, Sensitivity and Vulnerability

Population

According to Cal-Adapt projections, wildfire risk in the areas surrounding the City of Los Angeles may actually decrease over the next century. Other areas of California and the western United States are expected to have increased risk to wildfire, with increases in annual acres burned. Although residents may not experience increased risk to wildfire directly, secondary impacts, such as poor air quality may increase.

Property and Critical Facilities

If wildfire risk decreases, the exposure and vulnerability of property and critical facilities would remain the same.

Environment

It is possible that the exposure and vulnerability of the environment will be impacted by changes in wildfire risk due to climate change. Natural fire regimes may change, resulting in more or less frequent or higher intensity burns. These impacts may alter the composition of the ecosystems in areas in and surrounding the planning area.

Economy

As the risk from wildfire is currently projected to decrease, direct impacts on the economy would not be likely.

14.3 VULNERABILITY ASSESSMENT—SEA LEVEL RISE

14.3.1 Climate Change Impacts on the Hazard

Sea levels have been rising over the past several decades and are expected to continue to rise. Sea level rise is mostly attributed to two factors: the expansion of water as it warms (thermal expansion) and the melting of ice sheets and glaciers. As average ocean temperatures continue to increase, thermal expansion will continue and can be projected with some degree of certainty. Less certain is how quickly ice sheets will melt, accounting for most of the uncertainty in projections.

Sea level rise will cause currently dry areas to be permanently or chronically inundated. Temporary inundation from extreme tide events and storm surge also will change. Unlike many other impacts resulting from climate change, sea level rise will have a defined extent and location. This allows for a more-detailed risk assessment to be conducted for this climate change impact. Although the extent and timing of sea level rise is still uncertain, conducting an assessment of potential areas at risk provides information appropriate for planning purposes.

14.3.2 Exposure, Sensitivity and Vulnerability

The Level 2 Hazus coastal flood protocol was used to assess exposure and vulnerability to sea level rise in the planning area. Where possible, the Hazus default data was enhanced using local GIS data from local, state and federal sources. The assessment used Coastal Storm Modeling System data developed by the USGS and Deltares, which includes 40 scenarios that combine sea level rise and storm severity. Upon consultation with the Steering Committee, two scenarios were selected for assessment in this plan:

- 25 centimeters (9.84 inches) sea level rise with 100-year storm, including low-lying areas
- 150 centimeters sea level rise (59.06 inches) with 100-year storm, including low-lying areas.

These scenarios incorporate two conditions associated with sea level rise:

- Areas that would be permanently inundated (subject to tidal flooding on a daily basis)
- Areas that would be temporarily inundated (inundated when the 100-year storm occurs). These areas will not be permanently inundated, but will experience flooding at a rate equivalent to or greater than today’s regulated special flood hazard areas. This condition represents how the regulatory coastal floodplain and asset exposure will change as sea levels rise.

The Hazus assessment of exposure and vulnerability does not differentiate between temporary and permanent inundation. The exposure and vulnerability presented assume instantaneous changes in sea level associated with the predicted sea level rise and storm surge effects, with resulting impacts on assets as they are currently situated. This means that it may under-represent losses from permanent inundation if no adaptation measures, such as relocation or retreat occur, or may over-represent losses if adaptation efforts do take place in the coming decades.

Figure 14-5 through Figure 14-8 show the temporary and permanent inundation areas for the 25-centimeter sea level rise with storm scenario and the 150-centimeter sea level rise with storm scenario.

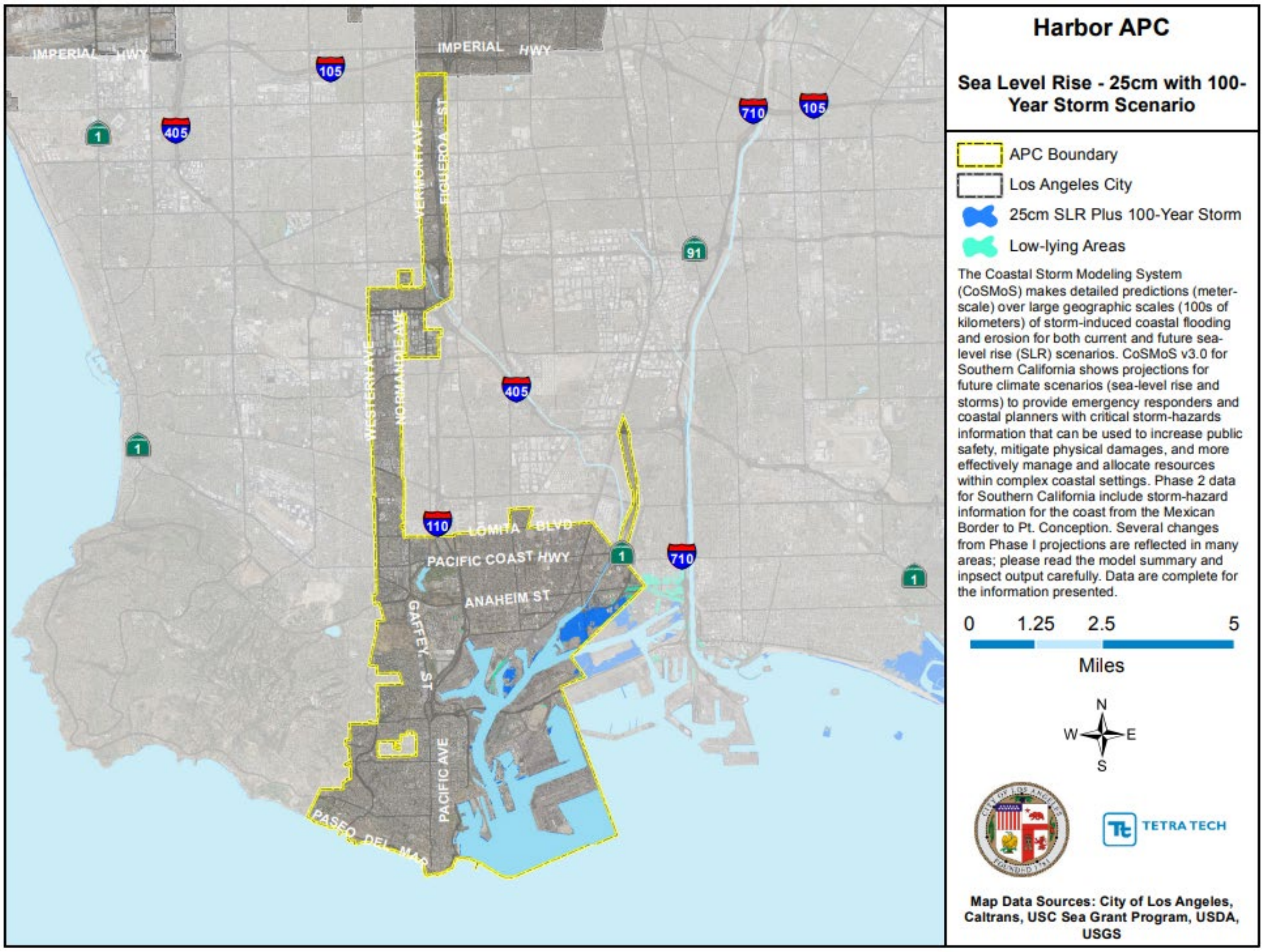


Figure 14-5. Sea Level Rise; 25-cm with 100-Year Storm Scenario; Harbor APC

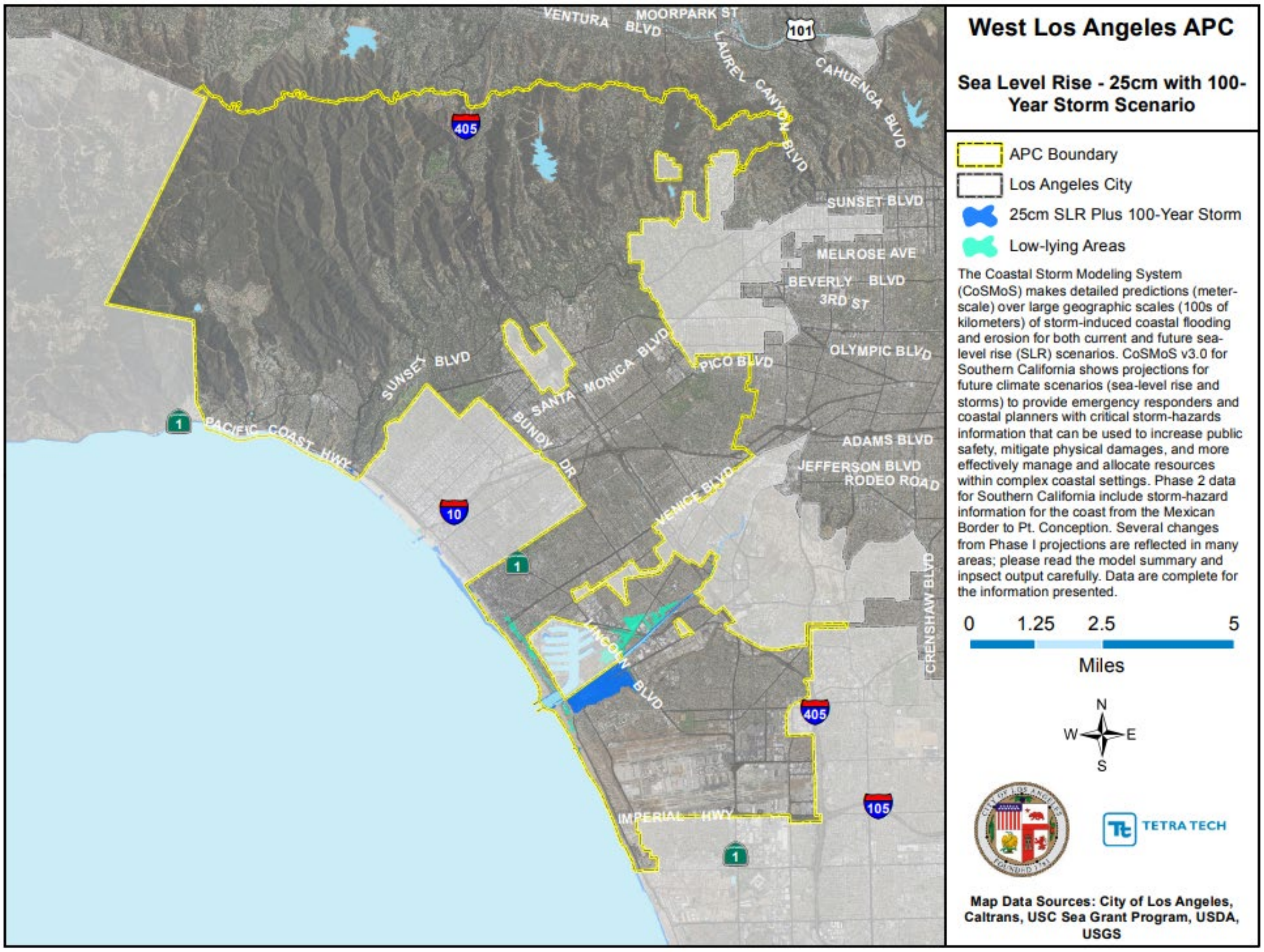


Figure 14-6. Sea Level Rise; 25-cm with 100-Year Storm Scenario; West Los Angeles APC

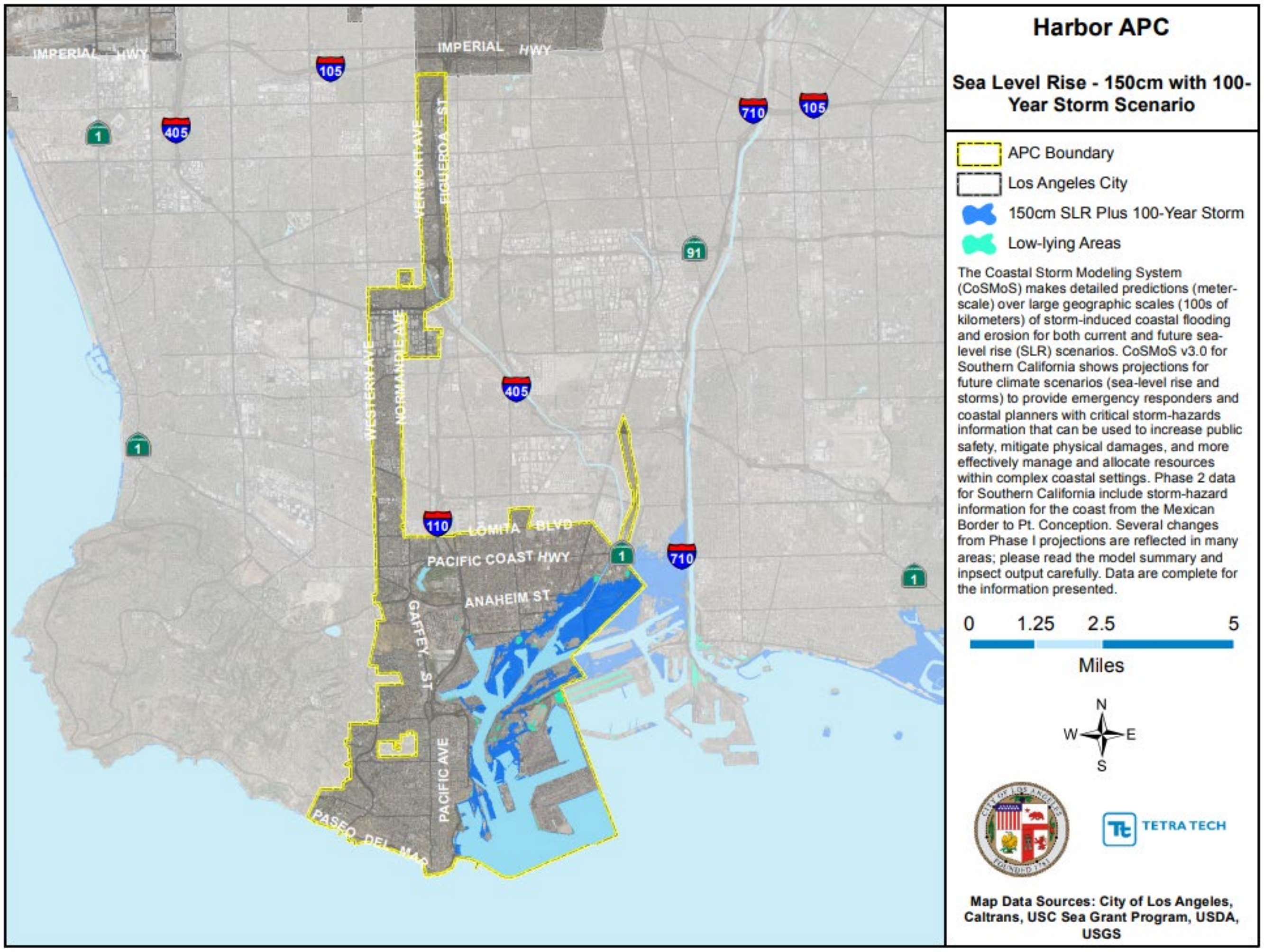


Figure 14-7. Sea Level Rise; 150-cm with 100-Year Storm Scenario; Harbor APC

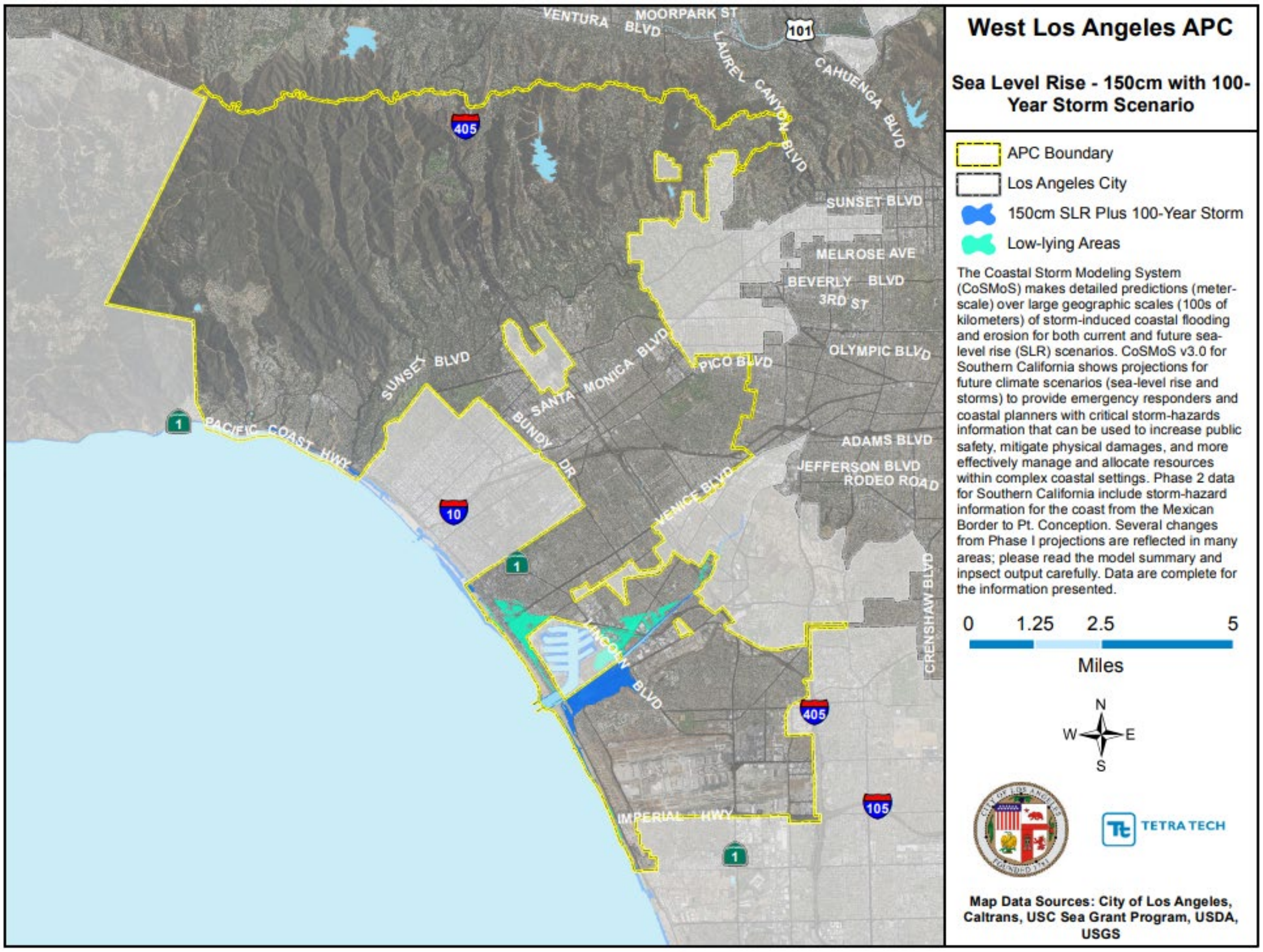


Figure 14-8. Sea Level Rise; 150-cm with 100-Year Storm Scenario; West Los Angeles APC

Population Exposure

Sea level rise will increase the population exposed to combined permanent and temporary inundation from coastal flooding. Currently, 0.1 percent of the population (3,406 persons) is estimated to reside in areas that are expected to be inundated by the 25-cm sea level rise with storm scenario, and 0.24 percent (10,010 persons) reside in areas that are expected to be inundated by the 150-cm sea level rise with storm scenario. Table 14-2 shows exposed population by APC.

Table 14-2. Estimated Population Residing Sea Level Rise Inundation Areas

	25-cm Sea Level Rise with 100-year Storm		150-cm Sea Level Rise with 100-year Storm	
APC[a]	Number	% of Total	Number	% of Total
Harbor	24	11	146	0.1%
West Los Angeles	3,395	0.8%	9,864	2.3%
Total	**3,406**	**0.1%**	**10,010**	**0.3%**

a. Only APCs with exposure to sea level rise are included. All other areas can be assumed to have zero exposure.

Property Exposure

Structures in Sea Level Rise Inundation Areas

There are 961 structures currently located in areas subject to 25-cm sea level rise with storm inundation and 2,998 structures located in areas subject to 150-cm sea level rise with storm inundation. The majority of these structures are residential. Table 14-3 and Table 14-4 show the distribution of structure types exposed and the area of each APC exposed to these impacts.

Table 14-3. Area and Structures in 25-cm with 100-year Storm Inundation Areas

	Inundation Area	Structures in 25-cm plus 100-year Storm Inundation Areas							
APC[a]	(acres)	Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Total
Harbor	3,691	2	5	17	0	0	0	0	**24**
West Los Angeles	1,001	868	54	9	0	1	4	1	**937**
Total	**4,692**	**870**	**59**	**26**	**0**	**1**	**4**	**1**	**961**

a. Only APCs with exposure to sea level rise are included. All other areas can be assumed to have zero exposure.

Table 14-4. Area and Structures in 150-cm with 100-year Storm Inundation Areas

	Inundation Area	Structures in 150-cm Plus 100-year Storm Inundation Areas							
APC[a]	(acres)	Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Total
Harbor	5,142	26	123	149	0	0	6	0	**304**
West Los Angeles	1,371	2,522	145	15	0	2	8	2	**2,694**
Total	**6,513**	**2,548**	**268**	**164**	**0**	**2**	**14**	**2**	**2,998**

a. Only APCs with exposure to sea level rise are included. All other areas can be assumed to have zero exposure.

Exposed Value

Structures that will be temporarily or permanently inundated by the scenario events represent 0.2 percent and 0.8 percent of the total current replacement value of the planning area. Table 14-5 and Table 14-6 show the estimated replacement value of structures exposed to inundation associated with the evaluated scenarios.

Table 14-5. Structure and Contents Value in 25-cm with 100-year Storm Sea Level Rise Inundation Areas

APC[a]	Structures Exposed	Estimated Value of Exposed Structures	Estimated Value of Exposed Contents	Estimated Total Value	% of Total Replacement Value
Harbor	24	$181,019,704	$205,312,004	$386,331,708	0.9%
West Los Angeles	937	$722,736,341	$536,079,904	$1,258,816,246	1.1%
Total	961	**$903,756,045**	**$741,391,909**	**$1,645,147,954**	**0.2%**

a. Only APCs with exposure to the sea level rise are included. All other areas can be assumed to have zero exposure.

Table 14-6. Structure and Contents Value in 150-cm with 100-year Storm Sea Level Rise Inundation Areas

Area Planning Commission[a]	Structures Exposed	Estimated Value of Exposed Structures	Estimated Value of Exposed Contents	Estimated Total Value	% of Total Replacement Value
Harbor	304	$1,850,761,753	$2,081,689,651	$3,932,451,404	9.6%
West Los Angeles	2,694	$1,496,557,712	$1,027,904,141	$2,524,461,853	2.3%
Total	2,998	**$3,347,319,466**	**$3,109,593,791**	**$6,456,913,257**	**0.8%**

a. Only APCs with exposure to the sea level rise are included. All other areas can be assumed to have zero exposure.

Land Use

Some land uses are more vulnerable to coastal flooding, such as single-family homes, while others are less vulnerable, such as agricultural land or parks. Table 14-7 shows the existing land use of all parcels in the scenario-event inundation areas, including vacant parcels and those in public/open space uses, broken down for the planning area. Open space uses make up about 42 percent of the area expected to be inundated by the 25-cm with storm event. These are favorable, lower-risk uses for coastal flood areas.

Table 14-7. Land Use Within the Sea Level Rise Inundation Scenarios

	25-cm Sea Level Rise with 100-Year Storm		150-cm Sea Level Rise with 100-Year Storm	
Land Use	Area (acres)	% of total	Area (acres)	% of total
Agriculture	0.8	0.06%	72.2	2.47%
Commercial	35.9	2.73%	138.9	4.75%
Government	38.5	2.93%	83.4	2.85%
Industrial	484.8	36.94%	1,621.7	55.52%
Multi-Family Residential	159.4	12.15%	242.4	8.30%
Open Space	555.0	42.29%	680.7	23.30%
Parking	0.0	0.00%	0.0	0.00%
Single-Family Residential	38.0	2.90%	81.8	2.80%
Total	**1,312.3**	**100.00%**	**2,921.0**	**100.00%**

Critical Facilities and Infrastructure Exposure

There are 29 critical facilities located in areas subject to impacts from 25-cm sea level rise with 100-year storm and 94 critical facilities in areas subject to impacts from 150-cm sea level rise with 100-year storm (see Table 14-8).

Table 14-8. Critical Facilities in Sea Level Rise Inundation Areas

APC	Critical Operating Facilities	Critical Response Facilities	Critical Infrastructure—Transportation	Critical Infrastructure—Utilities	Total
25-cm Sea Level Rise Scenario					
Central	0	0	0	0	**0**
East Los Angeles	0	0	0	0	**0**
Harbor	0	2	9	6	**17**
North Valley	0	0	0	0	**0**
South Los Angeles	0	0	0	0	**0**
South Valley	0	0	0	0	**0**
West Los Angeles	0	0	4	8	**12**
Total	**0**	**2**	**13**	**14**	**29**
150-cm Sea Level Rise Scenario					
Central	0	0	0	0	**0**
East Los Angeles	0	0	0	0	**0**
Harbor	0	2	28	45	**75**
North Valley	0	0	0	0	**0**
South Los Angeles	0	0	0	0	**0**
South Valley	0	0	0	0	**0**
West Los Angeles	0	1	9	9	**19**
Total	**0**	**3**	**37**	**54**	**94**

The following major roads in the planning area cross through areas at risk from 25-cm sea level rise with 100-year storm:

- E North Venice Blvd
- E Sepulveda Blvd
- E South Venice Blvd
- E Washington Blvd
- E Pacific Coast Hwy
- Ocean Blvd
- S Lincoln Blvd
- S Sepulveda Blvd
- W Culver Blvd
- W Jefferson Blvd

Population Vulnerability

Vulnerable Populations

A geographic analysis of demographics using the Hazus model identified populations vulnerable to the flood hazard as follows:

- **Economically Disadvantaged Populations**—It is estimated that 28 percent of the households within the 25-cm sea level rise inundation area are economically disadvantaged, defined as having household incomes of $50,000 or less.
- **Population over 65 Years Old**—It is estimated that 15 percent of the population in the census blocks that intersect the 25-cm sea level rise inundation area are over 65 years old.
- **Population under 16 Years Old**—It is estimated that 12 percent of the population within census blocks located in or near the 25-cm sea level rise inundation area are under 16 years of age.

Impacts on Persons and Households

Impacts on people in the planning area were estimated for the sea level rise scenario events through the Level 2 Hazus analysis. Table 14-9 summarizes the results.

Table 14-9. Estimated Sea Level Rise with 100-year Storm Impacts on People

APC[a]	25-cm Sea Level Rise with 100-year Storm		150-cm Sea Level Rise with 100-year Storm	
	Displaced Persons	Number of Persons Requiring Short-Term Shelter	Displaced Persons	Number of Persons Requiring Short-Term Shelter
Harbor	0	0	35	29
West Los Angeles	432	379	1,655	1,447
Total	**432**	**379**	**1,691**	**1,476**

a. Only APCs with exposure to the sea level rise are included. All other areas can be assumed to have zero exposure.

Property Vulnerability

Loss Estimates

Hazus calculates losses to structures from flooding by looking at depth of flooding and type of structure. Using historical flood insurance claim data, Hazus estimates the percentage of damage to structures and their contents by applying established damage functions to an inventory. For this analysis, local data on facilities was used instead of the default inventory data provided with Hazus. This analysis does not account for losses from permanent inundation that may be experienced as a result of sea level rise.

The results are summarized in Table 14-10 for the 25-cm sea level rise scenario and Table 14-11 for 150-cm sea level rise scenario. It is estimated that there would be up to $85 million of flood loss from 25-cm of sea level rise with 100-year storm event and $787 million of flood loss from the 150-cm sea level rise with 100-year storm event in the planning area. These estimates could increase significantly if structures are permanently inundated.

Table 14-10. Loss Estimates for 25-cm Sea Level Rise with 100-Year Storm

Area Planning Commission	Structures Impacted[a]	Estimated Loss Associated with Scenario			% of Total Replacement Value
		Structure	Contents	**Total**	
Harbor	6	$3,557,909	$9,025,907	$12,583,816	0.0%
West Los Angeles	36	$30,314,097	$42,210,519	$72,524,616	0.1%
Total	**42**	**$33,872,006**	**$51,236,426**	**$85,108,432**	**0.01%**

a. Impacted structures are those structures with finished floor elevations below the flood event water surface elevation. These structures are the most likely to receive significant damage in a flood event.

Table 14-11. Loss Estimates for 150-cm Sea Level Rise with 100-Year Storm

Area Planning Commission	Structures Impacted[a]	Estimated Loss Associated with Scenario			% of Total Replacement Value
		Structure	Contents	**Total**	
Harbor	238	$240,606,674	$453,459,295	$694,065,969	1.7%
West Los Angeles	205	$40,568,266	$52,625,914	$93,194,180	0.1%
Total	**443**	**$281,174,940**	**$506,085,209**	**$787,260,149**	**0.1%**

a. Impacted structures are those structures with finished floor elevations below the flood event water surface elevation. These structures are the most likely to receive significant damage in a flood event.

Coastal Flood-Caused Debris

Hazus debris estimates for the sea level rise scenario events for the planning area are shown in Table 14-12.

Table 14-12. Estimated Coastal Flood-Caused Debris

APC	Debris to Be Removed Because of Flood Event (tons)	
	25-cm Sea Level Rise with 100-Year Storm	150-cm Sea Level Rise with 100-Year Storm
Harbor	925	7,613
West Los Angeles	5,418	8,634
Total	**6,343**	**16,247**

Critical Facility and Infrastructure Vulnerability

Hazus was used to estimate the potential damage level to critical facilities in the sea level rise inundation areas. Table 14-13 summarizes the results. The scenario events modeled do not differentiate between permanent and temporary flooding from sea level rise. Facilities that are permanently inundated may not be able to remain in operation, which is equivalent to 100-percent damage; this is not represented in the information below, which assumes temporary inundation followed by restoration efforts.

Table 14-13. Potential Damage to Critical Facilities in Areas Affected by Sea Level Rise

	Number of Facilities Affected	Average % of Total Value Damaged	
		Structure	Content
25-cm Sea Level Rise Scenario			
Critical Operating Facilities	0	N/A	N/A
Critical Response Facilities	0	N/A	N/A
Critical Infrastructure—Transportation	2	2.98	4.42
Critical Infrastructure—Utilities	4	1.27	0.00
Total/Average	**6**	**2.13**	**2.21**
150-cm Sea Level Rise Scenario			
Critical Operating Facilities	0	N/A	N/A
Critical Response Facilities	0	N/A	N/A
Critical Infrastructure—Transportation	15	14.22	23.57
Critical Infrastructure—Utilities	19	15.62	29.80
Total/Average	**34**	**14.92**	**26.68**

Other infrastructure, such as stormwater systems may also be vulnerable. As sea levels rise, stormwater drainage capacity may be reduced as culverts and other parts of the conveyance system are inundated with normal tides. Low-lying roads may also be vulnerable to chronic flooding from higher tides and more frequent storm events.

Environment Exposure and Vulnerability

All sea level rise inundation areas are exposed and vulnerable to impacts. Important coastal habitat may be lost as sea level rise permanently inundates areas, or it may be damaged due to extreme tide and storm surge events. Saltwater intrusion into freshwater resources may occur, further altering habitat and ecosystems. Protective ecosystem services may be lost as land area and wetlands are permanently inundated.

Economy

Sea level rise will impact the local economy. The tourism industry may be impacted as historic coastal properties are inundated. Critical facilities and other important assets may be damaged by temporary inundation, resulting in loss of services such as power or wastewater treatment. Coastal businesses may relocate to other areas rather than face high costs from increased risk to storm surge and costs associated with managed retreat. Local tax revenue may decline as areas that were previously occupied by houses and businesses are permanently inundated.

Future Development

The land area of the City of Los Angeles will be reduced as sea level rise permanently inundates areas. This will have significant impacts on land use and planning in local communities. The City of Los Angeles General Plan will guide this future development.

14.4 ISSUES

The major issues for climate change are the following:

- Planning for climate change related impacts can be difficult due to inherent uncertainties in projection methodologies.
- Average temperatures are expected to continue to increase in the planning area, which may lead to a host of primary and secondary impacts, such as an increased incidence of heat waves.
- Expected changes in precipitation patterns are still poorly understood and could have significant impacts on the water supply and flooding in the planning area.
- Some impacts of climate change are poorly understood such as potential impacts on the frequency and severity of earthquakes, thunderstorms and tsunamis.
- Heavy rain events may result in inland stormwater flooding after stormwater management systems are overwhelmed.
- Permanent and temporary inundation resulting from sea level rise has the potential to impact significant portions of the population and assets in the planning area.

15. CRITICAL INFRASTRUCTURE, HIGH-RISE/HIGH-OCCUPANCY BUILDING FIRE, SPECIAL EVENTS

15.1 GENERAL BACKGROUND

The City of Los Angeles has nearly 4 million people within a 470-square-mile area. It is the second largest city in the U.S. and the 18th largest metropolitan area in the world. The City is a significant global business center and transportation hub. Its population increases by hundreds of thousands during daytime, drawing from the 15 million people that live in the greater Southern California area. With all these people and activities, the hazards of critical infrastructure, high-rise/high-occupancy building fire, and special event incidents pose an ongoing threat to the planning area.

In response to the September 11, 2001 terrorist attacks, the City of Los Angeles created a new critical infrastructure and key resource protection program, Operation Archangel, to identify and protect critical assets. Operation Archangel works in cooperation with Los Angeles County, the California State Office of Homeland Security, and the U.S. Department of Homeland Security for the prevention, deterrence, mitigation and response to critical facility incidents. Operation Archangel has been instrumental in gathering, storing, prioritizing, and reporting critical infrastructure information, enhancing the security of critical assets in the event of an interruption.

DEFINITIONS

Critical Asset—Any entity or location—physical or virtual—whose compromise would have a profound and negative effect on critical infrastructure, cause mass casualty, or have a profound and negative symbolic or psychological impact.

High-Rise/High-Occupancy Building Fire—A fire in a building that exceeds the aerial reach of local fire department equipment (usually 75 feet – 7 to 8 stories). Such structures are generally classified as residential, hotel/motel, office, hospital, or other.

Special Events—An activity on public or private property that will affect the standard and ordinary use of public streets, rights-of-way, or sidewalks, and/or which requires extraordinary levels of City services. The special event may increase the likelihood of human-caused incidents such as terrorism, civil unrest or building fires.

15.1.1 Critical Infrastructure

The City and the Department of Homeland Security define critical infrastructure as assets whose compromise would interrupt continuity of operations in one of 17 potential sectors:

- Agriculture and food
- Banking and finance
- Chemical
- Commercial assets
- Dams
- Defense Industrial Bases
- Emergency services
- Energy
- Government facilities
- Healthcare and public heath
- Information technology
- National monuments and icons
- Nuclear power
- Postal and shipping
- Telecommunications
- Transportation
- Water supply and delivery.

Power Failure

A power failure is any interruption or loss of electrical service due to disruption of power generation or transmission caused by an accident, sabotage, natural hazards, equipment failure, or fuel shortage. These interruptions can last anywhere from a few seconds to several days. Power failures are considered significant only if the local emergency management organization is required to coordinate basic services such as the provision of food, water, and heating or cooling as a result. Power failures are common with adverse weather.

The Los Angeles Department of Water and Power is responsible for operating and maintaining the electrical transmission and distribution system in the City and for over 5,000 customers in the Owens Valley. The utility supplies electricity to over 1.4 million residential and business customers within the service area. According to its 2016 Briefing Book, the system serves more than 6,752 miles of overhead lines and 3,626 miles of underground lines. The distribution lines and substations deliver 7,640 megawatts of generation capacity from a diverse mix of energy sources.

Water and/or Wastewater Disruption

Water and/or wastewater disruption is a secondary impact from a natural disaster or intentional act. The City of Los Angles water supply includes water from the Los Angeles Aqueduct, purchased water from the Bay Delta and Colorado River, groundwater, and a small amount of recycled water. Long-term disruption of the water source from these sources would have significant impacts on residences and businesses in the City of Los Angeles.

The Los Angeles Department of Water and Power is responsible for operating and maintaining the municipal water utility. According to its 2016 Briefing Book, the system supplies 167 billion gallons of water annually and an average of 458 million gallons per day for 681,000 residential and business water service connections.

Four water reclamation plants operated by City of Los Angeles Sanitation (LASAN) serve over 4 million people. LASAN oversees the City’s Clean Water, Solid Resources, and Watershed Protection programs (LASAN, 2017).

Data and Telecommunications Interruptions

The loss of data and/or telecommunications is often caused by a telecommunications interruption from natural and other human-caused hazards. Data and telecommunications provide a primary method for service to the community by the government and the private sector. A loss of data and telecommunications could result in loss of emergency dispatch capabilities, emergency planning services, infrastructure monitoring capabilities, access to statistical data, and access to financial and personnel records.

Pipeline Interruptions

Transmission pipelines and distribution pipelines provide different services. Transmission pipelines transport raw material for further refinement. These pipes are large and far reaching, operating under high pressure. Distribution pipelines provide processed materials to end users. These are smaller in diameter, some as small as a half an inch, and operate under lower pressure.

Although pipelines are the safest and most reliable way to transport natural gas, crude oil, liquid petroleum products, and chemical products, there is still an inherent risk due to the nature of the hazardous materials. Pipelines are regulated by the Office of the State Fire Marshal Pipeline Safety Division. Pipelines are also monitored by supervisory control and data acquisition (SCADA) systems that measure flow rate, temperature and pressure. SCADA systems transfer real-time data via satellite from the pipelines to a control center where valves, pumps, and motors are remotely operated. If tampering with the pipeline occurs, an alarm sounds. The ensuing valve reaction is instantaneous, with the alarm system isolating any rupture and setting off a chain reaction that shuts down pipeline pumps and alerts pipeline operators within seconds.

Failures of distribution and transmission pipelines can occur when pipes corrode, are damaged during excavation, are incorrectly operated, or are damaged by other forces. More serious accidents occur on distribution pipelines than on any other type due to their number, intricate networking, and location in highly populated areas.

Transportation Interruptions

The following transportation facilities and networks have the potential for interruption-related hazards:

- Los Angeles International Airport
- Van Nuys Airport
- Port of Los Angeles
- Port of Long Beach
- Interstate 110 – Harbor Freeway
- State Route 1 – Pacific Coast Highway
- Interstate 5 – Golden State Freeway
- State Route 2 – Glendale Freeway
- Interstate 10 – Santa Monica Freeway
- State Route 47 – Alameda Street
- State Route 60 – Pomona Freeway
- U.S. Route 101 – Hollywood Freeway
- Interstate 105 – Century Freeway
- Santa Monica Boulevard
- State Route 134 – Ventura Freeway
- Interstate 710 – Long Beach Freeway
- Interstate 605 – San Gabriel River Freeway
- AMTRAK – Passenger
- Los Angeles County Metro Rail
- Alameda Corridor

15.1.2 High-Rise/High-Occupancy Building Fire

High-rise structures are defined as structures exceeding the aerial reach of local fire department equipment—usually 75 feet (7 to 8 stories). High-rise structures are generally classified as residential, hotel/motel, office, hospital or other. The vast majority of reported high-rise fires occur in residential structures.

When buildings are constructed beyond the reach of a fire department's highest ladder, two important firefighting strategies are taken away from firefighters:

- Life-saving victim removals using ladders are eliminated. Searches and rescues can be accomplished only from inside stairways.
- There is no ability to extinguish the fire with an outside master stream. Firefighters must extinguish the fire using handheld hose streams advanced through heat and smoke from an inside stairway.

The response time in a high-rise building fire may be 15 minutes or longer. At a high-rise building, arriving firefighters may have to walk 100 to 200 feet through an open space or large lobby, question building employees about the fire location, check an alarm panel, etc.

Firefighters battling a fire in a high-rise building depend on the building systems for success in extinguishment. The elevator system must take firefighters, tools, and equipment up to the fire. The standpipe system must provide water pressure and volume to the upper floors. A building communication system must allow fire department firefighting radio transmission. The structural steel framework of a high-rise building interferes with fire department radios.

High-rise buildings have sealed or locked windows. Venting by breaking thick glass windows is extremely dangerous. Falling glass can injure people on the sidewalk and cut supply hoses. Because these buildings are sealed, large volumes of heat and smoke generated by the fire become trapped in the structure. The "stack effect"—the result of temperature difference between the inside and outside of a sealed high-rise building—causes smoke to spread up or down many floors during a fire. Large volumes of smoke and heat move uncontrollably during a high-rise fire.

Firefighters cannot order all the people in a high-rise building to leave quickly during a fire. It can take several hours for thousands of people to leave a burning building quickly.

15.1.3 Special Events Incidents

Los Angeles is the site of many special events. A special event is an activity on public or private property that will affect the standard and ordinary use of public streets, rights-of-way or sidewalks, and/or which requires extraordinary levels of City services. This includes, but is not limited to, fairs, festivals, carnivals, sporting events, foot races, run/walk/bike-a-thons, markets, parades, exhibitions, auctions, dances, and motion picture filming.

The Los Angeles Police Department (LAPD) Major Events Planning Unit reports over one thousand public events in the city annually, many of which provide challenges for the City. According to the Los Angeles Department of Transportation (LADOT), more than 600 events in a year required the deployment of LADOT personnel for activities such as posting and enforcing parking restrictions, closing streets, and directing traffic.

Special events pose three types of hazards:

- Special events result in concentrations of large numbers of people in limited geographic areas. Such concentrations exacerbate the effects of any other hazard that may result from, or be coincidental to the event. Special events may increase the likelihood of human-caused hazards such as terrorism, civil unrest or high-occupancy building fires. Injuries and/or loss of life may be much greater if naturally occurring hazards such as earthquakes or adverse weather occur during a special event. Simply having a massive concentration of people requires additional planning and caution, regardless of the special risks associated with any particular event.
- Large-scale special events require the deployment of police, fire, and emergency medical personnel, rendering these resources unavailable for response to emergencies in other locations in the City.
- Many large-scale special events result in street closures and increased traffic congestion, slowing response time for emergency personnel and equipment.

The major categories of special events are as follows:

- Entertainment industry or celebrity events, such as award shows, concerts or movie premieres.
- Sporting events
- VIP appearances or visits
- Political events
- Festivals and parades, such as 4th of July celebrations or block parties
- Fundraisers such as run/walk-a-thons.

Less regular but still frequent special events in Los Angeles include national political party conventions, sport championship series, and visits by high-level dignitaries. Each of these events draws thousands of participants or spectators, and has special security considerations.

Large special events can be terrorist targets or sources of civil unrest. Many ethnic and religious groups in Los Angeles have celebrations and public events throughout the year that may be targets for terrorists or counter-demonstrators. Entertainment industry events can be targeted by protestors or terrorists due to their symbolic nature. Protests or political rallies can easily turn violent.

The best planned special events are rarely without problems or unintended side-effects. Even without a major incident, massive public gatherings cause their own hazards for Los Angeles. Crowds in general are associated with increased crime, street closures, delayed traffic, and so on. In many cases, emergency vehicles must detour around special events. If an emergency occurs at the heart of such an event, emergency vehicles may have difficulty getting to the site of the incident.

Special Event Planning

Sponsors of special events in Los Angeles are required to obtain special permits. Depending upon the nature of the event, permits are obtained from the Police Commission (parade permits), Board of Public Works (street closure permits), and/or the City Council (motions declaring gatherings as special events). Most special events—even small ones such as street fairs—typically require deployment of LAPD and LADOT resources. In some cases, other City departments such as the Fire Department may deploy resources.

In addition to resource deployment, special events require advanced planning and coordination by various agencies. Working with event sponsors, LADOT develops plans for traffic control, routing, street closures, and special parking restrictions as required. LAPD develops plans for security, crowd control, and critical asset protection.

Special Event Traffic Management Plans

LADOT screens approved permits for special events to determine an appropriate level of response: from simply posting parking restrictions at the event location to preparing detailed special event traffic management plans. Many factors go into the preparation of a special event traffic management plan. Negotiations are held with event sponsors and other affected agencies to identify issues and areas of concern. Access to critical facilities such as hospitals, churches and schools must be maintained while minimizing the conflicts between event participants and vehicular traffic. Conflicts between event participants and non-event traffic are minimized by designing a cordoned area for event participants and designating detour routes around the cordoned area for non-event traffic and transit buses.

The proper preparation and implementation of a special event traffic management plan may require involvement from several units within LADOT, including field crews, engineering staff and parking enforcement personnel. For larger events, the LAPD and the Bureau of Street Services provide service in coordination with LADOT.

Special Event Security

Security for most events can be handled in a routine fashion. However, some high-profile events (such as the Special Olympics) require special preparations and planning. For security planning purposes, high-profile special events fall into three categories:

- Unique events that warrant a focus on security simply because they are rare (such as a visit by the President, or a foreign religious or political leader)
- Events that would otherwise be considered normal except for the unique nature of the guests or agenda
- Events that are controversial or worthy of media attention.

The assessment of potential threats must take into account a number of factors. Threats increase for high-profile events, especially where media coverage is involved. Participation by VIPs also raises threat levels, as does the symbolic value of the event or venue.

LAPD planning for special events is led by the Special Events Planning Unit, Major Events Planning Unit Task Force. Planning for special event security takes place on two levels. Since Los Angeles is home to a large number of special events, each of LAPD's 18 geographic areas is required to maintain standing plans to deal with a wide variety of such events. The LAPD also maintains single purpose operations plans for specific events or incidents.

For major special events, special operations plans may be prepared. Event planning consists of control and containment. This may be accomplished by the Major Events Planning Unit staff, or a special task force may be created depending upon the size of the event.

15.2 HAZARD PROFILE

15.2.1 Past Events

Critical Infrastructure

The City of Los Angeles has experienced accidental critical infrastructure incidents annually, with varying timeframes and numbers of people affected. The following are sample incidents that have occurred:

- **June 2015—**On the morning of June 30, 2015, the City of Los Angeles experienced three consecutive water pipe bursts in the 3700 block of Effingham Place leaving 30 customers without water. The Los Angeles Department of Water and Power shut off water in the immediate area.
- **April 2004**—Los Angeles International Airport (LAX) had three power outages within 10 days. On April 12, a power outage caused two planes to come within 5 miles of one another. Back-up batteries to the air traffic control tower malfunctioned, and the controllers were overloaded at the time of the outage. The power outage was caused by a crow that was electrocuted by power lines feeding the airport. While the outage only lasted a second, radar and communications systems failed and dozens of planes were delayed. During the second outage on April 19, the back-up batteries to the tower worked properly, but parts of the airport remained without power for 2 hours. This outage was traced to a failed transformer that regulates power to the two circuits that serve LAX, but the exact cause of the failure was never determined. A third power outage on April 21 was caused by a crow sitting on a wire. All back-up power systems operated properly, but there were delays when security and passengers screening systems had to be re-booted.
- **February 2003**—A migrating cloud of chromium 6 slowly encroached upon wells and water treatment facilities that serve Los Angeles, Burbank and Glendale. While the pollutant moved, all three cities were at risk of losing their local water supplies. Chromium is a naturally occluding metallic element that is used to harden steel and make paint pigments. Chromium 6 is a carcinogen created after chromium undergoes certain chemical reactions.
- **2002**—An underground Kinder Morgan high-pressure gas pipeline failed in 2002 causing a significant spill of diesel fuel in the Rocklin neighborhood adjacent to where the breach occurred (Fire Department, pers. com with Battalion Chief Jeff Carman).
- **November 5, 2001**—A power outage caused by a car accident led to the release of 1.4 million gallons of raw sewage into the Pacific Ocean, Marina del Rey, and Ballona Creek. The car crash knocked power lines into a sewage pumping station. While the subsequent power outage lasted only 20 minutes, the sewage pumps shut down completely. Enough raw sewage was released to affect beaches from Santa Monica to Manhattan Beach. The backup power and alarm system malfunctioned because the wastewater pumping plant was undergoing construction, and the systems were turned off. The sewage spill went unnoticed for 15 hours; 12 more hours passed before sanitation officials notified the Los Angeles County Public Health office; and at least 10 more hours passed before lifeguards were notified of the sewage release. Civilians in the area first reported raw sewage pouring out of manholes and flowing directly into storm drains. It took 24 hours before the beaches were closed.

High-Rise/High-Occupancy Building Fire

The following are the major high-rise fires in the City of Los Angeles since 1960:

- Westlake High-Rise Senior Living Facility Fire, October 10, 2016

- W. Olympic Blvd Fire, April 7, 2015
- Pan Pacific Auditorium Fire, May 24, 1989
- First Interstate Bank Fire (62-story building), May 4, 1988
- Los Angeles Central Library Fire, April 29, 1986
- Fickett Towers (12-story senior citizen building), 1984
- Dorothy Mae Apartment Fire, September 9, 1982
- Bunker Hill West Tower, 1979
- Ponet Square Hotel Fire, September 13, 1970.

The sections below describe two of the most serious high-rise fire incidents.

First Interstate Bank Fire, May 4, 1988

The fire in this 62-story building was the most materially damaging high-rise fire in City history. It began on the 12th floor and moved upwards to the 16th floor before it was contained and suppressed. It required the combined efforts of 64 fire companies, 10 City rescue ambulances, 17 private ambulances, four helicopters, 53 command officers and support personnel, 383 firefighters and paramedics, and considerable assistance from other City departments. Following the Interstate Fire, the City required fire sprinklers in the 363 existing commercial and office buildings constructed before state sprinkler regulations became effective. The fire also underscored to private industry the need for private back-up systems and facilities to enable continuance of business operations following a fire.

Los Angeles Central Library Fire, April 29, 1986

One of the most complex and difficult fires ever fought by the Los Angeles Fire Department was the 1986 Central Library Fire. The open book stacks, narrow corridors, circuitous stairways, interference of thick walls with the walkie-talkies, lack of windows and ventilation, dense smoke, intense heat (estimated as high as 2,500 degrees in some areas), limited access and firefighter exhaustion due to heat and exertion made the fire difficult to attack. Extensive pre-planning for a potential fire in the historic structure resulted in an orderly evacuation of library staff and patrons and familiarity of the fire commanders with the building and its unique fire suppression demands. Salvage units quickly instituted procedures to protect the 1.2 million books and documents from smoke and water damage. Methods were devised to direct smoke from the building and relay fire fighters in and out of the fire areas. After seven hours, the fire was brought under control. It took another five days to mop up the hot spots and for the building to cool down. The 350 firefighters saved over a million books. Only 350,000 books were damaged by fire or water, and structure damage amounted to only 4 percent of the $500 million value of the building.

Special Event Incidents

Special events that require event planning with police and traffic control coordination occur on a regular basis in the City, but no incidents have occurred in recent years that required an incident management team response.

15.2.2 Location

Critical Infrastructure

Critical infrastructure is located throughout the planning area. In particular, the Kinder Morgan company owns 3 miles of pipelines in the City, generally parallel to the Union Pacific railroad tracks, that transport high volumes of natural gas through the planning area. Other natural gas pipelines run along Interstate 80, with connections between the City of Los Angeles and Chico. The route to Chico travels through residential areas from a tank farm in Rocklin. The trans-Sierra route from the tank farm in Rocklin to Reno roughly follows the same track as

Interstate 80. Pacific Gas and Electric maintains natural gas pipelines in and through the City of Los Angeles as well.

High-Rise/High-Occupancy Building Fire

According to the Assessor's Office, there are 503 high-rise buildings in the City of Los Angeles. These buildings are located in almost all parts of the City, but they are concentrated in a few areas: the Central City, the Wilshire District, Westwood, West Los Angeles – Century City and Hollywood.

Special Events Incidents

Special entertainment industry and celebrity events, sporting events, VIP visits, political events, festivals, parades, and fundraisers can be permitted anywhere in the City. Each of these events draws thousands of participants or spectators, and has special security considerations.

15.2.3 Frequency

Critical Infrastructure

The frequency of critical infrastructure will continue but the length of time a utility is shut down should lessen in the future as more redundancies are built into infrastructure and utilities. In addition, leak detection sensors alert utilities to faults and failures more quickly.

High-Rise/High-Occupancy Building Fire

In addition to building, plumbing, and electrical codes that apply to all structures in Los Angeles, the City has adopted a High-Rise Fire Code to reduce the occurrence of high-rise fires and the resulting injuries, loss of life, and property damage (Section 57.118 *et seq.*, City of Los Angeles Fire Code). This section of the Fire Code promulgates detailed regulations related to fire control rooms, building communication systems, fire department voice communication systems, elevator systems, fire protective signaling systems, emergency smoke control systems, standby emergency power systems, stair shaft doors, and automatic sprinkler systems. In addition to requirements for new buildings, the City has taken an aggressive stance to require sprinkler system retrofit of older buildings.

Special Events Incidents

Thousands of planned and permitted special events occur in the City of Los Angeles on an annual basis. These special events will continue and incidents will continue to occur, with injuries or fatalities to people.

15.2.4 Severity

Critical Infrastructure

The severity of critical infrastructure interruptions varies too widely to be able to measure. Electricity, for example, may be out for a couple hours to several weeks, depending on the cause of the event.

High-Rise/High-Occupancy Building Fire

The City's adoption of the High-Rise Fire Code reduces the severity of high-rise building fires in Los Angeles.

Special Events Incidents

The severity of incidents associated at a special event varies greatly but some special events present more risks than others (i.e. a political rally). It is not uncommon for people to be injured and killed as perpetrators, participants and/or innocent spectators. This is why the LAPD plans for special events that are led by the Special Events Planning Unit, Major Events Planning Unit Task Force and tries to protect the public as much as possible.

15.2.5 Warning Time

Critical Infrastructure

Critical infrastructure interruptions occur without predictability under circumstances that give responders little time to prepare.

High-Rise/High-Occupancy Building Fire

The fire and life safety systems installed in high-rise buildings are designed to provide an early warning in the event of a fire. The challenge is to know if it is best to stay in place or descend the stairs to evacuate. Automatic fire sprinkler protection in modern buildings is designed to control a fire and therefore lessen the need to evacuate all occupants.

Special Events Incidents

There is usually no warning time for special events incidents unless a person calls in or posts a specific threat on social media. Then authorities may have a few hours warning time.

15.3 SECONDARY IMPACTS

15.3.1 Critical Infrastructure

The largest secondary impact associated with critical infrastructure interruption is economic. Economic impacts can be significant.

Power interruptions at chemical handling plants are of particular concern because of the potential for a chemical spill during restart after power is restored (EPA, 2001).

Without proper procedures for backup of data and systems, the loss of data, systems, and telecommunications is a risk incurred by utility failure. Data and telecommunications provide a primary method for service to the community by the government and the private sector. A loss of data or a system could result in loss of emergency dispatch capabilities, emergency planning services, infrastructure monitoring capabilities, access to statistical data, and loss of financial and personnel records. Loss of communication capability by first responders could have negative impacts on public safety. Backup systems such as amateur radio operators may be required during disaster to augment communications capabilities. Power outages can also lead to instances of civil disturbance, including looting.

Infrastructure failure is generally a secondary impact of other hazards such as high winds or earthquakes.

15.3.2 High-Rise/High-Occupancy Building Fire

The secondary impacts of a high-rise building fire is critical infrastructure disruption to an area or entire region.

15.3.3 Special Events Incidents

The secondary impacts of special events incidents are possible copy-cats deploying the same tactics at an event in their area.

15.4 EXPOSURE

15.4.1 Critical Infrastructure

All residents and visitors are exposed and impacted by critical infrastructure interruptions. This will continue as people are dependent on basic utility services such as electricity, water, wastewater, gasoline, natural gas, etc.

15.4.2 High-Rise/High-Occupancy Building Fire

In most cases, damage, injuries, and loss of life from a high-rise building fire are limited to the building itself and the immediate surroundings. The concentration of telecommunications facilities in the Central City area, most within high-rise buildings, presents a special case.

Since the late 1990s there has been a significant concentration of telecommunications facilities within a 10-square-block area in downtown Los Angeles. Most major telecommunications firms and many smaller ones serving the greater Los Angeles area have facilities in the area. The percent of space devoted to telecommunications in buildings within this area varies from about 10 percent to 100 percent. It is estimated that more than 2.4 million total square feet of floor space is devoted to telecommunications and related uses. Instead of housing office workers, these buildings house routers, switching equipment, servers, and associated support equipment.

According to The National Fire Prevention Association, 12 percent of structure fires in office properties are caused by electrical distribution and lighting equipment (NFPA, 2017). Only cooking equipment caused more structure fires. Therefore, not only does this high concentration of telecommunications infrastructure pose a significant fire hazard, but a catastrophic fire in a major telecommunications structure could cause major disruption to communications within the City, as well as nationally and internationally.

15.4.3 Special Events Incidents

Thousands of planned and permitted special events occur in the City of Los Angeles on an annual basis. These special events will continue, and exposure to incidents with injuries and fatalities to perpetrators, participants and/or innocent spectators will continue.

15.5 VULNERABILITY

15.5.1 Critical Infrastructure

With the high density of population, development, and business in Los Angeles, the entire planning area is vulnerable to interruptions. FEMA has developed standard loss-of-use estimates in conjunction with its benefit-cost analysis methodologies to estimate the cost of lost utilities on a per-person, per-use basis, as summarized in Table 15-1.

Table 15-1. FEMA Standard Value for Loss of Service for Utilities and Roads/Bridges

Interruption	Total Economic Impact
Complete Loss of Electric Power	$126 per person per day
Complete Loss of Potable Water Service	$93 per person per day
Complete Loss of Wastewater Service	$41 per person per day
Complete Loss of Road/Bridge Service	$38.15 per vehicle per hour of vehicle delay detour time $0.55 per mile of vehicle delay (or current federal mileage rate)

Source: FEMA BCA Reference Guide, June 2009, Appendix C

15.5.2 High-Rise/High-Occupancy Building Fire

High-rise buildings in the City of Los Angeles are divided into three categories according to date of construction:

- Pre-1960—Pre-1960 buildings were required to have a "dry" standpipe for firefighting and a "wet" standpipe for occupants. A "dry" standpipe does not have water or water pressure; water must be pumped through the system by firefighters from street level.
- 1960-1974—After 1960, all high-rise buildings were required to have a combo system—wet standpipes for both occupants and firefighters. This allowed firefighters to attack fires more quickly at higher floors, since water and water pressure are available on all floors.
- Post-1974—All buildings constructed after 1974 are required to be equipped with automatic sprinkler systems, considered to be the most effective tool for fighting high-rise fires.

An analysis of the high-rise building in Table 15-2 indicates that 28 percent of total high-rise buildings are pre-1960; approximately 27 percent were constructed between 1960 and 1974; and 45 percent were constructed in 1975 or later. This means that fewer than half of the high-rise buildings in the City were constructed with automatic sprinkler systems. This does not take into account, however, older buildings that may have been retrofitted with sprinkler systems.

Table 15-2. Analysis of High-Rise Buildings

	Number of High-Rise Buildings	Percentage of High-Rise Buildings by Built Year
Built pre-1960	147	28%
1960-1974	131	27%
Post 1974	225	45%
Total	**503**	**100%**

15.5.3 Special Event Incidents

Special event incidents occur when any large crowd of persons gather. For events having the potential for large crowds or mob activity, pre-planning and permits are issued, so potential disturbances are quelled through the presence of sufficient law enforcement personnel, pre-planning for crowd and traffic control.

15.6 FUTURE TRENDS IN DEVELOPMENT

15.6.1 Critical Infrastructure

The likelihood of critical infrastructure interruption in the future will continue as development and population growth continues in the City. A majority of critical infrastructure in Los Angeles is privately owned and market forces are, as a rule, insufficient to induce needed investments in protection. Private organizational strategies and policies will need to work together to ensure reliable and resilient services for the long term.

15.6.2 High-Rise/High-Occupancy Building Fire

There are 503 high-rise buildings in the City of Los Angeles, concentrated in a few areas: the Central City, the Wilshire District, Westwood, West Los Angeles – Century City and Hollywood. More will continue to be built in the future. Despite vigorous code enforcement, building inspection, and training for owners and occupants, the potential for a future disastrous event still exists. There is no way to predict when or where such an event will occur.

15.6.3 Special Events Incidents

Special events will continue to be planned and permitted in the City of Los Angeles and incidents will continue to occur. Recently vehicles are being used as weapons and plowing into crowds of spectators at events. The City of Los Angeles will be mindful of this trend when planning future special events.

15.7 SCENARIO

15.7.1 Critical Infrastructure

A worst-case scenario is when an entire region's electrical grid is out and millions of planning area residents are without electricity. This would cause stores to be closed, cellular phone service to fail, broadband internet to fail, traffic signals to go dark, and hospitals to operate on generators. Transportation would be affected by canceled airline flights, closed transit services and closed gas stations to fuel automobiles.

15.7.2 High-Rise/High-Occupancy Building Fire

A worst-case scenario would be an overnight 15-story apartment building fire with tenants trapped above a fire that is out of the reach with a typical longest aerial ladder. Fire department rescue personnel would try to rescue people by the interior stairs during primary search operations, and then rescue from the exterior using a rope, the roof, or a helicopter. Many trapped people might not have these options and might die via smoke inhalation, burning, or jumping.

15.7.3 Special Events Incidents

A worst case scenario may involve a person using an improvised explosive device (IED) at special event crowded with participants. The death toll could be high from a deployed IED in a crowd.

15.8 ISSUES

The major issues for critical infrastructure, high-rise/high-occupancy building fire, and special events are the following:

- Continue regular and redundant emergency preparedness training for field level responders (police, fire, and public works) and public information staff in order to respond quickly in the event of a disaster associated with these hazards.
- Continue to improve response times for public safety throughout the City so as to reduce exposure to human-caused incidents. Maintain appropriate staffing levels of public safety personnel to address vulnerabilities identified in this chapter.
- Participate in the Cal OES Disaster Resistant California annual conference and other training sessions sponsored by regional, state and federal agencies.
- Participate in regional training exercises per the requirements of Homeland Security Presidential Directive #8 in support of national preparedness.
- Work with the private sector to enhance and create business continuity plans to be followed in the event of an emergency.
- Maintain an emergency services information line that the public can contact 24 hours a day during an emergency to ask questions of emergency staff.
- Coordinate with all school districts in the City and individual cities to ensure that their emergency preparedness plans include preparation for human-caused incidents.
- Encourage local businesses to adopt information technology and telecommunications recovery plans.

- Promote 72-hour self-sufficiency through neighborhood associations, emergency preparedness efforts through local governments, emergency preparedness websites of local governments, civic organizations and the private sector, public outreach, and other means. Ensure inclusion of program information for people with disabilities and others with access and functional needs.
- Prepare and present the human-caused hazard risk and preparedness program to the public through Neighborhood Council meetings, town hall gatherings, and preparedness fairs and outreach.
- Maintain any and all resident advisory groups and periodically e-mail emergency preparedness information including human-caused hazard preparedness instructions and reminders.
- Carry out up-to-date and functional all-hazard contingency planning.

16. CYBER-ATTACK AND SPACE WEATHER

(TECHNOLOGY-IMPACTED HAZARDS)

DEFINITIONS

Cyber-Attack—An attempt to damage, disrupt, or gain unauthorized access to a computer, computer system, or electronic communications network.

Space Weather— Variations in the space environment between the sun and earth. It can influence the performance of technology used on Earth.

16.1 GENERAL BACKGROUND

16.1.1 Cyber-Attack

A cyber-attack is an intentional and malicious crime that compromises the digital infrastructure of a person or organization, often for financial or terror-related reasons. Such attacks vary in nature and are perpetrated using digital mediums or sometimes social engineering to target human operators. Generally, attacks last minutes to days, but large-scale events and their impacts can last much longer. As information technology continues to grow in capability and interconnectivity, cyber-attacks become increasingly frequent and destructive. According to the Ponemon Institute's *2015 Cost of Cyber Crime*, the cost of cyber-crime in the U.S. is at an annual average of $15.4 million per company.

Types of Cyber-Attack

Cyber-threats differ by motive, attack type and perpetrator profile. Motives range from the pursuit of financial gain to political or social aims. Cyber-threats are difficult to identify and comprehend. Types of threats include using viruses to erase entire systems, breaking into systems and altering files, using someone's personal computer to attack others, or stealing confidential information. The spectrum of cyber-risks is limitless, with threats having a wide-range of effects on the individual, community, organizational, and national threat (FEMA 2013).

This risk assessment includes cyber-attacks and cyber-terrorism under the inclusive hazard of cyber-threats. The terms often are used interchangeably, though they are not the same. While all cyber-terrorism is a form of cyber-attack, not all cyber-attacks are cyber-terrorism.

Public and private computer systems are likely to experience a variety of cyber-attacks, from blanket malware infection to targeted attacks on system capabilities. Cyber-attacks specifically seek to breach IT security measures designed to protect an individual or organization. The initial attack is followed by more severe attacks for the purpose of causing harm, stealing data, or financial gain. Organizations are prone to different types of attacks that can be either automated or targeted in nature. Table 16-1 describes the most common cyber-attack mechanisms faced by organizations today.

Since 2013, a new type of cyber-attack is becoming increasingly common against individuals and small- and medium-sized organizations. This attack is called cyber-ransom. Cyber-ransom occurs when an individual downloads ransom malware, or ransomware, often through phishing or drive-by download, and the subsequent execution of code results in encryption of all data and personal files stored on the system. The victim then receives a message that demands a fee in the form of electronic currency or cryptocurrency, such as Bitcoin, for the decryption code (Figure 16-1). In October 2015, the FBI said that commonly used ransomware is so difficult to override, that victims should pay the ransom to retrieve their data (Danielson 2015).

Table 16-1. Common Mechanisms for Cyber-Attacks

Type	Description
Socially Engineered Trojans	Programs designed to mimic legitimate processes (e.g. updating software, running fake antivirus software) with the end goal of human-interaction caused infection. When the victim runs the fake process, the Trojan is installed on the system.
Unpatched Software	Nearly all software has weak points that may be exploited by malware. Most common software exploitations occur with Java, Adobe Reader, and Adobe Flash. These vulnerabilities are often exploited as small amounts of malicious code are often downloaded via drive-by download.
Phishing	Malicious email messages that ask users to click a link or download a program. Phishing attacks may appear as legitimate emails from trusted third parties.
Password Attacks	Third party attempts to crack a user's password and subsequently gain access to a system. Password attacks do not typically require malware, but rather stem from software applications on the attacker's system. These applications may use a variety of methods to gain access, including generating large numbers of generated guesses, or dictionary attacks, in which passwords are systematically tested against all of the words in a dictionary.
Drive-by Downloads	Malware is downloaded unknowingly by the victims when they visit an infected site.
Denial of Service Attacks	Attacks that focus on disrupting service to a network in which attackers send high volumes of data until the network becomes overloaded and can no longer function.
Man in the Middle	Man-in-the-Middle attacks mirror victims and endpoints for online information exchange. In this type of attack, the attacker communicates with the victims, who believe they are interacting with a legitimate endpoint website. The attacker is also communicating with the actual endpoint website by impersonating the victim. As the process goes through, the attacker obtains entered and received information from both the victim and endpoint.
Malvertising	Malware downloaded to a system when the victim clicks on an affected ad.
Advanced Persistent Threat (APT)	An attack in which the attacker gains access to a network and remains undetected. APT attacks are designed to steal data instead of cause damage.

Source: Danielson 2015

Figure 16-1. Pop-Up Message Indicating Ransomware Infection

City of Los Angeles Executive Order

With millions of threats created each day, the mayor of Los Angeles signed an executive order in 2013 creating the City of Los Angeles Cyber Intrusion Command Center. Its mission is to lead cyber-security preparation and response across City departments. The Center is led by the Office of the Mayor and collaborates with multiple federal and intergovernmental agencies, including the FBI, Secret Service, California Military Department, and Joint Regional Intelligence Center. The executive order calls on the center to do the following:

- Facilitate the identification and investigation of cyber-threats and intrusions against City assets.
- Ensure incidents are quickly, properly, and thoroughly investigated by the appropriate law enforcement agency.
- Facilitate dissemination of cyber-security alerts and information.
- Provide a uniform governance structure accountable to City leadership.
- Coordinate incident response and remediation across the City.
- Serve as an advisory body to City departments.
- Sponsor independent security assessments to reduce security risks.
- Ensure awareness of best practices.

16.1.2 Cyber-Terrorism

Cyber-terrorism is the use of computers and information, particularly over the Internet, to recruit others to an organization’s cause, cause physical or financial harm, or cause a severe disruption of infrastructure service. Such disruptions can be driven by religious, political, or other motives. Like traditional terrorism tactics, cyber-terrorism seeks to evoke very strong emotional reactions, but it does so through information technology rather than a physically violent or disruptive action. Cyber-terrorism has three main types of objectives (Kostadinov 2012):

- **Organizational**—Cyber-terrorism with an organizational objective includes specific functions outside of or in addition to a typical cyber-attack. Terrorist groups today use the internet on a daily basis. This daily use may include recruitment, training, fundraising, communication, or planning. Organizational cyber-terrorism can use platforms such as social media as a tool to spread a message beyond country borders and instigate physical forms of terrorism. Additionally, organizational goals may use systematic attacks as a tool for training new members of a faction in cyber-warfare.
- **Undermining**—Cyber-terrorism with undermining as an objective seeks to hinder the normal functioning of computer systems, services, or websites. Such methods include defacing, denying, and exposing information. While undermining tactics are typically used due to high dependence on online structures to support vital operational functions, they typically do not result in grave consequences unless undertaken as part of a larger attack. Undermining attacks on computers include the following (Waldron 2011):
    - Directing conventional kinetic weapons against computer equipment, a computer facility, or transmission lines to create a physical attack that disrupts the reliability of equipment.
    - Using electromagnetic energy, most commonly in the form of an electromagnetic pulse, to create an electronic attack against computer equipment or data transmissions. By overheating circuitry or jamming communications, an electronic attack disrupts the reliability of equipment and the integrity of data.
    - Using malicious code directed against computer processing code, instruction logic, or data. The code can generate a stream of malicious network packets that disrupt data or logic by exploiting vulnerability in computer software, or a weakness in computer security practices. This type of cyber-attack can disrupt the reliability of equipment, the integrity of data, and the confidentiality of communications (Wilson 2008)
- **Destructive**—The destructive objective for cyber-terrorism is what organizations fear most. Through the use of computer technology and the Internet, the terrorists seek to inflict destruction or damage on tangible property or assets, and even death or injury to individuals. There are no cases of pure cyber-terrorism as of the date of this plan.

16.1.3 Space Weather

All weather on Earth, from the surface of the planet into space, is influenced by the small changes the sun undergoes during its solar cycle. These variations are referred to as space weather. Sudden bursts of plasma and magnetic field structures from the sun's atmosphere—called coronal mass ejections—together with sudden bursts of radiation, or solar flares, all cause weather effects here on Earth. Extreme space weather can cause damage to critical infrastructure, especially the electric grid. It can produce electromagnetic fields that induce extreme currents in wires, disrupting power lines, and even causing wide-spread blackouts. In severe cases, it produces solar energetic particles, which can damage satellites used for commercial communications, global positioning, intelligence gathering, and weather forecasting.

NOAA's Space Weather Prediction Center has developed space weather scales ranging from minor to extreme effects as a way to communicate to the general public the current and future space weather conditions and their possible effects on people and systems. Descriptions of three general NOAA classifications of space weather—geomagnetic storms, solar radiation storms and radio blackouts—are included in Figure 16-2. NOAA Space Weather Prediction Center studies have determined that different types of space weather may occur separately.

The most important impact the sun has on Earth is related to its brightness or irradiance. The sun produces energy in the form of photons of light. The variability of the sun's output is wavelength dependent:

- Most of the energy from the sun is emitted in the visible wavelengths. The output from the sun in these wavelengths is nearly constant and changes by only 0.1 percent over the course of the 11-year solar cycle.
- At ultraviolet or UV wavelengths, solar irradiance is more variable, with changes up to 15 percent over the course of the 11-year solar cycle. This has a significant impact on the absorption of energy by ozone and in the stratosphere.
- At still shorter wavelengths, like extreme ultraviolet, solar irradiance changes by 30 to 300 percent over a period of minutes. These wavelengths are absorbed in the upper atmosphere, so they have minimal impact on the climate of Earth.
- At the other end of the light spectrum, at infrared wavelengths, solar irradiance is very stable and only changes by a percent or less over the solar cycle.

Other types of space weather can impact the atmosphere. Energetic particles penetrating into the atmosphere can change chemical constituents. These changes in minor species such as nitrous oxide can have long lasting consequences in the upper and middle atmosphere; however, it has not been determined if these have a major impact on the Earth’s climate.

Space weather (geomagnetic storms, solar radiation storms, solar flare radio blackouts, solar radio bursts, and cosmic radiation) can impact aviation operations at LAX and Van Nuys Airport. Effects include degradation or loss of HF radio transmission and satellite navigation signals; navigation system disruptions; and avionics errors. Airport dispatchers use space weather forecasts for flight planning at high latitudes, especially for polar routes.

NOAA Space Weather Scales

Category Scale	Category Descriptor	Effect (Duration of event will influence severity of effects)	Physical measure	Average Frequency (1 cycle = 11 years)
Geomagnetic Storms			Kp values* determined every 3 hours	Number of storm events when Kp level was met; (number of storm days)
G 5	Extreme	Power systems: widespread voltage control problems and protective system problems can occur, some grid systems may experience complete collapse or blackouts. Transformers may experience damage. Spacecraft operations: may experience extensive surface charging, problems with orientation, uplink/downlink and tracking satellites. Other systems: pipeline currents can reach hundreds of amps, HF (high frequency) radio propagation may be impossible in many areas for one to two days, satellite navigation may be degraded for days, low-frequency radio navigation can be out for hours, and aurora has been seen as low as Florida and southern Texas (typically 40° geomagnetic lat.).**	Kp=9	4 per cycle (4 days per cycle)
G 4	Severe	Power systems: possible widespread voltage control problems and some protective systems will mistakenly trip out key assets from the grid. Spacecraft operations: may experience surface charging and tracking problems, corrections may be needed for orientation problems. Other systems: induced pipeline currents affect preventive measures, HF radio propagation sporadic, satellite navigation degraded for hours, low-frequency radio navigation disrupted, and aurora has been seen as low as Alabama and northern California (typically 45° geomagnetic lat.).**	Kp=8	100 per cycle (60 days per cycle)
G 3	Strong	Power systems: voltage corrections may be required, false alarms triggered on some protection devices. Spacecraft operations: surface charging may occur on satellite components, drag may increase on low-Earth-orbit satellites, and corrections may be needed for orientation problems. Other systems: intermittent satellite navigation and low-frequency radio navigation problems may occur, HF radio may be intermittent, and aurora has been seen as low as Illinois and Oregon (typically 50° geomagnetic lat.).**	Kp=7	200 per cycle (130 days per cycle)
G 2	Moderate	Power systems: high-latitude power systems may experience voltage alarms, long-duration storms may cause transformer damage. Spacecraft operations: corrective actions to orientation may be required by ground control; possible changes in drag affect orbit predictions. Other systems: HF radio propagation can fade at higher latitudes, and aurora has been seen as low as New York and Idaho (typically 55° geomagnetic lat.).**	Kp=6	600 per cycle (360 days per cycle)
G 1	Minor	Power systems: weak power grid fluctuations can occur. Spacecraft operations: minor impact on satellite operations possible. Other systems: migratory animals are affected at this and higher levels; aurora is commonly visible at high latitudes (northern Michigan and Maine).**	Kp=5	1700 per cycle (900 days per cycle)

* Based on this measure, but other physical measures are also considered.
** For specific locations around the globe, use geomagnetic latitude to determine likely sightings (see www.swpc.noaa.gov/Aurora)

Category Scale	Category Descriptor	Effect	Physical measure	Average Frequency
Solar Radiation Storms			Flux level of ≥ 10 MeV particles (ions)*	Number of events when flux level was met**
S 5	Extreme	Biological: unavoidable high radiation hazard to astronauts on EVA (extra-vehicular activity); passengers and crew in high-flying aircraft at high latitudes may be exposed to radiation risk. *** Satellite operations: satellites may be rendered useless, memory impacts can cause loss of control, may cause serious noise in image data, star-trackers may be unable to locate sources; permanent damage to solar panels possible. Other systems: complete blackout of HF (high frequency) communications possible through the polar regions, and position errors make navigation operations extremely difficult.	10^5	Fewer than 1 per cycle
S 4	Severe	Biological: unavoidable radiation hazard to astronauts on EVA; passengers and crew in high-flying aircraft at high latitudes may be exposed to radiation risk.*** Satellite operations: may experience memory device problems and noise on imaging systems; star-tracker problems may cause orientation problems, and solar panel efficiency can be degraded. Other systems: blackout of HF radio communications through the polar regions and increased navigation errors over several days are likely.	10^4	3 per cycle
S 3	Strong	Biological: radiation hazard avoidance recommended for astronauts on EVA; passengers and crew in high-flying aircraft at high latitudes may be exposed to radiation risk.*** Satellite operations: single-event upsets, noise in imaging systems, and slight reduction of efficiency in solar panel are likely. Other systems: degraded HF radio propagation through the polar regions and navigation position errors likely.	10^3	10 per cycle
S 2	Moderate	Biological: passengers and crew in high-flying aircraft at high latitudes may be exposed to elevated radiation risk.*** Satellite operations: infrequent single-event upsets possible. Other systems: effects on HF propagation through the polar regions, and navigation at polar cap locations possibly affected.	10^2	25 per cycle
S1	Minor	Biological: none. Satellite operations: none. Other systems: minor impacts on HF radio in the polar regions.	10	50 per cycle

* Flux levels are 5 minute averages. Flux in particles $s^{-1} \cdot ster^{-1} \cdot cm^{-2}$ Based on this measure, but other physical measures are also considered.
** These events can last more than one day.
*** High energy particle (>100 MeV) are a better indicator of radiation risk to passenger and crews. Pregnant women are particularly susceptible.

Category Scale	Category Descriptor	Effect	Physical measure	Average Frequency
Radio Blackouts			GOES X-ray peak brightness by class and by flux*	Number of events when flux level was met; (number of storm days)
R 5	Extreme	HF Radio: Complete HF (high frequency**) radio blackout on the entire sunlit side of the Earth lasting for a number of hours. This results in no HF radio contact with mariners and en route aviators in this sector. Navigation: Low-frequency navigation signals used by maritime and general aviation systems experience outages on the sunlit side of the Earth for many hours, causing loss in positioning. Increased satellite navigation errors in positioning for several hours on the sunlit side of Earth, which may spread into the night side.	X20 ($2x10^{-3}$)	Fewer than 1 per cycle
R 4	Severe	HF Radio: HF radio communication blackout on most of the sunlit side of Earth for one to two hours. HF radio contact lost during this time. Navigation: Outages of low-frequency navigation signals cause increased error in positioning for one to two hours. Minor disruptions of satellite navigation possible on the sunlit side of Earth.	X10 (10^{-3})	8 per cycle (8 days per cycle)
R 3	Strong	HF Radio: Wide area blackout of HF radio communication, loss of radio contact for about an hour on sunlit side of Earth. Navigation: Low-frequency navigation signals degraded for about an hour.	X1 (10^{-4})	175 per cycle (140 days per cycle)
R 2	Moderate	HF Radio: Limited blackout of HF radio communication on sunlit side of the Earth, loss of radio contact for tens of minutes. Navigation: Degradation of low-frequency navigation signals for tens of minutes.	M5 ($5x10^{-5}$)	350 per cycle (300 days per cycle)
R 1	Minor	HF Radio: Weak or minor degradation of HF radio communication on sunlit side of the Earth, occasional loss of radio contact. Navigation: Low-frequency navigation signals degraded for brief intervals.	M1 (10^{-5})	2000 per cycle (950 days per cycle)

* Flux, measured in the 0.1-0.8 nm range, in $W \cdot m^{-2}$. Based on this measure, but other physical measures are also considered.
** Other frequencies may also be affected by these conditions.

URL: *www.swpc.noaa.gov/NOAAscales*

April 7, 2011

Figure 16-2. NOAA Space Weather Scales

16.2 HAZARD PROFILE

16.2.1 Past Events

Cyber-Attacks

The 24-hour Cyber Intrusion Command Center actively monitors all physical police events around the city. Statistics are not available for occurrences in Los Angeles, but the number of attacks is increasing. Cyber-attacks on U.S. companies occur daily, and the quantity and quality of information being hacked, stolen, destroyed, or leaked is becoming more and more of a problem for consumers, government entities and businesses. The following are recent local cyber-attacks affecting Los Angeles residents:

- **December 2016**—A virus locked the Los Angeles Community College District's computer network as well as its email and voicemail systems. After consulting with cyber-security experts and law enforcement, the District paid a $28,000 cyber-ransom in bitcoin. The district had a cyber-security insurance policy to cover such attacks.
- **December 16, 2016**—Hackers compromised the County of Los Angeles Departments of Health and Mental Health's patient information. This affected over 700,000 people.
- **May 2016**—Cyber-attack on Los Angeles County employees targeted 1,000 county employees with a phishing email. A Nigerian national was charged with the crime.
- **September 2014**—A months-long cyber-attack on the University of California, Los Angeles hospital system compromised personal information for up to 4.5 million people.

Space Weather Events

Table 16-2 is a sample of recent space weather events affecting North America, as recorded by the NOAA Space Weather Prediction Center. NOAA Space Weather Prediction Center issues warnings in advance for these storm events that occur continuously and vary in strength and severity for the Earth.

Table 16-2. Past Space Weather Events

Date of Event	Event Type	Description
March 27-29,2017	Geomagnetic Storms	Moderate geomagnetic storm condition occurred because of a coronal hole effect impacting the Earth's magnetosphere. In turn this effects power grids, radios, and Aurora visible as low as New York to Wisconsin to Washington State.
October 13-15, 2016	Geomagnetic Storms	Moderate geomagnetic storm condition occurred because of a coronal hole effect impacting the Earth's magnetosphere. In turn this effects power grids, radios, and Aurora visible as low as New York to Wisconsin to Washington State.
September 28-30, 2016	Geomagnetic Storms	Moderate geomagnetic storm condition occurred as effects from a large coronal hole high speed stream. In turn this effects power grids, radios, and Aurora more intense in the northern latitudes.
May 9, 2016	Geomagnetic Storms	Strong geomagnetic storm condition with solar winds were observed.
September 12-14, 2014	Geomagnetic storms	Moderate geomagnetic storms occurred as result of the coronal mass ejection associated with solar flares. For several days, it impacted HF radio communications. Aurora watchers in the northern U.S. could see activity.
December 2006	Geomagnetic storms and solar flares	This event disabled Global Positioning System (GPS) signal acquisition over the United States.
October 2003	Solar Flares	A series of solar flares impacted satellite-based systems and communications. A one-hour long power outage occurred in Sweden as a result of the solar activity. Aurorae were observed as far south as Texas and the Mediterranean countries of Europe.
March 13, 1989	Space weather storm	A space weather storm disrupted the hydroelectric power grid in Quebec, Canada. This system-wide outage lasted for nine hours and left six million people without power.

16.2.2 Location

Cyber-Attacks

This hazard is not geography-based. Attacks can originate from any computer to affect any other computer in the world. If a system is connected to the Internet or operating on a wireless frequency, it is susceptible to exploitation. Targets of cyber-attacks can be individual computers, networks, organizations, business sectors, or governments. Financial institutions and retailers are often targeted to extract personal and financial data that can be used to steal money from individuals and banks. The most affected sectors are finance, energy and utilities, and defense and aerospace, as well as communication, retail, and health care. Both public and private operations in the City of Los Angeles are threatened on a near-daily basis by the millions of currently engineered cyberattacks developed to automatically seek technological vulnerabilities.

Space Weather

Different types of space weather can affect different technologies in the City of Los Angeles. Solar flares can produce strong x-rays that degrade or block high-frequency radio waves used for radio communication during events known as radio blackout storms. Solar energetic particles can penetrate satellite electronics and cause electrical failure. These energetic particles also block radio communications at high latitudes during solar radiation storms. Coronal mass ejections can cause geomagnetic storms on Earth and induce extra currents in the ground that can degrade power grid operations and modify the signal from radio navigation systems (GPS), causing accuracy to be degraded.

16.2.3 Frequency

Cyber-Attacks

Cyber-attacks are experienced on a daily basis, often without being noticed. Up-to-date virus protection software used in public and private sectors prevents most cyberattacks from becoming successful. Programs that promote public education on virus protection are an effective way to mitigate cyber-threats.

Space Weather

Space weather events occur daily, but do not always affect residents in the City of Los Angeles. They are all monitored and reported by NOAA’s Space Weather Prediction Center.

16.2.4 Severity

Cyber-Attacks

There is no official index for measuring the severity of a cyber-attack. An international study released by Malwarebytes in 2016 found that cyber-ransom threats caused 34 percent of business victims to lose revenue and 20 percent had to stop business immediately. The study also reported that nearly 60 percent of all cyber-ransom attacks demanded over $1,000, over 20 percent asked for more than $10,000, and 1 percent asked for over $150,000.

Space Weather

The severity of space weather can be far-reaching, as virtually all infrastructure and services depend on the electric power grid. Ground currents induced during geomagnetic storms can melt copper windings of transformers, which are the primary components of power distribution systems. Power lines traversing the planning area can pick up the currents and spread the problem over the entire area.

16.2.5 Warning Time

Cyber-Attacks

There is no warning time for cyber-attacks. The top vector for spreading cyber-ransom threats is email.

Space Weather

Space weather prediction services in the United States are provided primarily by NOAA's Space Weather Prediction Center and the U.S. Air Force's Weather Agency, which work closely together to address the needs of civilian and military user communities. The Space Weather Prediction Center draws on a variety of data sources, both space and ground-based, to provide forecasts, watches, warnings, alerts, and summaries as well as operational space weather products to civilian and commercial users.

16.3 SECONDARY IMPACTS

Cyber-Attacks

Computer breaches associated with data and communications losses can have significant economic impact.

Space Weather

The most likely secondary impact of space weather on residents, businesses and visitors to the City is disruption of the electric power grid. Space weather can have an impact on advanced technologies, which has a direct impact on daily life.

16.4 EXPOSURE

16.4.1 Population

The entire City's population is exposed to cyber-attacks personally or at places of employment. All populations who directly use a computer or receive services from automated systems are exposed to cyber-terrorism.

Space weather exposure of the City's population is minimal. The main exposure is of satellite operations, HF radio communications, and the power grid that people use.

16.4.2 Property

Structures are usually not impacted by cyber-attacks, but systems operated by electronics and computers are exposed. The impacts of space weather would not likely have a negative impact on structures.

16.4.3 Critical Facilities and Infrastructure

All critical facilities and infrastructure that are operated by electricity and/or a computer system are exposed to cyber-attacks and a space weather phenomena.

16.4.4 Environment

The natural environment is not exposed to cyber-threats and thus would not risk damage. It would only be through a secondary effect that the environment could be effected by a cyber-attack. For example if a cyber-attack shut down a hydroelectric dam so that a river would be effected. Migratory animals are exposed to geomagnetic storms associated with space weather.

16.5 VULNERABILITY

16.5.1 Population

The entire City's population is vulnerable to a cyber-attack. Because it is difficult to predict the particular target of cyber-terrorism, assessing vulnerability to the hazard is also difficult. All populations who directly use a computer or receive services from automated systems are vulnerable to cyber-terrorism. Although all individuals in the City are vulnerable to an attack, certain types of attacks would impact specific segments of the population. If the cyber-attack targeted the City's power or utility grid, individuals with medical needs would be impacted the greatest. These populations are most vulnerable because many of the life-saving systems they rely on require power. Also, if an attack occurred during months of extreme hot weather, those 65 years of age and older would be vulnerable to the effects of the lack of climate control. These individuals might require an air-conditioned shelter operating on a back-up generator. If a cyber-attack targeted a facility storing or manufacturing hazardous materials, individuals living adjacent to these facilities would be vulnerable to the secondary effects, should the attack successfully cause a critical failure at that facility.

The sun's activities cause extreme space weather events that can affect the City's population, mainly by power black-out events.

16.5.2 Property

A catastrophic cyber-attack can have far-ranging effects on public and private infrastructure systems. Cyber-attacks can cause physical damage if real assets or end consumers are affected by service disruption. This might occur if cyber-attacks target industries related to utilities, life support, transportation, human services, or telecommunications. In many cases, attacks on these systems initially will not be detected, and any malfunction will be thought to be system failure.

It is unlikely that the impacts of space weather would have a negative impact on property and structures themselves, but a magnetic or black-out event caused by space weather, would affect public and private infrastructure systems.

16.5.3 Critical Facilities and Infrastructure

All critical facilities and infrastructure that are operated by electricity and/or a computer system are vulnerable to cyber-attacks. Cyber-attacks may affect structures if any critical electronic systems suffer service disruption. For instance, a cyber-attack may cripple the electronic system that controls a cooling system or pressure system within critical infrastructure. This may result in physical damage to the structure from components overheating, or an explosion if pressure relief systems are rendered inoperable.

It is unlikely that the impacts of space weather would have a negative impact on property and structures themselves, but a magnetic storm or black-out event caused by space weather would affect public and private infrastructure systems.

16.5.4 Environment

While effects of cyber-threats on the natural environment are unlikely, they can occur. Such effects may come from a system failure that, for example, allows a release of hazardous materials or improper disposal of waste.

16.5.5 Economic Impacts

Economic impacts can be far-reaching if a cyber-attack or space weather event is prolonged for a week or longer. Cyber-attacks can have extensive fiscal impacts. Companies and government services can lose large sums of unrecoverable revenue from site downtime and possible compromise of sensitive confidential data. Cyber-incidents could result in the theft or modification of important data—including personal, agency, or corporate information— and the sabotage of critical processes, including the provision of basic services by government or private-sector entities.

16.6 FUTURE TRENDS IN DEVELOPMENT

The City of Los Angeles will continue to be impacted and compelled to respond to cyber-attacks in the future. The nature of these attacks is projected to evolve in sophistication over time. The City has taken a proactive position in its cyber-security efforts with the establishment of the Cyber Intrusion Command Center and is expected to remain vigilant in its efforts to prevent attacks from occurring or disrupting business operations. The reality remains that many computers and networks in organizations of all sizes and industries around the U.S. will continue to suffer intrusion attempts on a daily basis from viruses and malware that are passed through websites and emails.

16.7 SCENARIO

A cyber-ransom against all City departments would leave City employees locked out of all files and computer systems until the issue is resolved, which could be days, hours, or weeks.

A regional black-out power outage for several hours cause by a space weather event would cripple the City and the entire region. All critical facilities and infrastructure would be on generator back-up power if available.

16.8 ISSUES

The major issues for cyber-attack and space weather are the following:

- Participate in regional, state and federal efforts to gather terrorism information at all levels and keep public safety officials briefed at all times regarding local threats. Further develop response capabilities based on emerging threats.
- Encourage local businesses to adopt information technology and telecommunications recovery plans.
- Prepare and present the human-caused hazard risk and preparedness program to the public through meetings, town hall gatherings, and preparedness fairs and outreach.
- Maintain any and all resident advisory groups and periodically e-mail emergency preparedness information including human-caused hazard preparedness instructions and reminders.

17. HAZARDOUS MATERIAL, TRANSPORTATION AND RADIOLOGICAL INCIDENTS

17.1 GENERAL BACKGROUND

Technological hazards are incidents that arise from human activities such as the manufacture, transportation, storage and use of hazardous materials; pipeline and tank releases; and airline incidents. These incidents are assumed to be accidental in nature, with unintended consequences. This chapter discusses technological hazards related to hazardous materials, transportation, and radiological substances.

DEFINITIONS

Hazardous Material—A substance or combination of substances (biological, chemical, radiological, and/or physical) that, because of its quantity, concentration, or physical, chemical or infectious characteristics, has the potential to cause harm to humans, animals, or the environment, either by itself or through interaction with other factors.

Radiological Incidents—An incident involving radioactive materials that can occur wherever radioactive materials are used, stored, or transported.

Technological Hazards—Hazards from accidents associated with human activities such as the manufacture, transportation, storage and use of hazardous materials.

17.1.1 Hazardous Materials

Incidents related the manufacture, transportation, storage and use of hazardous materials are assumed to be accidental, with unintended consequences. Hazardous materials are present in nearly every city and county in the United States in facilities that produce, store, or use them. For example, water treatment plants use chlorine on-site to eliminate bacterial contaminants. Hazardous materials are transported along interstate highways and railways daily. Even the natural gas used in every home and business is a dangerous substance when a leak occurs.

Title 49 of the CFR lists thousands of hazardous materials, including gasoline, insecticides, household cleaning products, and radioactive materials. State regulated substances that have the greatest probability of adversely impacting the community are listed in the CCR, Title 19.

Incident Types

The following are the most common type of hazardous material incidents:

- **Fixed-Facility Hazardous Materials Incident**—This is the uncontrolled release of materials from a fixed site capable of posing a risk to health, safety and property as determined by the Resource and Conservation Recovery Act. It is possible to identify and prepare for a fixed-site incident because laws require those facilities to notify state and local authorities about what is being used or produced at the site.
- **Hazardous Materials Transportation Incident**—A hazardous materials transportation incident is any event resulting in uncontrolled release of materials during transport that can pose a risk to health, safety, and property as defined by Department of Transportation materials transport regulations. Transportation incidents are difficult to prepare for because there is little if any notice about what materials could be involved should an accident happen. Hazardous materials transportation incidents can occur at any place within the country, although most occur on the interstate highways or major federal or state highways, or on the major rail lines. In addition to materials such as chlorine that are shipped throughout the country by

rail, thousands of shipments of radiological materials, mostly medical materials and low-level radioactive waste, take place via ground transportation across the United States. Many incidents occur in sparsely populated areas and affect very few people.

- **Interstate Pipeline Hazardous Materials Incident**—There are a significant number of interstate natural gas, heating oil, and petroleum pipelines running through the State of California. These are used to provide natural gas to the utilities in California and to transport these materials from production facilities to end-users.

Oversight

Hazardous materials management is regulated by federal and state codes. In Los Angeles, the Fire Department is the designated enforcement agency. The state fire marshal and the Pipeline and Hazardous Materials Safety Administration enforce oil and gas pipeline safety regulations. The federal government enforces hazardous material transport pursuant to its interstate commerce regulation authority.

The Department of Toxic Substances Control (DTSC), a division of the California Environmental Protection Agency, acts to protect California from exposure to hazardous wastes by cleaning up existing contamination and looking for ways to reduce the hazardous waste produced in the state. The DTSC regulates hazardous waste in California primarily under the authority of the federal Resource Conservation and Recovery Act, and the California Health and Safety Code. Other laws that affect hazardous waste are specific to handling, storage, transportation, disposal, treatment, reduction, cleanup, and emergency planning.

DTSC reviews and monitors legislation to ensure that proposed regulations reflect DTSC goals. DTSC's major program areas develop regulations and consistent policies and procedures. Under the Resource Conservation and Recovery Act, DTSC has the authority to implement permitting, inspection, compliance and corrective action programs to ensure that people who manage hazardous waste follow state and federal requirements. As such, the management of hazardous sites in Los Angeles is under regulation by the DTSC, to ensure that state and federal regulations pertaining to hazardous waste are followed.

Businesses are required to disclose all hazardous materials and waste above certain designated quantities that they use, store, or handle at their facility. They must prepare chemical inventory and business emergency plans, review the plans regularly, and perform annual training. Any release or possible release of hazardous material must be reported to the California Office of Emergency Services (Cal OES) Warning Center. Businesses using certain regulated substances (a list of about 260 specific flammable or toxic chemicals) must develop a risk management plan. The risk management plan includes analysis of operations on-site, and projection of off-site consequences with accompanying mitigation plans.

Business practices and the laws that regulate them have changed dramatically over the years. Many businesses through intentional action, lack of awareness, or accidental occurrences have contamination in and around their property. The City retains a list of properties that were once contaminated and are now clean, as well as a few properties that are contaminated with a clean-up process underway.

17.1.2 Transportation

The City of Los Angeles transportation network consists of aviation, harbor, ground and rail systems. Disruption to any part of this system would result in major safety and economic impacts on the city, state and country.

Ports are major trade points and have complex infrastructures. Harbor and airport functions may be interrupted by many factors, including earthquakes, flooding or heavy storms, union strikes or criminal activity. Any such disruptions could cause delays of cargo delivery. Disruption of rail service can cause significant transportation system capacity problems, resulting in blocked streets and can create safety issues.

Transportation corridors, such as the Alameda Corridor, are essential to the delivery of critical medical supplies. Ground transportation is essential for ingress and egress for emergency vehicles during disasters and is essential for police services. Access for emergency vehicles on freeways, highways, primary roads and secondary roads due to road damage can significantly reduce response. Potential disruptions of roadway systems include the following:

- Loss of power to traffic signals could leave as many as 4,500 intersections in the City without a traffic control device to control right-of-way. With no regulation of right-of-way, there would be a significant potential for vehicle and pedestrian accidents, and congestion that could interfere with emergency response and recovery efforts.
- Disruption of LADOT's Automated Traffic Surveillance and Control System would result in the loss of the ability to adjust the timing of over 3,000 traffic signals from a remote location, to monitor the traffic flow and equipment status at intersections and to access LADOT's network of closed circuit cameras located throughout the City to observe traffic conditions.
- Loss of transit services, such as DASH and Commuter Express bus services, would affect the ability of millions of system users to get to work, to shop, to go to school and to get to medical appointments.
- Loss of private ambulance and non-ambulatory transportation services, which are licensed and regulated by DOT, would affect the ability of thousands of users to get to the hospital, dialysis treatments and medical appointments.

17.1.3 Radiological Incidents

Radiological materials have many uses and serve important purposes:

- Use by doctors to detect and treat diseases.
- Use by educational institutions and companies for research.
- Use by the military to power large ships and submarines.
- Use by companies in the manufacture of a variety of medical products.
- Use as a critical base material to help produce the commercial electrical power that is generated by a nuclear power plant.

The primary radiological threats to Los Angeles are from the transportation of radiological material and from facilities that produce radiation. Radioactive materials are transported through the City of Los Angeles daily for medical and scientific reasons. Prior to its permanent shutdown in January 2012, the San Onofre Nuclear Power Plant, a commercial nuclear power facility, was the largest radiological hazard to the City of Los Angeles.

The production, handling, and transportation of radioactive materials are regulated by the state and federal governments. The Los Angeles Fire Department exercises a significant response role to radiological accidents.

17.2 HAZARD PROFILE

17.2.1 Past Events

Hazardous Materials Incidents

Table 17-1 lists the number of hazardous material incidents reported to Cal OES Warning Center by year and spill site type from 2012 through 2016. Additional historical hazardous material spill report data is available on Cal OES website. The records show that a total of 940 hazardous materials spills occurred over 5-year timeframe in the City of Los Angeles.

Table 17-1. Hazard Materials Spills in the City of Los Angles Reported to Cal OES

Spill Site	2012	2013	2014	2015	2016	Total
Airport	3	9	8	7	11	**38**
Industrial Plant	0	4	1	2	4	**11**
Merchant/Business	14	26	19	17	19	**95**
Military Base	1	0	0	0	0	**1**
Oil Field	2	4	5	3	1	**15**
Other	13	22	8	20	20	**83**
Pipeline	3	1	1	1	0	**6**
Rail Road	21	35	30	63	50	**199**
Refinery	0	1	1	0	0	**2**
Residence	37	47	18	30	27	**159**
Road	33	42	28	36	16	**155**
School	1	7	10	5	5	**28**
Service Station	5	7	6	4	5	**27**
Ship/Harbor/Port	20	15	9	7	8	**59**
Treatment/Sewage Facility	3	0	0	2	0	**5**
Utilities/Substation	0	2	0	1	1	**4**
Waterways	9	4	11	15	14	**53**
Total	**165**	**226**	**155**	**213**	**181**	**940**

Source: Cal OES, 2017

Notable recent hazardous materials incidents include the following:

- **October-December 2015, Porter Ranch Gas Leak**—This natural gas leak released over 130,000 pounds of methane into the atmosphere every hour, and it took months to be sealed. It began October 23, 2015, at Southern California Gas' large underground natural gas storage facility, 20 miles northeast of Los Angeles. The leak forced the evacuation of over 1,700 homes in the Porter Ranch community. Over 2 million metric tons of greenhouse gases were released into the atmosphere. Although the leak was not within the City's boundaries, it did affect nearby Los Angeles residents and schools.
- **January 17, 1994, Northridge Earthquake**—Over a 100 releases of hazardous materials were reported because of the earthquake. Of these, 23 involved releases of natural gas, 10 involved liquid chemicals at educational institutions, and 8 involved the release of various hazardous materials at medical facilities. Gas leaks or chemical reactions triggered fires, which destroyed or damaged nine university science laboratories. Rupture of a high pressure natural gas line under Balboa Boulevard in Granada Hills resulted in a fire that damaged utility lines and adjacent homes. A petroleum pipeline leak released 4,000 barrels of crude oil into the Santa Clara River north of Los Angeles and caused fires in the Mission Hills area.
- **October 1, 1987, Whittier Narrows Earthquake**—This earthquake caused thousands of natural gas lines breaks and leaks.
- **August 8, 1972, GATX Tank Farm Explosion**— Explosions ripped through a tank farm in a chemical storage area at Los Angeles Harbor, touching off an inferno that illuminated much of San Pedro for more than three hours. At least 21 of the silo-like cylinders were destroyed, spilling highly inflammable solvents and chemicals. About 50 of the 250 firefighters battling the blaze suffered chemical burns on their legs, but none were seriously injured.
- **December 17, 1976, SS Sansinena Explosion**—A bulk oil tanker, the SS Sansinena, exploded in the Port of Los Angeles, killing nine people, injuring 46 and causing an estimated $21.6 million in damage. The tanker was empty. Poor maintenance and operating procedures on board the ship were identified as the cause of the explosion.

Transportation Incidents

According to Los Angeles Department of Transportation Annual Report 2015-2016, the number of fatalities and severe injuries from traffic accidents in vehicles has decreased since 2003 (see Figure 17-1).

Source: LADOT, 2016

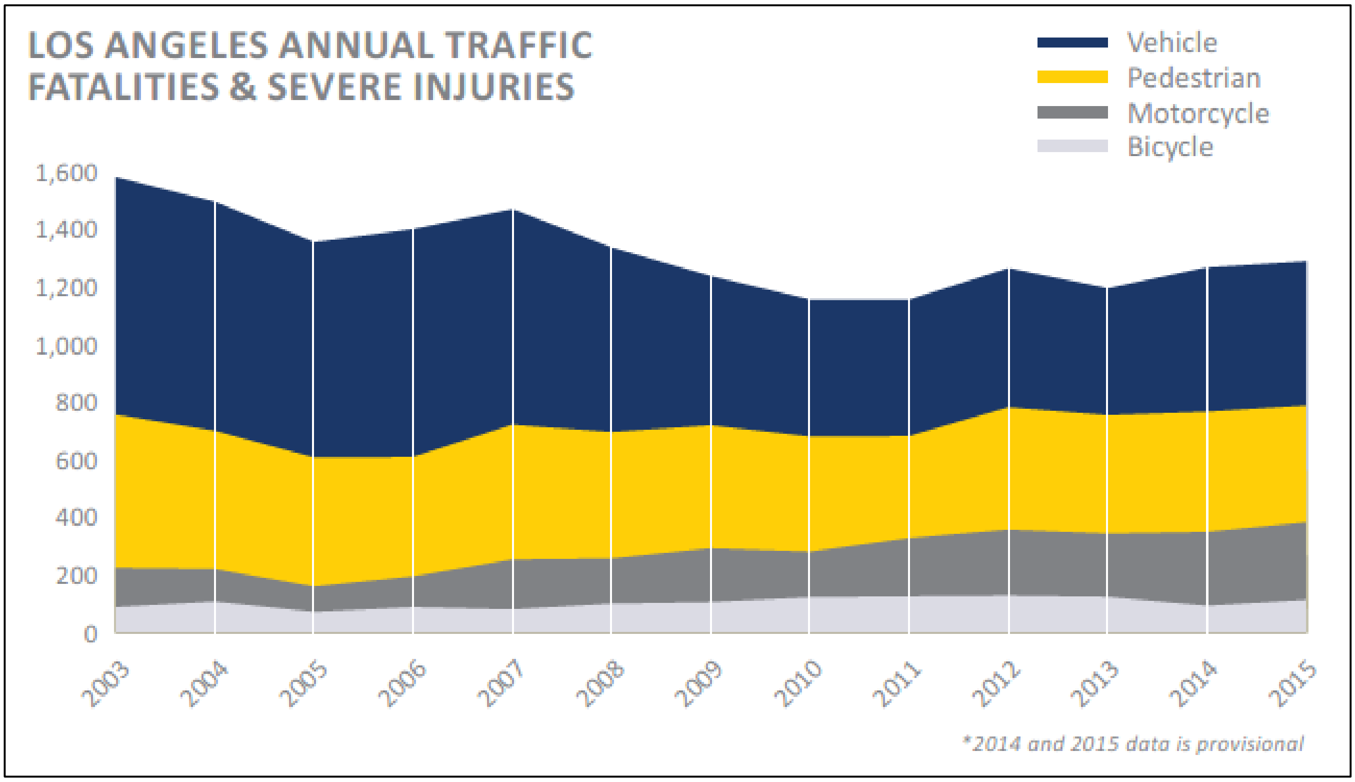


Figure 17-1. City of Los Angeles Traffic Accident Fatalities and Severe Injuries, 2003-2015

Between 2002 and 2016, there were 48 incidents at LAX, 56 incidents at Van Nuys, and three general aviation incidents in Los Angeles, as reported by the National Transportation Safety Board (NTSB). Of the 48 incidents at LAX, eight had no airplane damage, 35 had minor damage, and five had substantial damage. There were no fatalities and only seven injuries reported with these incidents. At Van Nuys, the 56 reported incidents included seven with no airplane damage, 45 with minor damage, and four with substantial damage. There were no fatalities or injuries reported with these incidents. The following is information regarding the three report general aviation incidents (NTSB 2017):

- January 25, 2008—A helicopter pilot cleared to travel to Century Boulevard collided with a high voltage transmission line and was killed.
- February 4, 2004—A Mooney M20K aircraft missed approach in instrument meteorological conditions and descended into a resident. There were two fatalities.
- June 6, 2003—During climb-out, a Beech A36TC aircraft entered an overcast cloud layer and then descended out of the clouds in a spinning, steep nose-down attitude, impacting a three-story apartment building. Five people were killed and seven serious injuries were reported.

Radiological Incidents

In January 2000, a radioactive spill in the Eagle Rock neighborhood caused the early morning closure of the Glendale Freeway. This transportation incident was caused by a car stalling on the freeway and being struck by at least four other vehicles, one of which was transporting radioactive materials.

Major radiological spills could occur following a major Southern California earthquake. While major medical centers and research universities have taken precautions to avoid such spills, earthquakes have historically resulted in numerous hazardous material leaks.

17.2.2 Location

Hazardous Materials

The following locations have the potential of hazardous materials releases:

- **Business and Industrial Areas**—Retail, manufacturing and light industrial firms are areas of concern. These facilities have the highest concentration of hazardous materials at fixed facilities in the City of Los Angeles due to their manufacturing operations. Each business is required to file a detailed, confidential plan with the Fire Department regarding materials on-site and safety measures taken to protect the public.
- **Agricultural Areas**—Accidental releases of pesticides, fertilizers, and other agricultural chemicals may be harmful to both humans and the environment. Agricultural pesticides are transported daily in and around the City of Los Angeles en route to their destination in rural areas.
- **Illegal Drug Operations**—Illegal operations such as laboratories for methamphetamine pose a significant threat. Laboratory residues are often dumped along roadways or left in rented hotel rooms, creating a serious health threat to unsuspecting individuals and to the environment.
- **Illegal Dumping Sites—**Hazardous wastes such as used motor oil, solvents, or paint are occasionally dumped in remote areas of the City of Los Angeles or along roadways, creating a potential health threat to unsuspecting individuals and to the environment.

Transportation Incidents

The following transportation facilities and networks (see Figure 17-2) have the potential for interruption-related hazards:

- Los Angeles International Airport (LAX)
- Van Nuys Airport
- Port of Los Angeles
- Port of Long Beach
- Interstate 110 – Harbor Freeway
- State Route 1 – Pacific Coast Highway
- Interstate 5 – Golden State Freeway
- State Route 2 – Glendale Freeway
- Interstate 10 – Santa Monica Freeway
- State Route 47 – Alameda Street
- State Route 60 – Pomona Freeway
- U.S. Route 101 – Hollywood Freeway
- Interstate 105 – Century Freeway
- Santa Monica Boulevard
- State Route 134 – Ventura Freeway
- Interstate 710 – Long Beach Freeway
- Interstate 605 – San Gabriel River Freeway
- AMTRAK – Passenger
- Los Angeles County Metro Rail
- Alameda Corridor

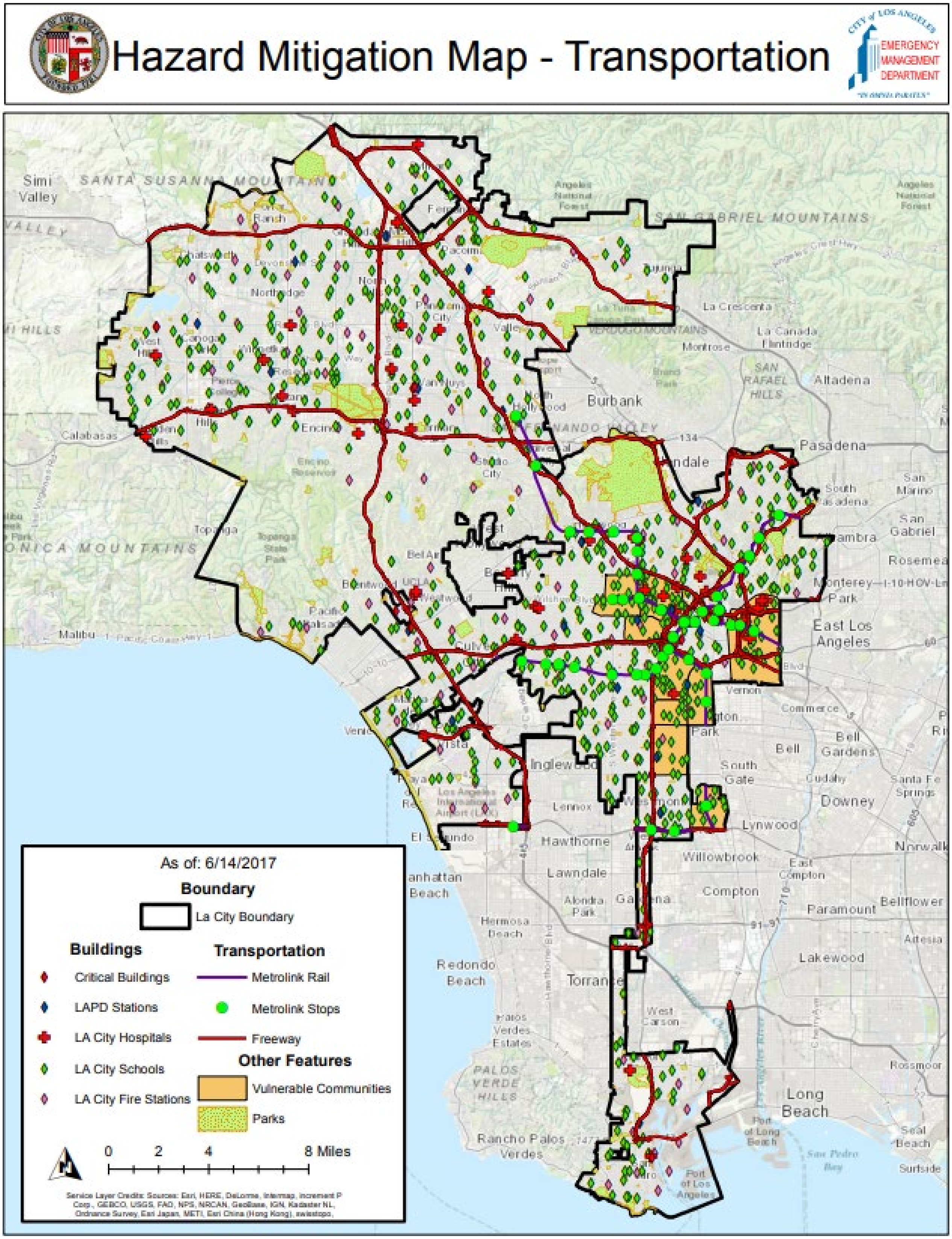


Figure 17-2. Transportation Infrastructure in the City of Los Angeles

Radiological Incidents

The greatest potential for an incident involving radioactive materials is related to transport. Due to the widespread use of radioactive materials in medical and industrial processes, an accident involving the transportation of radioactive materials could occur at almost any location on the 6,000-mile street network of the City of Los Angeles. However, the amount of radioactive material transported is usually very small. Regional transportation facilities—specifically including major highways, railways, airports and ports—are the most likely locations for accidents involving large quantities of radioactive materials. These regional facilities transport materials passing through the region, as well as materials originating in or destined to locations throughout the City.

17.2.3 Frequency

Hazardous Materials

Hazardous material incidents may occur at any time, given the presence of transportation routes dividing the planning area, the location of businesses and industry that use hazardous materials, the presence of scattered illegitimate businesses such as clandestine drug laboratories at any given time, and the improper disposal of hazardous waste. Table 17-1 lists 940 incidents that occurred in the City over a 5-year timeframe.

Transportation Incidents

Transportation incidents, including all modes of transportation, may occur at any time in the planning area.

Radiological Incidents

The frequency of radiological incidents in the City of Los Angeles is very low. While there are many sites within the City where small amounts of radioactive materials are used or stored, there are no known major radioactive material production or storage facilities in the City.

17.2.4 Severity

Hazardous Materials

Table 17-2 shows the number of injuries and fatalities associated with hazardous material spills reported to Cal OES Warning Center from 2012 through 2016. Additional historical hazardous material spill report data is available on the Cal OES website. The records shows that 60 people have been injured and 35 fatalities have occurred within a 5-year timeframe in the City of Los Angeles.

Table 17-2. Injuries and Fatalities from Hazardous Materials Spills in the City of Los Angles, Reported to Cal OES

Severity	2012	2013	2014	2015	2016	Total
Number of Injuries	4	3	4	29	20	**60**
Number of Fatalities	1	8	6	11	9	**35**
Total	**5**	**11**	**10**	**40**	**29**	**95**

Source: Cal OES, 2017

Hazardous material releases also affect the environment through contamination of soil, waterways (storm drains, creeks, rivers, flood channels, harbors, ports, etc.), drinking water, and roads. Evacuation orders can affect hundreds of people. Cal OES reports from 2012 through 2016 list 5,032 incidents that affected waterways and 12 evacuations.

Transportation Incidents

The term mass-casualty incident (MCI) is often applied to transportation accidents involving air and rail travel, as well as multi-vehicle highway accidents. Effects may include serious injuries, loss of life, and associated property damage. A mass-casualty incident is defined as any incident with three or more fatalities or critically injured. Because large numbers of patients may be involved, significant MCIs may tax local emergency medical and hospital resources, and therefore require a regional response. First responders, including fire, police, and emergency room staff at local hospitals, follow established protocols for an MCI. Mutual aid is requested should local officials be unable to respond appropriately with available personnel and equipment.

MCIs may occur throughout the planning area, day or night, at any time of the year. The following freeways have greater potential for MCIs because of the heavy volume of traffic, although no highway or surface street in the planning area is exempt from this hazard:

- Santa Monica Freeway (I-10)
- Harbor Freeway (I-110)
- San Diego Freeway (I-405/I-5)
- Long Beach Freeway (I-710)
- El Segundo Freeway (I-105)
- Century Freeway (I-105)
- Golden State Freeway (I-5)
- San Bernardino Freeway (I-10)
- San Gabriel Freeway (I-605).

The railroad tracks traversing the planning area, carrying Amtrak passengers as well as freight, also face the risk of an MCI, as do the Los Angeles International Airport and Van Nuys Airport.

Adverse weather may play a role in roadway, air, or rail accidents. MCIs may also result from acts of violence or terrorism, which could include a chemical, biological or radiological incident, contaminating persons and requiring mass decontamination.

Radiological Incidents

Radioactive material, whether naturally occurring or manufactured, is unstable and is constantly seeking a stable atomic configuration through a process called, “radioactive decay.” As radioactive material decays to stable, non-radioactive material (or to other types of radioactive material) ionizing radiation is emitted. This ionizing radiation is emitted in either particle or electromagnetic waveform. There are four basic types of radiation of concern:

- **Alpha Radiation (particles)—**Alpha radiation is less penetrating than beta or gamma radiation and may be completely stopped by a sheet of paper. Alpha radiation is not a hazard external to the body, but becomes a hazard if the alpha-emitting radioactive material is ingested.
- **Beta Radiation (particles)—**Beta radiation is more penetrating than alpha, but less penetrating than gamma radiation. Such radiation may be completely stopped by a thin sheet of metal such as aluminum. Beta radiation is an external hazard to the skin and eyes. It is an internal hazard if the beta-emitting radioactive material is ingested.
- **Gamma Radiation (electromagnetic waves)—**Gamma radiation is the most dangerous type of radiation as it cannot be easily stopped by physical barriers. Unlike alpha or beta radiation, gamma radiation is emitted as energy waves, not particles. It is a hazard to the entire body and has the potential to destroy healthy cells and bodily tissue.
- **Neutron Radiation (particles)—**Neutron radiation has the potential to be stopped by an appropriate thickness of a hydrogenous material such as water or concrete. Neutron radiation has the unique property

of being able to convert non-radioactive material to radioactive material. Such radiation could be an internal bodily hazard if a source emitting neutrons is ingested.

17.2.5 Warning Time

Hazardous materials, transportation incidents, and radiological incidents occur without predictability under circumstances that give responders little time to prepare.

17.3 SECONDARY IMPACTS

17.3.1 Hazardous Materials

Hazardous materials releases have the potential to cause major disruptions to local businesses that house hazardous materials. Additionally, a hazardous materials release could cause other businesses to close if they are in the path of the release.

17.3.2 Transportation Incidents

The largest secondary impact caused by transportation interruption would be economic. The economic impacts should a transportation facility be rendered impassable would be significant. The loss of a roadway or railroad would have serious effects on the local economy and the ability to provide services. Loss of major travel routes would result in loss of commerce, and could impact the ability to provide emergency services to residents by delaying response times or limiting routes for equipment such as fire apparatus, police vehicles, and ambulances. The ability to receive fuel deliveries would also be impacted. The effects of re-routed traffic could have a serious impact on local roadways.

17.3.3 Radiological Incidents

A secondary impact of radiological incidents is residual ground contamination.

17.4 EXPOSURE

17.4.1 Population

The EPA’s Toxics Release Inventory (TRI) tracks the management of over 650 toxic chemicals that pose a threat to human health and the environment. U.S. facilities in industry sectors that manufacture, process, or otherwise use these chemicals in amounts above established levels must report how each chemical is managed through recycling, energy recovery, treatment, and releases to the environment. A “release” of a chemical means that it is emitted to the air or water, or placed in some type of land disposal. The information submitted by facilities to the EPA and states is compiled annually as the TRI, and is stored in a publicly accessible database.

TRI facilities are required to report to EPA each year by July 1**.** Data are available for facilities that have submitted information since the program began in 1987. TRI on-site and off-site reports of materials disposed of or otherwise released by Los Angeles County industries for 2015 presents the following data (EPA Toxics Release Inventory, 2017):

- Total On-Site Disposal or Other Releases—2,888,000 pounds
- Total Off-Site Disposal or Other Releases—2,576,670 pounds
- Total On-Site and Off-Site Disposal or Other Releases—5,464,670 pounds

This list includes over 100 chemical types released during the 2015 reporting year. It reflects releases and other waste management activities of chemicals, but not whether, or to what degree, the public has been exposed to those chemicals. Release estimates are not sufficient to determine exposure or to calculate potential adverse effects on human health and the environment. TRI data, in conjunction with other information, can be used as a starting point in evaluating exposures that may result from releases and other waste management activities which involve toxic chemicals. The determination of potential risk depends on many factors, including the toxicity of the chemical, the disposal of the chemical, and the amount and duration of human or other exposure to the chemical after it is released.

Hazardous materials pose a significant risk to emergency response personnel. All potential first responders and follow-on emergency personnel in the City currently are and will be properly trained to the level of emergency response actions required of their individual position at the response scene.

For radiological incidents in particular, people need to minimize their exposure to radiation as low as possible. People will be given guidance to get inside and be protected by the wall of a building to block as much of the harmful radiation as possible. People may need to stay inside for at least 24 hours, as radioactive materials become weaker over time.

17.4.2 Property

Hazardous materials and radiological incidents can pose a serious long-term threat to property.

17.4.3 Critical Facilities and Infrastructure

A majority of critical facilities house and store hazardous materials and thus are exposed to possible incidents caused by blockage, mechanical, human error, or unknown causes. The City has more than 160 miles of freeways and 1,400 miles of major and secondary roadways that are exposed to hazardous materials, transportation, and radiological incidents.

17.4.4 Environment

Hazardous material incidents can kill wildlife, destroy habitat, and contaminate critical resources in the food chain.

17.5 VULNERABILITY

A hazardous materials incident can occur almost anywhere. So, all neighborhoods in Los Angeles are considered to have some vulnerability to this hazard. The impact of this type of disaster will likely be localized to the immediate area surrounding the incident. The initial concern will be for people, then the environment. If contamination occurs, the spiller is responsible for the cleanup actions and will work closely with responders in the jurisdiction, Cal OES, and EPA to ensure that cleanup is done safely and in accordance with local, state, and federal laws. All significant hazardous materials releases are required to be reported to the Cal OES State Warning Center.

17.5.1 Population

People near facilities producing, storing, or transporting hazardous substances are at higher risk. Populations downstream, downwind, and downhill of a released substance are particularly vulnerable. Depending on the characteristics of the substance released, more people in a larger area may be in danger from explosion, absorption, injection, ingestion, or inhalation. Many times, people in the radius area (outside the immediate affected area), are evacuated for precautionary reasons or told to shelter-in-place, depending on the release type and wind conditions.

17.5.2 Property

The impact of a fixed-facility incident will likely be localized to the property where it occurs. It is difficult to determine potential losses to existing development because of the variable nature of a hazardous material spill. For example, a very small chemical spill in a less populated area would be much less costly and possibly limited to remediation of soil.

17.5.3 Critical Facilities and Infrastructure

The impact of a hazardous material spill, transportation or radiological incident will likely be localized to the particular facility, hospital, port, airport, railroad, road, highway, or interstate. The potential losses to existing development vary because of the variable nature of the hazardous material spill, but costs from product loss, property damage and decontamination and other costs can add up to millions of dollars.

17.5.4 Environment

Most hazardous materials incidents are localized and are quickly contained or stabilized. Depending on the characteristic of the hazardous material or the volume of product involved, the affected area can be as small as a room in a building or as large as many square miles that require soil remediation. More widespread effects occur when a product contaminates the municipal water supply or water system such as a port, river, lake, or aquifer. Such environmental damage can linger for decades.

17.5.5 Economic Impacts

Large hazardous material spills can create havoc on the economy of Los Angeles by driving away tourists. Transportation incidents can temporarily shut down transportation routes. Studies that look at economic effects from bridge and highway losses consistently report job loss and economic losses in the billions. For example, 43 percent of businesses reporting losses after the 1994 Northridge Earthquake said they were due to transportation issues.

Airport Losses

Disrupted service would negatively impact LAX's non-aviation revenues (concessions sales, parking, etc.) and could impact the financial health of primary tenants. Similar interruptions at Van Nuys could negatively impact fuel fee revenues and the business of on-airport tenants. The extent of the impact on either airport is difficult to predict and would vary depending on the duration of the disruption.

The impact on City, state or federal functions would depend on the nature of the disruption. For example, Van Nuys Airport provides crash, fire, and rescue service for the Los Angeles Fire department, and disruption to any of these services would affect emergency response and public safety.

Extended disruption of service at either airport (but primarily LAX) would likely impact the local economy as the airports' operations are directly linked to tourism and the facilitation of regional, national and international commerce.

Port of Los Angeles and Long Beach Port Losses

More than 40 percent of U.S. imports go through the Los Angeles and Long Beach Port complex, so a shutdown would have a significant impact on all levels of government in the United States. Risk analysis for the Port of Los Angeles calculates that operational shutdowns of 15 days, 120 days, and a one year would result in losses of

$300 million, $63 billion and $252 billion, respectively. The impact of a 15-day shutdown would be small because most ships would wait out the port closures and businesses would be supplied through other ports. The 120-day and one-year shutdowns would be significant because they would delay the delivery of goods, with ripple effects throughout the nation's economy. This includes impacts ranging from the loss of local dock worker jobs to reduced income and possible forced closure of nationwide businesses not receiving necessary parts or retail products.

All levels of government would be working as quickly as possible to reopen the port. Almost every business in the City of Los Angeles would be impacted one way or the other if the port was shut down for extended periods. Long-term closure of the port would be an economic catastrophe because it is the only West Coast port that has the cargo handling capabilities to deal with the size of imports that come into this country. The amount of cargo transported each year through the combined Ports of Los Angeles and Long Beach is more than that of the entire East Coast.

Railroad Losses

In a typical year, over $100 billion dollars of domestically and internationally produced goods move east via the Union Pacific and BNSF Railway lines of the Alameda Corridor on their way to destinations around the country, and $45 billion in goods arrive from around the United States for consumption in the region or export abroad. It is estimated that a 10-day disruption of the Alameda Corridor would cost $4.1 billion, a 30-day disruption would cost $12.4 billion, and a 60-day disruption would cost $24.8 billion (City of Los Angeles, 2011).

17.6 FUTURE TRENDS IN DEVELOPMENT

The number and types of hazardous chemicals stored in and transported through the City of Los Angeles will likely continue to increase. As population grows, the number of people vulnerable to the impacts of hazardous materials spills, transportation incidents, and radiological incidents will increase. Population and business growth along major transportation corridors increases the vulnerability to transportation hazardous material spills.

17.7 SCENARIO

An incident involving hazardous materials being transported via ground transportation systems that cross the planning area could have a significant impact on the planning area. A release of hazardous materials could impact large population centers within the planning area. Advance knowledge of shipments and their contents would play a role in preparedness for this scenario, thus reducing its potential impact. The biggest issue in response to hazardous material is material identification and containment.

17.8 ISSUES

The major issues for hazardous materials, transportation incidents, and radiological incidents are the following:

- Continue all facets of emergency preparedness training for police, fire, public works, and public information staff in order to respond quickly in the event of a human-caused disaster.
- Work proactively with hazardous materials facilities to follow best management practices:
  - Placards and labeling of containers
  - Emergency plans and coordination
  - Standardized response procedures
  - Notification of the types of materials being transported through the planning area at least annually
  - Random inspections of transporters as allowed by each company
  - Installation of mitigating techniques along critical locations

  - Routine hazard communication initiatives
  - Consideration of using safer alternative products.

- Work with the private sector to enhance and create business continuity plans in the event of an emergency.
- Maintain a regional emergency services information line that the public can contact 24 hours a day during an emergency incident.
- Coordinate with planning area school districts to ensure that their emergency preparedness plans include preparation for human-caused incidents.

18. PUBLIC HEALTH HAZARDS

18.1 GENERAL BACKGROUND

Human health hazards include transmittable diseases and environmental hazards such as adverse weather. The following sections describe commonly recognized human health hazards.

> **DEFINITIONS**
>
> **Epidemic**—The spread of an infectious disease beyond a local population, reaching people in a wider geographical area. Several factors determine whether an outbreak will become an epidemic: the ease with which the disease spreads from vectors, such as animals, to people, and the ease with which it spreads from person to person.
>
> **Influenza**—A viral infection that attacks the respiratory system; commonly called flu.
>
> **Pandemic**—A worldwide epidemic.
>
> **Vector—**An organism (such as an insect or rodent) that transmits pathogens that cause disease
>
> **Vector-Borne Illness**—Diseases transmitted to people from insects and other animals. These include, but are not limited to, Hanta Virus, Plague, Tularemia, Lyme Disease, West Nile Virus and the Zika Virus.

18.1.1 Influenza

Flu epidemics typically occur in the fall and winter. Because flu seasons fluctuate in length and severity, a single estimate cannot be used to summarize influenza-associated deaths. The U.S. Centers for Disease Control (CDC) estimates that from the 1976-1977 flu season to the 2006-2007 season, flu-associated deaths ranged from a low of about 3,000 to a high of about 49,000. Yearly vaccination is the primary method for preventing influenza.

H1N1

In April 2009, the World Health Organization (WHO) issued a health advisory on an outbreak of influenza-like illness caused by a new subtype of influenza A (A/H1N1) in Mexico and the United States. The disease spread rapidly, and in June the WHO declared an H1N1 pandemic, marking the first global pandemic since the 1968 Hong Kong flu. In October, the U.S. declared H1N1 a national emergency. In August 2010, the WHO declared an end to the pandemic globally. H1N1 viruses and seasonal influenza viruses are co-circulating in many parts of the world. It is likely that the 2009 H1N1 virus will continue to spread for years to come, like a regular seasonal influenza virus.

H5N1/H7N9

The highly pathogenic H5N1 avian influenza virus is an influenza A subtype that occurs mainly in birds, causing high mortality among birds and domestic poultry. Outbreaks of highly pathogenic H5N1 among poultry and wild birds are ongoing in a number of countries.

H5N1 virus infections of humans are rare and most cases have been associated with direct poultry contact during poultry outbreaks. Rare cases of limited human-to-human spread of H5N1 virus may have occurred, but there is no evidence of sustained human-to-human transmission. Nonetheless, because all influenza viruses have the ability to change and mutate, scientists are concerned that H5N1 viruses one day could be able to infect humans more easily and spread more easily from one person to another, potentially causing another pandemic.

While the H5N1 virus does not now infect people easily, infection in humans is much more serious when it occurs than is infection with H1N1. More than half of people reported infected with H5N1 have died.

Infections in humans and poultry by a new avian influenza A virus (H7N9) continue to be reported in China. While mild illness in human cases has been seen, most patients have had severe respiratory illness and some have died. The only case identified outside of China was recently reported in Malaysia.

Source investigation by Chinese authorities is ongoing. Many of the people infected with H7N9 are reported to have had contact with poultry. However some cases reportedly have not had such contact. Close contacts of confirmed H7N9 patients are being followed to determine whether any human-to-human spread of H7N9 is occurring. No sustained person-to-person spread of the H7N9 virus has been found at this time. However, based on previous experience with avian flu viruses, some limited human-to-human spread of this the virus would not be surprising.

As of the publication of this document, H5N1 and the new H7N9 virus have not been detected in people or birds in the United States

18.1.2 Smallpox

Smallpox is a sometimes fatal infectious disease. There is no specific treatment, and the only prevention is vaccination. Symptoms include raised bumps on the face and body of an infected person. The oldest evidence of smallpox was found on the body of Pharaoh Ramses V of Egypt who died in 1157 BC.

Outbreaks have occurred from time to time for thousands of years, but the disease is now eradicated after a successful worldwide vaccination program. The last case of smallpox in the United States was in 1949. The last naturally occurring case in the world was in Somalia in 1977. As of the publication of this document, there are no cases of smallpox in the world. Currently only two locations in the world have samples of smallpox: the CDC in Atlanta and the Ivanovsky Institute of Virology in Russia.

After the disease was eliminated, routine vaccination among the general public was stopped. Therefore, any cases of smallpox in the world would be considered an immediate international emergency. In 2003, the Wisconsin Division of Public Health conducted an investigation of state residents who became ill after having contact with prairie dogs. The cases appeared in May and June of 2003, and symptoms in the human cases included fever, cough, pox-like rash and swollen lymph nodes. CDC laboratory test results indicated that the cause of the human illness was Monkeypox, an orthopox virus that could be transmitted by prairie dogs. This outbreak, and the potential use of smallpox as a weapon of bioterrorism, brought the fear of smallpox back to the forefront of the population. A detailed nationwide smallpox response plan created at the end of 2002 is designed to quickly contain a potential outbreak and vaccinate the population.

18.1.3 Viral Hemorrhagic Fevers

Viral hemorrhagic fevers (VHFs) are a group of illnesses caused by several distinct families of viruses. VHF describes a multisystem syndrome (multiple systems in the body are affected). Characteristically, the overall vascular system is damaged and the body's ability to regulate itself is impaired. These symptoms are often accompanied by hemorrhage (bleeding); however, the bleeding itself is rarely life-threatening. While some types of hemorrhagic fever viruses can cause relatively mild illnesses, many cause severe, life-threatening disease.

The viruses that cause VHFs are distributed over much of the globe. However, because each virus is associated with one or more particular host species, the virus and the disease it causes are usually seen only where the host species live. Some hosts, such as the rodent species carrying several of the New World arenaviruses, live in geographically restricted areas. Therefore, the risk of getting VHFs caused by these viruses is restricted to those areas. Other hosts range over continents, such as the rodents that carry viruses that cause the hantavirus pulmonary syndrome in North and South America, or the rodents that carry viruses that cause hemorrhagic fever with renal syndrome in Europe and Asia.

Ebola

The 2014 Ebola virus outbreak was unprecedented in geographical reach and impact on health care systems across the globe. This was the largest and deadliest Ebola virus outbreak ever recorded. It was the first time the West African countries of Guinea, Liberia, Sierra Leone, Nigeria, Mali, and Senegal saw the virus. Ebola is more common in Central African countries, such as the Democratic Republic of Congo and Sudan, where it was first discovered in 1976. It was also the first time that Ebola made it to the United States and Europe, prompting world-wide preparedness and response efforts. The outbreak was closely monitored and traveler screenings were developed for those returning from West Africa.

In August 2014 two U.S. healthcare workers returned to the United States for treatment for Ebola. The case that most impacted the health care system in the United States was a patient diagnosed with Ebola in Dallas, Texas who died due to Ebola in October 2014. The nurse who provided care for him later tested positive for Ebola. This caused responses across the country from hospitals, emergency medical teams, fire departments and public health agencies to enhance isolation precautions, develop emergency policies, train with personal protective equipment and conduct multi-agency emergency exercises in case the spread of Ebola became a pandemic.

Before the 2014 outbreak, only 2,200 cases of Ebola had been recorded and 68 percent were fatal. Twenty percent of new Ebola infections were linked to burial traditions in which family and community members wash and touch dead bodies before burial. In Guinea, 60 percent of Ebola infections were linked to traditional burial practices.

Hantavirus

Hantavirus is a rodent-borne disease. It was discovered in 1993 in the southwestern U.S., and it has determined that the disease had been present, but unrecognized, at least as early as 1959. It has now been identified in over half of the states of the U.S. In 2013, seven cases of Hantavirus occurred in Yosemite National Park. Hantavirus has also been detected in the Sierra Nevada region.

The hantavirus spreads when individuals touch or eat something contaminated with infected rodent urine, droppings or saliva. It can also be transmitted through aerosolization, which occurs when dried materials contaminated by infected rodent droppings or saliva are disturbed and brought up into the air and inhaled. Infected persons first develop symptoms one to two weeks, and up to five weeks, after exposure. Early symptoms include fever, headache, and muscle aches, especially in the thighs, hips, back, and shoulders. Other early symptoms include dizziness, chills, nausea, vomiting, diarrhea, and abdominal pain. After two to seven days of these symptoms, patients develop breathing difficulties that range from cough and shortness of breath to severe respiratory failure. Approximately 40 percent of hantavirus patients die from the disease.

18.1.4 Plague

Plague is a potentially fatal infectious disease of animals and humans caused by the *Yersinia pestis* bacterium. People usually get plague from being bitten by a flea that is carrying the plague bacterium or by handling an infected animal. Today, modern antibiotics are effective against plague, but if an infected person is not treated promptly, the disease is likely to cause illness or death.

Plague is an ancient disease but outbreaks throughout the world continue. Major plague epidemics occurred in the middle of the sixth century in Egypt, Europe and Asia; during the 14th century in Europe, following caravan routes; in the 18th century in Austria and the Balkans; and in the late 19th century worldwide (but mostly in China and India). Manchuria in 1910–1911 witnessed about 60,000 deaths due to pneumonic plague with a repeat in 1920–1921. A minor outbreak occurred as recently as the summer of 1994 in Surat, India, closely following an earthquake in September 1993. Globally, the WHO reports 1,000 to 3,000 cases of plague every year.

In North America, plague is found in certain animals and their fleas from the Pacific Coast to the Great Plains, and from southwestern Canada to Mexico. The last urban plague epidemic in the United States occurred in Los Angeles in 1924-25. Since then, human plague in the U.S. has occurred as mostly scattered cases in rural areas (an average of 10 to 15 persons each year per the CDC). Most human cases in the United States occur in northern New Mexico, northern Arizona, southern Colorado, California, southern Oregon, and far western Nevada.

18.1.5 Tick-Borne Disease

Ticks are small, insect-like creatures most often found in naturally vegetated areas. They feed by attaching to animals and humans, sticking their mouthparts into the skin, and sucking blood for up to several days. Ticks do not fall from trees, jump or fly. Most species are found on wild grasses and low plants. Adult ticks wait at the ends of grass or other foliage for a host to brush by so they may attach. Sometimes ticks carry bacteria or viruses that can be transmitted to a person while the tick is attached and feeding. The following species of ticks are known to commonly bite humans:

- Western blacklegged tick (*Ixodes pacificus*)
- American dog tick (*Dermacentor variabilis*)
- Pacific Coast tick (*Dermacentor occidentalis*)
- Wood tick (*Dermacentor andersoni*)
- Brown dog tick (*Rhipicephalus sanguineus*)
- *Ornithodoros hermsi*
- *Ornithodoros parkeri*
- *Ornithodoros coriaceus.*

Tularemia

Tularemia, named after Tulare County in California where it was first described in 1911, is a tick-borne disease of animals and humans caused by the bacterium *Francisella tularensis*. Tularemia is similar to plague, but is typically spread differently. While plague is usually spread to humans by fleas, humans usually become infected with Tularemia by tick and deer fly bites, skin contact with infected animals, ingestion of contaminated water or meat, or inhalation of contaminated dusts or aerosols. Symptoms vary depending upon the route of infection.

Rabbits, hares, and rodents are especially susceptible and often die in large numbers during outbreaks. Although Tularemia can be life-threatening, most infections can be treated successfully with antibiotics. Steps to prevent Tularemia include use of insect repellent, wearing gloves when handling sick or dead animals, and not mowing over dead animals. In the United States, naturally occurring infections have been reported from all states except Hawaii.

Lyme Disease

Lyme disease, named after the city in Connecticut where it was first identified in 1975, is a tick-borne disease caused by the bacterium *Borrelia burgdorferi,* which normally lives in mice, squirrels and other small animals. It is transmitted among these animals and to humans through the bites of certain species of ticks. In the northeastern and north-central United States, the black-legged tick (or deer tick, *Ixodes scapularis*) transmits Lyme disease. In the Pacific coastal United States, the disease is spread by the western black-legged tick (*Ixodes pacificus*). Other major tick species found in the United States have not been shown to transmit the disease.

Typical symptoms include fever, headache, fatigue, and a skin rash. If left untreated, infection can spread to joints, the heart, and the nervous system. Lyme disease is diagnosed based on symptoms, physical findings (e.g., rash), and the possibility of exposure to infected ticks. Laboratory testing is helpful in later stages of the disease. Most cases of Lyme disease can be treated successfully with a few weeks of antibiotics. Steps to prevent Lyme disease include using insect repellent, removing ticks promptly, landscaping, and integrated pest management. The ticks that transmit Lyme disease can occasionally transmit other tick-borne diseases as well.

Rocky Mountain Spotted Fever

Rocky Mountain spotted fever is a potentially fatal tick-borne disease caused by the bacterium *Rickettsia rickettsii*. It is transmitted to humans by the bite of an infected American dog tick (*Dermacentor variabilis*), Rocky Mountain wood tick (*Dermacentor andersoni*), or brown dog tick (*Rhipicephalus sanguineus)*.

Typical symptoms include fever, headache, abdominal pain, vomiting, and muscle pain. A rash may also develop, but is often absent in the first few days, and in some patients, never develops. Rocky Mountain spotted fever can be a severe or even fatal illness if not treated in the first few days of symptoms. It can be treated successfully with a few weeks of antibiotics. Steps to prevent the disease include using insect repellent, removing ticks promptly, landscaping, and integrated pest management. The ticks that transmit Rocky Mountain spotted fever can occasionally transmit other tick-borne diseases as well.

18.1.6 Mosquito-Borne Disease

Malaria

Malaria is a sometimes fatal mosquito-borne disease caused by a parasite that commonly infects the *Anopheles* mosquito, which feeds on humans. People who contract malaria are typically very sick with high fevers, chills, and flu-like illness. Although malaria can be fatal, illness and death can usually be prevented.

On average 1,500 cases of malaria are diagnosed in the United States each year. The vast majority are in travelers and immigrants returning from countries where malaria transmission occurs, many from sub-Saharan Africa and South Asia. In many temperate areas, such as Western Europe and the United States, economic development and public health measures have succeeded in eliminating malaria. However, most of these areas have *Anopheles* mosquitoes that can transmit malaria, and reintroduction of the disease is a constant risk.

Individuals in areas with malaria need to reduce their likelihood of being bitten by mosquitoes. Screens on windows and doors should be examined to confirm that they are in good repair. Repellents containing 20 to 30 percent DEET should be applied to exposed skin and clothing to keep mosquitoes from biting.

West Nile Virus

West Nile virus is a potentially serious mosquito-borne that may affect residents in the planning area. Experts believe West Nile virus is established as a seasonal epidemic in North America that flares up in the summer and continues into the fall. Mosquitoes transmit the virus to birds, livestock and humans. As of January 2016, human-infection cases of the virus had been reported in all states of the continental U.S. except West Virginia, New Hampshire and Vermont, and those states had reported non-human infections.

According to the CDC, approximately 80 percent of people who are infected with West Nile virus will show no symptoms. Up to 20 percent have symptoms such as fever, headache, and body aches, nausea, vomiting, and sometimes swollen lymph glands or a skin rash on the chest, stomach and back. Symptoms can last for as short as a few days, though even healthy people have become sick for several weeks. About 1 percent of people infected with West Nile virus will develop severe illness, with symptoms that can include high fever, headache, neck stiffness, stupor, disorientation, coma, tremors, convulsions, muscle weakness, vision loss, numbness and paralysis. These symptoms may last several weeks, and neurological effects may become permanent. There is no specific treatment for West Nile virus infection. In more severe cases, people may need to go to the hospital where they can receive supportive treatment including intravenous fluids, help with breathing and nursing care.

Individuals in areas with West Nile virus need to reduce their likelihood of being bitten by mosquitoes. Screens on windows and doors should be examined to confirm that they are in good repair. Repellents containing 20 to 30 percent DEET should be applied to exposed skin and clothing to keep mosquitoes from biting.

Dengue Fever

Dengue is a mosquito-borne disease caused by any of four closely related dengue viruses (DENV-1, DENV-2, DENV-3 and DENV-4). People get dengue from the bite of an infected mosquito. The mosquito becomes infected when it bites a person who has dengue virus in their blood. It takes a week or more for the dengue virus to replicate in the mosquito; then the mosquito can transmit the virus to another person when it bites. Dengue is transmitted by yellow fever mosquito (*Aedes aegypti*) and the Asian tiger mosquito *(Aedes albopictus)*. Dengue virus cannot be transmitted from person to person.

The main symptoms of dengue are high fever, severe headache, severe pain behind the eyes, joint pain, muscle and bone pain, rash, bruising, and sometimes mild bleeding from the nose or mouth. Generally, younger children and those with their first dengue infection have a milder illness than older children and adults. Severe dengue typically begins with signs and symptoms similar to dengue. Rather than recover, severe dengue patients proceed to experience more bleeding, severe pain in the abdomen, respiratory distress, and fluid accumulation in the abdomen and around the lungs as the smallest blood vessels (capillaries) begin to leak. If not treated, severe dengue can result in death. There is no specific treatment for dengue infection. Rest and fluids are generally sufficient for persons with dengue. Severe dengue may require hospitalization and intensive medical care.

Individuals in areas with dengue need to reduce their likelihood of being bitten by mosquitoes. Screens on windows and doors should be examined to confirm that they are in good repair. Repellents containing 20 to 30 percent DEET should be applied to exposed skin and clothing to keep mosquitoes from biting.

Zika Virus

Zika is a mosquito-borne disease. The most common symptoms of Zika are fever, rash, joint pain, and conjunctivitis (red eyes). The illness is usually mild, with symptoms lasting for several days to a week after being bitten by an infected mosquito. People usually do not get sick enough to go to the hospital, and they rarely die of Zika. For this reason, many people might not realize they have been infected. However, Zika virus infection during pregnancy can cause a serious birth defect called microcephaly, as well as other severe fetal brain defects. Once a person has been infected, he or she is likely to be protected from future infections.

Zika virus is transmitted by yellow fever mosquito (*Aedes aegypti*) and the Asian tiger mosquito *(Aedes albopictus)*. An *Aedes* mosquito can only transmit Zika virus after it bites a person who has this virus in their blood. Zika virus is not spread through casual contact, but can be spread by infected men to their sexual partners. There is a growing association between Zika and microcephaly (abnormally small head and brain) in newborns, as well as Zika and Guillain-Barré Syndrome, a disease affecting the nervous system. Studies are ongoing to further evaluate these associations.

Chikungunya

Chikungunya is an infectious mosquito-borne disease with symptoms that typically include fever and severe joint pain. It is caused by the chikungunya virus, which is transmitted by yellow fever mosquito (*Aedes aegypti*) and the Asian tiger mosquito *(Aedes albopictus)*. An *Aedes* mosquito can only transmit chikungunya virus after it bites a person who has this virus in their blood. A person with chikungunya is not contagious. As of the publication of this document, chikungunya infections have been documented only in persons who were infected while traveling outside the United States.

18.1.7 Anthrax

Anthrax is a disease caused by *Bacillus anthracis*, a bacterium that forms spores (a spore is a cell that is dormant but may come to life with the right conditions). There are three forms of anthrax:

- **Cutaneous**—The first symptom is a small sore that develops into a blister. The blister then develops into a skin ulcer with a black area in the center. The sore, blister and ulcer do not hurt.
- **Gastrointestinal**—The first symptoms are nausea, loss of appetite, bloody diarrhea, and fever, followed by bad stomach pain.
- **Inhalation**—The first symptoms of inhalation anthrax are like cold or flu symptoms and can include a sore throat, mild fever and muscle aches. Later symptoms include cough, chest discomfort, shortness of breath, tiredness and muscle aches.

Anthrax is a naturally occurring illness and isolated cases occur all over the world yearly. Humans can become infected with anthrax by handling products from infected animals or by breathing in anthrax spores from infected animal products (such as wool). People can become infected with gastrointestinal anthrax by eating undercooked meat from infected animals. Anthrax can be treated successfully with antibiotics.

Anthrax can be used as a weapon, as happened in the United States in 2001, when anthrax was spread through the postal system by sending letters with powder containing anthrax spores. This caused 22 cases of anthrax infection and brought anthrax back into the public eye.

18.1.8 Severe Acute Respiratory Syndrome

Severe Acute Respiratory Syndrome (SARS) is a viral respiratory illness caused by a coronavirus (SARS-CoV). SARS was first reported in Asia in February 2003. Over the next few months, the illness spread to more than two dozen countries in North America, South America, Europe, and Asia before the global outbreak was contained. According to the WHO, 8,098 people worldwide became sick with SARS during the 2003 outbreak and 774 died. In the United States, only eight people had laboratory evidence of SARS-CoV infection. All of these people had traveled to parts of the world where SARS was present. SARS did not spread more widely in the United States.

In general, SARS begins with a high fever, headache, an overall feeling of discomfort and body aches. Some people also have mild respiratory symptoms at the outset. About 10 percent to 20 percent of patients have diarrhea. After two to seven days, SARS patients may develop a dry cough. Most patients develop pneumonia.

The main way that SARS seems to spread is by close person-to-person contact. The virus that causes SARS is thought to be transmitted most readily by respiratory droplets produced when an infected person coughs or sneezes. Droplet spread can happen when droplets from the cough or sneeze of an infected person are propelled a short distance (generally up to 3 feet) through the air and deposited on the mucous membranes of the mouth, nose, or eyes of persons nearby. The virus also can spread when a person touches a surface or object contaminated with infectious droplets and then touches his or her mouth, nose, or eyes. It is also possible that the SARS virus might spread more broadly through the air or by other ways that are not now known.

As of May 2005, according to the CDC, there was no remaining sustained SARS transmission anywhere in the world. However, CDC has developed recommendations and guidelines to help public health and healthcare officials plan for and respond quickly to the reappearance of SARS if it occurs again. Lessons learned from the SARS outbreak helped healthcare facilities and communities successfully plan and respond to the 2009 H1N1 pandemic.

18.1.9 Adverse Weather

From 2006 to 2010, more people in the U.S. died from extreme heat or extreme cold than from hurricanes, tornadoes, floods and earthquakes combined.The western United States is subject to many weather extremes. Severe spring storms can lead to risk of traumatic injuries, mudslides, flooding and property damage. Extreme heat can lead to dehydration and heat-related illness. Severe winter weather can lead to risk of traumatic injuries, hypothermia and icy conditions.

Thunderstorms

When thunderstorms occur unexpectedly, the risk of injury and death increases. Advance planning can decrease the risks. Residents should pay close attention to changing weather conditions when there is a severe thunderstorm watch or warning. Lightning strikes are a danger during thunderstorms. A lightning bolt is 6 to 8 centimeters in diameter, carrying between 10 and 100 million volts in 20 to 50 thousand amps of direct current. The duration is approximately one millisecond. Volts of 2 billion and 500 thousand amps have been measured. A lightning strike can cause death or injury to one or several persons. Long-term injuries from lightning strike can include memory and attention loss, chronic numbness, muscle spasm, stiffness, depression, hearing loss and sleep disturbance. Seventy percent of all lightning injuries and fatalities occur in the afternoon; 85 percent of victims are children and young men (age 10 to 35) engaged in outdoor recreation and work activities. Hikers, campers, backpackers, skiers, fishermen, and hunters are especially vulnerable.

Extreme Heat

During periods of very high temperatures in the summer, those susceptible to extreme heat may suffer heat-related illnesses:

- **Heat Exhaustion—**Heat exhaustion is a mild form of heat-related illness that can develop after several days of exposure to high temperatures and inadequate or unbalanced replacement of fluids. It is the body's response to an excessive loss of the water and salt contained in sweat. Those most prone to heat exhaustion are elderly people, people with high blood pressure, and people working or exercising in a hot environment.
- **Heat Cramps—**Heat cramps usually affect people who sweat a lot during strenuous activity. This sweating depletes the body's salt and moisture. The low salt level in the muscles may be the cause of heat cramps. Heat cramps may also be a symptom of heat exhaustion.
- **Heat Stroke—**Heat stroke is a severe, dangerous form of heat-related illness. It occurs when the body's temperature rises rapidly, the sweating mechanism fails, and the body is unable to cool down. Body temperature may rise to 106°F or higher within 10 to 15 minutes. Heat stroke can cause death or permanent disability if emergency treatment is not provided. This is a medical emergency.

Heat has caused 9,000 deaths in the United States from 1979 to 2013. Air-conditioning is the number one protective factor against heat-related illness and death. If a home is not air-conditioned, people can reduce their risk for heat-related illness by spending time in public facilities that are air-conditioned.

Severe Winter Weather

When winter temperatures drop significantly below normal, staying warm and safe can become a challenge. Extremely cold temperatures often accompany a winter storm, which may also cause power failures and icy roads. Staying indoors as much as possible can help reduce the risk of car crashes and falls on the ice, but cold weather also can present hazards indoors. Many homes will be too cold, either due to a power failure or because the heating system is not adequate for the weather. When people must use space heaters and fireplaces to stay warm, the risk of residential fires increases, as well as the risk of carbon monoxide poisoning.

Extreme cold can bring on health emergencies in susceptible people, such as those without shelter or who are stranded, or who live in a home that is poorly insulated or without heat:

- **Hypothermia**—When exposed to cold temperatures, the body begins to lose heat faster than it can be produced. Prolonged exposure to cold will eventually use up the body's stored energy. The result is hypothermia, or abnormally low body temperature. Body temperature that is too low affects the brain, making the victim unable to think clearly or move well. This makes hypothermia particularly dangerous because a person may not know it is happening and will not be able to do anything about it. Warning signs of hypothermia include shivering, exhaustion, confusion, fumbling hands, memory loss, slurred speech, drowsiness, bright red cold skin, and very low energy.

- **Frostbite**—Frostbite is an injury to the body caused by freezing of the tissues. Frostbite causes a loss of feeling and color in affected areas. It most often affects the nose, ears, cheeks, chin, fingers, or toes. Frostbite can permanently damage the body, and severe cases can lead to amputation. The risk of frostbite is increased in people with reduced blood circulation and among people who are not dressed properly for extremely cold temperatures. A victim is often unaware of frostbite until someone else points it out because the frozen tissues are numb. Signs of frostbite may be a white or grayish-yellow skin area, skin that feels unusually firm or waxy and numbness.

Infants and the elderly are particularly at risk to cold temperatures, but anyone can be affected. Preventive action is the best defense against having to deal with extreme cold-weather conditions. Preparing homes and cars in advance for winter emergencies, and observing safety precautions during times of extremely cold weather can reduce the risk of weather-related health problems.

18.2 HAZARD PROFILE

The severity of human health hazards is dependent upon the hazard and the population exposed to it. As the population increases, so does the risk of exposure to hazards. The key to reducing the disease hazard is isolation so that the exposed population does not continue to spread the hazard to the uninfected population. For disease and weather-related human health hazards, promoting education and personal preparedness will help to mitigate and reduce the severity of the hazard.

18.2.1 Past Events

Communicable Diseases

The following is a summary of recent disease outbreak events:

- In the United States during the 2009 H1N1 influenza pandemic, there were 59,979,608 confirmed cases of the disease, 270,435 people hospitalized due to the illness and 12,271 deaths. In California, there were 4,134 people hospitalized due to the illness and 596 deaths.
- There were two confirmed cases of SARS in California during the worldwide outbreak in 2002-2003, neither of them in the planning area.
- From 2011 to the publishing of this document there have been 458 cases of Lyme disease in California.
- From 2011 to the publishing of this document there have been 16 cases of hantavirus in California.
- As of the publishing of this document, no cases of tularemia or plague have been reported in the planning area, but cases of these diseases have been reported in California. Even though these hazards may not be endemic to the area, they can be brought into the planning region and are still considered to be a risk.

Adverse Weather

The following is a summary of recent adverse weather events that threatened human health:

- From 2006 to 2010, excessive heat exposure caused 3,332 deaths in the United States.
- In July 2006, California experienced a heat wave impacting the entire state. Coroners attributed 140 deaths to hyperthermia, and it has been estimated from other data that more than 600 heat-related deaths may have occurred over a 17-day period.
- From 2006 to 2010, hypothermia caused 6,660 deaths in the United States.
- From 2006 to 2010, lightning strikes caused 657 deaths in the United States.

18.2.2 Location

All of the planning area is susceptible to the human health hazards discussed in this chapter. While some hazards, such as the West Nile Virus and Lyme disease, can have a geographic presence within the planning area, other diseases can cause exposure to the planning area from outside the local region. Local residents who travel can become exposed to diseases while abroad and bring the diseases back with them, potentially placing the region at risk for exposure. It is difficult to map the extent of human-health hazards compared to others, such as floods, wildfires and dam failures.

18.2.3 Frequency

Communicable Disease

Due to increased air travel, the growing population and the country's aging population, the probability of a communicable disease epidemic or pandemic is a growing threat. Certain human health hazards, such as influenza, can be expected seasonably, with variations on specific strains year to year. Additionally, tick-borne diseases are likely to increase during spring and fall, when people participate in outdoor activities such as hiking. The frequency of other health hazards is difficult to establish and depends largely on the unique circumstances surrounding a localized outbreak and its subsequent expansion into epidemics and eventually pandemics.

Adverse Weather

Trauma due to injures directly due to storms (such as motor vehicle collisions and falls), heat related illness and hypothermia are a factor of the weather and in some cases a technological hazard.

18.2.4 Severity

The severity of the human health hazard varies from individual to individual. Typically, young children and older adults are more susceptible to acquiring communicable diseases due to developing or diminishing immune systems or experiencing adverse effects to extreme weather conditions. These populations often experience the most severe of symptoms, as their immune systems are not capable of fighting off infection or efficiently regulating temperature. In general, severity varies depending on the pathology of the disease, the health of the infected, and the availability of treatments for alleviating symptoms or curing the disease.

18.2.5 Warning Time

Warning time for public health risks varies from a few hours or days to a few months, depending on the illness and outbreak to the population.

18.3 SECONDARY IMPACTS

Human health hazards are not like natural hazards that have measurable secondary impacts, such as earthquakes, floods or wildfires. This is primarily due to the fact that human health hazards do not generally impact buildings and critical infrastructure as natural hazards do. The largest secondary impact caused by human health hazards would be economic. Large outbreaks of any human health hazard could reduce the workforce significantly, causing businesses and agencies to close or be greatly impacted.

Another secondary impact could be stigmatization. The fear of the human health hazard and fear of the unknown could lead to isolation, violence and self-inflicted injury. Hospitals and healthcare providers could be overwhelmed with the "worried well" seeking care and comfort. Education and providing key and critical information can reduce and mitigate this secondary risk.

18.4 EXPOSURE

18.4.1 Population

All residents and visitors in the planning area could be susceptible to the human health hazards discussed in this chapter. A large outbreak or epidemic, a pandemic or a use of biological agents as a weapon of mass destruction could have devastating effects on the population.

18.4.2 Property

None of the health hazards discussed in this chapter would have significant measurable impact on the structural environment or property of the planning area.

18.4.3 Critical Facilities and Infrastructure

None of the health hazards discussed in this chapter would have significant measurable impact on the critical facilities or infrastructure of the planning area. However, health care facilities (including long-term care and clinics and even veterinary offices) have adopted the recommended "all-hazards" approach to preparedness and have prepared for the health hazards addressed in this chapter.

18.4.4 Environment

None of the health hazards discussed in this chapter would have significant measurable impact on the environment of the planning area. While many of the vectors of the health hazards discussed in this chapter (mosquitoes, rodents, fleas, ticks and deer flies) rely on local or regional environments for their survival, the human health hazard that they carry or potentially transmit would have no significant measurable impact on the environment.

18.5 VULNERABILITY

18.5.1 Population

While all of the population in the planning area is considered at risk to the human health hazards discussed in this chapter, the young and the elderly, those with compromised immune systems, and those with functional and access needs are considered the most vulnerable. The introduction of a disease such as the plague or influenza could rapidly impact those at risk.

18.5.2 Property

None of the health hazards discussed in this chapter would have significant measurable impact on the structural environment or property of the planning area.

18.5.3 Critical Facilities and Infrastructure

Emergency management and preparedness planning incorporates all response disciplines: fire, law, first responder ground and air ambulance agencies, public health, and mental and spiritual health. Planning includes identifying shelters, alternate treatment facilities, isolation capacity and methods to immediately expand physical and human resources.

18.5.4 Environment

None of the health hazards discussed in this chapter would have significant measurable impact on the environment of the planning area.

18.6 FUTURE TRENDS IN DEVELOPMENT

The potential for the human health hazards is not likely to slow expected growth in the planning area.

18.7 SCENARIO

A human health worst-case scenario for the planning area would be an epidemic or large-scale incident of any of the human health hazards discussed in this chapter. Medical treatment facilities in the planning area would be overwhelmed and taxed beyond their capabilities as the number of patients begins to escalate. Impacts on the workforce could have acute and long-term economic impacts on primary employers in the planning area. First responders would be exposed to the human health hazards, which could deplete the medical workforce and could have profound impact on the potential escalation of the scenario.

18.8 ISSUES

Important issues associated with the human health hazards include the following:

- Prevention through vaccination and personal emergency and disaster preparation will help to reduce the impacts of human health hazards.
- Medical and response personnel need to be integrated in a unified command to provide care when needed in response to human health hazards.
- Medical and response personnel must be adequately trained and supplied.
- Up-to-date and functional all-hazard contingency planning should be carried out.
- A system needs to be in place for informing the public with a unified message about the human health hazard.
- Health agencies and facilities require surge capacity management and adaptation to the rising number and needs of the region.

19. TERRORISM AND WEAPONS OF MASS DESTRUCTION, CIVIL UNREST

19.1 GENERAL BACKGROUND

19.1.1 Terrorism and Weapons of Mass Destruction

The Federal Bureau of Investigation (FBI) categorizes two types of terrorism in the United States:

- Domestic terrorism involves groups or individuals whose terrorist activities are directed at elements of our government or population without foreign direction. The bombing of the Alfred P. Murrah federal building in Oklahoma City is an example of domestic terrorism. The FBI is the primary response agency for domestic terrorism. The FBI coordinates domestic preparedness programs and activities of the United States to limit acts posed by terrorists including the use of weapons of mass destruction (WMDs).
- International terrorism involves groups or individuals whose terrorist activities are foreign-based and/or directed by countries or groups outside the United States, or whose activities transcend national boundaries. Examples include the 1993 bombing of the World Trade Center, the U.S. Capitol, and Mobil Oil's corporate headquarters and the attacks of September 11, 2001 at the World Trade Center and the Pentagon.

DEFINITIONS

Acts of Terrorism—The unlawful use or threatened use of force or violence against people or property with the intention of intimidating or coercing societies or governments. Terrorism is either foreign or domestic, depending on the origin, base, and objectives of the terrorist or organization.

Civil Unrest— A violent public disturbance of the peace by three or more individuals. Civil unrest is a result of displeasure with or protest against socio-political problems and varies in severity. The tactics can range from permitted protest to criminal activities, all of which can escalate into chaos for those participating in the activities as well as for the general public.

Weapons of Mass Destruction—Chemical, biological, radiological, nuclear, and explosive weapons associated with terrorism.

The three key elements to defining a terrorist event are as follows:

- Activities involve the use of illegal force.
- Actions are intended to intimidate or coerce.
- Actions are committed in support of political or social objectives.

As detailed in the Terrorism Contingency Plan, at least three important considerations distinguish terrorism hazards from other types of hazards.

- In the case of chemical, biological, and radioactive agents, their presence may not be immediately obvious, making it difficult to determine when and where they may have been released, who has been exposed, and what danger is present for first responders and emergency medical technicians.
- There is limited scientific understanding of how these agents affect the population at large.
- Terrorism evokes very strong emotional reactions, ranging from anxiety, to fear, to anger, to despair, to depression.

Those involved with terrorism response, including public health and public information staff, are trained to deal with the public's emotional reaction swiftly as response to the event occurs. The area of the event must be clearly identified in all emergency alert messages to prevent those not affected by the incident from overwhelming local emergency rooms and response resources therefore reducing service to those actually affected. The public will be informed clearly and frequently about what government agencies are doing to mitigate the impacts of the event. The public will also be given clear directions on how to protect the health of individuals and families.

Terrorism may involve the use of weapons of mass destruction, including biological, chemical, nuclear and radiological weapons; arson, incendiary, explosive and armed attacks; industrial sabotage and intentional hazardous materials releases; agro-terrorism; and cyber-terrorism (FEMA 386-7). The following are potential methods used by terrorists that could affect the planning area as a direct target or collaterally:

- Conventional bomb
- Biological agent
- Chemical agent
- Nuclear bomb
- Radiological agent
- Arson/incendiary attack
- Armed attack
- Cyber-terrorism
- Agro-terrorism
- Intentional hazardous material release.

Table 19-1 provides a hazard profile summary for terrorism-related hazards. Most terrorist events in the United States have been bombing attacks, involving detonated and undetonated explosive devices, tear gas, pipe bombs, and firebombs.

Table 19-1. Event Profiles for Terrorism

Hazard	Application Mode[a]	Hazard Duration[b]	Static/Dynamic Characteristics[c]	Mitigating and Exacerbating Conditions[d]
Conventional Bomb	Detonation of explosive device on or near target; delivery via person, vehicle, or projectile.	Instantaneous; additional secondary devices, or diversionary activities may be used, lengthening the duration of the hazard until the attack site is determined to be clear.	Extent of damage is determined by type and quantity of explosive. Effects generally static other than cascading consequences, incremental structural failure, etc.	Overpressure at a given standoff is inversely proportional to the cube of the distance from the blast; thus, each additional increment of standoff provides progressively more protection. Terrain, forestation, structures, etc. can provide shielding by absorbing and/or deflecting energy and debris. Exacerbating conditions include ease of access to target; lack of barriers and shielding; poor construction; and ease of concealment of device.
Chemical Agent	Liquid/aerosol contaminants dispersed using sprayers or other aerosol generators; liquids vaporizing from puddles/ containers; or munitions.	Hours to weeks, depending on the agent and the conditions in which it exists.	Contamination can be carried out of the initial target area by persons, vehicles, water, and wind. Chemicals may be corrosive or otherwise damaging over time if not remediated.	Air temperature can affect evaporation of aerosols. Ground temperature affects evaporation of liquids. Humidity can enlarge aerosol particles, reducing inhalation hazard. Precipitation can dilute and disperse agents but can spread contamination. Wind can disperse vapors but also cause target area to be dynamic. The micro-meteorological effects of buildings and terrain can alter travel and duration of agents. Shielding in the form of sheltering in place can protect people and property from harmful effects.

Hazard	Application Mode[a]	Hazard Duration[b]	Static/Dynamic Characteristics[c]	Mitigating and Exacerbating Conditions[d]
Arson/ Incendiary Attack	Initiation of fire or explosion on or near target via direct contact or remotely via projectile.	Generally minutes to hours.	Extent of damage is determined by type and quantity of device, accelerant, and materials present at or near target. Effects generally static other than cascading consequences, incremental structural failure, etc.	Mitigation factors include built-in fire detection and protection systems and fire-resistive construction techniques. Inadequate security can allow easy access to target, easy concealment of an incendiary device, and undetected initiation of a fire. Non-compliance with fire and building codes, as well as failure to maintain existing fire protection systems, can substantially increase the effectiveness of a fire weapon.
Armed Attack	Tactical assault or sniping from remote location, or random attack based on fear, emotion, or mental instability.	Generally minutes to days.	Varies based on the perpetrators' intent and capabilities.	Inadequate security can allow easy access to target, easy concealment of weapons, and undetected initiation of an attack.
Biological Agent	Liquid or solid contaminants dispersed using sprayers/ aerosol generators or by point or line sources such as munitions, covert deposits, and moving sprayers.	Hours to years, depending on the agent and the conditions in which it exists.	Depending on the agent used and the effectiveness with which it is deployed, contamination can be spread via wind and water. Infection can spread via humans or animals.	Altitude of release above ground can affect dispersion; sunlight is destructive to many bacteria and viruses; light to moderate wind will disperse agents but higher winds can break up aerosol clouds; the micro-meteorological effects of buildings and terrain can influence aerosolization and travel of agents.
Agro-terrorism	Direct, generally covert contamination of food supplies or introduction of pests and/or disease agents to crops and livestock.	Days to months.	Varies by type of incident. Food contamination events may be limited to specific distribution sites, whereas pests and diseases may spread widely. Generally no effects on built environment.	Inadequate security can facilitate adulteration of food and introduction of pests and disease agents to crops and livestock.
Radiological Agent	Radioactive contaminants dispersed using sprayers/ aerosol generators, or by point or line sources such as munitions.	Seconds to years, depending on material used.	Initial effects will be localized to site of attack; depending on meteorological conditions, subsequent behavior of radioactive contaminants may be dynamic.	Duration of exposure, distance from source of radiation, and the amount of shielding between source and target determine exposure to radiation.

Hazard	Application Mode[a]	Hazard Duration[b]	Static/Dynamic Characteristics[c]	Mitigating and Exacerbating Conditions[d]
Nuclear Bomb	Detonation of nuclear device underground, at the surface, in the air, or at high altitude.	Light/heat flash and blast/shock wave last for seconds; nuclear radiation and fallout hazards can persist for years. Electromagnetic pulse from a high-altitude detonation lasts for seconds and affects only unprotected electronic systems.	Initial light, heat, and blast effects of a subsurface, ground or air burst are static and determined by the device's characteristics and employment; fallout of radioactive contaminants may be dynamic, depending on meteorological conditions.	Harmful effects of radiation can be reduced by minimizing the time of exposure. Light, heat, and blast energy decrease logarithmically as a function of distance from seat of blast. Terrain, forestation, structures, etc. can provide shielding by absorbing and/or deflecting radiation and radioactive contaminants.
Intentional Hazardous Material Release (fixed facility or transportation)	Solid, liquid, and/or gaseous contaminants released from fixed or mobile containers	Hours to days.	Chemicals may be corrosive or otherwise damaging over time. Explosion and/or fire may be subsequent. Contamination may be carried out of the incident area by persons, vehicles, water and wind.	Weather conditions directly affect how the hazard develops. The micro-meteorological effects of buildings and terrain can alter travel and duration of agents. Shielding in the form of sheltering in place can protect people and property from harmful effects. Non-compliance with fire and building codes, as well as failure to maintain existing fire protection and containment features, can substantially increase the damage from a hazardous materials release.

a. **Application Mode**—Application mode describes the human acts or unintended events necessary to cause the hazard to occur.
b. **Duration**—Duration is the length of time the hazard is present. For example, a chemical warfare agent such as mustard gas, if un-remediated, can persist for hours or weeks under the right conditions.
c. **Dynamic or Static Characteristics**—These characteristics of a hazard describe its tendency, or that of its effects, to either expand, contract, or remain confined in time, magnitude, and space. For example, the physical destruction caused by an earthquake is generally confined to the place in which it occurs, and it does not usually get worse unless aftershocks or other cascading failures occur; in contrast, a cloud of chlorine gas leaking from a storage tank can change location by drifting with the wind and can diminish in danger by dissipating over time.
d. **Mitigation and Exacerbating Conditions**—Mitigating conditions are characteristics of the target and its physical environment that can reduce the effects of a hazard. For example, earthen berms can provide protection from bombs; exposure to sunlight can render some biological agents ineffective; and effective perimeter lighting and surveillance can minimize the likelihood of someone approaching a target unseen. In contrast, exacerbating conditions are characteristics that can enhance or magnify the effects of a hazard. For example, depressions or low areas in terrain can trap heavy vapors, and a proliferation of street furniture (trash receptacles, newspaper vending machines, mail boxes, etc.) can provide hiding places for explosive devices.

Source: FEMA 386-7

The effects of terrorism can include injuries, loss of life, property damage, or disruption of services such as electricity, water supplies, transportation, or communications. Effects may be immediate or delayed. Terrorists often choose targets that offer limited danger to themselves and areas with relatively easy public access. Foreign terrorists look for visible targets where they can avoid detection before and after an attack, such as international airports, large cities, major special events, and high-profile landmarks.

In dealing with terrorism, the unpredictability of human beings must be considered. People with a desire to perform such acts may seek out targets of opportunity that may not fall into established lists of critical areas or facilities. First responders train to respond not only to organized terrorism events, but also to random acts by individuals who, for a variety of reasons ranging from fear to emotional trauma to mental instability, may choose to harm others and destroy property. While education, heightened awareness, and early warning of unusual circumstances may deter terrorism, intentional acts that harm people and property are possible at any time. Public safety entities must react to the threat, locating, isolating, and neutralizing further damage and investigating potential scenes and suspects to bring criminals to justice.

19.1.2 Civil Unrest

Civil unrest refers to a violent public disturbance of the peace that disrupts a community to the degree that law enforcement intervention is required to maintain public safety. These incidents are generally associated with controversial political, judicial, or economic issues and may occur at any time of the year, although statistics indicate that they are more frequent during summer. The effects of civil unrest vary with the type, severity, scope, and duration of event. Essential services (e.g., electricity, water, public transportation, communications), may be disrupted, or property damage, injuries, and loss of life may occur. Facilities most at risk are government buildings, schools, utilities and correctional facilities.

Civil disorder and disturbances are human-caused disasters with tremendous potential for causing damage to the city. These events are especially harmful in that they generally occur in times of already heightened societal tension and in fact are often directly caused by them.

19.2 HAZARD PROFILE

19.2.1 Past Events

Terrorism

The following are the major past terrorism events that have affected the planning area:

- **September 16, 2010 Hawaiian Airlines Delayed After Bomb Threat—**A Hawaiian Airlines flight was delayed for nearly two hours after someone phoned in a bomb threat. The Los Angeles Police Department (LAPD) bomb squad and a canine team searched the plane, which was due to leave LAX for Honolulu with 225 people onboard. The Boeing 767 was carefully inspected, and passengers and luggage were re-screened.
- **September 7, 2010 Federal Authorities Investigate Threat on Thai Airways Flight—**Law enforcement authorities investigated a written threat found on a Thai Airways aircraft that landed at LAX. After landing shortly, Flight 794 was taken to a remote area of the airport, where crew members and passengers were interviewed. Bomb technicians searched the plane and authorities screened the luggage. The flight originated in Bangkok, Thailand.
- **June 19, 2010 LAX Terminal Evacuated on False Report of Explosives—**A man falsely claiming to be carrying an explosive at LAX prompted the closure of the Tom Bradley Terminal before police shot him with a stun gun and took him into custody. The incident began when the suspect grabbed a passenger's luggage outside of the terminal, ran inside and claimed the package contained a bomb. The terminal was evacuated for 20 minutes as officers pursued the man inside the facility. The package he was carrying did not contain explosives.
- **September 16, 2005 Attempted Arson—**Fire officials responded to a fire at the high-rise condominium home of the director of Los Angeles Animal Services, after residents observed smoke coming from a recyclables/janitorial closet. First responders recovered an improvised incendiary device consisting of a 4-inch-long tube labeled "TOXIC" and using a cigarette as a fuse. The device, which had been placed next to a stack of newspapers in the recyclables/janitorial closet, had malfunctioned and only scorched the concrete floor of the closet. The Animal Liberation Front claimed responsibility for this incident.
- **July 7, 2005 Attempted Arson—**Fire officials responded to a vehicle fire in the driveway of a private residence in Los Angeles, California. In extinguishing the fire, authorities recovered a partially melted,

plastic gasoline container from behind the vehicle's left front wheel. The car belonged to a representative for the Animal Care Technicians Union, which represents employees for the Los Angeles Animal Services (LAAS). LAAS and its affiliates have been targeted by local animal rights extremists, and the LAAS union representative had been placed on a "targets" list of individuals profiled by extremists.

- **2005 Disruption of Plot to Attack Military and Jewish Targets**—Officers with the Torrance Police Department arrested suspects during a commercial armed robbery in progress at a Los Angeles area gas station. Their arrest, and subsequent local and FBI investigation, revealed that the suspects were conducting the armed robberies to raise money for an alleged terrorist plot targeting U.S. military facilities, Israeli government facilities, and Jewish synagogues in the greater Los Angeles area.
- **August 22, 2003 Vandalism and Destruction of Property**—Individuals associated with the Earth Liberation Front (ELF) carried out acts of vandalism in Los Angeles, damaging roughly 125 vehicles and one commercial building. Much of the damage was caused by spray-painted graffiti, although in two cases, individuals set fire to vehicles. Some of the graffiti associated the vehicles with "terrorism."
- **July 2002 Attack by Lone Gunman at LAX**—An Egyptian citizen opened fire with a handgun at LAX while standing in line at the ticket counter of El Al, killing two persons and wounding four others before an airline security officer shot and killed him. The FBI assumed the primary responsibility for the investigation due to the possible terrorist connection, and in March 2003, the attack was determined a terrorist crime, with the gunman acting alone and not part of an identified group.
- **December 31, 1999 Attempted Terrorist Attack on LAX**—An Algerian national and suspected member of the Armed Islamic Group (GIA) was stopped as he came across the U.S.-Canadian border into Washington State on December 14, 1999. He had a trunk filled with explosives and timing devices and a plan to detonate a suitcase bomb at LAX. The Algerian said he picked LAX because, "it was sensitive politically and economically." He was arrested at Port Angeles, Washington.

Civil Unrest

The following are the major past civil unrest events that have affected the planning area:

- **July 2013 Trayvon Martin Protests**—Hundreds of demonstrators gathered on July 20, 2013 at the Los Angeles Federal Courthouse as part of a nationwide rally to honor Trayvon Martin. Civil rights groups mobilized for protests in cities across the United States amid charged emotions over a not-guilty verdict in the shooting death of the unarmed Florida teenager.
- **June 2000 Los Angeles Lakers' Victory Riot**—Hundreds of fans rioted when the Los Angeles Lakers beat the New Jersey Nets to win the NBA championship. The crowd was mostly peaceful until minutes after the game, when a group of fans began throwing debris at limousines and smashing the windows of a sport utility vehicle and a television news van.
- **1992 Civil Unrest in Los Angeles**—On April 29, 1992, immediately following and in response to the acquittal of four white police officers charged with the use of excessive force in their beating of black motorist Rodney King, thousands of people in Los Angeles took part in mass law breaking, including taking goods from stores, and setting fires. These acts lasted about four days. Estimates of the number of lives lost vary between 50 and 60, and estimates of the material damage done vary between $800 million and $1 billion. Approximately 600 fires were set, and about 10,000 people were arrested. In addition to the Los Angeles Police Department (LAPD), about 10,000 soldiers from the California National Guard, and thousands of soldiers from the United States Army and Marines were deployed to suppress the crowds. Factors cited as reasons for the unrest included high unemployment among residents of the South Central neighborhood and a long-standing perception that the LAPD engaged in racial profiling and use of excessive force.

19.2.2 Location

Terrorism and WMD

The City of Los Angeles has identified numerous high profile targets for potential terrorists and WMD. Large population centers, high visibility tourist attractions, and critical infrastructure accessible to the public present security challenges of an ongoing nature in the planning area.

Civil Unrest

Civil unrest can take the form of small gatherings or large groups blocking or impeding access to a building, or disrupting normal activities by generating noise and intimidating people throughout the entire City. Demonstrations can range from a peaceful sit-in to a full-scale riot, in which a mob burns or otherwise destroys property and terrorizes individuals. Even in more passive forms, groups that blocks roadways, sidewalks, or buildings interfere with public order. Often protests intended to be peaceful escalate into general chaos.

19.2.3 Frequency

Terrorism and WMD

The transportation, energy, and communications systems that cross the planning area have impacts on the local, regional, and even national economy. In general the risks of a terrorist event involving a WMD are as follows:

- **Chemical**—The risk of a chemical event is present in the planning area. The agricultural community uses and stores significant amounts of chemicals that could be used in destructive ways.
- **Explosives**—Pipe bomb and suspicious package events have occurred in the City of Los Angeles in the past. While none of the events has been specifically identified as a WMD, the elements necessary to construct a WMD are readily available. Additionally, the agricultural communities maintain sufficient products and quantities for use in explosive events.
- **Radiological/Nuclear**—The major transportation arteries for vehicles or rail that cross through or near the planning area contribute to the risk of a radiological event. Such products can unknowingly pass through any one of the regional transportation corridors.
- **Biological**—Anthrax incidents that occurred in the U.S. in October 2001 demonstrate the potential for spreading terror through biological WMDs.
- **Combined Hazards**—WMD agents can be combined to have a greater total effect. When combined, the impacts of the event can be immediate and longer-term. Casualties will likely suffer from both immediate and long-term burns and contamination. Given the risks associated with chemical agents in the City of Los Angeles, the possibility exists for such a combined event to occur.

Civil Unrest

Large civil unrest events with injuries and fatalities and public property damage occur infrequently. This type of large event gets a lot of national and international media coverage. Smaller gathering events occur more frequently in the planning area, but with fewer injuries and less property damage.

19.2.4 Severity

Terrorism and WMD

Mass-casualty incidents (MCIs) may result from acts of violence such as shootings or hostage situations. Effects may include serious injuries, loss of life, and associated property damage. A multi-casualty incident is defined as any incident with three or more fatalities or critically injured. Because large numbers of patients may be involved, significant MCIs may tax local emergency medical and hospital resources, and therefore require a regional response. First responders, including fire, police, and emergency room staffs at local hospitals, follow established protocols for an MCI. Mutual aid is requested should local officials be unable to respond appropriately with available personnel and equipment.

Civil Unrest

Civil unrest and disturbances are human-caused disasters with tremendous potential for causing damage to the City. They are especially harmful with their effects on human lives.

19.2.5 Warning Time

Terrorism and WMD

According to experts, fewer than 5 percent of all terrorism incidents are preceded by a warning or threat.

Civil Unrest

Civil unrest usually has minimal warning time, but when a controversial event has media coverage with a large gathering of people, the Los Angeles Police Department is on high alert along with other Emergency Operations Organization divisions.

19.3 SECONDARY IMPACTS

19.3.1 Terrorism and WMD

The largest secondary impact caused by a terrorist event would be economic. Economic impacts from terrorism could be significant. The cost of a terrorist act would be felt in loss of life and property, disruption of business activity and long-term emotional impacts. Recovery would take significant resources and expense at the local level.

19.3.2 Civil Unrest

Depending on the size and scope of the incident, civil unrest may lead to widespread urban fire, utility failure, transportation interruption, and environmental hazards. The most significant secondary impact is interruption of continuity of government, which can lead to several of the aforementioned secondary impacts.

19.4 EXPOSURE

19.4.1 Population

Terrorism and WMD

A terrorist event could range from an individual attack to a coordinated attack by multiple agents upon multiple targets. Large-scale incidents have the potential to kill or injure many people in the immediate vicinity, and may also affect people a relative distance from the initial event. Variables affecting exposure for a WMD attack include the physical and chemical properties of the WMD, the ambient temperature, wind speed, wind direction, barometric pressure, and humidity.

Civil Unrest

The entire population of the Los Angeles is exposed to the civil unrest hazard. Those that live in densely populated areas, those living near colleges/universities, correctional facilities, landmarks, courthouses, and other areas of significance may have a higher exposure and are thus more vulnerable to the effects of civil unrest.

19.4.2 Property

Terrorism and WMD

The City of Los Angeles is a high profile target for terrorism and all property is exposed to this hazard.

Civil Unrest

All City property is exposed during civil unrest and may be damaged or destroyed during a riot.

19.4.3 Critical Facilities and Infrastructure

Terrorism and WMD

Terrorism events can pose a serious long-term threat to damaging critical facilities and infrastructure. The exposure of critical facilities and infrastructure to a terrorism event is based on the facility's criticality and physical vulnerability:

- Criticality is a measure of the potential consequence of an accidental or terrorist event as well as the attractiveness of the facility to a potential adversary or threat. The criticality for each critical facility is based on the factors shown in Table 19-2.
- Vulnerability is a measure of the physical opportunity for an accident or an adversarial attack. This assessment takes into consideration physical design, existing countermeasures, and site layout. The vulnerability for each critical facility is based on the criteria shown in Table 19-3.

Table 19-2. Criticality Factors

Criterion	Low Criticality	Medium Criticality	High Criticality
Awareness[a]	Not known/Neighborhood	City/Region/County	State/National
Hazardous Materials[b]	None / limited and secure	Moderate to large and secure	Large, minimum or no security
Collateral Damage Potential[c]	None or low	Moderate/immediate area or within 1 mile radius	High/immediate area or within 1 mile radius
Site Population[d]	0 – 300	301 – 1,000	1,001 or greater
Public/ Emergency Function[e]	No emergency function, or could be used for emergency function in the future	Support emergency function—redundant site	Emergency function—critical service with or without redundancy

a. Awareness—How aware is the public of the existence of the facility, site, system, or location?
b. Hazardous Materials—Are flammable, explosive, biological, chemical and/or radiological materials present on site?
c. Collateral Damage Potential—What are the potential consequences for the surrounding area if the asset is attacked or damaged?
d. Site Population—What is the potential for mass causalities, based on the capacity of the facility.
e. Public or Emergency Functions—Does the facility perform a function during an emergency? Is this facility or function capable of being replicated elsewhere?

Table 19-3. Vulnerability Criteria

Criterion	Low Vulnerability	Medium Vulnerability	High Vulnerability
Accessibility[a]	Remote location, secure perimeter, tightly controlled access	Controlled access, protected or unprotected entry	Open access, unrestricted, patrolling security, sign restrictions
Automobile Proximity[b]	Not within 75' – 100'	Not within 25' – 50'	Adjacent or not within 10'
Asset Mobility[c]	Moves or is relocated frequently	Moves or is relocated occasionally	Permanent/Fixed
Proximity to other Critical Facilities[d]	Greater than 1.5 – 2 miles	Greater than 3/4 - 1 mile	Within 1/2 – 3/4 mile
Secure Design[e]	No areas for concealment of packages, air intakes are on roof, access ways are not under the structure.	Area of concealment present, greater than 25' from the structure; Air intakes located at least 10' above ground, may have under structure access drives.	Areas of concealment within 25', air intakes at ground level, under structure access drives.

a. Accessibility—How accessible is the facility or site to the public?
b. Automobile Proximity—How close can an automobile get to the facility? How vulnerable is the facility to a car bomb attack?
c. Asset Mobility—Is the facility or asset's location fixed or mobile? If mobile, how often is it moved, relocated, or repositioned?
d. Proximity to other critical facilities—If the facility is close to other critical facilities then there could be an increased probability of the facility receiving collateral damage.
e. Secure design—General evaluation of areas of obstruction, air intake locations, parking lot and road design and locations and other site design aspects

Civil Unrest

Critical facilities are exposed during a riot event and may be damaged or destroyed.

19.4.4 Environment

Terrorism and WMD

A terrorism event using a WMD can kill wildlife, destroy habitat, and contaminate critical resources in the food chain.

Civil Unrest

The environment is not generally affected by civil unrest.

19.5 VULNERABILITY

19.5.1 Population

Terrorism and WMD

As the largest city in the Western U.S., the City of Los Angeles has been identified as a prime target for terrorism. Numerous high profile targets exist throughout the city.

Civil Unrest

Riots or mob events have historically caused injuries and fatalities in the city.

19.5.2 Property

Terrorism and WMD

All structures in the planning area are physically vulnerable to a terrorism event. The emphasis on accessibility, the opportunity for roof access, driveways underneath some structures, unmonitored areas, the proximity of many structures to transportation corridors and underground pipelines, and the potential for a terrorist to strike any structure randomly all have an impact on the vulnerability of structures.

Civil Unrest

All City assets are susceptible to damage during civil unrest. Los Angeles Police Department facilities, specifically Parker Center, are probably the most at risk since several demonstrations or rallies have originated at this location in the past. In the 1992 civil unrest, numerous protestors began rallying in front of Parker Center before chaos erupted throughout the city. Other police and fire facilities have also been targeted during past events.

Previous experience indicates that critical response facilities (police stations, fire stations) are at risk during periods of civil unrest. In addition, critical operating facilities, such as City Hall, Parker Center, etc. are at risk of damage or destruction, or may be rendered inoperative for some period of time. Depending upon the nature of the event, however, all City owned assets may be considered vulnerable to damage or destruction as a result of civil unrest. Because of the unpredictability of civil unrest events, no specific estimates can be made concerning potential losses.

Los Angeles has one of the most culturally diverse and dynamic populations in the United States. As the city continues to develop, there will always be cultural and societal shifts, both geographically and socially. It is difficult to quantify potential losses to City facilities because of the unpredictability of civil disturbances.

19.5.3 Critical Facilities and Infrastructure

Terrorism and WMD

The U.S. Department of Homeland Security created the 2003 *National Strategy for the Physical Protection of Critical Infrastructure of Critical Infrastructure and Key Assets* that lays a foundation to work together to prepare and protect critical infrastructure and key assets nationwide from terrorist events. Thus the owners of critical facilities and infrastructure in the planning area know that they are vulnerable to terrorism and have executed preparedness planning and exercises for years, fortifying facilities to minimize their vulnerability.

Civil Unrest

Civil unrest can damage or destroy any facility and block roads and infrastructure from being used.

19.5.4 Environment

Terrorism and WMD

The environment vulnerable to a terrorist event is the same as the environment exposed to the hazard. While human-caused disasters have caused significant damage to the environment, estimating damage can be difficult. Loss estimation platforms such as Hazus are not equipped to measure environmental impacts of these types of hazards. The best gauge of vulnerability of the environment would be a review of damage from past terrorism events. Loss data for damage to the environment were not available at the time of this plan update. Capturing this data from future events could be beneficial in measuring the vulnerability of the environment for future updates.

Civil Unrest

The environment is typically not damaged by civil unrest. Most of the damage is to people and property.

19.5.5 Economic Impacts

Terrorism and WMD

The economic impact price tag of potential losses from terrorism could be huge if lives are lost, office space in a prime international business location is destroyed, jobs are lost and assets are damaged.

Civil Unrest

The economic impact of civil unrest is affected by the nature and duration of civil disturbance. The local economy may be affected by a civil unrest, as was the case during the 1992 riots, which targeted the business sector in the community. The limited number of instances of civil unrest in the city have occurred in large, densely populated areas. However, the causes are too dynamic and too inconsistent to quantify in a meaningful manner.

19.6 FUTURE TRENDS IN DEVELOPMENT

19.6.1 Terrorism and WMD

The agencies and organizations involved with terrorism in the City of Los Angles, specifically threat analyses and threat reduction capability studies, are examining the challenges presented by future development and expansion. Individually, and in collaboration with task forces and other facilities, plans are underway for continuation, changes and/or expansion of current initiatives. Buildings and other structures constructed to resist earthquakes and fires usually have qualities that also limit damage from blasts and resist fire spread and spread of noxious fumes in the event of a terrorist attack.

In particular, collaborative efforts are underway by the Port of Los Angeles and the Port of Long Beach. The Ports are creating joint plans to fully develop the security infrastructure throughout the Port Complex. Projects include: Joint Command and Control Center, interoperable communications, linked and redundant surveillance system monitoring, and full-port access control supported by a common credentialing system.

19.6.2 Civil Unrest

There is a correlation between civil unrest and higher population density in larger cities. Based on the previous occurrences of instances of civil unrest, larger more densely populated cities with culturally diverse populations tend to be more vulnerable to this hazard.

Because it is evident that societal trends and emerging social issues have led to these types of instances in the past, cities with a high amount cultural diversity such as Los Angeles may be subject to civil unrest in the future.

19.7 SCENARIO

Terrorism and WMD

The scenario that could have a significant impact on the planning area would be a terrorist event at a large gathering place such as the LA Coliseum, Los Angeles Convention Center, or Los Angeles International Airport. Terrorist events happen with little or no warning. With a population in excess of 4 million people, the City of Los Angeles does possess potential targets for terrorist activities. Assessment of these sites and probable scenarios are outlined in the Terrorism Contingency Plan.

Civil Unrest

A civil unrest scenario that could have significant impact would be an event that caused multiple fatalities and millions of dollars of property damage and the police were unable to manage the unrest for several days.

19.8 ISSUES

The major issues for terrorism, weapons of mass destruction, and civil unrest are the following:

- Continue regular and redundant emergency preparedness training for field level responders (police, fire, and public works) and public information staff in order to respond quickly in the event of a disaster associated with these hazards. Enhance awareness training for all local government employees to recognize threats or suspicious activity in order to prevent an incident from occurring.
- Continue to improve response times for public safety throughout the City so as to reduce exposure to human-caused incidents. Maintain appropriate staffing levels of public safety personnel to address vulnerabilities identified in this chapter.
- Participate in regional, state and federal efforts to gather terrorism information at all levels and keep public safety officials briefed at all times regarding any local threats. Further develop response capabilities based on emerging threats.
- Participate in the Cal OES Disaster Resistant California annual conference and other training sessions sponsored by regional, state and federal agencies.
- Use Crime Prevention Through Environmental Design in future planning efforts as well as enhancing existing infrastructure and buildings to prevent or mitigate human-cause incidents. Crime Prevention Through Environmental Design is an urban planning design process that integrates crime prevention with neighborhood design and community development. The process is based on the theory that the proper design and effective use of the built environment can reduce crime and the fear of crime and improve the quality of life. It creates an environment where the physical characteristics, building layout, and site planning allow inhabitants to become key agents in ensuring their own security.
- Participate in regional training exercises per the requirements of Homeland Security Presidential Directive #8 in support of national preparedness.
- Work with the private sector to enhance and create business continuity plans to be followed in the event of an emergency.
- Review existing automatic aid and mutual aid agreements with other public safety agencies to identify opportunities for enhancement.
- Maintain an emergency services information line that the public can contact 24 hours a day during an emergency to ask questions of emergency staff.
- Coordinate with all school districts in the City and individual cities to ensure that their emergency preparedness plans include preparation for human-caused incidents.
- Encourage local businesses to adopt information technology and telecommunications recovery plans.
- Promote 72-hour self-sufficiency through neighborhood associations, emergency preparedness efforts through local governments, emergency preparedness websites of local governments, civic organizations and the private sector, public outreach, and other means. Ensure inclusion of program information for people with disabilities and others with access and functional needs.
- Prepare and present the human-caused hazard risk and preparedness program to the public through meetings, town hall gatherings, and preparedness fairs and outreach.
- Maintain any and all resident advisory groups and periodically e-mail emergency preparedness information including human-caused hazard preparedness instructions and reminders.
- Carry out up-to-date and functional all-hazard contingency planning.

20. RISK RANKING

A risk ranking was performed for the natural hazards of concern described in this plan. Non-natural hazards were not ranked for the following reasons:

- Section 201.6 44CFR only requires the assessment of natural hazards for compliance with the regulation.
- It is very difficult to compare risk for between natural hazards and non-natural hazards based on one key component of risk, that being probability of occurrence. You can calculate recurrence intervals for natural hazards because of long records of historical occurrence. This type of data is not typically available for a defined planning area for non-natural hazards
- When talking about risk for non-natural hazards, the emphasis is typically on the threat and the highest degree of consequence from the event. When assessing non-natural hazards, the frequency of occurrence drives the defining of the risk.

20.1 PROBABILITY OF OCCURRENCE

The probability of occurrence of a hazard is indicated by a factor based on likelihood of annual occurrence:

- High—Hazard event is likely to occur within 25 years (Probability Factor = 3)
- Medium—Hazard event is likely to occur within 100 years (Probability Factor =2)
- Low—Hazard event is not likely to occur within 100 years (Probability Factor =1)
- No exposure—There is no probability of occurrence (Probability Factor = 0)

The assessment of hazard frequency is generally based on past natural hazard events in the area. Table 20-1 summarizes the probability assessment for each hazard of concern for this plan.

Table 20-1. Probability of Hazards

Hazard Event	Probability (high, medium, low)	Probability Factor
Adverse Weather	High	3
Dam Failure	Low	1
Drought	High	3
Earthquake	High	3
Flood	High	3
Landslide/Debris Flow	High	3
Tsunami	Low	1
Wildland/Urban Interface Fire	High	3
Sea level Rise	Medium	2

20.2 IMPACT

Hazard impacts were assessed in three categories: impacts on people, impacts on property and impacts on the local economy. Numerical impact factors were assigned as follows:

- **People**—Values were assigned based on the percentage of the total ***population exposed*** to the hazard event. The degree of impact on individuals will vary and is not measurable, so the calculation assumes for simplicity and consistency that all people exposed to a hazard because they live in a hazard zone will be equally impacted when a hazard event occurs. It should be noted that planners can use an element of subjectivity when assigning values for impacts on people. Impact factors were assigned as follows:
  - High—50 percent or more of the population is exposed to a hazard (Impact Factor = 3)
  - Medium—25 percent to 49 percent of the population is exposed to a hazard (Impact Factor = 2)
  - Low—25 percent or less of the population is exposed to the hazard (Impact Factor = 1)
  - No impact—None of the population is exposed to a hazard (Impact Factor = 0)
- **Property**—Values were assigned based on the percentage of the total ***property value exposed*** to the hazard event:
  - High—30 percent or more of the total assessed property value is exposed to a hazard (Impact Factor = 3)
  - Medium—15 percent to 29 percent of the total assessed property value is exposed to a hazard (Impact Factor = 2)
  - Low—14 percent or less of the total assessed property value is exposed to the hazard (Impact Factor = 1)
  - No impact—None of the total assessed property value is exposed to a hazard (Impact Factor = 0)
- **Economy**—Values were assigned based on the percentage of the total ***property value vulnerable*** to the hazard event. Values represent estimates of the loss from a major event of each hazard in comparison to the total replacement value of the property exposed to the hazard. For some hazards, such as wildfire, landslide and severe weather, vulnerability was considered to be the same as exposure due to the lack of loss estimation tools specific to those hazards. Loss estimates separate from the exposure estimates were generated for the earthquake and flood hazards using Hazus.
  - High—Estimated loss from the hazard is 20 percent or more of the total exposed property value (Impact Factor = 3)
  - Medium—Estimated loss from the hazard is 10 percent to 19 percent of the total exposed property value (Impact Factor = 2)
  - Low—Estimated loss from the hazard is 9 percent or less of the total exposed property value (Impact Factor = 1)
  - No impact—No loss is estimated from the hazard (Impact Factor = 0)

The impacts of each hazard category were assigned a weighting factor to reflect the significance of the impact. These weighting factors are consistent with those typically used for measuring the benefits of hazard mitigation actions: impact on people was given a weighting factor of 3; impact on property was given a weighting factor of 2; and impact on the economy was given a weighting factor of 1.

Table 20-2, Table 20-3 and Table 20-4 summarize the impacts for each hazard.

Table 20-2. Impact on People from Hazards

Hazard Event	Impact (high, medium, low)	Impact Factor	Multiplied by Weighting Factor (3)
Adverse Weather	High	3	3x3=9
Dam Failure	High	3	3x3=9
Drought	Low	1	1x3=3
Earthquake	High	3	3x3=9
Flood	Low	1	1x3=3
Landslide/Debris Flow	Medium	2	2x3=6
Tsunami	Low	1	1x3=3
Wildland/Urban Interface Fire	Medium	2	2x3=6
Sea level Rise	Low	1	1x3=3

Table 20-3. Impact on Property from Hazards

Hazard Event	Impact (high, medium, low)	Impact Factor	Multiplied by Weighting Factor (2)
Adverse Weather	Medium	2	2x2=4
Dam Failure	High	3	3x2=6
Drought	Low	1	1x2=2
Earthquake	High	3	3x2=6
Flood	Low	1	1x2=2
Landslide/Debris Flow	Medium	2	2x2=4
Tsunami	Low	1	1x2=2
Wildland/Urban Interface Fire	Low	1	1x2=2
Sea Level Rise	Low	1	1x2=2

Table 20-4. Impact on Economy from Hazards

Hazard Event	Impact (high, medium, low)	Impact Factor	Multiplied by Weighting Factor (1)
Adverse Weather	Medium	2	2x1=2
Dam Failure	High	3	3x1=3
Drought	Medium	2	2x1=2
Earthquake	High	3	3x1=3
Flood	Low	1	1x1=1
Landslide/Debris Flow	Low	1	1x1=1
Tsunami	Low	1	1x1=1
Urban /Wildland Interface Fire	Medium	2	2x1=2
Sea Level Rise	Low	1	1x1=1

20.3 RISK RATING AND RANKING

The risk rating for each hazard was determined by multiplying the probability factor by the sum of the weighted impact factors for people, property and operations, as summarized in Table 20-5.

Based on these ratings, a priority of high, medium or low was assigned to each hazard. The hazards ranked as being of highest concern are earthquake, adverse weather, landslide/debris flows, and wild/urban interface fire. Hazards ranked as being of medium concern are drought, flood and dam failure. The hazards ranked as being of lowest concern are sea level rise and tsunami. Table 20-6 shows the hazard risk ranking.

Table 20-5. Hazard Risk Rating

Hazard Event	Probability Factor	Sum of Weighted Impact Factors	Total (Probability x Impact)
Adverse Weather	3	9+4+2=15	45
Dam Failure	1	9+6+3=18	18
Drought	3	3+2+2=7	21
Earthquake	3	9+6+3=18	54
Flood	3	3+2+1=6	18
Landslide/Debris Flow	3	6+4+1=11	33
Tsunami	1	3+2+1=6	6
Wildland/Urban Interface Fire	3	6+2+2=10	30
Sea level Rise	2	3+2+1=6	12

Table 20-6. Hazard Risk Ranking

Hazard Ranking	Hazard Event	Category
1	Earthquake	High
2	Adverse Weather	High
3	Landslide/Debris Flow	High
4	Wildland/Urban Interface Fire	High
5	Drought	Medium
6	Flood	Medium
7	Dam Failure	Medium
8	Sea Level Rise	Low
9	Tsunami	Low

City of Los Angeles 2018 Local Hazard Mitigation Plan

PART 3—MITIGATION STRATEGY

21. GOALS AND OBJECTIVES

Hazard mitigation plans must identify goals for reducing long-term vulnerabilities to identified hazards (44 CFR Section 201.6(c)(3)(i)). The Steering Committee established a mission statement, a set of goals and measurable objectives for this plan, based on data from the preliminary risk assessment and the results of the public involvement strategy. The mission statement, goals, objectives and actions in this plan all support each other. Goals were selected to support the mission statement. Objectives were selected that meet multiple goals. Actions were prioritized based on ability to accomplish multiple objectives.

21.1 MISSION STATEMENT

To reduce risk and increase resilience, the mission of the City of Los Angeles Local Hazard Mitigation Plan is to establish and promote a comprehensive mitigation policy and program to protect City residents, their property, public facilities, infrastructure and the environment from natural and manmade hazards.

21.2 GOALS

Of five goals in the 2011 hazard mitigation plan, two were unchanged for this update and three were modified; one new goal was added, resulting in the following set of goals:

1. Protect life, property, and cultural resources.
2. Increase public awareness.
3. Coordinate with other programs that can support or enhance hazard mitigation.
4. Increase emergency services effectiveness.
5. Pursue cost-effective and environmentally sound mitigation measures.
6. Strive to increase adaptive capacity to reduce risk from hazard impacts based on future conditions.

21.3 OBJECTIVES

Individual Steering Committee members identified 50 plan objectives, of which the following were selected by 50 percent or more of the participants:

1. Reduce repetitive property losses due to flood, fire and earthquake by updating land use, design, and construction policies.
2. Identify natural and manmade hazards that threaten life and property in the City.
3. Use hazard data while reviewing proposed development opportunities.
4. Encourage the incorporation of mitigation measures into repairs, major alterations, new development, and redevelopment practices, especially in areas subject to substantial hazard risk.
5. Encourage and support leadership within the private sector, non-profit agencies and community-based organizations to promote and implement local hazard mitigation activities.
6. Incorporate risk reduction considerations in new and updated infrastructure and development plans to reduce the impacts of hazards.

7. Continue providing City emergency services with training and equipment to address all identified hazards.
8. Develop and provide updated information about threats, hazards, vulnerabilities, and mitigation strategies to state, regional, and local agencies, as well as private sector groups.
9. Establish and maintain partnerships among all levels of government, private sector, community groups, and institutions of higher learning that improve and implement methods to protect life and property.
10. Create financial and regulatory incentives to motivate stakeholders such as homeowners, private sector businesses, and nonprofit community organizations to mitigate hazards and risk.
11. Continue developing and strengthening inter-jurisdictional coordination and cooperation in the area of emergency services.
12. Support the protection of vital records, and strengthening or replacement of buildings, infrastructure, and lifelines to minimize post-disaster disruption and facilitate short-term and long-term recovery.
13. Coordinate state and local efforts to reduce greenhouse gas emissions and implement climate adaptation strategies through hazard mitigation plans and actions.
14. Implement mitigation programs and projects that protect not only life and property, but the environment as well.
15. Promote and implement hazard mitigation plans and projects that are consistent with state, regional and local climate action and adaptation goals, policies, and programs.
16. Advance community resilience through preparation, adoption, and implementation of state, regional and local multi-hazard mitigation plans and projects.

22. MITIGATION ALTERNATIVES

Catalogs of hazard mitigation alternatives were developed that present a broad range of alternatives to be considered for use in the planning area, in compliance with 44 CFR (Section 201.6(c)(3)(ii)). One catalog was developed for each natural hazard of concern evaluated in this plan. The catalogs present alternatives that are categorized in two ways:

- By who would have responsibility for implementation:
    - Individuals (personal scale)
    - Businesses (corporate scale)
    - Government (government scale).
- By what the alternative would do:
    - Manipulate the flooding hazard
    - Reduce exposure to the flooding hazard
    - Reduce vulnerability to the flooding hazard
    - Increase the ability to respond to or be prepared for the flooding hazard.

Hazard mitigation actions recommended in this plan were selected from among the alternatives presented in the catalogs. The catalogs provide a baseline of mitigation alternatives that are backed by a planning process, are consistent with the established goals and objectives, and are within the capabilities of the City of Los Angeles to implement. Some of these actions may not be feasible based on the selection criteria identified for this plan. The purpose of the catalog was to provide a list of what could be considered to reduce risk of the flood hazard within the planning area. Actions in the catalog that are not included in the action plan were not selected for one or more of the following reasons:

- The action is not feasible.
- The action is already being implemented.
- There is an apparently more cost-effective alternative.
- The action does not have public or political support.

The catalogs for each hazard are presented in Table 22-1 through Table 22-8.

Table 22-1. Alternatives to Mitigate the Adverse Weather Hazard

Personal-Scale	Corporate-Scale	Government-Scale
• **Manipulate the hazard:** ❖ None • **Reduce exposure to the hazard:** ❖ None • **Reduce vulnerability to the hazard:** ❖ Insulate house ❖ Provide redundant heat and power ❖ Insulate structure ❖ Plant appropriate trees near home and power lines ("Right tree, right place" National Arbor Day Foundation Program) • **Increase the ability to respond to or be prepared for the hazard:** ❖ Trim or remove trees that could affect power lines ❖ Promote 72-hour self-sufficiency ❖ Obtain a NOAA weather radio. ❖ Obtain an emergency generator.	• **Manipulate the hazard:** ❖ None • **Reduce exposure to the hazard:** ❖ None • **Reduce vulnerability to the hazard:** ❖ Relocate critical infrastructure (such as power lines) underground ❖ Reinforce or relocate critical infrastructure such as power lines to meet performance expectations ❖ Install tree wire • **Increase the ability to respond to or be prepared for the hazard:** ❖ Trim or remove trees that could affect power lines ❖ Create redundancy ❖ Equip facilities with a NOAA weather radio ❖ Equip vital facilities with emergency power sources.	• **Manipulate the hazard:** ❖ None • **Reduce exposure to the hazard:** ❖ None • **Reduce vulnerability to the hazard:** ❖ Harden infrastructure such as locating utilities underground ❖ Trim trees back from power lines ❖ Consider "cool roofs" and "green roofs" • **Increase the ability to respond to or be prepared for the hazard:** ❖ Support programs such as "Tree Watch" that proactively manage problem areas through use of selective removal of hazardous trees, tree replacement, etc. ❖ Establish and enforce building codes that require all roofs to withstand snow loads ❖ Increase communication alternatives ❖ Modify land use and environmental regulations to support vegetation management activities that improve reliability in utility corridors. ❖ Modify landscape and other ordinances to encourage appropriate planting near overhead power, cable, and phone lines ❖ Provide NOAA weather radios to the public

Table 22-2. Alternatives to Mitigate the Dam Failure Hazard

Personal-Scale	Corporate-Scale	Government-Scale
• **Manipulate the hazard:** ❖ None • **Reduce exposure to the hazard:** ❖ Relocate out of dam failure inundation areas. • **Reduce vulnerability to the hazard:** ❖ Elevate home to appropriate levels. • **Increase the ability to respond to or be prepared for the hazard:** ❖ Learn about risk reduction for the dam failure hazard. ❖ Learn the evacuation routes for a dam failure event. ❖ Educate yourself on early warning systems and the dissemination of warnings.	• **Manipulate the hazard:** ❖ Remove dams. ❖ Remove levees. ❖ Harden dams. • **Reduce exposure to the hazard:** ❖ Replace earthen dams with hardened structures. • **Reduce vulnerability to the hazard:** ❖ Flood-proof facilities within dam failure inundation areas. • **Increase the ability to respond to or be prepared for the hazard:** ❖ Educate employees on the probable impacts of a dam failure. ❖ Develop a continuity of operations plan.	• **Manipulate the hazard:** ❖ Remove dams. ❖ Remove levees. ❖ Harden dams. • **Reduce exposure to the hazard:** ❖ Replace earthen dams with hardened structures ❖ Relocate critical facilities out of dam failure inundation areas. ❖ Consider open space land use in designated dam failure inundation areas. • **Reduce vulnerability to the hazard:** ❖ Adopt higher floodplain standards in mapped dam failure inundation areas. ❖ Retrofit critical facilities within dam failure inundation areas. • **Increase the ability to respond to or be prepared for the hazard:** ❖ Map dam failure inundation areas. ❖ Enhance emergency operations plan to include a dam failure component. ❖ Institute monthly communications checks with dam operators. ❖ Inform the public on risk reduction techniques ❖ Adopt real-estate disclosure requirements for the re-sale of property located within dam failure inundation areas. ❖ Consider the probable impacts of climate in assessing the risk associated with the dam failure hazard. ❖ Establish early warning capability downstream of listed high hazard dams. ❖ Consider the residual risk associated with protection provided by dams in future land use decisions.

Table 22-3. Alternatives to Mitigate the Drought Hazard

Personal-Scale	Corporate-Scale	Government-Scale
• **Manipulate the hazard:** ❖ None • **Reduce exposure to the hazard:** ❖ None • **Reduce vulnerability to the hazard:** ❖ Drought-resistant landscapes ❖ Reduce water system losses ❖ Modify plumbing systems (through water saving kits) • **Increase the ability to respond to or be prepared for the hazard:** ❖ Practice active water conservation	• **Manipulate the hazard:** ❖ None • **Reduce exposure to the hazard:** ❖ None • **Reduce vulnerability to the hazard:** ❖ Drought-resistant landscapes ❖ Reduce private water system losses • **Increase the ability to respond to or be prepared for the hazard:** ❖ Practice active water conservation	• **Manipulate the hazard:** ❖ Groundwater recharge through stormwater management • **Reduce exposure to the hazard:** ❖ Identify and create groundwater backup sources • **Reduce vulnerability to the hazard:** ❖ Water use conflict regulations ❖ Reduce water system losses ❖ Distribute water saving kits • **Increase the ability to respond to or be prepared for the hazard:** ❖ Public education on drought resistance ❖ Encourage recycling ❖ Identify alternative water supplies for times of drought; mutual aid agreements with alternative suppliers ❖ Develop drought contingency plan ❖ Develop criteria "triggers" for drought-related actions ❖ Improve accuracy of water supply forecasts ❖ Modify rate structure to influence active water conservation techniques

Table 22-4. Alternatives to Mitigate the Earthquake Hazard

Personal-Scale	Corporate-Scale	Government-Scale
• **Manipulate the hazard:** ❖ None • **Reduce exposure to the hazard:** ❖ Locate outside of hazard area (off soft soils) • **Reduce vulnerability to the hazard:** ❖ Retrofit structure (anchor house structure to foundation) ❖ Secure household items that can cause injury or damage (such as water heaters, bookcases, and other appliances) ❖ Build to higher design • **Increase the ability to respond to or be prepared for the hazard:** ❖ Practice "drop, cover, and hold" ❖ Develop household mitigation plan, such as creating a retrofit savings account, communication capability with outside, 72-hour self-sufficiency during an event ❖ Keep cash reserves for reconstruction ❖ Become informed on the hazard and risk reduction alternatives available. ❖ Develop a post-disaster action plan for your household	• **Manipulate the hazard:** ❖ None • **Reduce exposure to the hazard:** ❖ Locate or relocate mission-critical functions outside hazard area where possible • **Reduce vulnerability to the hazard:** ❖ Build redundancy for critical functions and facilities ❖ Retrofit critical buildings and areas housing mission-critical functions • **Increase the ability to respond to or be prepared for the hazard:** ❖ Adopt higher standard for new construction; consider "performance-based design" when building new structures ❖ Keep cash reserves for reconstruction ❖ Inform your employees on the possible impacts of earthquake and how to deal with them at your work facility. ❖ Develop a continuity of operations plan	• **Manipulate the hazard:** ❖ None • **Reduce exposure to the hazard:** ❖ Locate critical facilities or functions outside hazard area where possible • **Reduce vulnerability to the hazard:** ❖ Harden infrastructure ❖ Provide redundancy for critical functions ❖ Adopt higher regulatory standards • **Increase the ability to respond to or be prepared for the hazard:** ❖ Provide better hazard maps ❖ Provide technical information and guidance ❖ Enact tools to help manage development in hazard areas (e.g., tax incentives, information) ❖ Include retrofitting and replacement of critical system elements in capital improvement plan ❖ Develop strategy to take advantage of post-disaster opportunities ❖ Warehouse critical infrastructure components such as pipe, power line, and road repair materials ❖ Develop and adopt a continuity of operations plan ❖ Initiate triggers guiding improvements (such as <50% substantial damage or improvements) ❖ Further enhance seismic risk assessment to target high hazard buildings for mitigation opportunities. ❖ Develop a post-disaster action plan that includes grant funding and debris removal components.

Table 22-5. Alternatives to Mitigate the Flood Hazard

Personal-Scale	Corporate-Scale	Government-Scale
• Manipulate the hazard: ❖ Clear storm drains and culverts ❖ Use low-impact development techniques • **Reduce exposure to the hazard:** ❖ Locate outside of hazard area ❖ Elevate utilities above base flood elevation ❖ Use low-impact development techniques • **Reduce vulnerability to the hazard:** ❖ Raise structures above base flood elevation ❖ Elevate items within house above base flood elevation ❖ Build new homes above base flood elevation ❖ Flood-proof structures • **Increase the ability to respond to or be prepared for the hazard:** ❖ Buy flood insurance ❖ Develop household plan, such as retrofit savings, communication with outside, 72-hour self-sufficiency during and after an event	• **Manipulate the hazard:** ❖ Clear storm drains and culverts ❖ Use low-impact development techniques • **Reduce exposure to the hazard:** ❖ Locate critical facilities or functions outside hazard area ❖ Use low-impact development techniques • **Reduce vulnerability to the hazard:** ❖ Build redundancy for critical functions or retrofit critical buildings ❖ Provide flood-proofing when new critical infrastructure must be located in floodplains • **Increase the ability to respond to or be prepared for the hazard:** ❖ Keep cash reserves for reconstruction ❖ Support and implement hazard disclosure for sale of property in risk zones. ❖ Solicit cost-sharing through partnerships with others on projects with multiple benefits.	• **Manipulate the hazard:** ❖ Maintain drainage system ❖ Institute low-impact development techniques on property ❖ Dredging, levee construction, and providing regional retention areas ❖ Structural flood control, levees, channelization, or revetments. ❖ Stormwater management regulations and master planning ❖ Acquire vacant land or promote open space uses in developing watersheds to control increases in runoff • **Reduce exposure to the hazard:** ❖ Locate or relocate critical facilities outside of hazard area ❖ Acquire or relocate identified repetitive loss properties ❖ Promote open space uses in identified high hazard areas via techniques such as: planned unit developments, easements, setbacks, greenways, sensitive area tracks. ❖ Adopt land development criteria such as planned unit developments, density transfers, clustering ❖ Institute low impact development techniques on property ❖ Acquire vacant land or promote open space uses in developing watersheds to control increases in runoff • **Reduce vulnerability to the hazard:** ❖ Harden infrastructure, bridge replacement program ❖ Provide redundancy for critical functions and infrastructure ❖ Adopt regulatory standards such as freeboard standards, cumulative substantial improvement or damage, lower substantial damage threshold; compensatory storage, non-conversion deed restrictions. ❖ Stormwater management regulations and master planning. ❖ Adopt "no-adverse impact" floodplain management policies that strive to not increase the flood risk on downstream communities. • **Increase the ability to respond to or be prepared for the hazard:** ❖ Produce better hazard maps ❖ Provide technical information and guidance ❖ Enact tools to help manage development in hazard areas (stronger controls, tax incentives, and information) ❖ Incorporate retrofitting or replacement of critical system elements in capital improvement plan ❖ Develop strategy to take advantage of post-disaster opportunities ❖ Warehouse critical infrastructure components ❖ Develop and adopt a continuity of operations plan ❖ Consider participation in the Community Rating System ❖ Maintain and collect data to define risks and vulnerability ❖ Train emergency responders ❖ Create an elevation inventory of structures in the floodplain ❖ Develop and implement a public information strategy ❖ Charge a hazard mitigation fee ❖ Integrate floodplain management policies into other planning mechanisms within the planning area. ❖ Consider the probable impacts of climate change on the risk associated with the flood hazard ❖ Consider the residual risk associated with structural flood control in future land use decisions ❖ Enforce National Flood Insurance Program ❖ Adopt a Stormwater Management Master Plan

Table 22-6. Alternatives to Mitigate the Landslide Hazard

Personal-Scale	Corporate-Scale	Government-Scale
• **Manipulate the hazard:** ❖ Stabilize slope (dewater, armor toe) ❖ Reduce weight on top of slope ❖ Minimize vegetation removal and the addition of impervious surfaces. • **Reduce exposure to the hazard:** ❖ Locate structures outside of hazard area (off unstable land and away from slide-run out area) • **Reduce vulnerability to the hazard:** ❖ Retrofit home • **Increase the ability to respond to or be prepared for the hazard:** ❖ Institute warning system, and develop evacuation plan ❖ Keep cash reserves for reconstruction ❖ Educate yourself on risk reduction techniques for landslide hazards	• **Manipulate the hazard:** ❖ Stabilize slope (dewater, armor toe) ❖ Reduce weight on top of slope • **Reduce exposure to the hazard:** ❖ Locate structures outside of hazard area (off unstable land and away from slide-run out area) • **Reduce vulnerability to the hazard:** ❖ Retrofit at-risk facilities • **Increase the ability to respond to or be prepared for the hazard:** ❖ Institute warning system, and develop evacuation plan ❖ Keep cash reserves for reconstruction ❖ Develop a continuity of operations plan ❖ Educate employees on the potential exposure to landslide hazards and emergency response protocol.	• **Manipulate the hazard:** ❖ Stabilize slope (dewater, armor toe) ❖ Reduce weight on top of slope • **Reduce exposure to the hazard:** ❖ Acquire properties in high-risk landslide areas. ❖ Adopt land use policies that prohibit the placement of habitable structures in high-risk landslide areas. • **Reduce vulnerability to the hazard:** ❖ Adopt higher regulatory standards for new development within unstable slope areas. ❖ Armor/retrofit critical infrastructure against the impact of landslides. • **Increase the ability to respond to or be prepared for the hazard:** ❖ Produce better hazard maps ❖ Provide technical information and guidance ❖ Enact tools to help manage development in hazard areas: better land controls, tax incentives, information ❖ Develop strategy to take advantage of post-disaster opportunities ❖ Warehouse critical infrastructure components ❖ Develop and adopt a continuity of operations plan ❖ Educate the public on the landslide hazard and appropriate risk reduction alternatives.

Table 22-7. Alternatives to Mitigate the Tsunami Hazard

Personal-Scale	Corporate-Scale	Government-Scale
• **Manipulate the hazard:** ❖ None • **Reduce exposure to the hazard:** ❖ Locate outside of hazard area • **Reduce vulnerability to the hazard:** ❖ Apply personal property mitigation techniques to your home such as anchoring your foundation and foundation openings to allow flow through • **Increase the ability to respond to or be prepared for the hazard:** ❖ Develop and practice a household evacuation plan. ❖ Support/participate in the Redwood Coast Tsunami Working Group. ❖ Educate yourself on the risk exposure from the tsunami hazard and ways to minimize that risk.	• **Manipulate the hazard:** ❖ None • **Reduce exposure to the hazard:** ❖ Locate structure or mission critical functions outside of hazard area whenever possible • **Reduce vulnerability to the hazard:** ❖ Mitigate personal property for the impacts of tsunami • **Increase the ability to respond to or be prepared for the hazard:** ❖ Develop and practice a corporate evacuation plan. ❖ Support/participate in the Redwood Coast Tsunami Working Group. ❖ Educate employees on the risk exposure from the tsunami hazard and ways to minimize that risk	• **Manipulate the hazard:** ❖ Build wave abatement structures (e.g. the "Jacks" looking structure designed by the Japanese) • **Reduce exposure to the hazard:** ❖ Locate structure or functions outside of hazard area whenever possible. ❖ Harden infrastructure for tsunami impacts. ❖ Relocate identified critical facilities located in tsunami high hazard areas. • **Reduce vulnerability to the hazard:** ❖ Adopt higher regulatory standards that will provide higher levels of protection to structures built in a tsunami inundation area. ❖ Utilize tsunami mapping once available, to guide development away from high risk areas through land use planning • **Increase the ability to respond to or be prepared for the hazard:** ❖ Create a probabilistic tsunami map for the planning area. ❖ Provide incentives to guide development away from hazard areas. ❖ Develop a tsunami warning and response system. ❖ Provide residents with tsunami inundation maps ❖ Join NOAA's Tsunami Ready program ❖ Develop and communicate evacuation routes ❖ Enhance the public information program to include risk reduction options for the tsunami hazard

Table 22-8. Alternatives to Mitigate the Wildfire Hazard

Personal-Scale	Corporate-Scale	Government-Scale
• **Manipulate the hazard:** ❖ Clear potential fuels on property such as dry overgrown underbrush and diseased trees • **Reduce exposure to the hazard:** ❖ Create and maintain defensible space around structures ❖ Locate outside of hazard area ❖ Mow regularly • **Reduce vulnerability to the hazard:** ❖ Create and maintain defensible space around structures and provide water on site ❖ Use fire-retardant building materials ❖ Create defensible spaces around home • **Increase the ability to respond to or be prepared for the hazard:** ❖ Employ techniques from the National Fire Protection Association's Firewise Communities program to safeguard home ❖ Identify alternative water supplies for fire fighting ❖ Install/replace roofing material with non-combustible roofing materials.	• **Manipulate the hazard:** ❖ Clear potential fuels on property such as dry underbrush and diseased trees • **Reduce exposure to the hazard:** ❖ Create and maintain defensible space around structures and infrastructure ❖ Locate outside of hazard area • **Reduce vulnerability to the hazard:** ❖ Create and maintain defensible space around structures and infrastructure and provide water on site ❖ Use fire-retardant building materials ❖ Use fire-resistant plantings in buffer areas of high wildfire threat. • **Increase the ability to respond to or be prepared for the hazard:** ❖ Support Firewise community initiatives. ❖ Create /establish stored water supplies to be utilized for fire fighting.	• **Manipulate the hazard:** ❖ Clear potential fuels on property such as dry underbrush and diseased trees ❖ Implement best management practices on public lands. • **Reduce exposure to the hazard:** ❖ Create and maintain defensible space around structures and infrastructure ❖ Locate outside of hazard area ❖ Enhance building code to include use of fire resistant materials in high hazard area. • **Reduce vulnerability to the hazard:** ❖ Create and maintain defensible space around structures and infrastructure ❖ Use fire-retardant building materials ❖ Use fire-resistant plantings in buffer areas of high wildfire threat. ❖ Consider higher regulatory standards (such as Class A roofing) ❖ Establish biomass reclamation activities • **Increase the ability to respond to or be prepared for the hazard:** ❖ More public outreach and education efforts, including an active Firewise program ❖ Possible weapons of mass destruction funds available to enhance fire capability in high-risk areas ❖ Identify fire response and alternative evacuation routes ❖ Seek alternative water supplies ❖ Become a Firewise community ❖ Use academia to study impacts/solutions to wildfire risk ❖ Establish/maintain mutual aid agreements between fire service agencies. ❖ Create/implement fire plans ❖ Consider the probable impacts of climate change on the risk associated with the wildfire hazard in future land use decisions

23. ACTION PLAN AND IMPLEMENTATION

23.1 STATUS OF PREVIOUS PLAN ACTIONS

The 2011 City of Los Angeles Hazard Mitigation Plan identified 307 mitigation actions for implementation. For the current update, these actions were reviewed by City bureaus and offices and other relevant agencies. For each action, it was determined whether the action had been completed, was in progress or had not been started. Incomplete actions were reviewed to determine if they should be carried over to the 2018 update or removed from the plan due to a change in priorities, capabilities, or feasibility. In total, 48 (16 percent) of the identified actions have been started or completed. Of the 307 identified actions 87 (28 percent) were carried over to the 2018 update. A total of 172 (56 percent) of the identified actions were withdrawn from the plan based on a review by the planning team. The reasons for a withdrawal of an action ranged from the action no longer being considered feasible to the action being identified as a core capability by the 2018 planning process. Each carried over has a new action number assigned to it for the 2018 update, and many were reworded to more clearly state their intent. Appendix C summarizes the status of the recommended actions from the 2011 hazard mitigation plan.

23.1.1 Status of Plan Incorporation Actions

As a demonstration of progress in local hazard mitigation efforts, 44 CFR 201.6(c)(4)(ii) requires plan updates to describe completed steps to incorporate the mitigation plan into other planning mechanisms as appropriate. The maintenance strategy for the 2011 City of Los Angeles Hazard Mitigation Plan called for incorporation into other planning mechanisms, but no clear actions or metrics were identified to measure successful incorporation. The capability assessment performed for this update identifies some links between the City's hazard mitigation planning and its core capabilities, but no information is available on specific actions related to incorporation during the past performance period for this plan.

Of the 307 mitigation actions in the 2011 plan, one action relates to incorporation of the mitigation plan into other planning mechanisms. Action DPW-03 called for coordinating the prioritization of the Department of Public Works Capital Improvement Plan with actions identified in the mitigation plan. This action was identified as "ongoing" and has been carried over to this plan update. The Department of Public Works is a key supporter of the hazard mitigation plan implementation, maintenance and update process, and will continue to coordinate its programs with initiatives identified in this plan.

This plan update identifies clear actions for plan incorporation with clear metrics to monitor their completion; therefore, meeting the objectives of 44 CFR 201.6(c)(4)(ii) for future updates should be easier for the City.

23.2 ACTION PLAN

The Steering Committee reviewed the catalogs of hazard mitigation alternatives and selected actions to be included in a hazard mitigation action plan. The selection of actions was based on the risk assessment of identified hazards of concern and the defined hazard mitigation goals and objectives.

Table 23-1 lists the recommended hazard mitigation actions that make up the action plan. The timeframe indicated in the table is defined as follows:

- Short Term = to be completed in 1 to 5 years
- Long Term = to be completed in greater than 5 years
- Ongoing = currently being funded and implemented under existing programs.

23.2.1 Benefit-Cost Review

The action plan must be prioritized according to a benefit/cost analysis of the proposed actions (44 CFR, Section 201.6(c)(3)(iii)). The benefits of proposed projects were weighed against estimated costs as part of the project prioritization process. The benefit/cost analysis was not of the detailed variety required by FEMA for project grant eligibility under the Hazard Mitigation Grant Program (HMGP) and Pre-Disaster Mitigation (PDM) grant program. A less formal approach was used because some projects may not be implemented for up to 10 years, and associated costs and benefits could change dramatically in that time. Therefore, a review of the apparent benefits versus the apparent cost of each project was performed. Parameters were established for assigning subjective ratings (high, medium, and low) to the costs and benefits of these projects.

Cost ratings were defined as follows:

- **High**—Existing funding will not cover the cost of the project; implementation would require new revenue through an alternative source (for example, bonds, grants, and fee increases).
- **Medium**—The project could be implemented with existing funding but would require a budget re-apportionment or amendment, or the cost of the project would have to be spread over multiple years.
- **Low—**The project could be funded under the existing budget. The project is part of or can be part of an ongoing existing program.

Benefit ratings were defined as follows:

- **High—**Project will provide an immediate reduction of risk exposure for life and property.
- **Medium—**Project will have a long-term impact on the reduction of risk exposure for life and property, or project will provide an immediate reduction in the risk exposure for property.
- **Low—**Long-term benefits of the project are difficult to quantify in the short term.

Using this approach, projects with positive benefit versus cost ratios (such as high over high, high over medium, medium over low, etc.) are considered cost-beneficial and are prioritized accordingly.

For many of the strategies identified in this action plan, financial assistance may be available under the HMGP or PDM programs, both of which require detailed benefit/cost analyses. These analyses will be performed on projects at the time of application using the FEMA benefit-cost model. For projects not seeking financial assistance from grant programs that require detailed analysis, "benefits" can be defined according to parameters that meet the goals and objectives of this plan.

Table 23-1. Action Plan

Applies to new or existing assets	Hazards Mitigated	Objectives Met	Lead Agency	Estimated Cost	Sources of Funding	Timeline
Department of Animal Services (DAS)						
DAS-01: Continue to coordinate with the Emergency Management Department and other City departments on identification and implementation of loss avoidance from the hazards assessed by this plan, and risk reduction projects for DAS managed facilities.						
New and Existing	All Hazards	7, 8, 9, 11, 12, 14, 15	DAS	Medium	DAS operational funds, FEMA hazard Mitigation Grants	Short-term, ongoing
Department of Building and Safety (LADBS)						
LADBS-01: Continue the development and distribution of; “Be Prepared, Homeowners” Guide for Erosion Control Booklets						
New and Existing	Flood, Landslide, Wildfire	8, 9, 11, 14, 16	LADBS	Low	LADBS operational funds	Short-term, ongoing
LADBS-02: Provide Updates to the Flood Hazard Mitigation Coordinator						
New and Existing	Flood, Tsunami, Dam failure , Sea-level rise	1, 3, 4, 6, 9, 14,16	LADBS, DPW	Low	LADBS operational funds	Short-term, ongoing
LADBS-03: Safety Assessment Program Training for LADBS Inspectors and Engineers						
New and Existing	Wildfire, flood, earthquake, tsunami, landslide, adverse weather, sea level rise	7, 8, 9	LADBS	LOW	Staff time, General Funds	Short term (2 years)
Department on Disability (DDS)						
DDS-01: Disaster Response Sign Language Interpreters						
New and Existing	All Hazards	2, 5, 8, 9, 14,16	DDS	Low	Staff time, General Funds	Short Term, Ongoing
DDS-02: Emergency Preparedness Manual (for People with Disabilities)						
New and Existing	All Hazards	2, 5, 8, 9, 14,16	DDS	Low	Staff time, General Funds	Short Term, Ongoing
DDS-03: Assessment of Disability Needs						
New and Existing	All Hazards	5, 7, 8, 9, 16	DDS	Low	Staff time, General Funds	Short Term, Ongoing
DDS-04: Disaster Preparedness On-Line Planning Tool for People with Disabilities						
New and Existing	All Hazards	2, 5, 8, 9, 14,16	DDS	Low	Staff time, General Funds	Short Term, Ongoing
Emergency Management Department (EMD)						
EMD-01: Coordinate the implementation and maintenance of the 2018 City of Los Angeles Hazard Mitigation Plan						
New and Existing	All Hazards assessed by the plan	All Objectives	EMD	Medium	Staff time, General Funds, FEMA Hazard Mitigation Assistance (HMA) Planning Grants	Ongoing

Applies to new or existing assets	Hazards Mitigated	Objectives Met	Lead Agency	Estimated Cost	Sources of Funding	Timeline
Fire Department (LAFD)						
LAFD-01: Protect Fire Stations 40, 49, 110, 111, 112 from tsunami impact						
Existing	Tsunami, Sea-level rise	1, 7, 12,16	LAFD	Medium	LAFD operations funds, FEMA HMA programs	Long-term, ongoing
LAFD-02: Continue implementation of Fire Road Maintenance Program						
New and Existing	Wildfire	7, 11,16	LAFD	Low	Staff time, General Funds	Short term, ongoing
LAFD-03: Update/maintain Wild Land Operational Plan with best available data and science on wildfire risk and severity within the operational area.						
New and Existing	Wildfire	1, 2, 6, 7, 8, 9, 11,14,16	LAFD	Medium	LAFD operations funds, FEMA HMA programs	Short term, ongoing
LAFD-04: Security/Safety action for memorial training center at 1700 stadium way. The current project is re securing the property by installing iron security fencing around the property.						
Existing	All Hazards	7, 9, 11,16	LAFD	$1,000,000 Low	LAFD operations funds	Short term (Dec 2018)
General Services Department (GSD)						
GSD-01: Continue Division Training in Emergency Procedures						
New and Existing	All Hazards	2, 7, 8, 9, 14,16	GSD with support from EMD	Low	Staff time, General Funds	Short term, ongoing
Harbor Department, Port of LA (HAR)						
HAR-01: Continue to Maintain Advanced Transportation Management Information System						
Existing	All hazards	2, 5, 7, 8, 9, 14, 16	HAR	Low	Staff time, General Funds	Short term, ongoing
HAR-02: Badger Avenue Conley joint improvement (24988)						
Existing	Transportation	1, 4, 14,16	HAR	Medium	HAR operational funds, possible FEMA HMA grant funding	Ongoing
HAR-03: Maintain operational capacity of terminals during all hazard events that may result in the interruption of power supply by installing or retrofitting emergency generators in terminals.						
Existing	Earthquake, flood, severe weather, urban fire, terrorism, cyber	7, 7, 16	HAR	Medium	HAR operational funds, possible FEMA HMA grant funding	Short term, ongoing
HAR-04: Conduct Non-Structural seismic hazard mitigation of vulnerable facilities						
Existing	Earthquake	1, 4, 6, 14,16	HAR	Medium	HAR operational funds, possible FEMA HMA grant funding	Short term, ongoing
HAR-05: 705 N. Front Street Inspection Facility (B 87-89 Scanning Facility 24971)						
Existing	Terrorism	1, 4, 6, 14,16	HAR	Low	Staff time, General Funds, DHS Urban Area Security Initiative grant funding	Short term, ongoing

Applies to new or existing assets	Hazards Mitigated	Objectives Met	Lead Agency	Estimated Cost	Sources of Funding	Timeline
HAR-06: B. 195-196 – Wharf Improvements / 300 Water Street – Maritime Law Enforcement Training Center (24989)						
Existing	Terrorism	1, 4, 6, 14,16	HAR	Low	Staff time, General Funds, DHS Urban Area Security Initiative grant funding	Short term, ongoing
HAR-07: Port Police Computer Aided Dispatch and Records Management System (25000)						
Existing	Terrorism	2, 5, 7, 8, 9, 14, 16	HAR	Low	Staff time, General Funds	Short term, ongoing
HAR-08: Port Police Tactical Radio Communications Improvement (25002)						
Existing	Terrorism	2, 5, 7, 8, 9, 14, 16	HAR	Low	Staff time, General Funds	Short term, ongoing
Housing Department (LAHD)						
LAHD is now referred to as Los Angeles Housing and Community Investment Department. See actions below.						
Los Angeles Housing and Community Investment Department (HCID)						
HCID-01: Pre-Disaster Housing Recovery Strategy for the City. This plan will provide the framework and strategy for how the City will: 1) manage the transition from mass care and shelter response to housing-related recovery in future disasters; 2) collect and analyze data and information related to the disaster; and 3) design effective housing recovery programs that may be implemented to maximize and leverage available recovery resources and funding to rehouse displaced residents and reconstruct damaged housing of all types.						
New and Existing	All hazards	9, 16	HCID	$2,000,000 Medium	City Staff time, FEMA Planning Grant, CDBG-DR	Short Term
HCID-02: Seismic Retrofit Program. This program seeks to complete mandatory seismic retrofitting of residential properties with identified soft-story hazards, as required by City Ordinance 184081 enacted in February 2016. In addition, other residential seismic retrofit needs in the city will be researched (e.g. non-ductile concrete buildings).						
Existing	Earthquake	4, 5, 10,12	HCID	$850,000,000 High	Apartment owner funds; Cost recovery from Tenants (i.e. rent increases and/or surcharges); City Staff time, FEMA HMA grant funding	Short term, ongoing
Information Technology Agency (ITA)						
ITA-01: Geographic Information Systems (GIS) Hazard Mapping						
New and Existing	All Hazards that have a clearly defined extent and location: dam failure, flood, earthquake, landslide, wildfire, tsunami, sea-level rise	2, 3, 8, 16	ITA	Low	Staff time, General Funds	Short term, ongoing
ITA-02: Disaster Recovery Support Services						
New and Existing	All Hazards	7, 11,16	ITA	Low	Staff time, General Funds	Short term, ongoing
ITA-03: Emergency Operations Center Incident Management System (IMS) Software Support						
New and Existing	All Hazards	2, 3, 8, 16	ITA	Low	Staff time, General Funds	Short term, ongoing

Applies to new or existing assets	Hazards Mitigated	Objectives Met	Lead Agency	Estimated Cost	Sources of Funding	Timeline
ITA-04: Participate in and provide IT support to Citywide & Departmental Emergency Exercises						
New and Existing	All Hazards	2, 3, 8, 16	ITA	Low	Staff time, General Funds	Short term, ongoing
ITA-05: Support EMD in the maintenance of the Hazus model that was created to support the update of this hazard mitigation plan. This support would be in the form of maintaining the necessary software licensing needed to run the Hazus platform and/or providing technical support in the use of the software.						
New and Existing	Dam failure, earthquake, flood, tsunami and Sea-level rise	2, 7, 8, 9, 14,16	ITA	Low	Staff time, General Funds	Short term, ongoing
Los Angeles World Airports (LAWA)						
LAWA-01: Improved LAX Airport Passenger Access and Airfield Modifications to Improve Safety and Efficiency (Airfield Expansions)						
New	Earthquake	4, 6, 14,16	LAWA	Medium	Staff time, General Funds, FEMA HMA Grants	Short term, ongoing
City Planning Department (PL)						
PL-01: Integrate the City's hazard mitigation plan into future updates to the general plan in compliance with CA. state mandates (AB2140, SB379, SB1000)						
New and Existing	All natural hazards assessed by this plan	2, 3, 4, 6, 8, 14, 16	PL	Low	Staff time, General Funds	Short term, ongoing
PL-02: All future updated to plans and programs that mange land use within the City should consider the best available date and science on the risk exposure and vulnerability to all hazards the City is susceptible to.						
New and Existing	All natural hazards assessed by this plan	2, 3, 4, 6, 8, 14, 16	PL	Low	Staff time, General Funds	Short term, ongoing
PL-03: consider the adoption of higher regulatory standards that are appropriate to manage risk and fall within the core capabilities of the City.						
New and Existing	All natural hazards assessed by this plan	2, 3, 4, 6, 8, 14, 16	PL	Low	Staff time, General Funds	Short term, ongoing
Police Department (LAPD)						
LAPD-01: Continue to deploy the Mobile Command Response Unit and inform it of the risks identified for the hazards assessed in this plan						
New and Existing	All Hazards	7, 9, 11,16	LAPD	Low	Staff time, General Funds	Short term, ongoing
LAPD-02: Technological, Chemical, and Biological Detection Devices						
New and Existing	Hazardous Materials	7, 9, 11,16	LAPD	Low	Staff time, General Funds	Short term, ongoing
LAPD-03: Emergency Cyber Incident Response Program						
New and Existing	Cyber	7, 9, 11,16	LAPD	Low	Staff time, General Funds	Short term, ongoing
LAPD-04: Technology – Video Downlink/Video Surveillance & Monitoring Equipment						
New and Existing	Civil Unrest	7, 9, 11,16	LAPD	Low	Staff time, General Funds	Short term, ongoing

Applies to new or existing assets	Hazards Mitigated	Objectives Met	Lead Agency	Estimated Cost	Sources of Funding	Timeline
LAPD-05: The City of Los Angeles identifies, assesses, and protects critical infrastructure through Operation Archangel, a comprehensive critical infrastructure and key resource protection program. Under this action, LAPD will Identify and implement critical asset protection measures through the critical asset protection program.						
Existing	All Hazards	7, 9, 11,16	LAPD	Low	Staff time, General Funds	Short term, ongoing
LAPD-06: Regional Video Command Center Equipment						
New and Existing	All Hazards	7, 9, 11,16	LAPD	Low	Staff time, General Funds	Short term, ongoing
LAPD-07: Technology – Explosive Detection Devices						
New and Existing	Terrorism	7, 9, 11,16	LAPD	Low	Staff time, General Funds	Short term, ongoing
LAPD-08: Update and maintain the Brushfire Response Plan (Wildland-Urban Interface Fires)						
New and Existing	Wildfire	2, 3, 4, 6, 8, 14, 16	LAPD	Medium	Staff time, General Funds	Short term, ongoing
LAPD-09: Continue to support and maintain the Terrorist Early Warning Group—Civil Disturbance						
New and Existing	Terrorism	7, 9, 11,16	LAPD	Low	Staff time, General Funds	Short term, ongoing
LAPD-10: Continue to deploy LAPD's Hazardous Materials Unit and inform it of the risks identified for the hazards assessed in this plan						
New and Existing	Hazardous materials	7, 9, 11,16	LAPD	Low	Staff time, General Funds	Short term, ongoing
LAPD-11: Identify and disseminate messaging on all phases of emergency management through a public outreach/education program.						
New and Existing	All Hazards	4, 5, 8, 9, 11,14,16	LAPD	Low	Staff time, General Funds	Short term, ongoing
LAPD-12: Update and maintain the Police Department Emergency Operations Guide						
New and Existing	All Hazards	7, 9, 11,16	LAPD	Low	Staff time, General Funds	Short term, ongoing
LAPD-13: Technology-Cellular Telephone Disruption Device						
New and Existing	Terrorism	7, 9, 11,16	LAPD	Low	Staff time, General Funds	Short term, ongoing
Department of Public Works (DPW)						
DPW-01: Construct new and/or retrofit existing stormwater facilities identified in the DPW CIP to manage stormwater from severe storm and flood events.						
New and Existing	Flood, adverse weather	1, 4, 6, 14,16	DPW	Medium	DPW operations funds, FEMA HMA programs	Long term, ongoing
DPW-02: : Prioritization for Capital Improvement Program						
New and Existing	Flood, adverse weather, tsunami, sea-level rise	1, 4, 6, 14,16	DPW	Medium	DPW operations funds, FEMA HMA programs	Long term, ongoing
DPW-03: Flood Zone Notification						
New and Existing	Flood, adverse weather, tsunami, sea-level rise	4, 5, 8, 9, 11,14,16	DPW	Low	Staff time, General Funds	Short term, ongoing
DPW-04: Bridge Improvement Program						
Existing	Flood, earthquake	1, 4, 6, 14,16	DPW	Medium	DPW operations funds, FEMA HMA programs	Long term, ongoing

Applies to new or existing assets	Hazards Mitigated	Objectives Met	Lead Agency	Estimated Cost	Sources of Funding	Timeline
DPW-05: Provide dam inundation maps to the public						
New and Existing	Dam failure	4, 5, 8, 9, 11,14,16	DPW	Low	Staff time, General Funds	Short term, ongoing
DPW-06: Brush Clearance at City owned landfills						
Existing	Wildfire	1, 7, 11,16	DPW	Low	Staff time, General Funds	Short term, ongoing
DPW-07: Continue ongoing Participation with Flood Organizations such as the CA Floodplain Management Association, the Association of State Floodplain Managers, and National Association of Stormwater and Floodplain Managers						
New and Existing	Flood, Adverse Weather, Tsunami, Sea-level rise	2, 3, 4, 6, 8, 14, 16	DPW	Low	Staff time, General Funds	Short term, ongoing
DPW-08: Mitigate vulnerable Wastewater Facilities						
Existing	Dam Failure, Earthquake, Flood, Landslide, Tsunami, Sea-level rise	1, 4, 6, 14,16	DPW	Medium	DPW operations funds, FEMA HMA programs	Long term, ongoing
DPW-09: Continue to support a Certified Flood Plain Manager initiative within DPW.						
New and Existing	Flood, Adverse Weather, Tsunami, Sea-level rise	2, 3, 4, 6, 8, 14, 16	DPW	Low	Staff time, General Funds	Short term, ongoing
DPW-10: Continue the implementation of the Seismic Bond Program						
Existing	Earthquake	1, 4, 6, 14,16	DPW	Medium	DPW operations funds, FEMA HMA programs	Long term, ongoing
DPW-11: Conduct National Flood Insurance Program Seminar for City staff with a role in floodplain management for the City.						
New and Existing	Flood, Adverse Weather, Tsunami, Sea-level rise	2, 3, 4, 6, 8, 14, 16	DPW	Low	Staff time, General Funds	Short term, ongoing
DPW-12: Continue the implementation of a Channel/Basin Debris Removal program						
Existing	Flood, Adverse Weather, Tsunami, Sea-level rise	1, 7, 11,16	DPW	Low	Staff time, General Funds	Short term, ongoing
DPW-13: Standby/Emergency Power Generation for All Wastewater Pumping & Treatment Plants						
Existing	All Hazards	1, 4, 6, 14,16	DPW	Medium	DPW operations funds, FEMA HMA programs	Long term, ongoing
DPW-14: Structural/Nonstructural seismic retrofit of Personnel Building						
Existing	Earthquake	1, 4, 6, 14,16	DPW	Medium	DPW operations funds, FEMA HMA programs	Short term, ongoing
DPW-15: Hazard Mapping and Survey Support						
New and existing	All hazards that have a clearly defined extent and location	2, 7, 8, 9, 14,16	DPW	Medium	DPW operations funds, FEMA HMA programs	Short term, ongoing
DPW-16: GIS Mapping and Modeling for Storm Water Facilities						
New and Existing	Adverse Weather, Flood	2, 7, 8, 9, 14,16	DPW	Medium	DPW operations funds, FEMA HMA programs	Short term, ongoing

Applies to new or existing assets	Hazards Mitigated	Objectives Met	Lead Agency	Estimated Cost	Sources of Funding	Timeline
DPW-17: Prioritize Flood Problem Sites						
New and Existing	Flood, Adverse Weather, Tsunami, Sea-level rise	1, 4, 6, 14,16	DPW	Medium	DPW operations funds, FEMA HMA programs	Long term, ongoing
DPW-18: Seismic structural retrofit of Hollywood Recreation Center						
Existing	Earthquake	1, 4, 6, 14,16	DPW	Medium	DPW operations funds, FEMA HMA programs	Short term, ongoing
DPW-19: Educate the Public About Debris in the Storm Water System						
New and Existing	Adverse Weather, Flood	4, 5, 8, 9, 11,14,16	DPW	Low	Staff time, General Funds	Short term, ongoing
DPW-20: Non Structural Earthquake Hazard Mitigation of identified vulnerable facilities.						
Existing	Earthquake	1, 4, 6, 14,16	DPW	Medium	DPW operations funds, FEMA HMA programs	Short term, ongoing
DPW-21: Improve Soil Stability and Erosion Abatement Regulations						
New and Existing	Landslide, Wildfire	2, 3, 4, 6, 8, 14, 16	DPW	Low	Staff time, General Funds	Short term, ongoing
DPW-22: Continue to Maintain and Evaluate FEMA Elevation Certificates						
New and Existing	Flood, Adverse Weather, Tsunami, Sea-level rise	4, 5, 8, 9, 11,14,16	DPW	Low	Staff time, General Funds	Short term, ongoing
DPW-23: Incorporate Flood Plain Management Information into the Zoning Information and Map Access System						
New and Existing	Flood, Adverse Weather, Tsunami, Sea-level rise	4, 5, 8, 9, 11,14,16	DPW	Low	Staff time, General Funds	Short term, ongoing
DPW-24: Identify new stormwater projects through the DPW CIP						
New	Adverse Weather, Flood	1, 4, 6, 14,16	DPW	Medium	DPW operations funds, FEMA HMA programs	Long term, ongoing
DPW-25: : Implementation of Flash Flood Warning System for Donald C. Tilman Plant, Los Angeles-Glendale Plant, Pumping Plant #3 and Pumping Plant #49						
Existing	Adverse Weather, Flood	1, 4, 6, 14,16	DPW	Medium	DPW operations funds, FEMA HMA programs	Long term, ongoing
DPW-26: Identify proposed mitigation measures under Department of Public Works						
New and Existing	All Hazards	1, 4, 6, 14,16	DPW	Medium	DPW operations funds, FEMA HMA programs	Long term, ongoing
DPW-27: Potrero Canyon Slope Stabilization on Pacific Coast Highway, a.k.a. Potrero Canyon Development Unit 4.						
New and Existing	Landslide, Wildfire	2, 3, 4, 6, 8, 14, 16	DPW	Low	Staff time, General Funds	Short term, ongoing
DPW-28: San Pedro 3rd Street Relief Storm Drain Project						
Existing	Adverse Weather, Flood	1, 4, 6, 14,16	DPW	Medium	DPW operations funds, FEMA HMA programs	Short-term, ongoing
DPW-29: Coordinate the implementation and maintenance of the 2015 City of Los Angeles Flood Hazard Management Plan with the implementation of this hazard mitigation plan. The 2015 City of Los Angeles Flood Hazard Management Plan and all of its actions and recommendation are considered to be fully integrated with this hazard mitigation plan by reference.						
New and Existing	Flood, Adverse Weather, Tsunami, Sea-level rise	2, 3, 4, 6, 8, 14, 16	DPW, EMD	Low	DPW operations funds, FEMA HMA programs	Short Term, ongoing

Applies to new or existing assets	Hazards Mitigated	Objectives Met	Lead Agency	Estimated Cost	Sources of Funding	Timeline
DPW-30: Continue to maintain good standing and compliance under the National Flood Insurance Program (NFIP). This will be accomplished through the implementation of floodplain management programs that will, at a minimum, meet the requirements of the NFIP: • Enforce the flood damage prevention ordinance • Participate in floodplain identification and mapping updates • Provide public assistance/information on floodplain requirements and impacts.						
New and Existing	Flood, Adverse Weather, Tsunami, Sea-level rise	2, 3, 4, 6, 8, 14, 16	DPW,LADBS	Low	DPW operations funds, LADBS operations funds	Short Term, ongoing
DPW-31: Oakdale Redwing Storm Drain Project						
Existing	Adverse Weather, Flood	1, 4, 6, 14,16	DPW	Medium	DPW operations funds, FEMA HMA programs	Short-term, ongoing
DPW-32: Burwood Figueroa Storm Drain Project						
Existing	Adverse Weather, Flood	1, 4, 6, 14,16	DPW	Medium	DPW operations funds, FEMA HMA programs	Short-term, ongoing
DPW-33: Westgate Montana Storm Drain Project						
Existing	Adverse Weather, Flood	1, 4, 6, 14,16	DPW	Medium	DPW operations funds, FEMA HMA programs	Short-term, ongoing
Department of Public Works-Bureau of Engineering (DPWBE)						
DPWBE-01: Nichols Canyon Road, Side-hill Structure Project. Restore lateral support to existing side-hill structure by drilling and installing rock anchors with reinforcing steel and shotcreting the slope to prevent further erosion.						
New and Existing	Landslide/Debris Flow	2, 4, 14	City of Los Angeles Public Works-Bureau of Engineering	750,000.00 Medium	Gas Tax, Measure M, General Fund, FEMA HMA grant funding	Short-4 years
DPWBE-02: Holly drive & Bryn Mawr Drive Rock-fall Mitigation Project. Lose rock and boulders will be scaled/removed from the slope surface. The slope will then be stabilized by drilling and installing rock anchor bolts and a wire mesh stabilization system in order to prevent the rock from toppling.						
New and Existing	Landslide/Debris Flow	2, 4, 14	City of Los Angeles Public Works-Bureau of Engineering	500,000.00 Medium	Gas Tax, FEMA HMA Grant funding	Short-4 Years
DPWBE-03: Mulholland Drive (13319) Bulkhead Project. This urgency/necessity project will restore lateral support to the existing roadway. Construction will consist of a new bulkhead extension.						
Existing	Landslide/Debris Flow	2, 4, 14	City of Los Angeles Public Works-Bureau of Engineering	634,000.00 Medium	Gas Tax Street Improvement Fund, FEMA HMA gran funding	Short
Department of Water and Power (DWP)						
DWP-01: Generation Backup Program						
New and Existing	All hazards that would interrupt power supply to DWP Facilities	1, 4, 6, 14,16	DWP	Medium	DPW operations funds, FEMA HMA programs	Long term, ongoing
DWP-02: Integrate Customer Connect with existing centers						
New and Existing	All Hazards	4, 5, 8, 9, 11,14,16	DWP	Low	Staff time, General Funds	Short term, ongoing

Applies to new or existing assets	Hazards Mitigated	Objectives Met	Lead Agency	Estimated Cost	Sources of Funding	Timeline
DWP-03: Security Lighting Upgrade Program						
Existing	Wildfire, flood, earthquake, tsunami, landslide, climate change, adverse weather	1, 4, 6, 14,16	DWP	Low	Staff time, General Funds	Short term, ongoing
DWP-04: Install perimeter security walls at RS-C, RS-G, RS-F, and River SS. All four stations have a long history of break-ins, vandalism, and theft. They could be targets for terrorism as well. RS-F and RS-G are medium low level CIP identified stations. Walls have been effective deterrents in other LADWP stations.						
Existing	All Hazards	1, 4, 6, 14,16	DWP	Low	Staff time, General Funds	Short term, ongoing
DWP-05: Weed Abatement						
Existing	Wildfire	1, 4, 6, 14,16	DWP	Low	Staff time, General Funds	Short term, ongoing
DWP-06: Identify new needs and enhance existing facilities through the LADWP Pump Station Refurbishment Program						
New and Existing	All Hazards	1, 4, 6, 14,16	DWP	Medium	DPW operations funds, FEMA HMA programs	Long term, ongoing
DWP-07: Identify new needs and enhance existing facilities through the Regulator Stations Program						
New and Existing	All Hazards	1, 4, 6, 14,16	DWP	Medium	DPW operations funds, FEMA HMA programs	Long term, ongoing
DWP-08: Identify new and enhance existing trunk lines and major system connections through the Trunk Lines and Major System Connections Program						
New and Existing	All Hazards	1, 4, 6, 14,16	DWP	Medium	DPW operations funds, FEMA HMA programs	Long term, ongoing
DWP-09: Identify HMA eligible projects in the Infrastructure Reservoir Improvements Program (tanks only)						
New and Existing	All Hazards	1, 4, 6, 14,16	DWP	Medium	DPW operations funds, FEMA HMA programs	Long term, ongoing
DWP-10: Griffith Park Improvements Project						
New	All hazards	1, 4, 6, 14,16	DWP	Medium	DPW operations funds, FEMA HMA programs	Short term, ongoing
DWP-11: Security projects at reservoirs, Dams, Facilities						
Existing	All Hazards	2, 6, 14,16	DWP	Medium	Staff time, General Funds	Short term, ongoing
DWP-12: Water Quality Additions and Betterments						
Existing	All Hazards	1, 4, 6, 14,16	DWP	Medium	Staff time, General Funds	Short term, ongoing
DWP-13: Infrastructure Reservoir Improvements Program (dams only)						
Existing	Dam Failure	1, 4, 6, 14,16	DWP	Medium	Staff time, General Funds	Long term, ongoing
DWP-14: Water Quality Improvement Project Reservoir Improvement Program						
Existing	Dam Failure	1, 4, 6, 14,16	DWP	Medium	Staff time, General Funds	Long term, ongoing
DWP-15: Seismic Strengthen of DS Yard walls						
Existing	Earthquake	1, 4, 6, 14,16	DWP	Medium	Staff time, General Funds	Long term, ongoing

Applies to new or existing assets	Hazards Mitigated	Objectives Met	Lead Agency	Estimated Cost	Sources of Funding	Timeline
DWP-16: S. Haiwee Reservoir Spillway Channel Modifications. Harden Spillway channel upstream and downstream to prevent Erosion and Scour. Needed to protect new LADWP-owned Facilities downstream of S. Haiwee Dam.						
Existing	Adverse Weather, Flood, Dam Failure, Critical Infrastructure	4, 6, 12	DWP	Medium	LADWP	Short Term
DWP-17: Tinemaha Reservoir Spillway Channel Improvement Project. Earthen Spillway channel requires a hardened invert and approach apron to prevent excessive Erosion and Scour. Higher Side Berms and Hardened Arizona crossings are needed to protect the channel from breaching its banks and preventing back flows towards the toe of the Dam. Increased spillway channel capacity back to the Owens River will reduce the risks of flooding State Highway 395 and reduce the risk of Dam failure.						
Existing	, Flood, Dam Failure, Critical Infrastructure	4, 6, 12	DWP	Medium	LADWP	Short Term
DWP-18: Four Culverts Replacement Project – Bishop Flood Bypass Channel. This facility was severely damaged during High flow events in Run-off Season 2017. The entire system of four CMP culverts and Regulatory slide gates, retaining walls and wing walls require 100 % rebuild. This release facility protects the City of Bishop, CA from flood damage by rerouting flood waters to a Flood Control Channel designed by the Army Corps of Engineers.						
Existing	Flood, Critical Infrastructure	4, 6, 12	DWP	Medium	LADWP	Short Term
DWP-19: Self-Propelled Suction Dredge for Sediment Removal along the LAA. A self-propelled suction dredge is required for sand trap cleaning, sediment removal operations in our aqueduct, and channel maintenance for flows through our reservoirs from inlet to outlet structures. The last suction Dredge was decommissioned in the late 1980's and needs to be replaced. New uses are channel maintenance for major Environmental Mitigation Projects like the 62-mile long Lower Owens River Project.						
Existing	, Flood, Critical Infrastructure	4, 6, 12	DWP	Medium	LADWP	Short Term
DWP-20: Tinemaha Reservoir Outlet Tower Seismic Evaluation & Hazard Mitigation Study to Determine Remedial Actions Required. Hazard Mitigation Study is Ongoing. A 2004 Seismic Evaluation determined that the tower would fail to perform its primary function of being able to control the outflow of water from the reservoir. The current H.M. Study will determine the ultimate remedial actions required. Alternatives vary from Demolition and 100% Rebuilding of a new outlet tower, down to Seismic strengthening of the existing tower and relining the outlet tunnel & and adding a new control valve downstream of the existing Dam.						
Existing	Adverse Weather, Flood, Critical Infrastructure	4, 6, 12	DWP	Medium	LADWP	Short Term
City of Los Angeles, Industrial Safety & Compliance Division, Hazardous Material & Waste management (LASAN)						
LASAN-01: Special, Mobile Hazardous Waste Collection						
Existing	Hazardous Materials	2, 5	LASAN/PW	$3,300,000.00	Special Fund	Annually
LASAN-02: Spill Prevention Program at Industrial Waste Management Division						
Existing	Hazardous Materials	2, 5	LASAN/PW	$70,000.00	General Fund	Annually
LASAN-03: Debris Removal						
Existing	Hazardous Materials	2, 6	LASAN/PW	$1,345,283.00	Special/General Fund	Annually
LASAN-04: Standby Power Generation for All Wastewater Pumping & Treatment Plants						
Existing	Public Health	11,12,14	LASAN/PW	N/A	Special Fund	Annually
LASAN-05: Accelerated Sewer Repair						
Existing	Public Health	6	LASAN/PW	$9,697.00	Special/General Fund	01/09/2021
LASAN-06: ICSD – Offsite Backup Tape Storage/Archiving for LASAN						
Existing	Terrorism	11,12	LASAN/PW	Low	Staff Time	Long Term

Applies to new or existing assets	Hazards Mitigated	Objectives Met	Lead Agency	Estimated Cost	Sources of Funding	Timeline
LASAN-07: Implementation of Flash Flood Warning System for Donald C. Tilman Plant, Los Angeles-Glendale Plant, Pumping Plant #3 and Pumping Plant #49						
Existing	Urban Flood	1	LASAN/PW	N/A		Long Term
LASAN-08: Refine the Use of the Plan Check Inspection System						
Existing	Urban Flood	8, 14	LASAN, DPWBE	Low	General Fund, Storm Water Pollution Abatement Fund	N/A
LASAN-09: Revise the map of hillside areas to identify urban flooding “hot-spots” for maintenance needs and the identification of future stormwater management projects.						
Existing	Urban Flood	8, 14	LASAN, DPWBE	Low	Storm Water Pollution Abatement Fund, General Fund	
LASAN-10: Educate the Public About Debris in the Storm Water System						
Existing	Urban Flood	5, 9, 10,15	LASAN, DPWBE	Low	Storm Water Pollution Abatement Fund	Long Term
LASAN-11: Establish New Flood Hazard Mitigation Techniques						
Existing	Urban Flood	1, 2, 3, 4, 15	LASAN, DPWBE	Low	Storm Water Pollution Abatement Fund	Long Term

23.2.2 Action Plan Prioritization

Table 23-2 lists the priority of each action. The priorities are defined as follows:

- **High Priority**—A project that meets multiple objectives (i.e., multiple hazards), has benefits that exceed cost, has funding secured or is an ongoing project and meets eligibility requirements for the HMGP or PDM grant program. High priority projects can be completed in the short term (1 to 5 years).
- **Medium Priority**—A project that meets goals and objectives, that has benefits that exceed costs, and for which funding has not been secured but that is grant eligible under HMGP, PDM or other grant programs. Project can be completed in the short term, once funding is secured. Medium priority projects will become high priority projects once funding is secured.
- **Low Priority**—A project that will mitigate the risk of a hazard, that has benefits that do not exceed the costs or are difficult to quantify, for which funding has not been secured, that is not eligible for HMGP or PDM grant funding, and for which the time line for completion is long term (1 to 10 years). Low priority projects may be eligible for other sources of grant funding from other programs.

Table 23-2. Prioritization of Actions

Action #	# of Objectives Met	Benefits	Costs	Do Benefits Equal or Exceed Costs?	Is Project Grant-Eligible?	Can Project Be Funded Under Existing Programs/ Budgets?	Implementation Priority[a]	Grant Priority[a]
DASA-01	8	Medium	Medium	Yes	No	Yes	High	N/A
LADBS-01	5	Medium	Low	Yes	No	Yes	High	N/A
LADBS-02	7	Medium	Low	Yes	No	Yes	High	N/A
LADBS-03	3	Medium	Low	Yes	No	Yes	High	N/A
DDS-01	6	Medium	Low	Yes	No	Yes	High	N/A
DDS-02	6	Medium	Low	Yes	No	Yes	High	N/A
DDS-03	5	Medium	Low	Yes	No	Yes	High	N/A
DDS-04	6	Medium	Low	Yes	No	Yes	High	N/A
EMD-01	16	High	Medium	Yes	Yes	Yes	High	High
LAFD-01	4	Medium	Medium	Yes	No	Yes	High	N/A
LAFD-02	3	Low	Low	Yes	No	Yes	High	N/A
LAFD-03	9	Medium	Medium	Yes	Yes	Yes	Medium	Medium
LAFD-04	4	Medium	Low	Yes	No	Yes	High	N/A
GSD-01	6	Low	Low	Yes	No	Yes	High	N/A
HAR-01	7	Medium	Low	Yes	No	Yes	High	N/A
HAR-02	4	Medium	Medium	Yes	Yes	Yes	High	High
HAR-03	3	Medium	Medium	Yes	Yes	Yes	High	High
HAR-04	5	High	Medium	Yes	Yes	Yes	High	High
HAR-05	5	Medium	Low	Yes	Yes	Yes	High	High
HAR-06	5	Medium	Low	Yes	Yes	Yes	High	High
HAR-07	7	Low	Low	Yes	No	Yes	High	N/A
HAR-08	7	Low	Low	Yes	No	Yes	High	N/A
HCID-01	2	Medium	Medium	Yes	Yes	Yes	High	High
HCID-02	4	High	High	Yes	Yes	No	Medium	High
ITA-01	4	Low	Low	Yes	Yes	Yes	High	N/A
ITA-02	3	Low	Low	Yes	Yes	Yes	High	N/A
ITA-03	4	Low	Low	Yes	Yes	Yes	High	N/A
ITA-04	4	Low	Low	Yes	Yes	Yes	High	N/A
ITA-05	6	Low	Low	Yes	Yes	Yes	High	N/A
LAWA-01	4	High	Medium	Yes	Yes	Yes	High	High
PL-01	7	Medium	Low	Yes	No	Yes	High	N/A
PL-02	7	Medium	Low	Yes	No	Yes	High	N/A
PL-03	7	Medium	Low	Yes	No	Yes	High	N/A
LAPD-01	4	Medium	Low	Yes	No	Yes	High	N/A
LAPD-02	4	Medium	Low	Yes	No	Yes	High	N/A
LAPD-03	4	Medium	Low	Yes	No	Yes	High	N/A
LAPD-04	4	Low	Low	Yes	No	Yes	High	N/A
LAPD-05	4	Low	Low	Yes	No	Yes	High	N/A
LAPD-06	4	Low	Low	Yes	No	Yes	High	N/A
LAPD-07	4	High	Low	Yes	No	Yes	High	N/A

Action #	# of Objectives Met	Benefits	Costs	Do Benefits Equal or Exceed Costs?	Is Project Grant-Eligible?	Can Project Be Funded Under Existing Programs/ Budgets?	Implementation Priority[a]	Grant Priority[a]
LAPD-08	7	Low	Low	Yes	No	Yes	High	N/A
LAPD-09	4	Low	Low	Yes	No	Yes	High	N/A
LAPD-10	4	Low	Low	Yes	No	Yes	High	N/A
LAPD-11	7	Low	Low	Yes	No	Yes	High	N/A
LAPD-12	4	Low	Low	Yes	No	Yes	High	N/A
LAPD-13	4	Low	Low	Yes	No	Yes	High	N/A
DPW-01	5	Medium	Medium	Yes	Yes	Yes	High	High
DPW-02	5	Medium	Medium	Yes	Yes	Yes	High	High
DPW-03	7	Low	Low	Yes	No	Yes	High	N/A
DPW-04	5	High	Medium	Yes	Yes	Yes	High	High
DPW-05	7	Low	Low	Yes	No	Yes	High	N/A
DPW-06	4	Medium	Low	Yes	No	Yes	High	N/A
DPW-07	7	Low	Low	Yes	No	Yes	High	N/A
DPW-08	5	High	Medium	Yes	Yes	Yes	High	High
DPW-09	7	Low	Low	Yes	No	Yes	High	N/A
DPW-10	5	High	Medium	Yes	Yes	Yes	High	Medium
DPW-11	7	Low	Low	Yes	No	Yes	High	N/A
DPW-12	4	Medium	Low	Yes	No	Yes	High	N/A
DPW-13	5	Medium	Medium	Yes	Yes	Yes	High	High
DPW-14	5	High	Medium	Yes	Yes	Yes	High	High
DPW-15	6	Medium	Medium	Yes	Yes	Yes	High	Medium
DPW-16	6	Medium	Medium	Yes	Yes	Yes	High	Medium
DPW-17	5	High	Medium	Yes	Yes	Yes	High	High
DPW-18	5	High	Medium	Yes	Yes	Yes	High	High
DPW-19	7	Low	Low	Yes	No	Yes	High	N/A
DPW-20	5	High	Medium	Yes	Yes	Yes	High	High
DPW-21	7	Medium	Low	Yes	No	Yes	High	N/A
DPW-23	7	Low	Low	Yes	No	Yes	High	N/A
DPW-24	7	High	Low	Yes	No	Yes	High	N/A
DPW-25	5	High	Medium	Yes	Yes	Yes	High	Medium
DPW-26	5	High	Medium	Yes	No	Yes	High	N/A
DPW-27	7	Medium	Medium	Yes	No	Yes	High	N/A
DPW-28	5	Medium	Low	Yes	Yes	Yes	High	Medium
DPW-29	7	High	Medium	Yes	Yes	Yes	High	High
DPW-30	7	High	Low	Yes	No	Yes	High	N/A
DPW-31	5	Medium	Low	Yes	Yes	Yes	High	Medium
DPW-32	5	Medium	Low	Yes	Yes	Yes	High	Medium
DPW-33	5	Medium	Low	Yes	Yes	Yes	High	Medium
DPWBE-01	3	High	Medium	Yes	Yes	Yes	High	High
DPWBE-02	3	High	Medium	Yes	Yes	Yes	High	High
DPWBE-03	3	High	Medium	Yes	Yes	Yes	High	High

Action #	# of Objectives Met	Benefits	Costs	Do Benefits Equal or Exceed Costs?	Is Project Grant-Eligible?	Can Project Be Funded Under Existing Programs/ Budgets?	Implementation Priority[a]	Grant Priority[a]
DWP-01	5	Medium	Medium	Yes	Yes	Yes	High	High
DWP-02	7	Medium	Low	Yes	No	Yes	High	N/A
DWP-03	5	Medium	Low	Yes	No	Yes	High	N/A
DWP-04	5	Medium	Low	Yes	No	Yes	High	N/A
DWP-05	5	Medium	Low	Yes	No	Yes	High	N/A
DWP-06	5	Medium	Medium	Yes	Yes	Yes	High	High
DWP-07	5	Medium	Medium	Yes	Yes	Yes	High	High
DWP-08	5	Medium	Medium	Yes	Yes	Yes	High	High
DWP-09	5	Medium	Medium	Yes	Yes	Yes	High	High
DWP-10	5	Medium	Medium	Yes	Yes	Yes	High	High
DWP-11	4	Medium	Medium	Yes	No	Yes	High	N/A
DWP-12	5	Medium	Medium	Yes	No	Yes	High	N/A
DWP-13	5	Medium	Medium	Yes	No	Yes	High	N/A
DWP-14	5	Medium	Medium	Yes	No	Yes	High	N/A
DWP-15	5	Medium	Medium	Yes	No	Yes	High	N/A
DWP-16	4	High	Medium	Yes	Yes	Yes	Medium	Medium
DWP-17	4	High	Medium	Yes	Yes	Yes	Medium	Medium
DWP-18	4	High	Medium	Yes	Yes	Yes	Medium	Medium
DWP-19	4	High	Medium	Yes	Yes	Yes	Medium	Medium
DWP-20	4	High	Medium	Yes	Yes	Yes	Medium	Medium
LASAN-01	2	Medium	Low	Yes	No	Yes	High	N/A
LASAN-02	2	Medium	Low	Yes	No	Yes	High	N/A
LASAN-03	2	Medium	Low	Yes	No	Yes	High	N/A
LASAN-04	3	Medium	Low	Yes	Yes	Yes	High	High
LASAN-05	1	Medium	Low	Yes	Yes	Yes	High	High
LASAN-06	2	Medium	Low	Yes	No	Yes	High	N/A
LASAN-07	1	Medium	Low	Yes	No	Yes	High	N/A
LASAN-08	2	Medium	Low	Yes	No	Yes	High	N/A
LASAN-09	2	Medium	Low	Yes	No	Yes	High	N/A
LASAN-10	5	Medium	Low	Yes	No	Yes	High	N/A
LASAN-11	5	Medium	Low	Yes	Yes	Yes	High	High

23.2.3 Analysis of Actions

Each recommended action was classified based on the hazard it addresses and the category it involves. Table 23-3 shows the classification based on this analysis. Mitigation types used for this categorization are as follows:

- **Prevention**—Government, administrative or regulatory actions that influence the way land and buildings are developed to reduce hazard losses. Includes planning and zoning, floodplain laws, capital improvement programs, open space preservation, and stormwater management regulations.
- **Property Protection**—Modification of buildings or structures to protect them from a hazard or removal of structures from a hazard area. Includes acquisition, elevation, relocation, structural retrofit, storm shutters, and shatter-resistant glass.
- **Public Education and Awareness**—Actions to inform residents and elected officials about hazards and ways to mitigate them. Includes outreach projects, real estate disclosure, hazard information centers, and school-age and adult education.
- **Natural Resource Protection**—Actions that minimize hazard loss and preserve or restore the functions of natural systems. Includes sediment and erosion control, stream corridor restoration, watershed management, forest and vegetation management, and wetland restoration and preservation.
- **Emergency Services**—Actions that protect people and property during and immediately after a hazard event. Includes warning systems, emergency response services, and the protection of essential facilities.
- **Structural Projects**—Actions that involve the construction of structures to reduce the impact of a hazard. Includes dams, setback levees, floodwalls, retaining walls, and safe rooms.
- **Climate Resilience—**Any action that will promote or support the community's adaptive capacity to the potential impacts from global climate change.

Table 23-3. Analysis of Actions

Hazard Type	Action Addressing Hazard, by Mitigation Type[a]						
	1. Prevention	2. Property Protection	3. Public Education and Awareness	4. Natural Resource Protection	5. Emergency Services	6. Structural Projects	7. Climate Resilient
Adverse Weather	DAS-01, LADBS-02, EMD-01, HAR-01, ITA-01, PL-01, PL-02,PL-03, DPW-07, DPW-09 DPW-12, DPW-15 DPW-16, DPW-22 DPW-29, DWP-06	LADBS-03, HAR-03, LAFD-04, DPW-08, DPW-09, DPW-13, DPW-22 DPW-29, DWP-03 DWP-04, DWP-07	DDS-01, DDS-02 DDS-04, LAPD-11 DPW-03 DPW-09 DPW-19 DPW-23 DPW-29 DWP-02 LASAN-10	PL-01, PL-02, PL-03 DPW-09 DPW-29 DWP-12	DDS-03, GSD-01, ITA-02, ITA-03, ITA-04, LAPD-01 LAPD-12, DPW-09 DPW-25, DPW-29, DWP-01,	DPW-01, DPW-02 DPW-09 DPW-24 DPW-26 DPW-28 DPW-29 DPW-31 DPW-32 DPW-33 DWP-09 DWP-16	PL-01, PL-02, PL-03 DPW-09 DPW-29
Dam Failure	DAS-01, EMD-01 HAR-01, ITA-01, ITA-05, PL-01, PL-02, PL-03, DPW-07, DPW-09 DPW-12, DPW-15 DPW-22, DPW-29 DWP-06, DWP-14 DWP -20	LADBS-03 HAR-03, LAFD-04 DPW-08, DPW-09 DPW-13, DPW-22 DPW-29, DWP-03 DWP-04, DWP-07 DWP-13	DDS-01, DDS-02 DDS-04 LAPD-11 DPW-03 DPW-05 DPW-09 DPW-23 DPW-29 DWP-02	PL-01, PL-02, PL-03 DPW-09 DPW-29 DWP-12 DWP-14	DDS-03, GSD-01, ITA-02, ITA-03, ITA-04, ITA-05, LAPD-01, LAPD-12 DPW-09, DPW-29, DWP-01,	DPW-02, DPW-09 DPW-26 DPW-29 DWP-08 DWP-09 DWP-16 DWP-17 DWP -18:	PL-01, PL-02, PL-03 DPW-09 DPW-29
Drought	DAS-01, EMD-01 HAR-01, ITA-01, PL-01, PL-02, PL-03 DPW-15, DWP-06	HAR-03, LAFD-04 DPW-08, DPW-13, DWP-04, DWP-07	DDS-01, DDS-02 DDS-04 LAPD-11 DWP-02	PL-01, PL-02, PL-03 DWP-12	DDS-03, GSD-01, ITA-02, ITA-03, ITA-04, LAPD-01 LAPD-12, DWP-01,	DPW-26 DWP-08	PL-01, PL-02, PL-03 DWP-09
Earthquake	DAS-01, EMD-01 HAR-01, ITA-01, ITA-05, LAWA-01, PL-01, PL-02, PL-03 DPW-10, DPW-15 DWP-06, DWP -20	LADBS-03 HAR-03 HAR-04, LAFD-04, HCID-02, LAWA-01 DPW-04, DPW-08 DPW-10, DPW-13 DPW-14, DPW-18 DPW-20, DWP-03 DWP-04, DWP-07 DWP-15	DDS-01, DDS-02 DDS-04, LAPD-11 DWP-02	PL-01, PL-02, PL-03 DWP-12	DDS-03, GSD-01, ITA-02 , ITA-03, ITA-04, ITA-05, LAPD-01, LAPD-12 DWP-01,	LAWA-01 DPW-26 DWP-08	PL-01, PL-02, PL-03 DWP-09

Hazard Type	Action Addressing Hazard, by Mitigation Type[a]						
	1. Prevention	2. Property Protection	3. Public Education and Awareness	4. Natural Resource Protection	5. Emergency Services	6. Structural Projects	7. Climate Resilient
Flood	DAS-01, LADBS-02, EMD-01 HAR-01, ITA-01, ITA-05, PL-01, PL-02, PL-03, DPW-07, DPW-09 DPW-12, DPW-15 DPW-16, DPW-22 DPW-29, DPW-30 DWP-06, DWP -20 LASAN-08, LASAN-09	LADBS-03 HAR-03, LAFD-04 DPW-04, DPW-08 DPW-09, DPW-13 DPW-22, DPW-29 DPW-30, DWP-03 DWP-04, DWP-07 LASAN-11	LADBS-01, DDS-01, DDS-02, DDS-04 LAPD-11 DPW-03 DPW-09 DPW-11 DPW-19 DPW-23 DPW-29 DPW-30 DWP-02 LASAN-10	PL-01, PL-02, PL-03 DPW-09 DPW-29 DPW-30 DWP-12	DDS-03, GSD-01, ITA-02, ITA-03, ITA-04, ITA-05, LAPD-01, LAPD-12 DPW-09, DPW-25 DPW-29, DPW-30 DWP-01, LASAN-07	DPW-01, DPW-02, DPW-09 DPW-17 DPW-24 DPW-26 DPW-28 DPW-29 DPW-30 DPW-31 DPW-32 DPW-33 DWP-08 DWP-10 DWP-16 DWP-17 DWP -18: DWP -19	PL-01, PL-02, PL-03 DPW-09 DPW-29 DPW-30 DWP-09
Landslide	DAS-01, EMD-01 HAR-01, ITA-01, PL-01, PL-02, PL-03 DPW-15, DWP-06 LASAN-09	LADBS-03 HAR-03, LAFD-04, DPW-08, DPW-13 DWP-03, DWP-04 DWP-07	LADBS-01, DDS-02, DDS-04, LAPD-11 DWP-02	PL-01, PL-02, PL-03 DWP-12	DDS-03 GSD-01, HCID-01, ITA-02, ITA-03, ITA-04, LAPD-01 LAPD-12, DWP-01,	DPW-21 DPW-26 DPW-27 DPWBE-01 DPWBE-02 DWPBE-03 DWP-08 DWP-10	PL-01, PL-02, PL-03 DWP-09
Tsunami	DAS-01, LADBS-02, EMD-01 HAR-01, ITA-01, ITA-05, PL-01, PL-02, PL-03, DPW-07, DPW-09 DPW-12, DPW-15 DPW-22, DPW-29 DWP-06	LADBS-03 HAR-03, LAFD-01, LAFD-04, DPW-08 DPW-09, DPW-13 DPW-22, DPW-29 DWP-03, DWP-04 DWP-07	DDS-01, DDS-02 DDS-04 LAPD-11 DPW-03 DPW-09 DPW-23 DPW-29 DWP-02	PL-01, PL-02, PL-03 DPW-09 DPW-29 DWP-12	DDS-03, LAFD-01 GSD-01, HCID-01, ITA-02, ITA-03, ITA-04, ITA-05, LAPD-01, LAPD-12 DPW-09, DPW-29 DWP-01,	DPW-09 DPW-26 DPW-29 DWP-08 DWP-10	PL-01, PL-02, PL-03 DPW-09 DPW-29 DWP-09
Wildfire	DAS-01, EMD-01 HAR-01, LAFD-02. LAFD-03, ITA-01, PL-01, PL-02, PL-03 DPW-06, DPW-15 DWP-05, DWP-06	LADBS-03 HAR-03, LAFD-04, DPW-08, DPW-13 DPW-13, DWP-03 DWP-04, DWP-07	LADBS-01, DDS-01, DDS-02 LAPD-11 DWP-02	PL-01, PL-02, PL-03 DPW-06 DWP-12	DDS-03, LAFD-02, LAFD-03 GSD-01, LAFD-03, HCID-01, ITA-02, ITA-03, ITA-04, LAPD-01, LAPD-08 LAPD-12, DWP-01,	DPW-21 DPW-26 DPW-26 DPW-27 DWP-08 DWP-10	PL-01, PL-02, PL-03 DWP-09

Hazard Type	Action Addressing Hazard, by Mitigation Type[a]						
	1. Prevention	2. Property Protection	3. Public Education and Awareness	4. Natural Resource Protection	5. Emergency Services	6. Structural Projects	7. Climate Resilient
Sea-Level Rise	DAS-01, LADBS-02, EMD-01 HAR-01, ITA-01, ITA-05, PL-01, PL-02, PL-03, DPW-07, DPW-09 DPW-12, DPW-15 DPW-22, DPW-29 DWP-06	LADBS-03 HAR-03, LAFD-01, LAFD-04, DPW-08 DPW-09, DPW-13 DPW-22, DPW-29, DWP-04, DWP-07	DDS-01, DDS-02, DDS-04 LAPD-11 DPW-03 DPW-09 DPW-23 DPW-29 DWP-02	PL-01, PL-02, PL-03 DPW-09 DPW-29 DWP-12	DDS-03, LAFD-01 GSD-01, HCID-01, ITA-02, ITA-03, ITA-04, ITA-05, LAPD-01, LAPD-12 DPW-09, DPW-29 DWP-01,	DPW-02 DPW-09 DPW-26 DPW-29 DWP-08 DWP-10 DWP-16	PL-01, PL-02, PL-03 DPW-09 DPW-29 DWP-09
Critical Infrastructure	DAS-01, EMD-01 HAR-01, ITA-01, PL-02, PL-03 DWP-06, DWP -20	LADBS-03, LAFD-04 HAR-02: HAR-03, LAFD-04 DPW-13, DWP-03 DWP-04, DWP-07	DDS-01, DDS-02, DDS-04 LAPD-11 DWP-02	DWP-12	DDS-03 GSD-01, HCID-01, ITA-02, ITA-03, ITA-04, LAPD-01, LAPD-06, LAPD-12 DWP-01,	DWP-10 DWP-17 DWP -18:	DWP-09
Cyber-attack	DAS-01, EMD-01 HAR-01, ITA-01, DWP-06	HAR-03, LAPD-05 DWP-03, DWP-04 DWP-07	DDS-01, DDS-02, DDS-04, LAPD-11 DWP-02	DWP-12	DDS-03 GSD-01, HCID-01, ITA-02, ITA-03, ITA-04, LAPD-01, LAPD-03, LAPD-06 LAPD-12, DWP-01,	DWP-10	DWP-09
Hazardous Materials Incidents	DAS-01, EMD-01 HAR-01, ITA-01, LAPD-02, DWP-06 LASAN-01, LASAN-02, LASAN-03	HAR-03, LAFD-04, LAPD-05, DWP-03 DWP-04, DWP-07	DDS-01, DDS-02, DDS-04, LAPD-11 DWP-02	DWP-12 LASAN-03	DDS-03 GSD-01, HCID-01, ITA-02, ITA-03, ITA-04, LAPD-01, LAPD-06, LAPD-10 LAPD-12, DWP-01,	DWP-10	DWP-09
High-Rise/ High-Occupancy Building Fire	DAS-01, EMD-01 HAR-01, ITA-01, DWP-06	LADBS-03 HAR-03, LAFD-04, LAPD-05, DWP-03 DWP-04, DWP-07	DDS-01, DDS-02 DDS-04, LAPD-11 DWP-02	DWP-12	DDS-03 GSD-01, HCID-01, ITA-02, ITA-03, ITA-04, LAPD-01, LAPD-06, LAPD-12 DWP-01,	DWP-10	DWP-09
Public Health Hazards	DAS-01, EMD-01 HAR-01, ITA-01, DWP-06	HAR-03, LAPD-05 DWP-03, DWP-04 DWP-07, LASAN-04	DDS-01, DDS-02, DDS-04, LAPD-11 DWP-02	DWP-12	DDS-03 GSD-01, HCID-01, ITA-02, ITA-03, ITA-04, LAPD-01 LAPD-12, DWP-01,	DWP-10 LASAN-05	DWP-09

	Action Addressing Hazard, by Mitigation Type[a]						
Hazard Type	1. Prevention	2. Property Protection	3. Public Education and Awareness	4. Natural Resource Protection	5. Emergency Services	6. Structural Projects	7. Climate Resilient
Radiological Incidents	DAS-01, EMD-01 HAR-01, ITA-01, DWP-06	LADBS-03 HAR-03, LAFD-04, LAPD-05, DWP-03 DWP-04, DWP-07	DDS-01, DDS-02, DDS-04, LAPD-11 DWP-02	DWP-12	DDS-03 GSD-01, HCID-01, ITA-02, ITA-03, ITA-04, LAPD-01, LAPD-06, LAPD-12 DWP-01,	DWP-10	DWP-09
Special Events	DAS-01, EMD-01 HAR-01, ITA-01, LAPD-04, DWP-06	LAFD-04 HAR-03, LAFD-04, LAPD-05, DWP-03 DWP-04, DWP-07	DDS-01, DDS-02, DDS-04, LAPD-11 DWP-02	DWP-12	DDS-03 GSD-01, HCID-01, ITA-02, ITA-03, ITA-04, LAPD-01, LAPD-04,LAPD-06 LAPD-12, DWP-01,	DWP-10	DWP-09
Terrorism and Weapons of Mass Destructions	DAS-01, EMD-01 HAR-01, HAR-05, HAR-07, ITA-01, LAPD-04, LAPD-07, LAPD-13 DWP-06, LASAN-06	LADBS-03,LAFD-04,LAPD-05,LAPD-07, DPW-13, DWP-03, DWP-04, DWP-07	DDS-01, DDS-02' DDS-04, HAR-06, LAPD-11 DWP-02	DWP-12	DDS-03 GSD-01, HAR-08, HCID-01, ITA-02, ITA-03, ITA-04, LAPD-01, LAPD-06, LAPD-07 LAPD-08, LAPD-12 DWP-01,	DWP-10	DWP-09

a. See Section 23.2.3 for description of mitigation types

23.3 PLAN ADOPTION

A hazard mitigation plan must document that it has been formally adopted by the governing body of the jurisdiction requesting federal approval of the plan (44 CFR Section 201.6(c)(5)). DMA compliance and its benefits cannot be achieved until the plan is adopted. This plan will be submitted for a pre-adoption review to Cal OES prior to adoption. Once pre-adoption approval has been provided, the City of Los Angeles will formally adopt the plan. A copy of the resolution is provided in Appendix E.

23.4 PLAN MAINTENANCE STRATEGY

A hazard mitigation plan must present a plan maintenance process that includes the following (44 CFR Section 201.6(c)(4)):

- A section describing the method and schedule of monitoring, evaluating, and updating the mitigation plan over a 5-year cycle
- A process by which local governments incorporate the requirements of the mitigation plan into other planning mechanisms, such as comprehensive or capital improvement plans, when appropriate
- A discussion of how the community will continue public participation in the plan maintenance process.

This section details the formal process that will ensure that the hazard mitigation plan remains an active and relevant document and that the City of Los Angeles maintains its eligibility for applicable funding sources. The plan maintenance process includes a schedule for monitoring and evaluating the plan annually and producing an updated plan every five years. This section also describes how public participation will be integrated throughout the plan maintenance and implementation process. It also explains how the mitigation strategies outlined in this plan will be integrated with existing planning mechanisms and programs, such as comprehensive land-use planning processes, capital improvement planning, and building code enforcement and implementation. The plan's format allows sections to be reviewed and updated when new data become available, resulting in a plan that will remain current and relevant.

23.4.1 Plan Implementation

The effectiveness of the hazard mitigation plan depends on its implementation and incorporation of its action items into existing local plans, policies and programs. Together, the action items in the Plan provide a framework for activities that the City of Los Angeles can implement over the next 5 years. The planning team and the Steering Committee have established goals and objectives and have prioritized mitigation actions that will be implemented through existing plans, policies, and programs.

The City of Los Angeles Emergency Management department (EMD) will have lead responsibility for overseeing the Plan implementation and maintenance strategy. Plan implementation and evaluation will be a shared responsibility among all agencies identified as lead agencies in the mitigation action plan.

23.4.2 Steering Committee

The Steering Committee is a total volunteer body that oversaw the development of the Plan and made recommendations on key elements of the plan, including the maintenance strategy. It was the Steering Committee's position that an oversight committee with representation similar to that of the Steering Committee should have an active role in the plan maintenance strategy. Therefore, it is recommended that a steering committee remain a viable body involved in key elements of the Plan maintenance strategy. The new steering committee should include representation from stakeholders in the planning area.

The principal role of the new steering committee in this plan maintenance strategy will be to review the annual progress report and provide input to EMD on possible enhancements to be considered at the next update. Future plan updates will be overseen by a steering committee similar to the one that participated in this plan development process, so keeping an interim steering committee intact will provide a head start on future updates. It will be the steering committee's role to review the progress report in an effort to identify issues needing to be addressed by future plan updates.

23.4.3 Annual Progress Report

The minimum task of the ongoing annual steering committee meeting will be the evaluation of the progress of its individual action plan during a 12-month performance period. This review will include the following:

- Summary of any hazard events that occurred during the performance period and the impact these events had on the planning area
- Review of mitigation success stories
- Review of continuing public involvement
- Brief discussion about why targeted strategies were not completed
- Re-evaluation of the action plan to determine if the timeline for identified projects needs to be amended (such as changing a long-term project to a short-term one because of new funding)
- Recommendations for new projects
- Changes in or potential for new funding options (grant opportunities)
- Impact of any other planning programs or actions that involve hazard mitigation.

The planning team has created a template for preparing a progress report (see Appendix D). The plan maintenance steering committee will provide feedback to the planning team on items included in the template. The planning team will then prepare a formal annual report on the progress of the plan. This report should be used as follows:

- Posted on the EMD website page dedicated to the hazard mitigation plan
- Provided to the local media through a press release
- Presented to Los Angeles City Council inform them of the progress of actions implemented during the reporting period

Annual progress reporting is not a requirement specified under 44 CFR. However, it may enhance opportunities for funding. While failure to implement this component of the plan maintenance strategy will not jeopardize compliance under the DMA, it may jeopardize the opportunity to leverage funding opportunities with other agencies.

23.4.4 Plan Update

Local hazard mitigation plans must be reviewed, revised if appropriate, and resubmitted for approval in order to remain eligible for benefits under the DMA (44 CFR, Section 201.6(d)(3)). The City of Los Angeles intends to update the hazard mitigation plan on a 5-year cycle from the date of initial plan adoption. This cycle may be accelerated to less than 5 years based on the following triggers:

- A Presidential Disaster Declaration that impacts the planning area
- A hazard event that causes loss of life
- A comprehensive update of the City of Los Angeles General Plan.

It will not be the intent of future updates to develop a complete new hazard mitigation plan for the planning area. The update will, at a minimum, include the following elements:

- The update process will be convened through a steering committee.
- The hazard risk assessment will be reviewed and, if necessary, updated using best available information and technologies.
- The action plan will be reviewed and revised to account for any actions completed, dropped, or changed and to account for changes in the risk assessment or new policies identified under other planning mechanisms (such as the General Plan).
- The draft update will be sent to appropriate agencies and organizations for comment.
- The public will be given an opportunity to comment on the update prior to adoption.
- The Los Angeles City Council will adopt the updated plan.

23.4.5 Continuing Public Involvement

The public will continue to be apprised of the plan's progress through the EMD website and by providing copies of annual progress reports to the media. The website will not only house the final plan, it will become the one-stop shop for information regarding the plan and plan implementation. Copies of the plan will be distributed to the City of Los Angeles library system. Upon initiation of future update processes, a new public involvement strategy will be initiated based on guidance from a new steering committee. This strategy will be based on the needs and capabilities of the City of Los Angeles at the time of the update. At a minimum, this strategy will include the use of local media outlets within the planning area.

23.4.6 Integration with Other Planning Mechanisms

The City of Los Angeles, through adoption of a General Plan and zoning ordinance, has planned for the impact of natural hazards. The process of updating this hazard mitigation plan provided the opportunity to review and expand on policies in these planning mechanisms. The information on hazard, risk, vulnerability, and mitigation contained in this hazard mitigation plan is based on the best science and technology available at the time this plan was prepared. The General Plan and the hazard mitigation plan are complementary documents that work together to achieve the goal of reducing risk exposure. The General Plan is considered to be an integral part of this plan. An update to the General Plan may trigger an update to the hazard mitigation plan.

The City of Los Angeles will create a linkage between the hazard mitigation plan and the General Plan by identifying a mitigation action as such and giving that action a high priority. Other planning processes and programs to be coordinated with the recommendations of the hazard mitigation plan include the following:

- City of Los Angeles General Plan
- Climate Action Plans
- Resilience Plans
- Recovery Plan
- Emergency response plans
- Capital improvement programs
- Municipal codes
- Community design guidelines
- Water-efficient landscape design guidelines
- Stormwater management programs
- Water system vulnerability assessments
- Master fire protection plans.

Some action items do not need to be implemented through regulation. Instead, these items can be implemented through the creation of new educational programs, continued interagency coordination, or improved public participation. As information becomes available from other planning mechanisms that can enhance this plan, that information will be integrated via the update process.

REFERENCES

Association of State Dam Safety Officials. 2013. "Introduction to Dams." Dam Safety 101. Accessed 2017. http://www.damsafety.org/news/?p=e4cda171-b510-4a91-aa30-067140346bb2.

Brown, W. et al. 2001. U.S. Geological Survey (USGS). "Hazard Maps Help Save Lives and Property." 2001. Accessed 2017. http://pubs.usgs.gov/fs/1996/fs183-96/fs183-96.pdf.

Cal-Adapt. 2016. "Exploring California's Climate Change Research." Accessed January 2017. http://cal-adapt.org/.

California Code of Regulations. 2017. http://leginfo.legislature.ca.gov/faces/codesTOCSelected.xhtml?tocCode=WAT&tocTitle=+Water+Code+-+WAT.

California Department of Conservation. 2010. "The Alquist-Priolo Earthquake Fault Zoning (AP) Act." Accessed 2017. http://www.conservation.ca.gov/cgs/rghm/ap.

California Department of Finance, 2017. http://www.dof.ca.gov/research/demographic/reports/estimates/e-1/view.php "Forecasting." Accessed February 2017. http://www.dof.ca.gov/Forecasting/Demographics/Estimates/.

California Department of Forestry and Fire Protection (CAL FIRE). 2017. "Incident Information." Accessed April 2017. http://cdfdata.fire.ca.gov/incidents/incidents_archived.

California Department of Forestry and Fire Protection (CAL FIRE). 2017a. "FRAP Maps." FRAP Projects. Accessed April 2017. http://frap.fire.ca.gov/.

California Department of Water Resources (DWR). 2005. *The California Water Plan*. Accessed February 2017. http://www.waterplan.water.ca.gov/docs/cwpu2009/0310final/v4c06a01_cwp2009.pdf.

California Department of Water Resources (DWR). 2013. *The California Water Plan*. Accessed February 2017. http://www.waterplan.water.ca.gov/docs/cwpu2013/Final/Vol2_SanFranciscoBayRR.pdf

California Department of Water Resources (DWR). 2016. "Listing of Dams". Division of Safety of Dams. Accessed 2017. http://www.water.ca.gov/damsafety/damlisting/index.cfm.

California Department of Water Resources (DWR). 2017. "State Hydrologic Data." Accessed March 2017. http://www.watersupplyconditions.water.ca.gov.

California Department of Water Resources (DWR). 2017a. Climate Change page of California DWR website. Accessed online at http://www.water.ca.gov/climatechange/

California Division of Safety of Dams. 2017. "Listing of Dams." Accessed 2017. http://www.water.ca.gov/damsafety/damlisting/index.cfm.

California Environmental Protection Agency and Office of Environmental Health Hazard Assessment. 2015. *CalEnviroScreen 3.0, California Communities Environmental Health Screening Tool*.

California Emergency Management Agency (Cal EMA) et al. 2012. “California Adaptation Planning Guide.” Accessed 2017. http://resources.ca.gov/docs/climate/APG_Understanding_Regional_Characteristics.pdf.

California Governor’s Office of Emergency Services (Cal OES). 2013. *State of California Multi-Hazard Mitigation Plan.* Accessed November 2016. http://hazardmitigation.calema.ca.gov/plan/state_multi-hazard_mitigation_plan_shmp.

California Governor’s Office of Emergency Services (Cal OES). 2017. California State Warning Center Hazardous materials spill report data. http://www.caloes.ca.gov/cal-oes-divisions/warning-center

California Office of Traffic Safety. 2017. “Collison rankings and data.” Accessed April 2017. http://www.ots.ca.gov/Media_and_Research/Rankings/default.asp

Centers for Disease Control and Prevention (CDC). 2012. “Drought and Health.” Accessed February 2017. http://www.cdc.gov/nceh/drought/.

City of Los Angeles. 2011. *City of Los Angeles Hazard Mitigation Plan Update*. Accessed January 2017.

City of Los Angeles. 2014. *Urban/Wildland Interface Fire Annex to the City of Los Angeles Emergency Operations Plan.* Accessed June 2017.

City of Los Angeles. 2015. Annexation Map; City of Los Angeles. Prepared by the City of Los Angeles Department of Public Works Bureau of Engineering. Available online at http://navigatela.lacity.org/common/mapgallery/pdf/annex34x44.pdf

City of Los Angeles. 2016. *City of Los Angeles Floodplain Management Plan*. City of Los Angeles Department of Public Works Bureau of Engineering.

City of Los Angeles. *2017.* *City of Los Angeles General Plan.* Accessed February 2017. https://planning.lacity.org/GP_elements.html

City of Los Angeles. 2017. Los Angeles River Revitalization Website. Accessed March 2017. http://www.lariver.org/index.htm.

City of Los Angeles Department of Transportation (LADOT). 2016. LADOT Annual Report, 2015-2016.

City of Los Angeles Department of Water and Power. 2015. *Urban Water Management Plan*. Accessed January 2017.

City of Los Angeles Police Department. 2017. “Operation Archangel.” Accessed April 2017. http://www.lapdonline.org/emergency_services_division/content_basic_view/33044.

City of Los Angeles Stormwater Program. 2017. Enhanced Watershed Management Plans website. Accessed March 2017 at http://www.lastormwater.org/green-la/enhanced-watershed-management-plans/.

City of Los Angeles Sanitation (LASAN). 2017. “What We Do.” Accessed June 2017. https://www.lacitysan.org/san/faces/home/portal/s-lsh-wwd?_adf.ctrl-state=16q9keg5ti_4&_afrLoop=340566205060389#

Danielson, T. 2015. “How to avoid the curse of ransomware.” Accessed April 2017. http://www.businessinsider.com/ransomware-is-everywhere-but-this-software-can-save-you-2015-10

Disaster Mitigation Act of 2000 (DMA 2000). Public Law 106-390. 42 U.S.C. §§ 5121 note et seq. October 30, 2000.

Federal Emergency Management Agency (FEMA). 1977. "Executive Order 11988." Accessed 2016. https://www.fema.gov/laws-executive-orders.

Federal Emergency Management Agency (FEMA). 1997. "FEMA's Multi-Hazard Identification and Risk Assessment (MHIRA)." Accessed 2016. http://www.fema.gov/library/viewRecord.do?id=2214.

FEMA. 1999. Flood Insurance Study; City of Los Angeles, California; Los Angeles County. Community Number 060137. Revised May 4, 1999.

Federal Emergency Management Agency FEMA. 2001. *Understanding Your Risks; Identifying Hazards and Determining your Risks*. FEMA (386-2). August 2001

Federal Emergency Management Agency FEMA. 2002. *Getting Started; Building support for Mitigation Planning.* FEMA (386-1). September 2002

Federal Emergency Management Agency FEMA. 2003. *Developing the Mitigation Plan; Identifying Mitigation Actions and Implementing Strategies. FEMA* (386-3). April 2003

Federal Emergency Management Agency FEMA. 2003a. *Integrating Manmade Hazards Into Mitigation Planning*. FEMA (386-7). September 2003.

Federal Emergency Management Agency FEMA. 2004. *Using Hazus for Risk Assessment, How to Guide*. FEMA (433). August 2004

Federal Emergency Management Agency (FEMA). 2004b. *Federal Guidelines for Dam Safety*. Accessed 2017. http://www.fema.gov/media-library-data/20130726-1516-20490-7951/fema-333.pdf.

Federal Emergency Management Agency (FEMA). 2004c. *National Response Plan, Cyber Incident Annex.* https://www.fema.gov/media-library-data/20130726-1825-25045-8307/cyber_incident_annex_2004.pdf

Federal Emergency Management Agency (FEMA). June 2009. *Benefit Cost Analysis Reference Guide.* https://www.fema.gov/media-library-data/20130726-1736-25045-7076/bca_reference_guide.pdf.

Federal Emergency Management Agency (FEMA). 2010. "Wind Zones in the United States." http://www.fema.gov/safe-rooms/wind-zones-united-states.

Federal Emergency Management Agency (FEMA). 2013. "Why Dams Fail." Accessed 2017. http://www.fema.gov/why-dams-fail.

Federal Emergency Management Agency (FEMA). 2013a. *Engineering Principles and Practices*. Accessed 2017. http://www.fema.gov/media-library-data/20130726-1506-20490-3574/fema259_ch2.pdf.

Federal Emergency Management Agency (FEMA). 2008. "*Flood Insurance Study for City of Los Angeles, CA*: Revised 2008."

Federal Emergency Management Agency (FEMA). 2015a. "Federal Flood Risk Management Standard." Accessed 2017. https://www.fema.gov/federal-flood-risk-management-standard-ffrms.

Federal Emergency Management Agency (FEMA). 2015b. "*Flood Insurance Study for Contra Costa County, CA*: Revised 2015."

Federal Emergency Management Agency (FEMA). 2016. "NFIP Community Rating System Communities and their Classes." Accessed January 2017. https://www.fema.gov/national-flood-insurance-program-community-status-book.

Federal Emergency Management Agency (FEMA). 2017. "Disaster Declarations-Open Government Dataset." Accessed February 2017. https://www.fema.gov/disasters.

Federal Emergency Management Agency (FEMA). 2017a. "Policy and Claim Statistics for Flood Insurance." Accessed January 2017. https://www.fema.gov/policy-claim-statistics-flood-insurance.

Federal Emergency Management Agency (FEMA) Region IX. 2016. "Report of Repetitive Losses."

Hanks, Thomas C.; Kanamori, Hiroo. 1979. "Moment magnitude scale." Journal of Geophysical Research. May 1979.

Intergovernmental Panel on Climate Change (IPCC). 2014. "Climate Change 2014: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Parts A, B and Annexes." Accessed January 2017. http://www.ipcc.ch/report/ar5/wg2/.

Intergovernmental Panel on Climate Change (IPCC). 2014a. "Climate Change 2014: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Parts A, B and Annexes." Accessed January 2017. http://www.ipcc.ch/report/ar5/wg2/.

International Strategy for Disaster Reduction. 2008. "Disaster Risk Reduction Strategies and Risk Management Practices: Critical Elements for Adaptation to Climate Change"

Keller, Edward A., and Robert H. Blodgett. Natural Hazards: Earth's Processes as Hazards, Disasters, and Catastrophes. Upper Saddle River, NJ: Pearson/Prentice Hall, 2008. Print.

KPCC. 2017. Los Angeles metro area posted dip in housing building permits. Posted on KPCC website April 13, 2017: http://www.scpr.org/news/2017/04/13/70756/los-angeles-metro-area-posted-dip-in-housing/

Layne, James Gregg. 1935. Annals of Los Angeles 1769–1861, Special Publication No. 9. San Francisco: California Historical Society.

Los Angeles Almanac. 2017. "Employment and Income". Accessed February 2017. http://www.laalmanac.com/employment/index.php.

McCawley, William. 1996. The First Angelinos: The Indians of Los Angeles. Banning, California: Malki Museum Press and Ballena Press Cooperative.

Morratt and Nichol. 2007. *Tsunami Hazard Assessment for the Ports of Long Beach and Los Angeles.*

National Aeronautics and Space Administration (NASA). 2004. "NASA Earth Observatory News." Accessed January 2017. http://earthobservatory.nasa.gov/Newsroom/view.php?id=25145.

National Aeronautics and Space Administration (NASA). 2016. "NASA, NOAA Data Show 2016 Warmest Year on Record Globally." Accessed February 2017. https://www.nasa.gov/press-release/nasa-noaa-data-show-2016-warmest-year-on-record-globally.

National Aeronautics and Space Administration (NASA). 2017. "Global Climate Change: Vital Signs of the Planet." Accessed May 2017. http://climate.nasa.gov/vital-signs/carbon-dioxide/.

National Aeronautics and Space Administration (NASA). 2017a. "Global Climate Change: Vital Signs of the Planet." Accessed May 2017. http://climate.nasa.gov/vital-signs/carbon-dioxide/.

National Aeronautics and Space Administration (NASA). 2017b. "Global Climate Change: Vital Signs of the Planet." Accessed May 2017. http://climate.nasa.gov/vital-signs/carbon-dioxide/.

National Aeronautics and Space Administration (NASA). 2017c. "Global Climate Change: Vital Signs of the Planet." Accessed May 2017. http://climate.nasa.gov/vital-signs/carbon-dioxide/.

National Aeronautics and Space Administration (NASA). 2017d. "Global Climate Change: Vital Signs of the Planet." Accessed May 2017. http://climate.nasa.gov/vital-signs/carbon-dioxide/.

National Drought Mitigation Center. 2017. "Drought Impact Report for Contra Costa County." Accessed February 2017. http://drought.unl.edu/MonitoringTools/DroughtImpactReporter.aspx.

National Drought Mitigation Center. 2017a. "Drought Affecting People." Accessed February 2017. http://drought.unl.edu/droughtbasics/ensoandforecasting.aspx.

National Climate Assessment. 2014. Third *National Climate Assessment Report for the United States.* Accessed March 2017. http://www.globalchange.gov/browse/reports/climate-change-impacts-united-states-third-national-climate-assessment-0.

National Climate Assessment. 2014a. "Climate Change Impacts in the United States." Accessed March 2017. http://nca2014.globalchange.gov/.

National Geophysical Data Center / World Data Service. 2017. Global Historical Tsunami Database. National Geophysical Data Center, NOAA. Accessed February 28, 2017. doi:10.7289/V5PN93H7.

National Oceanic and Atmospheric Administration (NOAA). 2015. Severe Weather 101; Thunderstorm Basics. Accessed October 2016. http://www.nssl.noaa.gov/education/svrwx101/thunderstorms/.

National Oceanic and Atmospheric Administration (NOAA). 2016. "National Centers for Environmental Information Estimated Tsunami Travel Times to Coastal Locations." Accessed November 2016. https://maps.ngdc.noaa.gov/viewers/ttt_coastal_locations/.

National Oceanic and Atmospheric Administration (NOAA). 2016a. "Climate Data Online." Accessed November 2016. https://www.ncdc.noaa.gov/cdo-web/.

National Oceanic and Atmospheric Administration (NOAA). 2017. "National Centers for Environmental Information Storm Events Database." Accessed January 2017. https://www.ncdc.noaa.gov/stormevents/.

National Transportation Safety Board (NTSB). 2017. "Aviation Accident Database and Synopses." Accessed June 2017. https://www.ntsb.gov/_layouts/ntsb.aviation/index.aspx

NOAA, National Weather Service (NWS). 2009. "National Weather Service Glossary." Accessed 2017. http://w1.weather.gov/glossary/.

NOAA, National Weather Service (NWS). 2016. "NWS Heat Index." Accessed March 2017. http://www.nws.noaa.gov/os/heat/heat_index.shtml.

National Weather Service (NWS). 2016a. "Introduction to Thunderstorms." Accessed October 2016. http://www.srh.noaa.gov/jetstream/tstorms/tstorms_intro.html.

NOAA, NWS. 2017. "Climate Prediction Center, Palmer Crop Moisture Index." Accessed March 2017. http://www.cpc.ncep.noaa.gov/products/monitoring_and_data/drought.shtml.

NOAA, NWS. 2017a. "Climate Prediction Center, Palmer Z Index." Accessed March 2017. http://www.cpc.ncep.noaa.gov/products/monitoring_and_data/drought.shtml.

NOAA, NWS. 2017b. "Climate Prediction Center, Palmer Drought Severity Index." Accessed March 2017. http://www.cpc.ncep.noaa.gov/products/monitoring_and_data/drought.shtml.

NOAA, NWS. 2017c. "Climate Prediction Center, Palmer Hydrological Drought Index." Accessed March 2017. http://www.cpc.ncep.noaa.gov/products/monitoring_and_data/drought.shtml.

NOAA, NWS. 2017d. "Climate Prediction Center, Standard Precipitation Index." Accessed March 2017. http://www.cpc.ncep.noaa.gov/products/Drought/Monitoring/spi.shtml.

OTA (Congressional Office of Technology Assessment). 1993. Preparing for an Uncertain Climate, Vol. I. OTA–O–567. U.S. Government Printing Office, Washington, D.C.

Press Telegram. 2015. New Census figures show nation is following Los Angeles in diversity. Posted on the Press-Telegram website June 25, 2015: http://www.presstelegram.com/social-affairs/20150625/new-census-figures-show-nation-is-following-los-angeles-in-diversity

Ready.gov. 2016. "Chemical threats." Accessed December 2016. https://www.ready.gov/chemical-threats.

Stanford University National Performance of Dams Program. 2017. "NPDP Dams Database." Accessed January 2017. https://npdp.stanford.edu/dams_database.

Gregory Lee Thompson. 1993. The Passenger Train in the Motor Age: California's Rail and Bus Industries, 1910-1941

U.S. Army. 2005. "Civil Disturbance Operations." FM 3-19.15. Accessed 2016. https://www.fas.org/irp/doddir/army/fm3-19-15.pdf.

U.S. Army Center for Health Promotion and Preventive Medicine. 2015. "Chlorine Improvised Explosive Devices and Preventive Medicine Actions." Accessed 2016. https://mesl.apgea.army.mil/mesl/account/EHFileDownload%3FfileString%3D/webu03/meslp/webUploads/EH/moduleI/59476N.pdf+&cd=12&hl=en&ct=clnk&gl=us.

U.S. Army Corps of Engineers. 1997. "*Annual Flood Damage Report to Congress for Fiscal Year 1997.*"

U.S. Army Corps of Engineers. 2016. "Dam Safety Program." Accessed March 2017. http://www.usace.army.mil/Missions/Civil-Works/Dam-Safety-Program/.

U.S. Army Corps of Engineers. 2017. National Inventory of Dams. Accessed March 2017. https://catalog.data.gov/dataset/national-inventory-of-dams.

U.S. Census. 2010. http://censtats.census.gov/data/CA/05006081.pdf.

U.S. Census. 2016. "2011-2015 American Community Survey 5-Year Estimates." Accessed 2017. https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?src=bkmk.

U. S. Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS). 2005. “Final Rule, 7 Code of Federal Rules Part 624. Emergency Watershed Protection Program.” Accessed November 2016. https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/landscape/ewpp/.

U.S. Department of Homeland Security. 2003. *National Strategy for the Physical Protection of Critical Infrastructure of Critical Infrastructure and Key Assets.*

U.S. Department of Homeland Security and National Academies. 2004. *Chemical Attack Fact Sheet: Warfare Agents, Industrial Chemicals, and Toxins.* Accessed January 2017. https://www.dhs.gov/publication/chemical-attack-fact-sheet .

U.S. Environmental Protection Agency (EPA). 2003. “Protecting Water Quality from Urban Runoff.” Publication EPA 841-F-03-003.

U.S. Environmental Protection Agency (EPA). 2016. “Climate Change Indicators in the United States.” 2016. https://www.epa.gov/climate-indicators/climate-change-indicators-atmospheric-concentrations-greenhouse-gases.

U.S. Environmental Protection Agency (EPA). 2016a. “Toxics Release Inventory (TRI) Program.” https://www.epa.gov/toxics-release-inventory-tri-program/learn-about-toxics-release-inventory.

U.S. Environmental Protection Agency (EPA). 2016b. “Climate Change Indicators in the United States.” 2016. EPA 430-R-16-004. www.epa.gov/climate-indicators.

U.S. Environmental Protection Agency (EPA). 2017. “Surf Your Watershed.” Accessed April 2017. https://cfpub.epa.gov/surf/county.cfm?fips_code=06013.

U.S. Geological Survey (USGS). 1987. The Morgan Hill, California, Earthquake of April 24, 1984, U.S. Geological Survey Bulletin 1639.

U.S. Geological Survey (USGS). 1989. *The Severity of an Earthquake*. U.S. Government Printing Office: 1989-288-913. Accessed 2017. http://pubs.usgs.gov/gip/earthq4/severity_text.html.

U.S. Geological Survey (USGS). 2008. An Atlas of ShakeMaps for Selected Global Earthquakes. U.S. Geological Survey Open-File Report 2008-1236. Prepared by Allen, T.I., Wald, D.J., Hotovec, A.J., Lin, K., Earle, P.S. and Marano, K.D.

U.S. Geological Survey (USGS). 2010. “PAGER—Rapid Assessment of an Earthquake’s Impact. U.S. Geological Survey Fact Sheet 2010-3036”.

U.S. Geological Survey (USGS). 2013. SAFRR - Science Application for Risk Reduction; ARkStorm Scenario: Multi-Hazard West Coast Winter Storm Project. USGS website last modified August 5, 2013. Accessed at https://www2.usgs.gov/natural_hazards/safrr/projects/arkstorm.asp

U.S. Geological Survey (USGS). 2014. “Global Seismographic Network.” Earthquake Hazards Program. Accessed February 2017. http://earthquake.usgs.gov/monitoring/gsn/.

U.S. Geological Survey (USGS). 2016. “Search Earthquake Archives.” Earthquake Hazards Program. Accessed 2016. http://earthquake.usgs.gov/earthquakes/search/.

U.S. Geological Survey (USGS). 2017. “California Drought.” Accessed January 2017. https://ca.water.usgs.gov/data/drought/.

U.S. Geological Survey (USGS). 2017a. "Measuring Earthquakes FAQs." Accessed February 2017. https://www2.usgs.gov/faq/categories/9828/3357.

U.S. Global Change Research Program (USGCRP). 2009. "Global Climate Change Impacts in the United States." Thomas R. Karl, Jerry M. Melillo and Thomas C. Peterson, (eds.). Cambridge University Press. Accessed 2016. https://downloads.globalchange.gov/usimpacts/pdfs/climate-impacts-report.pdf.

U.S. Global Change Research Program (USGCRP). 2017. "Indicators of Change." Accessed January 2017. http://www.globalchange.gov/.

U.S. Pipeline and Hazardous Materials Safety Administration National Pipeline Mapping System. 2017. https://www.npms.phmsa.dot.gov/GeneralPublic.aspx.

Western Regional Climate Center. 2017 "Temperature and Precipitation Summaries." Accessed February 2017.

World Health Organization (WHO). 2014. "Geographic distribution of Ebola virus disease outbreaks in humans and animals." Accessed 2016. http://www.who.int/csr/disease/ebola/ebola-map-humans-animals-2014.png?ua=1.

GLOSSARY

ACRONYMS

CCR—California Code of Regulations

CDBG-DR—Community Development Block Grant—Disaster Recovery

CEQA—California Environmental Quality Act

CFR—Code of Federal Regulations

CIP—Capital Improvement Plan

CRS—Community Rating System

DFIRM—Digital Flood Insurance Rate Maps

DMA —Disaster Mitigation Act

DSOD—Division of Safety of Dams

DTSC—Department of Toxic Substances Control

DWR—Department of Water Resources (California)

EDD—Employment Development Department (California)

EF— Enhanced Fujita Scale

EPA—U.S. Environmental Protection Agency

ESA—Endangered Species Act

FEMA—Federal Emergency Management Agency

FERC—Federal Energy Regulatory Commission

FIRM—Flood Insurance Rate Map

FHSZ—Fire hazard severity zone

GIS—Geographic Information System

Hazus—Hazards, United States

HMGP—Hazard Mitigation Grant Program

IBC—International Building Code

IRC—International Residential Code

LACDA—Los Angeles County Drainage Area

LADOT—Los Angeles Department of Transportation

LADWP—Los Angeles Department of Water and Power

LAPD—Los Angeles Police Department

LATCB— Los Angeles Tourism & Convention Board

MCI—Multi-casualty incident

MM—Modified Mercalli Scale

NCEI—National Centers for Environmental Information

NEHRP—National Earthquake Hazards Reduction Program

NIMS—National Incident Management System

NFIP—National Flood Insurance Program

NOAA—National Oceanic and Atmospheric Administration

NWS—National Weather Service

OES—Office of Emergency Services (California)

PDM—Pre-Disaster Mitigation Grant Program

PGA—Peak Ground Acceleration

SFHA—Special Flood Hazard Area

SPI—Standardized Precipitation Index

TRI—Toxics Release Inventory

UHI—Urban heat island

USGS—U.S. Geological Survey

WMD—Weapon of mass destruction

WRCC—Western Regional Climate Center

DEFINITIONS

100-Year Flood: The term “100-year flood” can be misleading. The 100-year flood does not necessarily occur once every 100 years. Rather, it is the flood that has a 1 percent chance of being equaled or exceeded in any given year. Thus, the 100-year flood could occur more than once in a relatively short period of time. The Federal Emergency Management Agency (FEMA) defines it as the 1 percent annual chance flood, which is now the standard definition used by most federal and state agencies and by the National Flood Insurance Program (NFIP).

Acre-Foot: An acre-foot is the amount of water it takes to cover 1 acre to a depth of 1 foot. This measure is used to describe the quantity of storage in a water reservoir. An acre-foot is a unit of volume. One acre foot equals 7,758 barrels; 325,829 gallons; or 43,560 cubic feet. An average household of four will use approximately 1 acre-foot of water per year.

Asset: An asset is any man-made or natural feature that has value, including people; buildings; infrastructure, such as bridges, roads, sewers, and water systems; lifelines, such as electricity and communication resources; and environmental, cultural, or recreational features such as parks, wetlands, and landmarks.

Base Flood: The flood having a 1% chance of being equaled or exceeded in any given year, also known as the “100-year” or “1% chance” flood. The base flood is a statistical concept used to ensure that all properties subject to the National Flood Insurance Program (NFIP) are protected to the same degree against flooding.

Basin: A basin is the area within which all surface water—whether from rainfall, snowmelt, springs, or other sources—flows to a single water body or watercourse. The boundary of a river basin is defined by natural topography, such as hills, mountains, and ridges. Basins are also referred to as "watersheds" and "drainage basins."

Benefit: A benefit is a net project outcome and is usually defined in monetary terms. Benefits may include direct and indirect effects. For the purposes of benefit-cost analysis of proposed mitigation measures, benefits are limited to specific, measurable, risk reduction factors, including reduction in expected property losses (buildings, contents, and functions) and protection of human life.

Benefit/Cost Analysis: A benefit/cost analysis is a systematic, quantitative method of comparing projected benefits to projected costs of a project or policy. It is used as a measure of cost effectiveness.

Building: A building is defined as a structure that is walled and roofed, principally aboveground, and permanently fixed to a site. The term includes manufactured homes on permanent foundations on which the wheels and axles carry no weight.

Capability Assessment: A capability assessment provides a description and analysis of a community's current capacity to address threats associated with hazards. The assessment includes two components: an inventory of an agency's mission, programs, and policies, and an analysis of its capacity to carry them out. A capability assessment is an integral part of the planning process in which a community's actions to reduce losses are identified, reviewed, and analyzed, and the framework for implementation is identified. The following capabilities were reviewed under this assessment:

- Legal and regulatory capability
- Administrative and technical capability
- Fiscal capability

Community Rating System (CRS): The CRS is a voluntary program under the NFIP that rewards participating communities (provides incentives) for exceeding the minimum requirements of the NFIP and completing activities that reduce flood hazard risk by providing flood insurance premium discounts.

Critical Area: An area defined by state or local regulations as deserving special protection because of unique natural features or its value as habitat for a wide range of species of flora and fauna. A sensitive/critical area is usually subject to more restrictive development regulations.

Critical Facility: Facilities and infrastructure that are critical to the health and welfare of the population. These become especially important after any hazard event occurs. For the purposes of this plan, critical facilities include:

- Structures or facilities that produce, use, or store highly volatile, flammable, explosive, toxic and/or water reactive materials;
- Hospitals, nursing homes, and housing likely to contain occupants who may not be sufficiently mobile to avoid death or injury during a hazard event.
- Police stations, fire stations, vehicle and equipment storage facilities, and emergency operations centers that are needed for disaster response before, during, and after hazard events, and
- Public and private utilities, facilities and infrastructure that are vital to maintaining or restoring normal services to areas damaged by hazard events.
- Government facilities.

Dam: Any artificial barrier or controlling mechanism that can or does impound 10 acre-feet or more of water.

Dam Failure: Dam failure refers to a partial or complete breach in a dam (or levee) that impacts its integrity. Dam failures occur for a number of reasons, such as flash flooding, inadequate spillway size, mechanical failure of valves or other equipment, freezing and thawing cycles, earthquakes, and intentional destruction.

Debris Flow: Dense mixtures of water-saturated debris that move down-valley; looking and behaving much like flowing concrete. They form when loose masses of unconsolidated material are saturated, become unstable, and move down slope. The source of water varies but includes rainfall, melting snow or ice, and glacial outburst floods.

Debris Slide: Debris slides consist of unconsolidated rock or soil that has moved rapidly down slope. They occur on slopes greater than 65 percent.

Disaster Mitigation Act of 2000 (DMA); The DMA is Public Law 106-390 and is the latest federal legislation enacted to encourage and promote proactive, pre-disaster planning as a condition of receiving financial assistance under the Robert T. Stafford Act. The DMA emphasizes planning for disasters before they occur. Under the DMA, a pre-disaster hazard mitigation program and new requirements for the national post-disaster hazard mitigation grant program (HMGP) were established.

Drainage Basin: A basin is the area within which all surface water- whether from rainfall, snowmelt, springs or other sources- flows to a single water body or watercourse. The boundary of a river basin is defined by natural topography, such as hills, mountains and ridges. Drainage basins are also referred to as **watersheds** or **basins**.

Drought: Drought is a period of time without substantial rainfall or snowfall from one year to the next. Drought can also be defined as the cumulative impacts of several dry years or a deficiency of precipitation over an extended period of time, which in turn results in water shortages for some activity, group, or environmental function. A hydrological drought is caused by deficiencies in surface and subsurface water supplies. A socioeconomic drought impacts the health, well being, and quality of life or starts to have an adverse impact on a region. Drought is a normal, recurrent feature of climate and occurs almost everywhere.

Earthquake: An earthquake is defined as a sudden slip on a fault, volcanic or magmatic activity, and sudden stress changes in the earth that result in ground shaking and radiated seismic energy. Earthquakes can last from a few seconds to over 5 minutes, and have been known to occur as a series of tremors over a period of several days. The actual movement of the ground in an earthquake is seldom the direct cause of injury or death. Casualties may result from falling objects and debris as shocks shake, damage, or demolish buildings and other structures.

Exposure: Exposure is defined as the number and dollar value of assets considered to be at risk during the occurrence of a specific hazard.

Extent: The extent is the size of an area affected by a hazard.

Fire Behavior: Fire behavior refers to the physical characteristics of a fire and is a function of the interaction between the fuel characteristics (such as type of vegetation and structures that could burn), topography, and weather. Variables that affect fire behavior include the rate of spread, intensity, fuel consumption, and fire type (such as underbrush versus crown fire).

Fire Frequency: Fire frequency is the broad measure of the rate of fire occurrence in a particular area. An estimate of the areas most likely to burn is based on past fire history or fire rotation in the area, fuel conditions, weather, ignition sources (such as human or lightning), fire suppression response, and other factors.

Flash Flood: A flash flood occurs with little or no warning when water levels rise at an extremely fast rate

Flood Insurance Rate Map (FIRM): FIRMs are the official maps on which the Federal Emergency Management Agency (FEMA) has delineated the Special Flood Hazard Area (SFHA).

Flood Insurance Study: A report published by the Federal Insurance and Mitigation Administration for a community in conjunction with the community's Flood Insurance rate Map. The study contains such background data as the base flood discharges and water surface elevations that were used to prepare the FIRM. In most cases, a community FIRM with detailed mapping will have a corresponding flood insurance study.

Floodplain: Any land area susceptible to being inundated by flood waters from any source. A flood insurance rate map identifies most, but not necessarily all, of a community's floodplain as the Special Flood Hazard Area (SFHA).

Floodway: Floodways are areas within a floodplain that are reserved for the purpose of conveying flood discharge without increasing the base flood elevation more than 1 foot. Generally speaking, no development is allowed in floodways, as any structures located there would block the flow of floodwaters.

Floodway Fringe: Floodway fringe areas are located in the floodplain but outside of the floodway. Some development is generally allowed in these areas, with a variety of restrictions. On maps that have identified and delineated a floodway, this would be the area beyond the floodway boundary that can be subject to different regulations.

Freeboard: Freeboard is the margin of safety added to the base flood elevation.

Frequency: For the purposes of this plan, frequency refers to how often a hazard of specific magnitude, duration, and/or extent is expected to occur on average. Statistically, a hazard with a 100-year frequency is expected to occur about once every 100 years on average and has a 1 percent chance of occurring any given year. Frequency reliability varies depending on the type of hazard considered.

Fujita Scale of Tornado Intensity: Tornado wind speeds are sometimes estimated on the basis of wind speed and damage sustained using the Fujita Scale. The scale rates the intensity or severity of tornado events using numeric values from F0 to F5 based on tornado wind speed and damage. An F0 tornado (wind speed less than 73 miles per hour (mph)) indicates minimal damage (such as broken tree limbs), and an F5 tornado (wind speeds of 261 to 318 mph) indicates severe damage.

Goal: A goal is a general guideline that explains what is to be achieved. Goals are usually broad-based, long-term, policy-type statements and represent global visions. Goals help define the benefits that a plan is trying to achieve. The success of a hazard mitigation plan is measured by the degree to which its goals have been met (that is, by the actual benefits in terms of actual hazard mitigation).

Geographic Information System (GIS): GIS is a computer software application that relates data regarding physical and other features on the earth to a database for mapping and analysis.

Hazard: A hazard is a source of potential danger or adverse condition that could harm people and/or cause property damage.

Hazard Mitigation Grant Program (HMGP): Authorized under Section 202 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act, the HMGP is administered by FEMA and provides grants to states, tribes, and local governments to implement hazard mitigation actions after a major disaster declaration. The purpose of the program is to reduce the loss of life and property due to disasters and to enable mitigation activities to be implemented as a community recovers from a disaster

Hazards U.S. Multi-Hazard Loss Estimation Program (Hazus): Hazus is a GIS-based program used to support the development of risk assessments as required under the DMA. The Hazus software program assesses risk in a quantitative manner to estimate damages and losses associated with natural hazards. Hazus is FEMA's nationally applicable, standardized methodology and software program and contains modules for estimating potential losses from earthquakes, floods, and wind hazards. Hazus has also been used to assess vulnerability (exposure) for other hazards.

Hydraulics: Hydraulics is the branch of science or engineering that addresses fluids (especially water) in motion in rivers or canals, works and machinery for conducting or raising water, the use of water as a prime mover, and other fluid-related areas.

Hydrology: Hydrology is the analysis of waters of the earth. For example, a flood discharge estimate is developed by conducting a hydrologic study.

Intensity: For the purposes of this plan, intensity refers to the measure of the effects of a hazard.

Inventory: The assets identified in a study region comprise an inventory. Inventories include assets that could be lost when a disaster occurs and community resources are at risk. Assets include people, buildings, transportation, and other valued community resources.

Landslide: Landslides can be described as the sliding movement of masses of loosened rock and soil down a hillside or slope. Fundamentally, slope failures occur when the strength of the soils forming the slope exceeds the pressure, such as weight or saturation, acting upon them.

Lightning: Lightning is an electrical discharge resulting from the buildup of positive and negative charges within a thunderstorm. When the buildup becomes strong enough, lightning appears as a "bolt," usually within or between clouds and the ground. A bolt of lightning instantaneously reaches temperatures approaching 50,000ºF. The rapid heating and cooling of air near lightning causes thunder. Lightning is a major threat during thunderstorms. In the United States, 75 to 100 Americans are struck and killed by lightning each year (see http://www.fema.gov/hazard/thunderstorms/thunder.shtm).

Liquefaction: Liquefaction is the complete failure of soils, occurring when soils lose shear strength and flow horizontally. It is most likely to occur in fine grain sands and silts, which behave like viscous fluids when liquefaction occurs. This situation is extremely hazardous to development on the soils that liquefy, and generally results in extreme property damage and threats to life and safety.

Local Government: Any county, municipality, city, town, township, public authority, school district, special district, intrastate district, council of governments (regardless of whether the council of governments is incorporated as a nonprofit corporation under State law), regional or interstate government entity, or agency or instrumentality of a local government; any Indian tribe or authorized tribal organization, or Alaska Native village or organization; and any rural community, unincorporated town or village, or other public entity.

Magnitude: Magnitude is the measure of the strength of an earthquake, and is typically measured by the Richter scale. As an estimate of energy, each whole number step in the magnitude scale corresponds to the release of about 31 times more energy than the amount associated with the preceding whole number value.

Mass movement: A collective term for landslides, debris flows, and lahars.

Mitigation: A preventive action that can be taken in advance of an event that will reduce or eliminate the risk to life or property.

Mitigation Actions: Mitigation actions are specific actions to achieve goals and objectives that minimize the effects from a disaster and reduce the loss of life and property.

Objective: For the purposes of this plan, an objective is defined as a short-term aim that, when combined with other objectives, forms a strategy or course of action to meet a goal. Unlike goals, objectives are specific and measurable.

Peak Ground Acceleration: Peak Ground Acceleration (PGA) is a measure of the highest amplitude of ground shaking that accompanies an earthquake, based on a percentage of the force of gravity.

Preparedness: Preparedness refers to actions that strengthen the capability of government, residents, and communities to respond to disasters.

Presidential Disaster Declaration: These declarations are typically made for events that cause more damage than state and local governments and resources can handle without federal government assistance. Generally, no specific dollar loss threshold has been established for such declarations. A Presidential Disaster Declaration puts into motion long-term federal recovery programs, some of which are matched by state programs, designed to help disaster victims, businesses, and public entities.

Probability of Occurrence: The probability of occurrence is a statistical measure or estimate of the likelihood that a hazard will occur. This probability is generally based on past hazard events in the area and a forecast of events that could occur in the future. A probability factor based on yearly values of occurrence is used to estimate probability of occurrence.

Repetitive Loss Property: Any NFIP-insured property that, since 1978 and regardless of any changes of ownership during that period, has experienced:

- Four or more paid flood losses in excess of $1000.00; or
- Two paid flood losses in excess of $1000.00 within any 10-year period since 1978 or
- Three or more paid losses that equal or exceed the current value of the insured property.

Return Period (or Mean Return Period): This term refers to the average period of time in years between occurrences of a particular hazard (equal to the inverse of the annual frequency of occurrence).

Riverine: Of or produced by a river. Riverine floodplains have readily identifiable channels. Floodway maps can only be prepared for riverine floodplains.

Risk: Risk is the estimated impact that a hazard would have on people, services, facilities, and structures in a community. Risk measures the likelihood of a hazard occurring and resulting in an adverse condition that causes injury or damage. Risk is often expressed in relative terms such as a high, moderate, or low likelihood of sustaining damage above a particular threshold due to occurrence of a specific type of hazard. Risk also can be expressed in terms of potential monetary losses associated with the intensity of the hazard.

Risk Assessment: Risk assessment is the process of measuring potential loss of life, personal injury, economic injury, and property damage resulting from hazards. This process assesses the vulnerability of people, buildings, and infrastructure to hazards and focuses on (1) hazard identification; (2) impacts of hazards on physical, social, and economic assets; (3) vulnerability identification; and (4) estimates of the cost of damage or costs that could be avoided through mitigation.

Risk Ranking: This ranking serves two purposes, first to describe the probability that a hazard will occur, and second to describe the impact a hazard will have on people, property, and the economy. Risk estimates are based on the methodology used to prepare the risk assessment for this plan. The following equation shows the risk ranking calculation:

Risk Ranking = Probability + Impact (people + property + economy)

Robert T. Stafford Act: The Robert T. Stafford Disaster Relief and Emergency Assistance Act, Public Law 100-107, was signed into law on November 23, 1988. This law amended the Disaster Relief Act of 1974, Public Law 93-288. The Stafford Act is the statutory authority for most federal disaster response activities, especially as they pertain to FEMA and its programs.

Special Flood Hazard Area: The base floodplain delineated on a Flood Insurance Rate Map. The SFHA is mapped as a Zone A in riverine situations and zone V in coastal situations. The SFHA may or may not encompass all of a community's flood problems

Stakeholder: Business leaders, civic groups, academia, non-profit organizations, major employers, managers of critical facilities, farmers, developers, special purpose districts, and others whose actions could impact hazard mitigation.

Stream Bank Erosion: Stream bank erosion is common along rivers, streams and drains where banks have been eroded, sloughed or undercut. However, it is important to remember that a stream is a dynamic and constantly changing system. It is natural for a stream to want to meander, so not all eroding banks are "bad" and in need of repair. Generally, stream bank erosion becomes a problem where development has limited the meandering nature of streams, where streams have been channelized, or where stream bank structures (like bridges, culverts, etc.) are located in places where they can actually cause damage to downstream areas. Stabilizing these areas can help protect watercourses from continued sedimentation, damage to adjacent land uses, control unwanted meander, and improvement of habitat for fish and wildlife.

Steep Slope: Different communities and agencies define it differently, depending on what it is being applied to, but generally a steep slope is a slope in which the percent slope equals or exceeds 25%. For this study, steep slope is defined as slopes greater than 33%.

Thunderstorm: A thunderstorm is a storm with lightning and thunder produced by cumulonimbus clouds. Thunderstorms usually produce gusty winds, heavy rains, and sometimes hail. Thunderstorms are usually short in duration (seldom more than 2 hours). Heavy rains associated with thunderstorms can lead to flash flooding during the wet or dry seasons.

Tornado: A tornado is a violently rotating column of air extending between and in contact with a cloud and the surface of the earth. Tornadoes are often (but not always) visible as funnel clouds. On a local scale, tornadoes are the most intense of all atmospheric circulations, and winds can reach destructive speeds of more than 300 mph. A tornado's vortex is typically a few hundred meters in diameter, and damage paths can be up to 1 mile wide and 50 miles long.

Vulnerability: Vulnerability describes how exposed or susceptible an asset is to damage. Vulnerability depends on an asset's construction, contents, and the economic value of its functions. Like indirect damages, the vulnerability of one element of the community is often related to the vulnerability of another. For example, many businesses depend on uninterrupted electrical power. Flooding of an electric substation would affect not only the substation itself but businesses as well. Often, indirect effects can be much more widespread and damaging than direct effects.

Watershed: A watershed is an area that drains downgradient from areas of higher land to areas of lower land to the lowest point, a common drainage basin.

Wildfire: These terms refer to any uncontrolled fire occurring on undeveloped land that requires fire suppression. The potential for wildfire is influenced by three factors: the presence of fuel, topography, and air mass. Fuel can include living and dead vegetation on the ground, along the surface as brush and small trees, and in the air such as tree canopies. Topography includes both slope and elevation. Air mass includes temperature, relative humidity, wind speed and direction, cloud cover, precipitation amount, duration, and the stability of the atmosphere at the time of the fire. Wildfires can be ignited by lightning and, most frequently, by human activity including smoking, campfires, equipment use, and arson.

Windstorm: Windstorms are generally short-duration events involving straight-line winds or gusts exceeding 50 mph. These gusts can produce winds of sufficient strength to cause property damage. Windstorms are especially dangerous in areas with significant tree stands, exposed property, poorly constructed buildings, mobile homes (manufactured housing units), major infrastructure, and aboveground utility lines. A windstorm can topple trees and power lines; cause damage to residential, commercial, critical facilities; and leave tons of debris in its wake.

Zoning Ordinance: The zoning ordinance designates allowable land use and intensities for a local jurisdiction. Zoning ordinances consist of two components: a zoning text and a zoning map.

City of Los Angeles 2018 Local Hazard Mitigation Plan

Appendix A. Outreach Survey & Results

A. OUTREACH SURVEY & RESULTS

To Be Provided When Available

Appendix B. Data Sources and Methods Used for Mapping

B. DATA SOURCES AND METHODS USED FOR MAPPING

DAM INUNDATION MAPPING

Dam inundation area data provided by Los Angeles County, Chief Executive Office ITS, in 2014 for the City's 2015 Floodplain Management Plan. No additional metadata is available.

EARTHQUAKE MAPPING

Liquefaction Zones

Liquefaction zones data provided by the City of Los Angeles. This data originated with Los Angeles County and the California Department of Conservation as part of a seismic hazards zones dataset. The seismic hazards zones datasets includes areas where liquefaction may occur during a strong earthquake. Developers of properties falling within the zones may be required to investigate the potential hazard and mitigate its threat during the local permitting process. The data is used by cities and counties to regulate development and by property owners selling property within areas where seismic hazard zones have been identified. Local governments can withhold development permits until geologic or soils investigations are conducted for specific sites and mitigation measures are incorporated into development plans. Sellers of property use the data to check the location of their specific site and, if applicable, disclose to the buyer that the property lies within a seismic hazard zone as required by the Seismic Hazards Mapping Act of 1990 (Public Resources Code, Division 2, Chapter 7.8). This data may not show all areas that have potential for liquefaction. Also, a single earthquake capable of causing liquefaction will not uniformly affect the entire zone. The identification and location of liquefaction zones are based on the best available data. However, the quality of data used is varied. Zone boundaries have been drawn as accurately as possible at the map scale (1:24,000).

National Earthquake Hazard Reduction Program (NEHRP) Soils

Soil classification data provided by the California Department of Conservation. The data is based on surficial geology published at a scale of 1:250,000. The surficial geologic units were grouped into composite units with similar average shear wave velocity to 30 meters depth (Vs30) values. This data was prepared as part of the Probabilistic Seismic Hazard Map of California (Petersen et. al., 1999)

Susceptibility to Deep-Seated Landslides

Landslide susceptibility data provided by the California Geological Survey.

The map, and associated data, show the relative likelihood of deep-seated landsliding based on regional estimates of rock strength and steepness of slopes. On the most basic level, weak rocks and steep slopes are most likely to generate landslides. The map uses detailed information on the location of past landslides, the location and relative strength of rock units, and steepness of slope to estimate susceptibility to deep-seated landsliding (0 to X, low to high). The USGS 2009 National Elevation Dataset (NED) with 10-m grid size was used as the base map. This landslide susceptibility map is intended to provide infrastructure owners, emergency planners and the public with a general overview of where landslides are more likely to occur. (Wills, et. al., 2011)

Shake Maps

A shake map is designed as a rapid response tool to portray the extent and variation of ground shaking throughout the affected region immediately following significant earthquakes. Ground motion and intensity maps are derived from peak ground motion amplitudes recorded on seismic sensors (accelerometers), with interpolation based on both estimated amplitudes where data are lacking, and site amplification corrections. Color-coded instrumental intensity maps are derived from empirical relations between peak ground motions and Modified Mercalli intensity. For this plan, shake maps were prepared for five earthquake scenarios:

- An earthquake on the Newport-Inglewood fault with the following characteristics:
  - Magnitude: 7.2
  - Epicenter: N33.65 W117.97
- An earthquake on the Palos Verde fault with the following characteristics:
  - Magnitude: 7.3
  - Epicenter: N33.3 W117.93
  - Also identified as Fleet Week scenario
- An earthquake on the Puente Hills fault with the following characteristics:
  - Magnitude: 7.0
  - Epicenter: N34.13 W118.08
  - Also identified as DTLA direct hit
- An earthquake on the San Andreas fault with the following characteristics:
  - Magnitude: 7.8
  - Epicenter: N33.35 W115.71
  - Also identified as the ShakeOut scenario
- An earthquake on the Santa Monica fault with the following characteristics:
  - Magnitude: 6.8
  - Epicenter: N34.16 W118.36

FLOOD MAPPING

For the City's 2015 Floodplain Management Plan, flood hazard areas are mapped as depicted on the effective FEMA Digital Flood Insurance Rate Maps dated September 26, 2008 with last Letter of Map Revision incorporated on February 7, 2014. For this plan, the following letters of map revision were also incorporated into the flood mapping:

- 2/9/2015
- 7/27/2015
- 9/28/2016
- 9/30/2016
- 11/2/2016.

For the Floodplain Management Plan, repetitive flood loss data was provided by FEMA as of October, 2014.

LANDSLIDE MAPPING

See Susceptibility to Deep-Seated Landslides data description under earthquake mapping.

SEA LEVEL RISE MAPPING

Coastal Storm Modeling System (CoSMoS) data provided by the U.S. Geological Survey. CoSMoS was developed by the U.S. Geological Survey and Deltares. CoSMoS is a suite of coupled hydrodynamic models that utilize a total water level approach which includes the following elements: sea level rise; tides; waves; storm surge; freshwater discharge from rivers; and seasonal influences such as El Niño. The full suite of CoSMoS results and data covering 40 scenarios for Southern California was released in fall 2016.

CoSMoS provides region-specific flood hazard projections at a detailed parcel scale from Point Conception to the Mexican border. It is based on an active scientific development approach that utilizes cutting-edge science to provide the optimum model outputs possible at this time. CoSMoS uses a combination of historic conditions and global climate models to project future conditions. It also provides flood projections specific for the bathymetry and topography of Southern California. Flood hazard projections include flooding extent, depth, duration, and uncertainty.

TSUNAMI INUNDATION MAPPING

Tsunami inundation areas data provided by the California Governor’s Office of Emergency Services. Data was published in 2009.

Initial tsunami modeling was performed by the University of Southern California Tsunami Research Center funded through the California Emergency Management Agency by the National Tsunami Hazard Mitigation Program. The tsunami modeling process utilized the MOST (Method of Splitting Tsunamis) computational program (Version 0), which allows for wave evolution over a variable bathymetry and topography used for the inundation mapping (Titov and Gonzalez, 1997; Titov and Synolakis, 1998). The bathymetric/topographic data that were used in the tsunami models consist of a series of nested grids. Near-shore grids with a 3 arc-second (75- to 90-meters) resolution or higher, were adjusted to “Mean High Water” sea-level conditions, representing a conservative sea level for the intended use of the tsunami modeling and mapping. A suite of tsunami source events was selected for modeling, representing realistic local and distant earthquakes and hypothetical extreme undersea, near-shore landslides. Local tsunami sources that were considered include offshore reverse-thrust faults, restraining bends on strike-slip fault zones and large submarine landslides capable of significant seafloor displacement and tsunami generation. Distant tsunami sources that were considered include great subduction zone events that are known to have occurred historically (1960 Chile and 1964 Alaska earthquakes) and others which can occur around the Pacific Ocean “Ring of Fire.” In order to enhance the result from the 75- to 90-meter inundation grid data, a method was developed utilizing higher-resolution digital topographic data (3- to 10-meters resolution) that better defines the location of the maximum inundation line (U.S. Geological Survey, 1993; Intermap, 2003; NOAA, 2004). The location of the enhanced inundation line was determined by using digital imagery and terrain data on a GIS platform with consideration given to historic inundation information (Lander, et al., 1993). This information was verified, where possible, by field work coordinated with local county personnel. The accuracy of the inundation line shown on these maps is subject to limitations in the accuracy and completeness of available terrain and tsunami source information, and the current understanding of tsunami generation and propagation phenomena as expressed in the models. Thus, although an attempt has been made to identify a credible upper bound to inundation at any location along the coastline, it remains possible that actual inundation could be greater in a major tsunami event. This map does not represent inundation from a single scenario event. It was created by combining inundation results for an ensemble of source events affecting a given region. For this reason, all of the inundation region in a particular area will not likely be inundated during a single tsunami event. (State of California, 2009)

WILDFIRE MAPPING

Fire Hazard Severity Zones in Local Responsibility Areas data were provided by the California Department of Forestry and Fire Protection. Government Code 51175-89 directs CAL FIRE to identify areas of very high fire hazard severity zones within Local Responsibility Areas (LRA). Mapping of the areas, referred to as Very High Fire Hazard Severity Zones (VHFHSZ), is based on data and models of, potential fuels over a 30-50 year time horizon and their associated expected fire behavior, and expected burn probabilities to quantify the likelihood and nature of vegetation fire exposure (including firebrands) to buildings. Local Responsibility Area VHFHSZ maps were initially developed in the mid-1990s and are now being updated based on improved science, mapping techniques, and data. This specific geographic information system dataset depicts final CAL FIRE recommendations for Very High FHSZs within the local jurisdiction. The process of finalizing these boundaries involved an extensive local review process. Local government has 120 days to designate, by ordinance, very high fire hazard severity zones within its jurisdiction after receiving the recommendation. Local government can add additional VHFHSZs. There is no requirement for local government to report their final action to CAL FIRE when the recommended zones are adopted.

In late 2005 to be effective in 2008, the California Building Commission adopted California Building Code Chapter 7A requiring new buildings in VHFHSZs to use ignition resistant construction methods and materials. These new codes include provisions to improve the ignition resistance of buildings, especially from firebrands. The updated very high fire hazard severity zones will be used by building officials for new building permits in LRA. The updated zones will also be used to identify property whose owners must comply with natural hazards disclosure requirements at time of property sale and 100 foot defensible space clearance.

REFERENCES

Petersen, M., D. Beeby, W. Bryant, T. Cao, C. Cramer, J. Davis, M. Reichle, G. Saucedo, S. Tan G.,Taylor, T. Toppozada, J. Treiman, and C. Wills. 1999. Seismic Shaking Hazard Maps of California: California Division of Mines and Geology Map Sheet 48.

Intermap Technologies, Inc., 2003, Intermap product handbook and quick start guide: Intermap NEXTmap document on 5-meter resolution data, 112 p.

Lander, J.F., Lockridge, P.A., and Kozuch, M.J., 1993, Tsunamis Affecting the West Coast of the United States 1806-1992: National Geophysical Data Center Key to Geophysical Record Documentation No. 29, NOAA, NESDIS, NGDC, 242 p.

National Atmospheric and Oceanic Administration (NOAA), 2004, Interferometric Synthetic Aperture Radar (IfSAR) Digital Elevation Models from GeoSAR platform (EarthData): 3-meter resolution data.

State of California. 2009. Tsunami Inundation Map for Emergency Planning; produced by California Emergency Management Agency, California Geological Survey, and University of Southern California – Tsunami Research Center; dated December 9, 2009.

Titov, V.V., and Gonzalez, F.I., 1997, Implementation and Testing of the Method of Tsunami Splitting (MOST): NOAA Technical Memorandum ERL PMEL –112, 11 p.

Titov, V.V., and Synolakis, C.E., 1998, Numerical modeling of tidal wave runup: Journal of Waterways, Port, Coastal and Ocean Engineering, ASCE, 124 (4), pp 157-171.

U.S. Geological Survey, 1993, Digital Elevation Models: National Mapping Program, Technical Instructions, Data Users Guide 5, 48 p.

USGS. 2006. Maps of Quaternary Deposits and Liquefaction Susceptibility in the Central San Francisco Bay Region, California. Open-File Report 2006-1037. Version 1.1. U.S. Geological Survey in cooperation with the California Geological Survey.

Wills C.J., Perez, F., Gutierrez, C. 2011. Susceptibility to deep-seated landslides in California: California Geological Survey Map Sheet 58.

City of Los Angeles 2018 Local Hazard Mitigation Plan

Appendix C. Review of Previous Plan Actions

C. Review of Previous Plan Actions

The 2011 City of Los Angeles Hazard Mitigation Plan identified 307 mitigation actions for implementation. For the current update, these actions were reviewed by City bureaus and offices and other relevant agencies. For each action, it was determined whether the action had been completed, was in progress or had not been started. Incomplete actions were reviewed to determine if they should be carried over to the 2018 update or removed from the plan due to a change in priorities, capabilities, or feasibility. In total, 48 (16 percent) of the identified actions have been started or completed. Of the 307 identified actions 87 (28 percent) were carried over to the 2018 update. A total of 172 (56 percent) of the identified actions were withdrawn from the plan based on a review by the planning team. The reasons for a withdrawal of an action ranged from the action no longer being considered feasible to the action being identified as a existing capability by the 2018 planning process. The table below summarizes the status of the 2011 recommended actions.

Status of Actions Identified in the 2011 Hazard Mitigation Plan			
Action Item	Completed	Carry Over to 2018 Update	Removed or No Longer Feasible
Department of Animal Services (DAS)			
DAS-01: Extreme Heat Brochure ***Comment***: *Action complete 1/1/2016*	✓		
DAS-02: Animal Decontamination System ***Comment***: Action completed 12/29/2015	✓		
DAS-03: Animal and Human Critical Watering System ***Comment***: Action completed 3/1/2016	✓		
Department of Building and Safety (LADBS)			
LADBS-01, 09, 10, 11, 13 and 13: Enforcement of Existing Building Codes; LABC Chapt. 88 ***Comment***: This was removed as an action because it has been identified as an existing capability under the 2018 planning process			✓
LADBS-02, 05: Enforcement of the City of Los Angeles Planning & Zoning Codes ***Comment***: This was removed as an action because it has been identified as an existing capability under the 2018 planning process			✓
LADBS-03: "Be Prepared, Homeowners" Guide for Erosion Control Booklets ***Comment***: This is an ongoing action that has been carried over to the 2018 plan (LABDS-01)		✓	
LABDS-04: Provide Updates to the Flood Hazard Mitigation Coordinator ***Comment:*** This is an ongoing action that has been carried over to the 2018 plan (LABDS-02)		✓	
LABDS-06: Enforcement of Existing Elevator Codes; LABC Chapt. 95 ***Comment***: This was removed as an action because it has been identified as an existing capability under the 2018 planning process			✓
LABDS-07: Enforcement of Existing Boiler (and Other Mechanical Equipment) Codes ***Comment***: This was removed as an action because it has been identified as an existing capability under the 2018 planning process			✓

Status of Actions Identified in the 2011 Hazard Mitigation Plan			
Action Item	Completed	Carry Over to 2018 Update	Removed or No Longer Feasible
LABDS-08: Seismic Gas Shut-Off Valve Ordinance			✓
***Comment**: This was removed as an action because it has been identified as an existing capability under the 2018 planning process*			
LADBS-14: Enforcement of City of LA Boilers, Unfired Pressure Vessels and Other Equipment Codes and related State of California Codes			✓
***Comment**: This was removed as an action because it has been identified as an existing capability under the 2018 planning process*			
Department on Disability (DDS)			
DDS-01: Disaster Response Sign Language Interpreters		✓	
***Comment**: This is an ongoing action that has been carried over to the 2018 plan (DDS-01)*			
DDS-02: Emergency Preparedness Manual (for People with Disabilities)		✓	
***Comment**: This is an ongoing action that has been carried over to the 2018 plan (DDS-02)*			
DDS-03: Evacuation Chairs for all City Departments and Facilities			✓
Comment: Removed. Determined to be no longer feasible			
DDS-04: Assessment of Disability Needs		✓	
Comment: This is an ongoing action that has been carried over to the 2018 plan (DDS-03)			
DDS-05: Durable Medical Equipment for Persons with Disabilities			✓
***Comment**: Removed. Determined to be no longer feasible*			
DDS-06: Communication Equipment for persons with disabilities	✓		
Comment: Action complete 6/30/2015			
DDS-07: Disaster Response Personal Care Attendants			✓
***Comment**: This was removed as an action because it has been identified as an existing capability under the 2018 planning process*			
DDS-08: Disaster Preparedness On-Line Planning Tool for People with Disabilities		✓	
Comment: This is an ongoing action that has been carried over to the 2018 plan (DDS-04)			
Emergency Management Department (EMD)			
EMD-01: Countywide, Citywide and Departmental Emergency Exercises			✓
Comment: This was removed as an action because it has been identified as an existing capability under the 2018 planning process			
EMD-02: Earthquake Management Course			✓
***Comment**: This was removed as an action because it has been identified as an existing capability under the 2018 planning process*			
EMD-03: Distribute Flood Information to Public			✓
***Comment**: This was removed as an action because it has been identified as an existing capability under the 2018 planning process*			
EMD-04: Emergency Operations Center (EOC) Training			✓
Comment: This was removed as an action because it has been identified as an existing capability under the 2018 planning process			
EMD-05: Community Outreach / Education Program			✓
***Comment**: This was removed as an action because it has been identified as an existing capability under the 2018 planning process*			
EMD-06: Annual Emergency Management Workshop		✓	
***Comment**: This was removed as an action because it has been identified as an existing capability under the 2018 planning process*			
EMD-07: Tsunami Emergency Response Plan Annex	✓		
***Comment**: Action complete 7/21/2015*			
EMD-08: Alternate Emergency Operations Centers (AEOC)			✓
***Comment**: This was removed. Determined to be no longer feasible*			
EMD-09: Annual Emergency Preparedness Fair			✓
***Comment**: This was removed as an action because it has been identified as an existing capability under the 2018 planning process*			
EMD-10: Tsunami Alert Evacuation Program	✓		
Comment: Action completed. 7/21/2015			

Status of Actions Identified in the 2011 Hazard Mitigation Plan			
Action Item	Completed	Carry Over to 2018 Update	Removed or No Longer Feasible
EMD-11: Emergency Operations Organization Handbook			✓
***Comment**: This was removed as an action because it has been identified as an existing capability under the 2018 planning process*			
EMD-12: Integration of Public/Private Sector Communication System			✓
***Comment**: This was removed. Determined to be no longer feasible*			
EMD-13: 800 MHZ Radio Alert System / Two-way handheld mobile communications equipment			✓
***Comment**: This was removed. Determined to be no longer feasible*			
Fire Department (LAFD)			
LAFD-01: Facility Protection Program			✓
***Comment**:* This was removed as an action because it has been identified as an existing capability under the 2018 planning process			
LAFD-02: Project for Fire Stations: 23, 47, 56, 69, 76, 97, 99, 108, 109	✓		
***Comment**: Action completed during the 2011 plan performance period.*			
LAFD-03: Civil Disturbance Response Program			✓
***Comment**: This was removed as an action because it has been identified as an existing capability under the 2018 planning process*			
LAFD-04: Project for all existing Fire Stations			✓
***Comment**: This was removed as an action because it has been identified as an existing capability under the 2018 planning process*			
LAFD-05: Projects for Fire Stations: 18, 24, 28, 74, 75, 77, 91	✓		
***Comment**: Action completed during the 2011 plan performance period.*			
LAFD-06: Maintain High Rise Building Emergency Plans – Title 19 of the Los Angeles Fire Code			✓
***Comment**: This was removed as an action because it has been identified as an existing capability under the 2018 planning process*			
LAFD-07: Underground Storage Tank Program			✓
***Comment**:* This was removed as an action because it has been identified as an existing capability under the 2018 planning process			
LAFD-08: Terrorism Response Program/Terrorist Liaison Officer Program			✓
***Comment**: This was removed as an action because it has been identified as an existing capability under the 2018 planning process*			
LAFD-09: Protect Fire Stations 40, 49, 110, 111, 112 from tsunami impact		✓	
***Comment**: This is an ongoing action that has been carried over to the 2018 plan (LAFD-01)*			
LAFD-10: Hospital Emergency Plans, Title 22, 24 of the LA Fire Code 57.113			✓
***Comment**: This was removed as an action because it has been identified as an existing capability under the 2018 planning process*			
LAFD-11: Earthquake Response Program			✓
***Comment**: This was removed as an action because it has been identified as an existing capability under the 2018 planning process*			
LAFD-12: Sandbag Storage			✓
***Comment**: This was removed as an action because it has been identified as an existing capability under the 2018 planning process*			
LAFD-13: Certificate of Fitness: High Rise and Health Care Facilities			✓
***Comment**: This was removed as an action because it has been identified as an existing capability under the 2018 planning process*			
LAFD-14: Hazardous Materials Inspection and Data Management Program			✓
***Comment**: This was removed as an action because it has been identified as an existing capability under the 2018 planning process*			
LAFD-15: California Accidental Release Program			✓
***Comment**: This was removed as an action because it has been identified as an existing capability under the 2018 planning process*			
LAFD-16: "Fire Chief" Message – Webpage on Neighborhood Preparedness			✓
***Comment**: This was removed as an action because it has been identified as an existing capability under the 2018 planning process*			
LAFD-17: Disaster Awareness Course (DAC) Training Program			✓
***Comment**:* This was removed as an action because it has been identified as an existing capability under the 2018 planning process			
LAFD-18: Swift-Water Rescue Team			✓
***Comment**: This was removed as an action because it has been identified as an existing capability under the 2018 planning process*			

Status of Actions Identified in the 2011 Hazard Mitigation Plan			
Action Item	Completed	Carry Over to 2018 Update	Removed or No Longer Feasible
LAFD-19: Hazardous Material Response Program			✓
Comment*: This was removed as an action because it has been identified as an existing capability under the 2018 planning process*			
LAFD-20: California Accidental Release Prevention Program			✓
Comment: This was removed as an action because it has been identified as an existing capability under the 2018 planning process			
LAFD-21: Building Inventory, Ship Inventory & Aircraft Inventory Programs			✓
Comment: This was removed as an action because it has been identified as an existing capability under the 2018 planning process			
LAFD-22: Update the Flood Hazard Mitigation Coordinator			✓
Comment*: This was removed as an action because it has been identified as an existing capability under the 2018 planning process*			
LAFD-23: Fire Prevention Program			✓
Comment: This was removed as an action because it has been identified as an existing capability under the 2018 planning process			
LAFD-24: Fire Safety in the Home, Fire Fatality Reduction Campaign			✓
Comment*: This was removed as an action because it has been identified as an existing capability under the 2018 planning process*			
LAFD-25: Community Emergency Response Training			✓
Comment*: This was removed as an action because it has been identified as an existing capability under the 2018 planning process*			
LAFD-26: Community Outreach Program			✓
Comment*: This was removed as an action because it has been identified as an existing capability under the 2018 planning process*			
LAFD-27: Erickson Sky Crane Helicopter Purchase			✓
Comment*: removed. Action determined to be no longer feasible at this time*			
LAFD-28: Fire Road Maintenance Program		✓	
Comment*: This is an ongoing action that has been carried over to the 2018 plan (LAFD-02)*			
LAFD-29: Urban Search & Rescue Program – California Task Force 1			✓
Comment*: This was removed as an action because it has been identified as an existing capability under the 2018 planning process*			
LAFD-30: Written Communications Projects			✓
Comment*: This was removed as an action because it has been identified as an existing capability under the 2018 planning process*			
LAFD-31: No Parking Enforcement Program			✓
Comment*: This was removed as an action because it has been identified as an existing capability under the 2018 planning process*			
LAFD-32: Wild Land Operational Plan		✓	
Comment*: This is an ongoing action that has been carried over to the 2018 plan (LAFD-03)*			
General Services Department (GSD)			
GSD-1: Division Training in Emergency Procedures		✓	
Comment*: This is an ongoing action that has been carried over to the 2018 plan (GSD-1)*			
Harbor Department, Port of LA (HAR)			
HAR-01: Maintain Advanced Transportation Management Information System (ATMIS) (24663)		✓	
Comment*: This is an ongoing action that has been carried over to the 2018 plan (HAR-01))*			
HAR-02: Install fill-in areas that have receded in Terminals No. 4, 6, 14, 26, 34, 38, 55, 62, 63, 67, 77, 79, 80, 81, 82, 91 and Ports of Call			✓
Comment*: Action withdrawn. Not considered feasible at this time.*			
HAR-03: Landscape project to protect from landslide impacts	✓		
Comment*: Action completed 5/3/2013*			
HAR-04: Badger Avenue Bridge rail beams repair	✓		
Comment*: Action completed 10/10/2014*			
HAR-05: Warehouse 1 Fire Sprinkler Replacement (25013)	✓		
Comment*: Action completed 8/21/2014*			

Status of Actions Identified in the 2011 Hazard Mitigation Plan			
Action Item	Completed	Carry Over to 2018 Update	Removed or No Longer Feasible
HAR-06: Install dikes in problematic areas in Terminals No. 4, 6, 14, 26, 34, 38, 55, 62, 63, 67, 77, 79, 80, 81, 82, 91 and Ports of Call ***Comment**: Action withdrawn. Not considered feasible at this time.*			✓
HAR-07: Berth 70-72 demo of liquid bulk terminal ***Comment**: Actin completed 8/22/2014*	✓		
HAR-08: Install retaining walls in affected area of Terminal 26 ***Comment**: Action withdrawn. Not considered feasible at this time.*			✓
HAR-09: Badger Avenue Conley joint improvement (24988) ***Comment**: This is an ongoing action that has been carried over to the 2018 plan (HAR-02))*		✓	
HAR-10: Warehouse No.9, 10, 13, 16, & 17 Fire Sprinkler Head Upgrade (24973) ***Comment**:* Action completed 8/21/2014	✓		
HAR-11: Install or Retrofit Emergency Generators in Terminals ***Comment**:* This is an ongoing action that has been carried over to the 2018 plan (HAR-03))		✓	
HAR-12: Install pumps in problematic areas in Terminals No. 4, 6, 14, 26, 34, 38, 55, 62, 63, 67, 77, 79, 80, 81, 82, 91 and Ports of Call ***Comment**:* Action withdrawn. Not considered feasible at this time.			✓
HAR-13: Project No. 1 Waterside Security Surveillance System (24690) (TSA Project 1831) ***Comment**:* Action completed 8/21/2014	✓		
HAR-14: Mass Notification System ***Comment**: Action withdrawn. Not considered feasible at this time.*			✓
HAR-15: Conduct Non-Structural seismic hazard mitigation of vulnerable facilities **Comment:** This is an ongoing action that has been carried over to the 2018 plan (HAR-04)		✓	
HAR-16: John Gibson Blvd. Slope Storm Drain (24913) ***Comment** : Action completed 1/1/2017*	✓		
HAR-17: "Project No 4. Passenger Complex Perimeter Security(24691) (TSA Project 1834)" ***Comment**:* Action completed 1/1/2017	✓		
HAR-18: Prevent Shoaling in Terminals ***Comment**:* Action withdrawn. Not considered feasible at this time.			✓
HAR-19: B- 161 C&M Administration Building Emergency Generator Upgrade (24856) ***Comment**: Action completed 8/21/2014*	✓		
HAR-20: Port of Los Angeles Administration Building Information Systems Backup Power Generator (24720) ***Comment**: Action completed 8/21/2014*	✓		
HAR-21: Port-wide Container Wharf Seismic Study & Code Update (24785) ***Comment**: Action competed 8/22/2014*	✓		
HAR-22: Project No.2 Port of Los Angeles Facility Security Enhancements (24694)(TSA Project 635-00) ***Comment**: Action completed 8/22/2014*	✓		
HAR-23: 300 E. Water Street Port Police Substation (24896) ***Comment**: Action completed 8/22/2014*	✓		
HAR-24: Port of Los Angeles Fiber Optic Network Program (24903) ***Comment**: Action completed 8/22/2014*	✓		
HAR-25: Harbor Admin Building- Main Lobby Remodel Security (24912) ***Comment**: Action completed 8/22/2014*	✓		
HAR-26: 705 N. Front Street Inspection Facility (B 87-89 Scanning Facility 24971)		✓	

Status of Actions Identified in the 2011 Hazard Mitigation Plan			
Action Item	Completed	Carry Over to 2018 Update	Removed or No Longer Feasible
Comment: *This is an ongoing action that has been carried over to the 2018 plan (HAR-05)*			
HAR-27: B. 195-196 – Wharf Improvements / 300 Water Street – Maritime Law Enforcement Training Center (24989)		✓	
Comment: *This is an ongoing action that has been carried over to the 2018 plan (HAR-06)*			
HAR-28: Port Police Integrated Command and Control System (24999)	✓		
Comment: *Action completed 10/10/2014*			
HAR-29: Port Police Computer Aided Dispatch and Records Management System (25000)		✓	
Comment: *This is an ongoing action that has been carried over to the 2018 plan (HAR-07)*			
HAR-30: Port Police Law Enforcement Resource Tracking System (25001)	✓		
Comment: Action completed 10/10/2014			
HAR-31: Port Police Tactical Radio Communications Improvement (25002)		✓	
Comment: This is an ongoing action that has been carried over to the 2018 plan (HAR-08)			
HAR-32: Port Police Interoperable Communications System (25003)	✓		
Comment: *Action completed 10/10/2014*			
HAR-33: 22nd Street Park Surveillance System (25033)	✓		
Comment: Action completed 10/10/2014			
HAR-34: Port-wide Security Surveillance System – Phase II (25035)	✓		
Comment: *Action completed 10/10/2014*			
HAR-35: Port of Los Angeles Facilities Perimeter Monitoring & Access Control System upgrades (25040)	✓		
Comment: *Action completed 10/10/2014*			
Housing Department (LAHD)			
LAHD-01: Enforce the CA Health & Safety Codes			✓
Comment: *This was removed as an action because it has been identified as an existing capability under the 2018 planning process*			
LAHD-02: Enforce the City of Los Angeles/CA Building Code			✓
Comment: *This was removed as an action because it has been identified as an existing capability under the 2018 planning process*			
LAHD-03: Inspect residential rental properties for property violations under the Systematic Code Enforcement Program			✓
Comment: This was removed as an action because it has been identified as an existing capability under the 2018 planning process			
LAHD-04: Tenant Relocation Program			✓
Comment: This was removed as an action because it has been identified as an existing capability under the 2018 planning process			
LAHD-05: Enforce the City of Los Angeles/CA Building Code related to maintaining resistance to seismic activity			✓
Comment: *This was removed as an action because it has been identified as an existing capability under the 2018 planning process*			
LAHD-06: Enforce the City of Los Angeles/CA Plumbing Code			✓
Comment: This was removed as an action because it has been identified as an existing capability under the 2018 planning process			
LAHD-07: Enforce the City of Los Angeles/CA Plumbing Code related to maintaining resistance to seismic activity			✓
Comment: *This was removed as an action because it has been identified as an existing capability under the 2018 planning process*			
LAHD-08: Enforce the City of Los Angeles/CA Planning and Zoning Codes			✓
Comment: *This was removed as an action because it has been identified as an existing capability under the 2018 planning process*			
LAHD-09: Enforce the City of Los Angeles/CA Electrical Code related to maintaining resistance to seismic activity			✓
Comment: *This was removed as an action because it has been identified as an existing capability under the 2018 planning process*			
LAHD-10: Enforce the City of Los Angeles/CA Electrical Code			✓

Status of Actions Identified in the 2011 Hazard Mitigation Plan			
Action Item	Completed	Carry Over to 2018 Update	Removed or No Longer Feasible
***Comment**: This was removed as an action because it has been identified as an existing capability under the 2018 planning process*			
LAHD-11: Enforce the City of Los Angeles/CA Mechanical Code			✓
Comment: This was removed as an action because it has been identified as an existing capability under the 2018 planning process			
LAHD-12: Enforce the City of Los Angeles/CA Planning and Zoning Codes related to maintaining resistance to seismic activity			✓
Comment: This was removed as an action because it has been identified as an existing capability under the 2018 planning process			
LAHD-13: Establish and maintain a Wildfire Hazards and Housing – Working Group			✓
***Comment**: This was removed as an action because it has been identified as an existing capability under the 2018 planning process*			
LAHD-14: Tenant Relocation Program			✓
Comment: This was removed as an action because it has been identified as an existing capability under the 2018 planning process			
LAHD-15: Safety Damage Assessment Data Management			✓
***Comment**: This was removed as an action because it has been identified as an existing capability under the 2018 planning process*			
LAHD-16: Mobile Operations Center/Field Command Post/ Public Information Center			✓
***Comment**: This was removed as an action because it has been identified as an existing capability under the 2018 planning process*			
LAHD-17: Personal Property Retrieval Plan			✓
***Comment**: This was removed as an action because it has been identified as an existing capability under the 2018 planning process*			
LAHD-18: Dist5ribute Earthquake Survival Kits			✓
***Comment**: This was removed as an action because it has been identified as an existing capability under the 2018 planning process*			
LAHD-19 Vacant Housing Unit Identification Plan			✓
Comment: This was removed as an action because it has been identified as an existing capability under the 2018 planning process			
LAHD-20: Securing Vacant Buildings			✓
Comment: This was removed as an action because it has been identified as an existing capability under the 2018 planning process			
LAHD-21: Individual Grant Distribution			✓
***Comment**: This was removed as an action because it has been identified as an existing capability under the 2018 planning process*			
LAHD-22: Reassurance Team Development Plan			✓
Comment: This was removed as an action because it has been identified as an existing capability under the 2018 planning process			
LAHD-23: Rent Stabilization Ordinance Revision/Outreach			✓
Comment: This was removed as an action because it has been identified as an existing capability under the 2018 planning process			
Information Technology Agency (ITA)			
ITA-01: Building Emergency Coordinator (BEC) Program			✓
Comment: This was removed as an action because it has been identified as an existing capability under the 2018 planning process			
ITA-02: Emergency Operations Center (EOC) Computer Upgrades	✓		
***Comment**: Action completed 06/29/2015*			
ITA-03: Geographic Information Systems (GIS) Hazard Mapping		✓	
Comment: This is an ongoing action that has been carried over to the 2018 plan (ITA-01)			
ITA-04: Voice & Data Communication Systems			✓
Comment: This was removed as an action because it has been identified as an existing capability under the 2018 planning process			
ITA-05: Facilitate Public Communication			✓
Comment: This was removed as an action because it has been identified as an existing capability under the 2018 planning process			
ITA-06: EOC IBM Enterprise Server Maintenance			✓
***Comment**: This was removed as an action because it has been identified as an existing capability under the 2018 planning process*			
ITA-07: EOC Printer Maintenance			✓
Comment: This was removed as an action because it has been identified as an existing capability under the 2018 planning process			
ITA-08: Disaster Recovery Support Services		✓	

Status of Actions Identified in the 2011 Hazard Mitigation Plan			
Action Item	Completed	Carry Over to 2018 Update	Removed or No Longer Feasible
***Comment**: This is an ongoing action that has been carried over to the 2018 plan (ITA-02)*			
ITA-09: Communication Systems Support			✓
Comment: This was removed as an action because it has been identified as an existing capability under the 2018 planning process			
ITA-10: Emergency Operations Center (EOC) Incident Management System (IMS) Software Support		✓	
***Comment**: This is an ongoing action that has been carried over to the 2018 plan (ITA-03)*			
ITA-11: Participate in and provide IT support to Citywide & Departmental Emergency Exercises		✓	
Comment: This is an ongoing action that has been carried over to the 2018 plan (ITA-04)			
ITA-12: Emergency Operations Center (EOC) & Department Operations Center (DOC) Training			✓
***Comment**: This was removed as an action because it has been identified as an existing capability under the 2018 planning process*			
ITA-13: Annual Emergency Management Workshop (Arrowhead)			✓
Comment: This was removed as an action because it has been identified as an existing capability under the 2018 planning process			
Los Angeles World Airports (LAWA)			
LAWA-01: Airport Response Coordination Center (ARCC) and Department Operations Center (DOC)	✓		
***Comment**: Action completed 12/1/2010*			
LAWA-02: Improved LAX Airport Passenger Access and Airfield Modifications to Improve Safety and Efficiency (Airfield Expansions)		✓	
Comment: This is an ongoing action that has been carried over to the 2018 plan (LAWA-01)			
LAWA-03: LAX LAFD Aircraft Rescue and Firefighting (ARFF) Station 80	✓		
***Comment**: Action completed 12/01/2010*			
LAWA-04: Security Program: Security Screening Checkpoint (SSCP) Modifications – Ontario Airport (ONT)			✓
Comment: This was removed as an action because it has been identified as an existing capability under the 2018 planning process			
LAWA-05: In-line Baggage Screening System (ONT)			✓
***Comment**: This was removed as an action because it has been identified as an existing capability under the 2018 planning process*			
City Planning Department (PL)			
PL-01: Environmental Review Process			✓
Comment: This was removed as an action because it has been identified as an existing capability under the 2018 planning process			
Police Department (LAPD)			
LAPD-01: Mobile Command Response Unit		✓	
***Comment**: This is an ongoing action that has been carried over to the 2018 plan (LAPD-01)*			
LAPD-02: Terrorist Early Warning (TEW): "Response Information Folders"	✓		
Comment: Action completed 9/8/2016			
LAPD-03: Mobile Field Force (MFF) Wild-Urban Interface Fires			✓
***Comment**: This was removed as an action because it has been identified as an existing capability under the 2018 planning process*			
LAPD-04: Standing Plans			✓
Comment: This was removed as an action because it has been identified as an existing capability under the 2018 planning process			
LAPD-05: Technological, Chemical, and Biological Detection Devices		✓	
***Comment**: This is an ongoing action that has been carried over to the 2018 plan (LAPD-02)*			
LAPD-06: Technology – Explosive Detection Device			✓
Comment: This was removed as an action because it has been identified as an existing capability under the 2018 planning process			
LAPD-07: Special Events Planning Unit (SEPU), Major Events Planning Unit (MEPU), Task Force			✓
***Comment**: This was removed as an action because it has been identified as an existing capability under the 2018 planning process*			
LAPD-08: Emergency Cyber Incident Response Program		✓	
Comment: This is an ongoing action that has been carried over to the 2018 plan (LAPD-03)			

Status of Actions Identified in the 2011 Hazard Mitigation Plan			
Action Item	Completed	Carry Over to 2018 Update	Removed or No Longer Feasible
LAPD-09: Terrorist Early Warning (TEW): "Play Book" ***Comment**: Action completed 9/08/2016*	✓		
LAPD-10: Department's Emergency Operations Guide-Wildland-Urban Interface Fires ***Comment**:* Action completed 08/24/2015	✓		
LAPD-11: Technological, Chemical & Biological Detection Devices ***Comment**: This was removed as an action because it has been identified as an existing capability under the 2018 planning process*			✓
LAPD-12: Technology – Video Downlink/Video Surveillance & Monitoring Equipment ***Comment**:* This is an ongoing action that has been carried over to the 2018 plan (LAPD-04)		✓	
LAPD-13: Critical Asset Protection Program ***Comment**: This is an ongoing action that has been carried over to the 2018 plan (LAPD-05)*		✓	
LAPD-14: Incident Command Post Unit (ICPU) ***Comment**:* This was removed as an action because it has been identified as an existing capability under the 2018 planning process			✓
LAPD-15: Regional Video Command Center Equipment ***Comment**: This is an ongoing action that has been carried over to the 2018 plan (LAPD-06)*		✓	
LAPD-16: Technology – Explosive Detection Devices ***Comment**:* This is an ongoing action that has been carried over to the 2018 plan (LAPD-07)		✓	
LAPD-17: Brushfire Response Plan (Wildland-Urban Interface Fires) ***Comment**: This is an ongoing action that has been carried over to the 2018 plan (LAPD-08)*		✓	
LAPD-18: Personal Protective Equipment (PPE) ***Comment**:* This was removed as an action because it has been identified as an existing capability under the 2018 planning process			✓
LAPD-19: Major Crimes Division ***Comment**:* This was removed as an action because it has been identified as an existing capability under the 2018 planning process			✓
LAPD-20: Technology – Biometric Identification Verification ***Comment**: This was removed as an action because it has been identified as an existing capability under the 2018 planning process*			✓
LAPD-21: Special Events Planning Unit (SEPU), Major Events Planning Unit (MEPU), Task Force ***Comment**:* This was removed as an action because it has been identified as an existing capability under the 2018 planning process			✓
LAPD-22: Terrorist Early Warning Group-Civil Disturbance ***Comment**:* This is an ongoing action that has been carried over to the 2018 plan (LAPD-09)		✓	
LAPD-23: LAPD's Hazardous Materials Unit ***Comment**: This is an ongoing action that has been carried over to the 2018 plan (LAPD-10)*		✓	
LAPD-24: Maintain Standing Plans ***Comment**:* This was removed as an action because it has been identified as an existing capability under the 2018 planning process			✓
LAPD-25: Mobile Command Response Unit ***Comment**:* Action completed 9/12/2016	✓		
LAPD-26: Terrorist Early Warning Group-Civil Disturbance ***Comment**: This is an ongoing action that has been carried over to the 2018 plan (LAPD-09)*		✓	
LAPD-27: LAPD's Explosive Unit Bomb Squad ***Comment**:* This was removed as an action because it has been identified as an existing capability under the 2018 planning process			✓
LAPD-28: Public Outreach/Education ***Comment**:* This is an ongoing action that has been carried over to the 2018 plan (LAPD-12)		✓	
LAPD-29: Joint Terrorism Task Force (JTTF) ***Comment**: Action completed 9/08/2016*	✓		
LAPD-30: Police Department Emergency Operations Guide ***Comment**:* This is an ongoing action that has been carried over to the 2018 plan (LAPD-13)		✓	

Status of Actions Identified in the 2011 Hazard Mitigation Plan			
Action Item	Completed	Carry Over to 2018 Update	Removed or No Longer Feasible
LAPD-31: 24-Hour Tip Telephone Number: (877) A-THREAT ***Comment***: Action Completed 09/08/2016	✓		
LAPD-32: Terrorism Threat Level System ***Comment***: *This was removed as an action because it has been identified as an existing capability under the 2018 planning process*			✓
LAPD-33: Technology – Radiation Detection Device – Aerial Platform ***Comment***: This was removed as an action because it has been identified as an existing capability under the 2018 planning process			✓
LAPD-34: Technology-Cellular Telephone Disruption Device ***Comment***: This is an ongoing action that has been carried over to the 2018 plan (LAPD-14)		✓	
LAPD-35: Construction/Codes to Resist Conventional Weapons ***Comment***: *Action was withdrawn. Not considered to be feasible at this time.*			✓
LAPD-36: Operational Archangel ***Comment***: Action was withdrawn. Not considered to be feasible at this time.			✓
Department of Public Works (DPW)			
DPW-01: Weed abatement private property ***Comment***: This was removed as an action because it has been identified as an existing capability under the 2018 planning process			✓
DPW-02: Storm Water Facilities ***Comment***: *This is an ongoing action that has been carried over to the 2018 plan (DPW-01)*		✓	
DPW-03: Prioritization for Capital Improvement Program ***Comment***: This is an ongoing action that has been carried over to the 2018 plan (DPW-02)		✓	
DPW-04: Special Mobile Hazardous Waste Collection ***Comment***: This was removed as an action because it has been identified as an existing capability under the 2018 planning process			✓
DPW-05: Accelerated Storm Sewer Repair ***Comment***: *This was removed as an action because it has been identified as an existing capability under the 2018 planning process*			✓
DPE-06: Flood Zone Notification ***Comment***: This is an ongoing action that has been carried over to the 2018 plan (DPW-03)		✓	
DPW-07: Weed abatement public property ***Comment***: This was removed as an action because it has been identified as an existing capability under the 2018 planning process			✓
DPW-08: Bridge Improvement Program ***Comment***: *This is an ongoing action that has been carried over to the 2018 plan (DPW-04)*		✓	
DPW-09: Provide dam inundation maps to the public ***Comment***: This is an ongoing action that has been carried over to the 2018 plan (DPW-05)		✓	
DPW-10: Coordination with Other Agencies ***Comment***: This was removed as an action because it has been identified as an existing capability under the 2018 planning process			✓
DPW-11: Spill Prevention Program at Industrial Waste Management Division ***Comment***: *This was removed as an action because it has been identified as an existing capability under the 2018 planning process*			✓
DPW-12: Brush Clearance at City owned landfills ***Comment***: This is an ongoing action that has been carried over to the 2018 plan (DPW-06)		✓	
DPW-13: Continue ongoing Participation with Flood Organizations such as the CA Floodplain Management Association, Association of State Floodplain Managers, and National Association of Stormwater and Floodplain Managers ***Comment***: This is an ongoing action that has been carried over to the 2018 plan (DPW-07)		✓	
DPW-14: Load Checking Program at Central Los Angeles Recycling & Transfer Station (CLARTS) ***Comment***: *This was removed as an action because it has been identified as an existing capability under the 2018 planning process*			✓

Status of Actions Identified in the 2011 Hazard Mitigation Plan			
Action Item	Completed	Carry Over to 2018 Update	Removed or No Longer Feasible
DPW-15: Mitigate vulnerable Wastewater Facilities ***Comment***: This is an ongoing action that has been carried over to the 2018 plan (DPW-08)		✓	
DPW-16: Continue to support a Certified Flood Plain Manager initiative within DPW. ***Comment***: This is an ongoing action that has been carried over to the 2018 plan (DPW-09)		✓	
DPW-17: Tree Maintenance ***Comment***: *This was removed as an action because it has been identified as an existing capability under the 2018 planning process*			✓
DPW-18: Continue the implementation of the Seismic Bond Program ***Comment***: This is an ongoing action that has been carried over to the 2018 plan (DPW-10)		✓	
DPW-19: Conduct National Flood Insurance Program Seminar for City staff with a role in floodplain management for the City. ***Comment***: This is an ongoing action that has been carried over to the 2018 plan (DPW-11)		✓	
DPW-20: Continue the implementation of a Channel/Basin Debris Removal program ***Comment***: *This is an ongoing action that has been carried over to the 2018 plan (DPW-12)*		✓	
DPW-21: Standby/Emergency Power Generation for All Wastewater Pumping & Treatment Plants ***Comment***: This is an ongoing action that has been carried over to the 2018 plan (DPW-13)		✓	
DPW-22: Structural/Nonstructural seismic retrofit of Personnel Building ***Comment***: This is an ongoing action that has been carried over to the 2018 plan (DPW-14)		✓	
DPW-23: Update Procedures and Training Materials ***Comment***: *This was removed as an action because it has been identified as an existing capability under the 2018 planning process*			✓
DPW-24: Hazard contract for Venice Canal maintenance ***Comment***: This was removed as an action because it has been identified as an existing capability under the 2018 planning process			✓
DPW-25: Street Cleaning ***Comment***: This was removed as an action because it has been identified as an existing capability under the 2018 planning process			✓
DPW-26: ICSD – Offsite Backup Tape Storage/Archiving for BOS ***Comment***: *This was removed as an action because it has been identified as an existing capability under the 2018 planning process*			✓
DPW-27: Information Systems Control Division Data Backup ***Comment***: This was removed as an action because it has been identified as an existing capability under the 2018 planning process			✓
DPW-28: La Fayette Park ***Comment***: Action completed 9/1/2016	✓		
DPW-29: Hazard Mapping and Survey Support ***Comment***: *This is an ongoing action that has been carried over to the 2018 plan (DPW-15)*		✓	
DPW-30: Emergency Street Repairs ***Comment***: This was removed as an action because it has been identified as an existing capability under the 2018 planning process			✓
DPW-31: Manchester Jr. Arts Center ***Comment***: This was removed as an action because it has been identified as an existing capability under the 2018 planning process			✓
DPW-32: GIS Mapping and Modeling for Storm Water Facilities ***Comment***: *This is an ongoing action that has been carried over to the 2018 plan (DPW-16)*		✓	
DPW-33: Public Safety Facilities ***Comment***: This was removed as an action because it has been identified as an existing capability under the 2018 planning process			✓
DPW-34: Structural Bridge Repairs ***Comment***: This was removed as an action because it has been identified as an existing capability under the 2018 planning process			✓
DPW-35: Mid-Valley Multi-Purpose Center ***Comment***: *Action Completed 9/01/2016*	✓		

Status of Actions Identified in the 2011 Hazard Mitigation Plan			
Action Item	Completed	Carry Over to 2018 Update	Removed or No Longer Feasible
DPW-36: Maintain Survey Benchmarks			✓
Comment: This was removed as an action because it has been identified as an existing capability under the 2018 planning process			
DPW-37: Street Program			✓
Comment: This was removed as an action because it has been identified as an existing capability under the 2018 planning process			
DPW-38: Lincoln Heights Youth Center	✓		
Comment: *Action Completed 9/01/2016*			
DPW-39: Prioritize Flood Problem Sites		✓	
Comment: This is an ongoing action that has been carried over to the 2018 plan (DPW-17)			
DPW-40: Seismic structural retrofit of Hollywood Recreation Center		✓	
Comment: This is an ongoing action that has been carried over to the 2018 plan (DPW-18)			
DPW-41: Inspect and Maintain Problem Sites			✓
Comment: *This was removed as an action because it has been identified as an existing capability under the* 2018 *planning process*			
DPW-42: Engine Company 23 Arts Center	✓		
Comment: Acton will be complete by 12/01/2018			
DPW-43: Educate the Public About Debris in the Storm Water System		✓	
Comment: This is an ongoing action that has been carried over to the 2018 plan (DPW-19)			
DPW-44: Post "No Dumping" Signs at points of entry to the storm water system			✓
Comment: *This was removed as an action because it has been identified as an existing capability under the* 2018 *planning process*			
DPW-45: Evaluation of FEMA-Designated Flood Zones			✓
Comment: Withdrawn. Action is addressed by the City's 2015 Floodplain management plan which has been integrated by reference to this plan.			
DPW-46: Non Structural Earthquake Hazard Mitigation of identified vulnerable facilities.		✓	
Comment: This is an ongoing action that has been carried over to the 2018 plan (DPW-20)			
DPW-47: Revise the Map of Hillside Areas			✓
Comment: *This was removed as an action because it has been identified as an existing capability under the* 2018 *planning process*			
DPW-48: Annual Inspection of Structural Integrity			✓
Comment: This was removed as an action because it has been identified as an existing capability under the 2018 planning process			
DPW-49: Evaluate Development Regulations			✓
Comment: This was removed as an action because it has been identified as an existing capability under the 2018 planning process			
DPW-50: Verify Compliance of New Development Plans			✓
Comment: *This was removed as an action because it has been identified as an existing capability under the* 2018 *planning process*			
DPW-51: Base Flood Elevation Checks			✓
Comment: This was removed as an action because it has been identified as an existing capability under the 2018 planning process			
DPW-52: Study Height Limitations and Elevation Requirements			✓
Comment: This was removed as an action because it has been identified as an existing capability under the 2018 planning process			
DPW-53: Bridge Improvement Program			✓
Comment: *This was removed as an action because it has been identified as an existing capability under the* 2018 *planning process*			
DPW-54: Improve Soil Stability and Erosion Abatement Regulations		✓	
Comment: This is an ongoing action that has been carried over to the 2018 plan (DPW-21)			
DPW-55: Update the Flood Hazard Mitigation Coordinator			✓
Comment: This was removed as an action because it has been identified as an existing capability under the 2018 planning process			
DPW-56: Continue to Maintain and Evaluate FEMA Elevation Certificates		✓	
Comment: *This is an ongoing action that has been carried over to the* 2018 *plan (DPW-22)*			

Status of Actions Identified in the 2011 Hazard Mitigation Plan			
Action Item	Completed	Carry Over to 2018 Update	Removed or No Longer Feasible
DPW-57: Refine the Use of the Plan Check Inspection System			✓
Comment: This was removed as an action because it has been identified as an existing capability under the 2018 planning process			
DPW-58: Incorporate Flood Plain Management Information into the Zoning Information and Map Access System		✓	
Comment: This is an ongoing action that has been carried over to the 2018 plan (DPW-23)			
DPW-59: Privately Financed			✓
Comment: *This was removed as an action because it has been identified as an existing capability under the 2018 planning process*			
DPW-60: Notify Insurance Agencies and Realtors of Requirements			✓
Comment: Withdrawn. Action is addressed by the City's 2015 Floodplain management plan which has been integrated by reference to this plan.			
DPW-61: Public Safety Facilities			✓
Comment: This was removed as an action because it has been identified as an existing capability under the 2018 planning process			
DPW-62: Provide Citizens with the Flood Zone Information			✓
Comment: *Withdrawn. Action is addressed by the City's 2015 Floodplain management plan which has been integrated by reference to this plan.*			
DDPW-63: High Risk Area Flood Protection Information			✓
Comment: Withdrawn. Action is addressed by the City's 2015 Floodplain management plan which has been integrated by reference to this plan.			
DPW-64: ICSD - Multiple Data Center Project for the Bureau of Sanitation			✓
Comment: This was removed as an action because it has been identified as an existing capability under the 2018 planning process			
DPW-65: Critical Facilities in Designated Flood Zones			✓
Comment: *Withdrawn. Action is addressed by the City's 2015 Floodplain management plan which has been integrated by reference to this plan.*			
DPW-66: Flood Hazard Assessment Questionnaire			✓
Comment: Withdrawn. Action is addressed by the City's 2015 Floodplain management plan which has been integrated by reference to this plan.			
DPW-67: Investigate Repetitive Loss Properties			✓
Comment: Withdrawn. Action is addressed by the City's 2015 Floodplain management plan which has been integrated by reference to this plan.			
DPW-68: Flag Repetitive Loss Properties			✓
Comment: *Withdrawn. Action is addressed by the City's 2015 Floodplain management plan which has been integrated by reference to this plan.*			
DPW-69: Request Modification of Repetitive Loss Property List			✓
Comment: Withdrawn. Action is addressed by the City's 2015 Floodplain management plan which has been integrated by reference to this plan.			
DPW-70: Identify Alternate Funding for Repetitive Loss Properties			✓
Comment: Withdrawn. Action is addressed by the City's 2015 Floodplain management plan which has been integrated by reference to this plan.			
DPW-71: Convert High Flood Risk Properties into Open Space			✓
Comment: *Withdrawn. Action is addressed by the City's 2015 Floodplain management plan which has been integrated by reference to this plan.*			
DPW-72: Establish New Flood Hazard Mitigation Techniques			✓
Comment: Withdrawn. Action is addressed by the City's 2015 Floodplain management plan which has been integrated by reference to this plan.			

Status of Actions Identified in the 2011 Hazard Mitigation Plan			
Action Item	Completed	Carry Over to 2018 Update	Removed or No Longer Feasible
DPW-73: New Storm Water Projects		✓	
Comment: This is an ongoing action that has been carried over to the 2018 plan (DPW-24)			
DPW-74: Environmentally Sensitive Property Management			✓
Comment: *This was removed as an action because it has been identified as an existing capability under the 2018 planning process*			
DPW-75: Annual FMP Evaluation Report			✓
Comment: Withdrawn. Action is addressed by the City's 2015 Floodplain management plan which has been integrated by reference to this plan.			
DPW-76: Implementation of Flash Flood Warning System for Donald C. Tilman Plant, Los Angeles-Glendale Plant, Pumping Plant #3 and Pumping Plant #49		✓	
Comment: This is an ongoing action that has been carried over to the 2018 plan (DPW-25)			
DPW-77: Proposed Mitigation Measures under Department of Public Works		✓	
Comment: This is an ongoing action that has been carried over to the 2018 plan (DPW-26)			
DPW-78: Potrero Canyon Slope Stabilization on Pacific Coast Highway, a.k.a. Potrero Canyon Development Unit 4.		✓	
Comment: *This is an ongoing action that has been carried over to the 2018 plan (DPW-27)*			
DPW-79: San Pedro 3rd Street Relief Storm Drain Project		✓	
Comment: This is an ongoing action that has been carried over to the 2018 plan (DPW-28)			
Department of Water and Power (DWP)			
DWP-01: Generation Backup Program		✓	
Comment: This is an ongoing action that has been carried over to the 2018 plan (DWP-01)			
DWP-02: Asbestos Training Program			✓
Comment: *This was removed as an action because it has been identified as an existing capability under the 2018 planning process*			
DWP-03: Mobile Radio System Upgrades Study	✓		
Comment: Action Completed 07/2012			
DWP-04: Integrate Customer Connect with existing centers		✓	
Comment: This is an ongoing action that has been carried over to the 2018 plan (DWP-02)			
DWP-05: Water District HQ Water Yard Renovation			✓
Comment: This was removed as an action because it has been identified as an existing capability under the 2018 planning process			
DWP-06: Mail Center Disaster Recovery Site	✓		
Comment: *Action Completed in 2013*			
DPW-07: Security Lighting Upgrade Program		✓	
Comment: This is an ongoing action that has been carried over to the 2018 plan (DWP-03)			
DPW-08: Perimeter Fencing		✓	
Comment: This is an ongoing action that has been carried over to the 2018 plan (DWP-04)			
DPW-09: WQIP Reservoir Improvement Program			✓
Comment: *This was removed as an action because it has been identified as an existing capability under the 2018 planning process*			
DPW-10: Spill Prevention Control & Countermeasures			✓
Comment: This was removed as an action because it has been identified as an existing capability under the 2018 planning process			
DPW-11: Asbestos Abatement			✓
Comment: This was removed as an action because it has been identified as an existing capability under the 2018 planning process			
DPW-12: Lead Abatement			✓
Comment: This was removed as an action because it has been identified as an existing capability under the 2018 planning process			
DPW-13: Weed Abatement		✓	
Comment: *This is an ongoing action that has been carried over to the 2018 plan (DWP-05)*			

Status of Actions Identified in the 2011 Hazard Mitigation Plan			
Action Item	Completed	Carry Over to 2018 Update	Removed or No Longer Feasible
DPW-14: IT Security Program			✓
Comment: This was removed as an action because it has been identified as an existing capability under the 2018 planning process			
DPW-15: Emergency Telephone Pilot Project			✓
Comment: This was removed as an action because it has been identified as an existing capability under the 2018 planning process			
DPW-16: Emergency Response Equipment			✓
Comment: *This was removed as an action because it has been identified as an existing capability under the 2018 planning process*			
DPW-17: Groundwater System Improvement Study			✓
Comment: This was removed as an action because it has been identified as an existing capability under the 2018 planning process			
DPW-18: Electronic/Water Quality Monitoring			✓
Comment: This was removed as an action because it has been identified as an existing capability under the 2018 planning process			
DPW-19: Terminal Hill Tunnel Project	✓		
Comment: Action completed 01/01/2011			
DPW-20: Pump Stations Program		✓	
Comment: *This is an ongoing action that has been carried over to the 2018 plan (DWP-06)*			
DPW-21: Regulator Stations Program		✓	
Comment: This is an ongoing action that has been carried over to the 2018 plan (DWP-07)			
DPW-22: Trunk Lines and Major System Connections Program		✓	
Comment: This is an ongoing action that has been carried over to the 2018 plan (DWP-08)			
DPW-23: Infrastructure Reservoir Improvements Program(tanks only)		✓	
Comment: *This is an ongoing action that has been carried over to the 2018 plan (DWP-09)*			
DPW-24: Griffith Park Improvements Project		✓	
Comment: This is an ongoing action that has been carried over to the 2018 plan (DWP-10)			
DPW-25: Van Norman High Speed Bypass Channels Project			✓
Comment: This was removed as an action because it has been identified as an existing capability under the 2018 planning process			
DPW-26: Fencing - LA Aqueduct and Reservoirs			✓
Comment: This was removed as an action because it has been identified as an existing capability under the 2018 planning process			
DPW-27: Purchase Generator – Bishop Administration Office	✓		
Comment: *Action completed 07/01/2011*			
DPW-28: Security projects at reservoirs, Dams, Facilities		✓	
Comment: This is an ongoing action that has been carried over to the 2018 plan (DWP-11)			
DPW-29: LA Aqueduct Ground Based Patrols			✓
Comment: This was removed as an action because it has been identified as an existing capability under the 2018 planning process			
DPW-30: LA Aqueduct Helicopter Security Patrolling			✓
Comment: *This was removed as an action because it has been identified as an existing capability under the 2018 planning process*			
DPW-31: In-City Daily Security Patrols			✓
Comment: This was removed as an action because it has been identified as an existing capability under the 2018 planning process			
DPW-32: In-City Daily Helicopter Security Patrols			✓
Comment: This was removed as an action because it has been identified as an existing capability under the 2018 planning process			
DPW-33: Electronic Surveillance of Critical Water Facilities; video cameras and access controls			✓
Comment: This was removed as an action because it has been identified as an existing capability under the 2018 planning process			
DPW-34: Security component to remove open reservoirs			✓
Comment: *This was removed as an action because it has been identified as an existing capability under the 2018 planning process*			
DPW-35: Water Quality Additions and Betterments		✓	
Comment: This is an ongoing action that has been carried over to the 2018 plan (DWP-12)			

Status of Actions Identified in the 2011 Hazard Mitigation Plan			
Action Item	Completed	Carry Over to 2018 Update	Removed or No Longer Feasible
DPW—36: Physical security improvements at dams, reservoirs			✓
Comment: This was removed as an action because it has been identified as an existing capability under the 2018 planning process			
DPW-37: Infrastructure Reservoir Improvements Program (dams only)		✓	
Comment: *This is an ongoing action that has been carried over to the* 2018 *plan (DWP-13)*			
DPW-38: Chloramine Conversion Program			✓
Comment: This was removed as an action because it has been identified as an existing capability under the 2018 planning process			
DPW-39: Cement Lining Program	✓		
Comment: Action completed 12/31/2012			
DPW-40: WQIP Reservoir Improvement Program		✓	
Comment: This is an ongoing action that has been carried over to the 2018 plan (DWP-14)			
DPW-41: Seismic Strengthen of DS Yard walls		✓	
Comment: *This is an ongoing action that has been carried over to the* 2018 *plan (DWP-15)*			
DPW-42: Online water quality monitoring			✓
Comment: This was removed as an action because it has been identified as an existing capability under the 2018 planning process			
DPW-43: Alternate Crisis Management Center	✓		
Comment: Action completed 09/01/2014			
DPW-44: First Los Angeles Aqueduct Deadman Sag Pipe			✓
Comment: *This was removed as an action because it has been identified as an existing capability under the* 2018 *planning process*			

City of Los Angeles 2018 Local Hazard Mitigation Plan

Appendix D. Progress Report Template

D. PROGRESS REPORT TEMPLATE

Reporting Period: *(Insert reporting period)*

Background: The City of Los Angeles developed a hazard mitigation plan to reduce risk from hazards by identifying resources, information, and strategies for risk reduction. The federal Disaster Mitigation Act of 2000 requires state and local governments to develop hazard mitigation plans as a condition for federal disaster grant assistance. To prepare the plan, the City organized resources, assessed risks from hazards, developed planning goals and objectives, reviewed mitigation alternatives, and developed an action plan to address probable impacts from natural hazards. By completing this process, these jurisdictions maintained compliance with the Disaster Mitigation Act, achieving eligibility for mitigation grant funding opportunities afforded under the Robert T. Stafford Act. The plan can be viewed on-line at:

INSERT LINK

Summary Overview of the Plan's Progress: The performance period for the Hazard Mitigation Plan became effective on __[date]__, with the final approval of the plan by FEMA. The performance period for this plan will be 5 years, with an anticipated update to the plan to occur before __[date]__. As of this reporting period, the performance period for this plan is considered to be __% complete. The Hazard Mitigation Plan has targeted 113 hazard mitigation actions to be pursued during the 5-year performance period. As of the reporting period, the following overall progress can be reported:

- __ out of __ actions (__%) reported ongoing action toward completion.
- __ out of __ actions (__%) were reported as being complete.
- __ out of __ actions (___%) reported no action taken.

Purpose: The purpose of this report is to provide an annual update on the implementation of the action plan identified in the Hazard Mitigation Plan. The objective is to ensure that there is a continuing and responsive planning process that will keep the Hazard Mitigation Plan dynamic and responsive to the needs and capabilities of the City of Los Angeles. This report discusses the following:

- Hazard events that have occurred within the last year.
- Changes in risk exposure within the planning area.
- Mitigation success stories.
- Review of the action plan.
- Changes in capabilities that could impact plan implementation.
- Recommendations for changes/enhancement.

The Plan Maintenance Steering Committee: It was determined through the plan's development process that a plan maintenance steering committee would remain in service to oversee maintenance of the plan. The plan maintenance steering committee, made up of City staff and other stakeholders from the planning area, reviewed and approved this progress report at its annual meeting held on __[date]__. At a minimum, the plan maintenance steering committee is to provide technical review and oversight on the development of the annual progress report.

It is anticipated that there will be turnover in the membership annually, which will be documented in the progress reports. For this reporting period, the plan maintenance steering committee membership is as indicated in Table 1.

Table 1. Plan Maintenance Steering Committee Members

Name	Title	Department/Agency

Hazard Events within the Planning Area: During the reporting period, there were __ hazard events in the planning area that had a measurable impact on people or property. A summary of these events is as follows:

- ______________________________
- ______________________________

Changes in Risk Exposure in the Planning Area: *(Insert brief overview of any natural hazard event in the planning area that changed the probability of occurrence or ranking of risk for the hazards addressed in the hazard mitigation plan)*

Mitigation Success Stories: *(Insert brief overview of mitigation accomplishments during the reporting period)*

Review of the Action Plan: Table 2 reviews the action plan, reporting the status of each action. Reviewers of this report should refer to the Hazard Mitigation Plan for more detailed descriptions of each action and the prioritization process.

Address the following in the "status" column of the following table:

- Was any element of the action carried out during the reporting period?
- If no action was completed, why?
- Is the timeline for implementation for the action still appropriate?
- If the action was completed, does it need to be changed or removed from the action plan?

Table 2. Action Plan Matrix

Action Taken? (Yes or No)	Time Line	Priority	Status	Status (X, O,✓)
Action #__—____________________[description]				
Action #__—____________________[description]				
Action #__—____________________[description]				
Action #__—____________________[description]				
Action #__—____________________[description]				
Action #__—____________________[description]				
Action #__—____________________[description]				
Action #__—____________________[description]				
Action #__—____________________[description]				
Action #__—____________________[description]				
Action #__—____________________[description]				
Action #__—____________________[description]				
Action #__—____________________[description]				
Action #__—____________________[description]				
Action #__—____________________[description]				
Action #__—____________________[description]				
Action #__—____________________[description]				
Action #__—____________________[description]				
Action #__—____________________[description]				

Completion status legend:
✓= Project Completed
O = Action ongoing toward completion
X = No progress at this time

Changes That May Impact Implementation of the Plan: *(Insert brief overview of any significant changes in the planning area that would have a profound impact on the implementation of the plan. Specify any changes in technical, regulatory and financial capabilities identified during the plan's development)*

Recommendations for Changes or Enhancements: Based on the review of this report by the plan maintenance steering committee, the following recommendations will be noted for future updates or revisions to the plan:

- ______________________________
- ______________________________
- ______________________________
- ______________________________
- ______________________________
- ______________________________

Public review notice: *The contents of this report are considered to be public knowledge and have been prepared for total public disclosure. Copies of the report have been provided to the City of Los Angeles City Council and to local media outlets. The report is posted on the City of Los Angeles Hazard Mitigation Plan website. Any questions or comments regarding the contents of this report should be directed to:*

Insert Contact Info Here

Appendix E. City of Los Angeles Adoption Resolution

E. CITY OF LOS ANGELES ADOPTION RESOLUTION