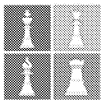
City of Pasadena Multi-Hazard Mitigation Plan

Draft Date:
May 15, 2013



LECMgt

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Part I: Introduction

EXECUTIVE SUMMARY:

Five -Year Action Plan Review

The City of Pasadena Multi-Hazard Mitigation Action Plan includes resources and information to assist City residents, public and private sector organizations, and others interested in participating in planning for natural hazards. The Mitigation Plan provides a list of activities that may assist Pasadena in reducing risk and preventing loss from future natural hazard events. The action items address multi-hazard issues, as well as activities for earthquakes, earth movements, flooding, wildfires and windstorms.

How is the Plan Organized?

The Mitigation Plan contains a five-year action plan, background on the purpose and methodology used to develop the mitigation plan, a profile of Pasadena, sections on five natural hazards that occur within the City, and a number of appendices. All of the sections are described in detail in Section 1, the plan introduction.

Who Participated in Developing the Plan?

The City of Pasadena Multi-Hazard Mitigation Action Plan is the result of a collaborative effort between Pasadena citizens, public agencies, non-profit organizations, the private sector, and regional and state organizations. Public participation played a key role in development of goals and action items. Interviews were conducted with stakeholders across the City, and two public workshops were held to include City of Pasadena residents in plan development. The City provided a link on its website to allow for ongoing citizen/stakeholder input. A Hazard Mitigation Advisory Committee guided the process of developing the plan.

The Hazard Mitigation Advisory Committee was comprised of representatives from:

- ✓ City of Pasadena Planning
- ✓ City of Pasadena Emergency Services Coordinator
- ✓ City of Pasadena Fire Department
- ✓ City of Pasadena Police Department
- ✓ City of Pasadena Finance
- ✓ City of Pasadena Department of Information Technology
- ✓ City of Pasadena Transportation
- ✓ City of Pasadena Public Affairs
- ✓ City of Pasadena Public Works Department
- ✓ City of Pasadena Human Services and Recreation Department
- ✓ City of Pasadena Public Health Department

What is the Plan Mission?

The mission of the City of Pasadena Multi-Hazard Mitigation Plan is to promote sound public policy designed to protect citizens, critical facilities, infrastructure, private property, and the environment from natural hazards. This can be achieved by increasing public awareness, documenting the resources for risk reduction and loss-prevention, and identifying activities to guide the City towards building a safer, more sustainable community. The mission of this update is to evaluate where we have been and provide leadership and direction for future mitigation planning.

What are the Plan Goals?

The plan goals describe the overall direction Pasadena agencies, organizations, and citizens can take to work toward mitigating risk from natural hazards. The goals are stepping-stones between the broad direction of the mission statement and the specific recommendations outlined in the action items.

Protect Life and Property:

- ✓ Implement activities that assist in protecting lives by making homes, businesses, infrastructure, critical facilities, and other property more resistant to losses from natural hazards.
- ✓ Reduce losses and repetitive damages for chronic hazard events while promoting insurance coverage for catastrophic hazards.
- ✓ Improve hazard assessment information to make recommendations for discouraging new development in high hazard areas and encouraging preventative measures for existing development in areas vulnerable to natural hazards.

Public Awareness:

- ✓ Develop and implement education and outreach programs to increase public awareness of the risks associated with natural hazards.
- ✓ Provide information on tools, partnership opportunities, and funding resources to assist in implementing mitigation activities.

Natural Systems:

- ✓ Balance natural resource management and land use planning with natural hazard mitigation to protect life, property, and the environment.
- ✓ Preserve, rehabilitate, and enhance natural systems to serve natural hazard mitigation functions.

Partnerships and Implementation:

- ✓ Strengthen communication and coordinate participation among and within public agencies, citizens, non-profit organizations, businesses, and industry to gain a vested interest in implementation.

- ✓ Encourage leadership within public and private sector organizations to prioritize and implement local and regional hazard mitigation activities.

Emergency Services:

- ✓ Establish policy to ensure mitigation projects for critical facilities, services, and infrastructure.

- ✓ Strengthen emergency operations by increasing collaboration and coordination among public agencies, non-profit organizations, businesses, and industry.

- ✓ Coordinate and integrate natural hazard mitigation activities, where appropriate, with emergency operations plans and procedures.

How Are the Action Items Organized?

The action items are a listing of activities in which City agencies and citizens can be engaged to reduce risk. Each action item includes an estimate of the time line for implementation. Short-term action items are activities that City agencies may implement with existing resources and authorities within one to two years. Long-term action items may require new or additional resources or authorities, and may take between one and five years (or more) to implement.

The action items are organized within the following matrix, which lists all of the multi-hazard and hazard-specific action items included in the mitigation plan. Data collection and research and the public participation process resulted in the development of these action items. The following information is included for each action item:

Coordinating Organization:

The coordinating organization is the public agency with regulatory responsibility to address natural hazards, or that is willing and able to organize resources, find appropriate funding, or oversee activity implementation, monitoring, and evaluation. Coordinating organizations may include local, county, or regional agencies that are capable of or responsible for implementing activities and programs.

Timeline:

Action items include both short- and long-term activities. Each action item includes

an estimate of the timeline for implementation. Short-term action items are activities which City agencies are capable of implementing with existing resources and authorities within one to two years. Long-term action items may require new or additional resources or authorities, and may take between one and five years (or more) to implement.

Ideas for Implementation:

Each action item includes ideas for implementation and potential resources, which may include grant programs or human resources. The matrix includes the page number within the mitigation plan where this information can be found.

Potential Funding Sources:

This plan describes potential funding sources to implement short-term mitigation actions. Funding for medium and longer-term activities has not yet been identified due to the uncertain timeline for the individual projects. It is expected that future funding will combine City funds and state and/or federal grant programs as listed in Appendix B.

Plan Goals Addressed:

The plan goals addressed by each action item are included as a way to monitor and evaluate how well the mitigation plan is achieving its goals once implementation begins. The plan goals are organized into the following five areas:

- ✓ Protect Life and Property
- ✓ Public Awareness
- ✓ Natural Systems
- ✓ Partnerships and Implementation
- ✓ Emergency Services

Partner Organizations:

The partner organizations are not listed with the individual action items or in the plan matrix. The partner organizations listed in the resource directories of the City of Pasadena Multi-Hazard Mitigation Plan are potential partners recommended by the Hazard Mitigation Advisory Committee, but they were not necessarily contacted during the development of the Mitigation Plan. Partner organizations should be contacted by the coordinating organization to establish commitment of time and resources to action items.

Constraints:

Constraints may apply to some of the action items. These constraints may be a lack of City staff, lack of funds, or vested property rights which might expose the City to legal action as a result of adverse impacts on private property.

How Will the Plan be Implemented, Monitored, and Evaluated?

The Plan Maintenance Section of this document details the formal process that will ensure that the City of Pasadena Multi-Hazard Mitigation Plan remains an active and relevant document. The plan maintenance process includes a schedule for monitoring and evaluating the Plan annually and producing a Plan revision every five years. This section describes how the City will integrate public participation throughout the plan maintenance process. Finally, this section includes an explanation of how the City of Pasadena government intends to incorporate the mitigation strategies outlined in this Plan into existing planning mechanisms such as the City's General Plan, Capital Improvement Plans, and Building & Safety Codes.

Plan Adoption

Adoption of the Multi-Hazard Mitigation Plan by the local jurisdiction's governing body is one of the prime requirements for approval of the Plan. Once the Plan is completed, the City Council will be responsible for adopting the City of Pasadena Multi-Hazard Mitigation Plan. The local governing body has the responsibility and authority to promote sound public policy regarding natural hazards. The City Council will periodically need to re-adopt the Plan as it is revised to meet changes in the natural hazard risks and exposures in the community. The approved Multi-Hazard Mitigation Plan will be significant in the future growth and development of the community.

Coordinating Body

A City of Pasadena Hazard Mitigation Advisory Committee will be responsible for coordinating implementation of Plan action items and undertaking the formal review process. The City Manager, or designee, will assign representatives from City agencies, including but not limited to the current Hazard Mitigation Advisory Committee members.

Convener

The City Council will adopt the City of Pasadena Multi-Hazard Mitigation Plan, and the Hazard Mitigation Advisory Committee will take responsibility for Plan implementation. The City Manager, or designee, will serve as a convener to facilitate the Hazard Mitigation Advisory Committee meetings, and will assign tasks such as updating and presenting the Plan to the members of the committee. Plan implementation and evaluation will be a shared responsibility among all of the Hazard Mitigation Advisory Committee members.

Implementation through Existing Programs

The City of Pasadena addresses statewide planning goals and legislative requirements through its General Plan, Capital Improvement Plan, and City Building & Safety Codes. The Multi-Hazard Mitigation Plan provides a series of recommendations that are closely related to the goals and objectives of these existing planning programs. The City of Pasadena will have the opportunity to implement recommended mitigation action items through existing programs and procedures.

Economic Analysis of Mitigation Projects

The Federal Emergency Management Agency's approaches to identify costs and benefits associated with natural hazard mitigation strategies or projects fall into two general categories: benefit/cost analysis and cost-effectiveness analysis. Conducting benefit/cost analysis for a mitigation activity can assist communities in determining whether a project is worth undertaking now, in order to avoid disaster-related damages later. Cost-effectiveness analysis evaluates how best to spend a given amount of money to achieve a specific goal. Determining the economic feasibility of mitigating natural hazards can provide decision makers with an understanding of the potential benefits and costs of an activity, as well as a basis upon which to compare alternative projects. The City departments responsible for the various short-term actions items will include the related costs into their annual department budgets.

Formal Review Process

The City of Pasadena Multi-Hazard Mitigation Plan will be evaluated on an annual basis to determine the effectiveness of programs, and to reflect changes in land development or programs that may affect mitigation priorities. The evaluation process includes a firm schedule and timeline, and identifies the local agencies and organizations participating in Plan evaluation. The convener will be responsible for contacting the Hazard Mitigation Advisory Committee members and organizing the annual meeting. Committee members will be responsible for monitoring and evaluating the progress of the mitigation strategies in the Plan.

Continued Public Involvement

The City of Pasadena is dedicated to involving the public directly in the continual review and updates of the Multi-Hazard Mitigation Plan. Copies of the Plan will be catalogued and made available at City Hall and at all City-operated public libraries. The existence and location of these copies will be publicized in City newsletters. The Plan also includes the address and the phone number of the City Emergency Management Coordinator, responsible for keeping track of public comments on the Plan. In addition, copies of the Plan and any proposed changes will be posted on the City website. This site will also contain an email address and phone number to which people can direct their comments and concerns.

Part II:

Mitigation Background and Planning

SECTION 1:

- Introduction -

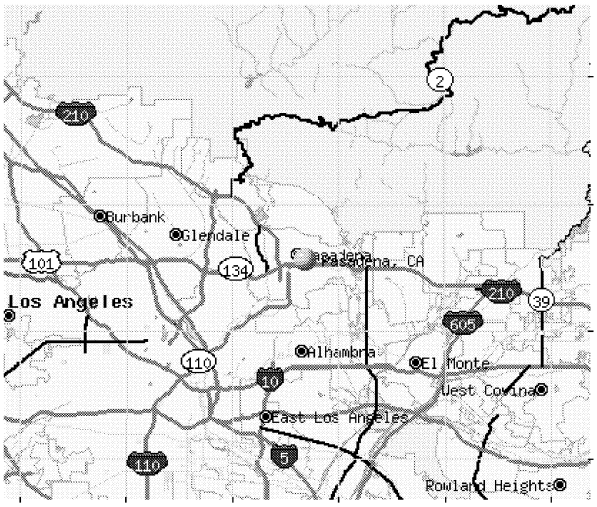
Throughout history, the residents of the City of Pasadena have dealt with the various natural hazards affecting the area. Photos, journal entries, and newspapers from the 1800s show that the residents of the area dealt with earthquakes, earth movements, flooding, and windstorms.

Although there were fewer people in the area, the natural hazards adversely affected the lives of those who depended on the land and climate conditions for food and welfare. As the population of the City continues to increase, the exposure to natural hazards creates an even higher risk than previously experienced.

The City of Pasadena is the 9th most populous city in Los Angeles County, and offers the benefits of living in a Mediterranean type of climate. The City is characterized by the unique and attractive landscape that makes the area so popular. However, the potential impacts of natural hazards associated with the terrain make the environment and population vulnerable to natural disaster situations.

The City is subject to earthquakes, earth movements, flooding, wildfire, and windstorms. It is impossible to predict exactly when these disasters will occur, or the extent to which they will affect the City. However, with careful planning and collaboration among public agencies, private sector organizations, and citizens within the community, it is possible to minimize the losses that can result from these natural disasters.

The City of Pasadena most recently experienced some destruction during the 1994 Northridge earthquake.



Why Develop a Mitigation Plan?

As the costs of damage from natural disasters continue to increase, the community realizes the importance of identifying effective ways to reduce vulnerability to disasters. Multi-hazard mitigation plans assist communities in reducing risk from natural hazards by identifying resources, information, and strategies for risk reduction, while helping to guide and coordinate mitigation activities throughout the City.

The Plan update provides a set of action items to reduce risk from natural hazards through education and outreach programs. It also aims to foster the development of partnerships and the implementation of preventative activities such as land use programs that restrict and control development in areas subject to damage from natural hazards.

The resources and information within the Multi-Hazard Mitigation Plan:

(1) Establish a basis for coordination and collaboration among agencies and the public in the City of Pasadena;
(2) Identify and prioritize future mitigation projects; and
(3) Assist in meeting the requirements of federal assistance programs.

The Mitigation Plan works in conjunction with other City plans, including the City General Plan and Emergency Operations Plan.

Whom Does the Mitigation Plan Affect?

The City of Pasadena Multi-Hazard Mitigation Plan affects the entire City. This Plan provides a framework for planning for natural hazards. The resources and background information in the Plan is applicable City-wide, and the goals and recommendations can lay groundwork for local mitigation plans and partnerships.

Natural Hazard Land Use Policy in California:

Planning for natural hazards should be an integral element of any city's land use planning program. All California cities and counties have General Plans and the implementing ordinances that are required to comply with the statewide planning regulations.

The continuing challenge faced by local officials and state government is to keep the network of local plans effective in responding to the changing conditions and needs of California's diverse communities, particularly in light of the very active seismic region in which residents of California live.

This is particularly true in the case of planning for natural hazards, where communities must balance development pressures with detailed information on the nature and extent of hazards.

Planning for natural hazards calls for local plans to include inventories, policies, and

ordinances to guide development in hazard areas. These inventories should include the compendium of hazards facing the community, the built environment at risk, the personal property that may be damaged by hazard events, and most of all, the people who live in the shadow of these hazards.

Support for Natural Hazard Mitigation:

All mitigation is local, and the primary responsibility for development and implementation of risk reduction strategies and policies lies with local jurisdictions. Local jurisdictions, however, are not alone. Partners and resources exist at the regional, state, and federal levels. Numerous California state agencies have a role in natural hazards and natural hazard mitigation. Some of the key agencies include:

- ✓ The California Emergency Management Agency (CalEMA) is responsible for disaster mitigation, preparedness, response, recovery, and the administration of federal funds after a major disaster declaration;

- ✓ The Southern California Earthquake Center (SCEC) gathers information about earthquakes, integrates this information on earthquake phenomena, and communicates this to end-users and the general public to increase earthquake awareness, reduce economic losses, and save lives.

- ✓ The California Division of Forestry (CDF) is responsible for all aspects of wildland fire protection on private and state lands, and it administers forest practices regulations, including landslide mitigation, on non-federal lands.

- ✓ The California Division of Mines and Geology (DMG) is responsible for geologic hazard characterization, public education, the development of partnerships aimed at reducing risk, and exceptions (based on science-based refinement of tsunami inundation zone delineation) to state-mandated tsunami zone restrictions.

- ✓ The California Division of Water Resources (DWR) plans, designs, constructs, operates, and maintains the State Water Project; regulates dams; provides flood protection and assists in emergency management. It also educates the public and serves local water needs by providing technical assistance.

Plan Methodology

Information in the Mitigation Plan is based on research from a variety of sources. Staff from the City of Pasadena reviewed the previously-approved 2005 Plan to identify areas in which updated hazard information and mitigation action progress would be incorporated. Additionally, the 2005 Plan was reviewed to consider potential changes in the City's mitigation priorities. After this review, City staff concluded that the natural hazards identified in the 2005 Plan still had the potential to affect the City. A new section on human threats was added. Additionally, the plan goals from the 2005 Plan were determined to still be valid for the updated Plan.

While preparing the updated Plan, staff from the City of Pasadena conducted data research and analysis, facilitated steering committee meetings and public workshops, and developed the final Mitigation Plan. The research methods and various contributions to the Plan include the following:

Input From the Hazard Mitigation Advisory Committee:

The Hazard Mitigation Advisory Committee guided development of the Mitigation Plan. The committee played an integral role in developing the mission, goals, and action items for the Mitigation Plan.

City of Pasadena City Manager's Office
City of Pasadena Emergency Management
City of Pasadena Fire Department
City of Pasadena Police Department
City of Pasadena Finance
City of Pasadena Planning
City of Pasadena Public Affairs
City of Pasadena Transportation Department
City of Pasadena Public Health Department
City of Pasadena Water and Power Department

Stakeholder Interviews:

The Pasadena Emergency Management Coordinator met with representatives from organizations interested in hazard mitigation planning. The meeting identified common concerns related to natural hazards and identified key long- and short-term activities to reduce risk from natural hazards. The stakeholders included:

The Tournament of Roses Committee
Kaiser Permanente Hospital
California Institute of Technology
United States Marine Corps Reserve Center
Avon International
Pasadena Urgent Care

State and Federal Guidelines and Requirements for Mitigation Plans:

Following are the federal requirements for approval of a Multi-Hazard Mitigation Plan:

- ✓ Open public involvement, with public meetings that introduce the process and project requirements.
- ✓ Opportunities for the public to be involved in identifying and assessing risk, drafting a Plan, and the approval stages of the Plan.

- ✓ Community cooperation, with opportunity for other local government agencies, the business community, educational institutions, and non-profits to participate in the process.

- ✓ Incorporation of local documents, including the City's General Plan, the Zoning Ordinance, the Building Codes, and other pertinent documents.

The following components must be part of the planning process:

- ✓ Complete documentation of the planning process;

- ✓ A detailed risk assessment on hazard exposures in the community;

- ✓ A comprehensive mitigation strategy which describes the goals and objectives, including proposed strategies, programs and actions to avoid long-term vulnerabilities;

- ✓ A plan maintenance process, which describes the method and schedule of monitoring, evaluating and updating the Plan and integration of the Multi-Hazard Mitigation Plan into other planning mechanisms;

- ✓ Formal adoption by the City Council; and

- ✓ Plan Review by both CalEMA and FEMA.

These requirements are spelled out in greater detail in the following Plan sections and supporting documentation.

A public workshop (or other public forum) is recommended to allow for public participation, in addition to the inclusion of representatives from outside organizations on the planning committee itself. The timing and scheduling of the workshops may vary from one community to another depending on how each city's committee organizes its work and the particular needs of the community.

City of Pasadena staff examined existing mitigation plans from around the country, current FEMA hazard mitigation planning standards (386 series) and the State of California Multi-Hazard Mitigation Plan Guidance.

Other reference materials consisted of county and city mitigation plans, including:

- ✓ Clackamas County (Oregon) Multi-Hazard Mitigation Plan
- ✓ State of Washington Multi-Hazard Mitigation Plan
- ✓ Los Angeles Specific Planning Guidebook provided by the Disaster Management Area Coordinators of Areas D, E, and F

Hazard Specific Research:

Pasadena staff collected data and compiled research on five hazards: earthquakes, earth movements (landslides), flooding, wildfires and windstorms. Research materials came from federal agencies including FEMA, state agencies including CalEMA and CDF, City level such as the Safety Plan, and other sources. City of Pasadena staff conducted research by referencing historical local newspapers, interviewing longtime residents, long time City of Pasadena employees and locating City of Pasadena information in historical documents.

City of Pasadena staff identified current mitigation activities, resources and programs, and potential action items from research materials and stakeholder interviews.

Public Workshops:

City of Pasadena staff facilitated a public workshop to gather comments and ideas from Pasadena citizens about mitigation planning and priorities for mitigation plan goals. This was held on November 1, 2011.

How the Plan Is Used:

Each section of the Mitigation Plan provides information and resources to assist people in understanding the City and the hazard-related issues facing citizens, businesses, and the environment. Combined, the sections of the Plan work together to create a document that guides the mission to reduce risk and prevent loss from future natural hazard events.

The structure of the Plan enables people to use a section of interest to them. It also allows City government to review and update sections when new data becomes available. The ability to update individual sections of the Mitigation Plan places less of a financial burden on the City.

Decision-makers can allocate funding and staff resources to selected pieces in need of review, thereby avoiding a full update, which can be costly and time-consuming. New data can be easily incorporated, resulting in a Multi-Hazard Mitigation Plan that remains current and relevant to City of Pasadena.

The plan is divided into four sections: introduction, mitigation background and planning, hazard-specific information, and appendices.

Part I: Introduction

Executive Summary:

This provides an overview of the Multi-Hazard Mitigation Plan mission, goals, and action items. This section describes how the plan was developed, who was involved, the goals of the plan, how it is organized, and how it will be implemented and evaluated.

Introduction:

The Introduction describes the background and purpose of developing the Mitigation Plan for the City of Pasadena.

Plan Development:

Who participated in the development of the plan?

Goal of the Plan:

What is this plan intended to accomplish?

Organization and Priority of Action Items:

How are the action items for general and specific hazards organized and prioritized?

Implementation, Monitoring and Evaluation:

How is the new plan implemented? How will the City monitor and evaluate the progress of the plan?

Part II: Mitigation Background and Planning

Section 1: Introduction

The Introduction describes the background and purpose of developing the mitigation plan for the City of Pasadena.

Section 2: Community Profile

This section presents the history, geography, demographics, and socioeconomics of City of Pasadena. It serves as a tool to provide a historical perspective of natural hazards in the City.

Section 3: Risk Assessment

This section provides information on hazard identification, vulnerability, and risks associated with natural hazards in the City of Pasadena.

Section 4: Multi-Hazard Goals and Action Items

This section provides a description of the original action items and describes how they were implemented. This is followed by a list of the new action items for next five years.

Section 5: Plan Maintenance

This section provides information on plan implementation, monitoring, and evaluation.

Part III: Hazard-Specific Information:

Hazard-specific information on natural and man-made hazards is addressed in this plan. Chronic hazards occur with some regularity and may be predicted through historic evidence and scientific methods. The hazards addressed in the plan include:

Section 1: Earthquake
Section 2: Flooding
Section 3: Landslide
Section 4: Wildfire
Section 5: Windstorms
Section 6: Human Threats

Catastrophic hazards do not occur with the frequency of chronic hazards, but can have devastating impacts on life, property, and the environment. In Southern California, earthquakes, earth movement, flooding, and wildfire have the potential to be catastrophic as well as chronic hazards. For the coastal areas of Southern California, tsunamis, while very rare, have the potential to calamitously devastate low-lying coastal areas.

Each of the hazard-specific sections includes information on the history of that hazard, causes and characteristics, hazard assessment, goals and action items, and local, state, and national resources.

Part IV: Appendices:

The plan appendices are designed to provide users of the City of Pasadena Multi-Hazard Mitigation Plan with additional information to assist them in understanding the contents of the mitigation plan, and potential resources to assist them with implementation.

Appendix A: Cost Benefit Analysis Discussion

This section describes FEMA's requirements for benefit/cost analysis in natural hazards mitigation, as well as various approaches for conducting economic analysis of proposed mitigation activities.

Appendix B: Potential Grant Funding

This appendix lists state and federal grant funding that is available for hazard mitigation, and it includes a summary of current private funding opportunities.

Appendix C: Acronyms

This section provides a list of acronyms for City, regional, state, and federal agencies and organizations that may be referred to within the City of Pasadena Multi-Hazard Mitigation Plan.

Appendix D: Glossary

This section provides a glossary of terms used throughout the plan.

Appendix E: Charts and Maps

This appendix lists the various maps and charts found throughout the plan.

SECTION 2:

- Community Profile -

Why Plan for Natural Hazards in the City of Pasadena?

Natural hazards impact citizens, property, the environment, and the economy of the City of Pasadena. Earthquakes, earth movements, flooding and windstorms have exposed Pasadena residents and businesses to the financial and emotional costs of recovering after natural disasters. The risk associated with natural hazards increases as more people move to areas affected by natural hazards.

Even in those communities that are essentially "built-out" (i.e. have little or no vacant land remaining for development), population density continues to increase when low-density housing is replaced with medium- and high-density development projects.

The inevitability of natural hazards coupled with the growing population and activity within the City create an urgent need to develop strategies, coordinate resources, and increase public awareness to reduce risk and prevent loss from future natural hazard events. Identifying the risks posed by natural hazards, and developing strategies to reduce the impact of a hazard event can assist in protecting life and property of citizens and communities. Local residents and businesses can work together with the City to create a hazard mitigation plan that addresses the potential impacts of hazard events.

Geography and the Environment

Pasadena has an area of 23 square miles and is located in northeast Los Angeles County.

Elevations in the City range from a high of 3,300 feet to a low of 606 feet. The terrain of the city is a combination of flat and hilly terrain.

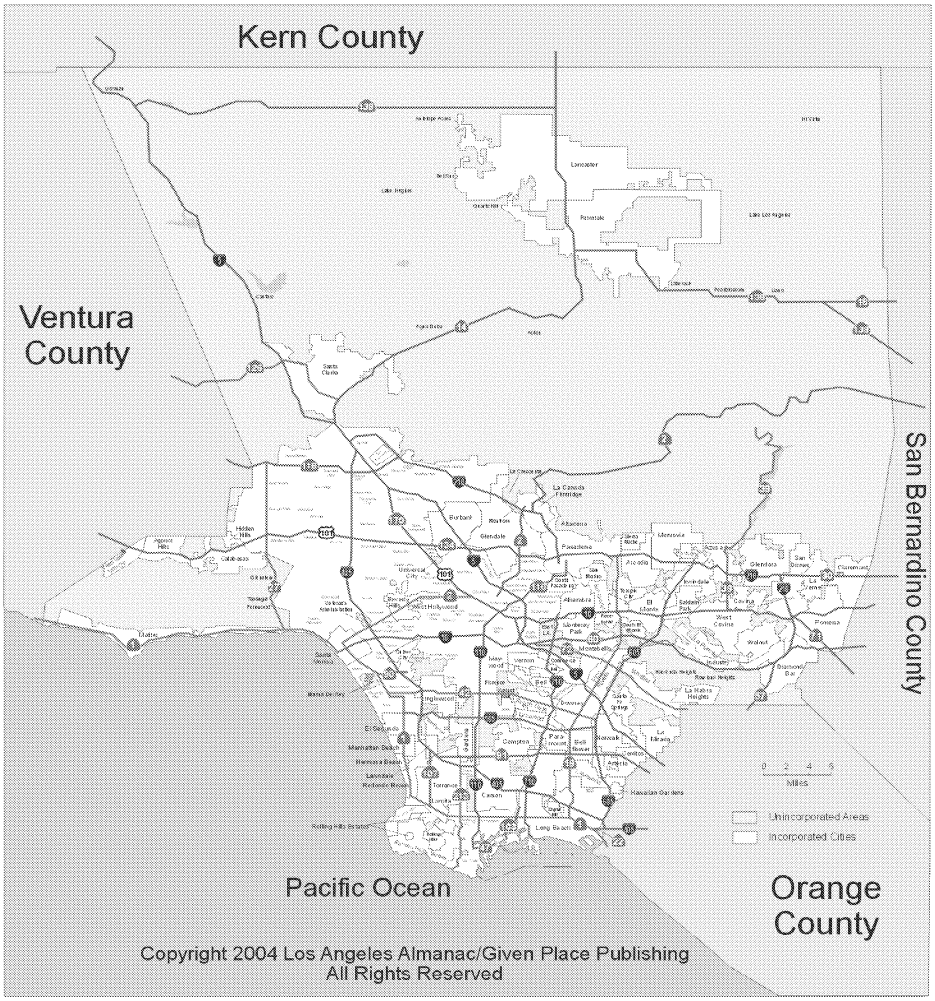
Community Profile

The City of Pasadena is rich in history. The area comprising the City of Pasadena was first settled in 1771 and the city itself was incorporated in 1886.

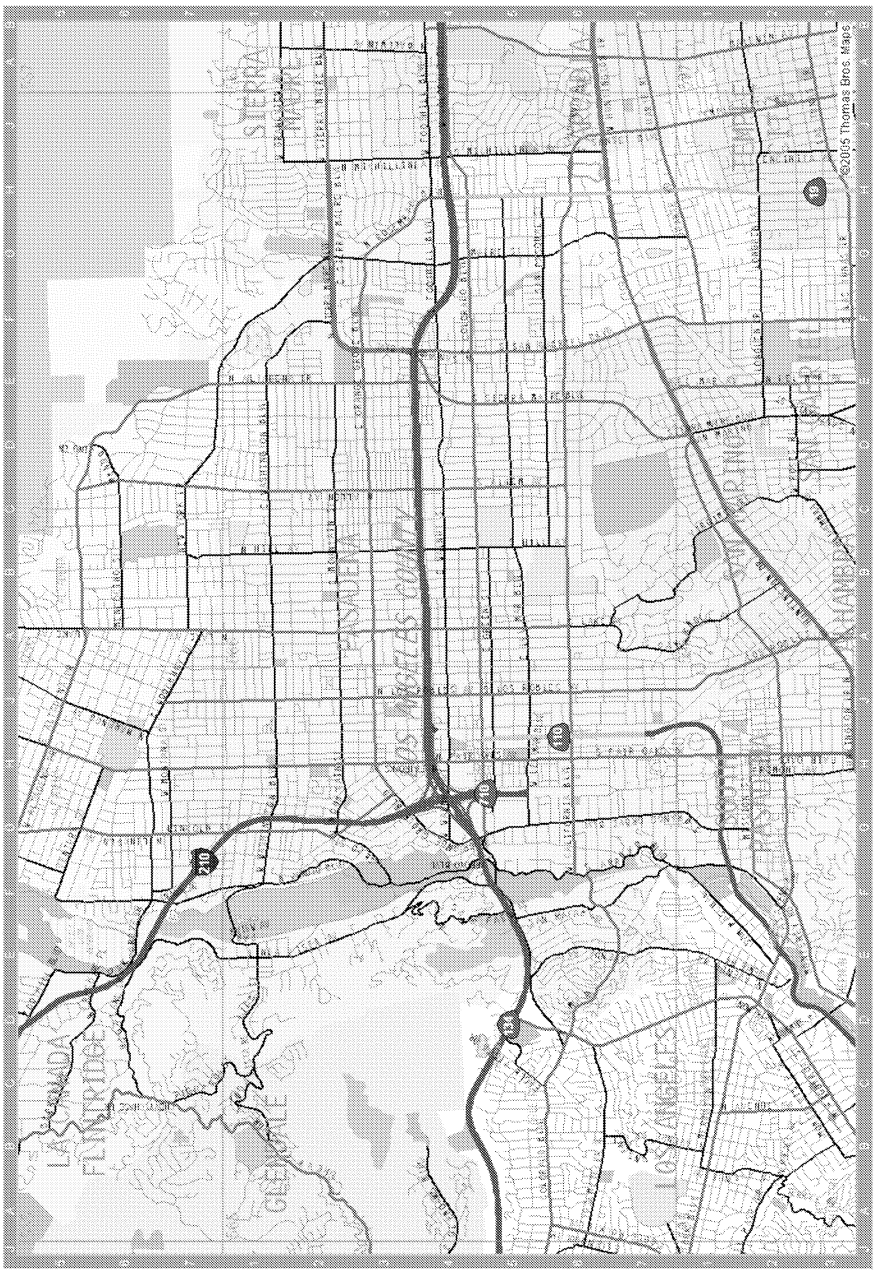
The City is served by the 210, 134, 710, and 110 freeways. The major arterial highways are Fair Oaks Avenue, Lake Avenue, and Los Robles Avenue, which run north to south, and Colorado Blvd., Walnut Street, Del Mar Blvd., and Green Street, which run east to west.

Passenger transportation is provided by Foothill Transit bus lines, Metropolitan Transportation Authority bus lines, Pasadena ARTS shuttle, and the MTA Gold Line light rail system.

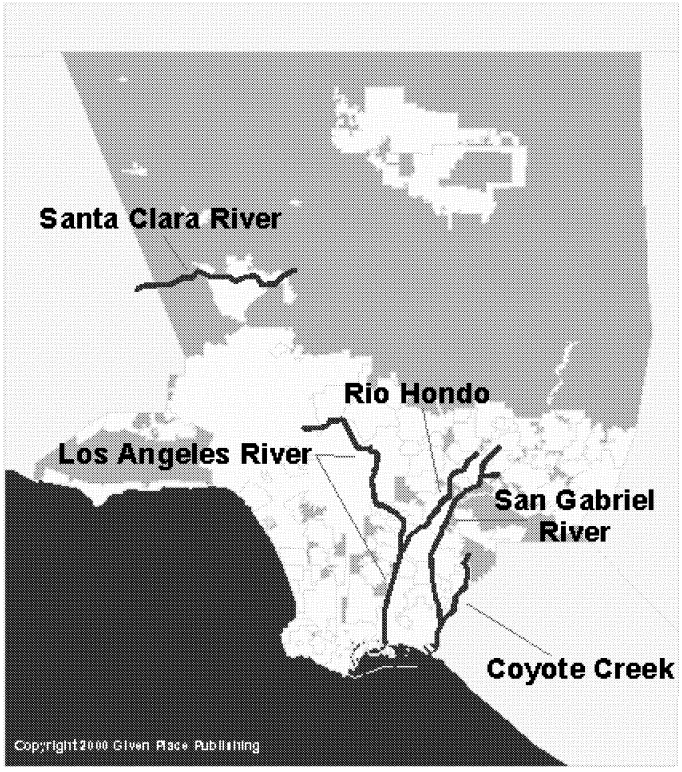
Freeway Map of Los Angeles County



Map of Pasadena



Major Rivers

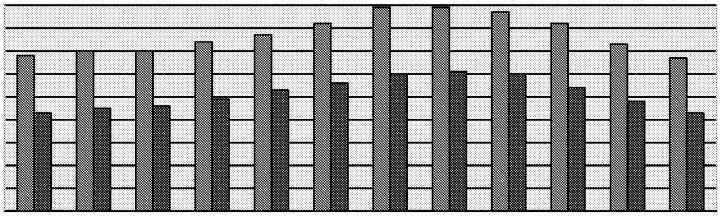


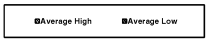
The nearest major river is the Los Angeles River. This river does not have any potential impact on the City of Pasadena. Normally this river channel is dry and only carries a significant water flow during a major rain storm. Two main north-to-south flowing stream systems drain the Pasadena area. The Arroyo Seco Wash runs along the western edge of the City of Pasadena, while Eaton Canyon Creek and Eaton Wash drain the eastern side of the City.

Climate

Temperatures in the City of Pasadena range from a low of 56 degrees in the winter months to a high of 91 degrees in the summer months. However the temperatures can vary over a wide range, particularly when the Santa Ana winds blow, bringing higher temperatures and very low humidity. Temperatures rarely exceed 100 degrees F in the summer months (June-September), and rarely drop below 30 degrees F in the winter months (November-March).

Average Temperature in Degrees Fahrenheit

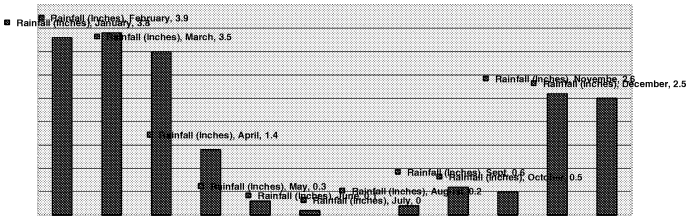


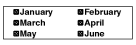


Rainfall in the City averages 20.4 inches of rain per year. However the term "average rainfall" is misleading because over the recorded history of rainfall in the City of Pasadena rainfall amounts have ranged from one-third the normal amount to more than double the normal amount. There are three types of storms that produce precipitation in the Southern California area, which includes Pasadena: winter storms, locally-generated thunderstorms, and summer tropical storms.

Furthermore actual rainfall in Southern California tends to fall in large amounts during sporadic and often heavy storms rather than consistently during storms at somewhat regular intervals. In short, rainfall in Southern California might be characterized as feast or famine within a single year. Because the metropolitan basin is largely built-out, water originating in higher elevation communities can have a sudden impact on adjoining communities that have a lower elevation.

Average Yearly Rainfall in Inches





Minerals and Soils

The characteristics of the minerals and soils present in City of Pasadena indicate the potential types of hazards that may occur. Rock hardness and soil characteristics can determine whether or not an area will be prone to geologic hazards such as earthquakes, liquefaction, and landslides.

The surface material includes unconsolidated, fine-grained deposits of silt, sand, gravel, and recent flood plain deposits. Torrential flood events can introduce large deposits of sand and gravel. Sandy silt and silt containing clay are moderately dense and firm, and are primarily considered to be prone to liquefaction, and earthquake-related hazards. Basaltic lava consists mainly of weathered and non-weathered, dense, fine-grained basalt. Though the characteristics of this lava may offer solid foundation support, landslides are common in many of these areas where weathered residual soil overlies the basalt.

Understanding the geologic characteristics of Pasadena is an important step in hazard mitigation and avoiding at-risk development.

Other Significant Geologic Features

The City of Pasadena, like most of the Los Angeles Basin, lies over the area of one or more known earthquake faults and potentially many more unknown faults, particularly so-called lateral or blind thrust faults.

The major faults that have the potential to affect the greater Los Angeles Basin, and therefore the City of Pasadena, are:

- ✓ San Andreas
- ✓ Newport / Inglewood
- ✓ Palos Verdes
- ✓ Whittier
- ✓ Santa Monica
- ✓ Sierra Madre
- ✓ Verdugo
- ✓ Elysian Park
- ✓ Raymond

The Los Angeles Basin has a history of powerful and relatively frequent earthquakes, dating back to the powerful 8.0+ San Andreas earthquake of 1857, which did substantial damage to the relatively few buildings that existed at the time. Paleoseismological research indicates that large (8.0+) earthquakes occur on the San Andreas fault at intervals between 45 and 332 years with an average interval of 140 years.

Other lesser faults have also caused very damaging earthquakes since 1857. Notable earthquakes include the 1933 Long Beach earthquake, the 1971 San Fernando earthquake, the 1987 Whittier earthquake, and the 1994 Northridge earthquake.

In addition, many areas in the Los Angeles basin have sandy soils that are subject to liquefaction. The City of Pasadena has liquefaction zones as shown on a map in the landslide section.

Population and Demographics

According to the 2010 Census, the City of Pasadena has a population of 137,122 in an area of 23 square miles. The population of City of Pasadena has steadily increased from the mid-1800s through 2000, and increased 1.8% from 1990 to 2000. The population increased from 2000 to 2009 to a high of 144,133. This number has declined slightly in the past two or three years.

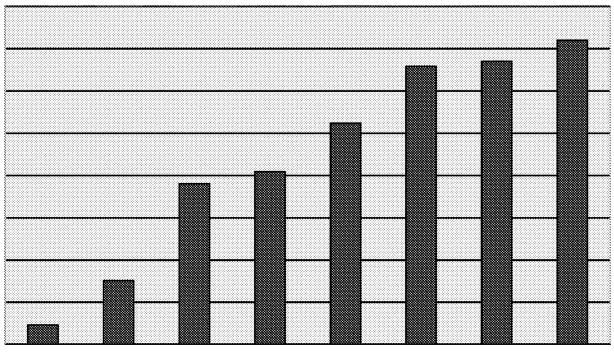
The increase of people living in City of Pasadena creates more community exposure, and changes how agencies prepare for and respond to natural hazards. For example, more people living on the urban fringe can increase risk of fire. Wildfire has an increased chance of starting due to human activities in the urban/rural interface, as well as the potential to injure more people and cause more property damage.

But a wildfire is not the only fire risk to the City of Pasadena. The City is also at risk from a post-earthquake fire. A conflagration could be started by fires resulting from earthquake damage but made much worse by the loss of pressure in the fire mains, caused by either lack of electricity to power water pumps, and/or loss of water pressure resulting from broken water mains.

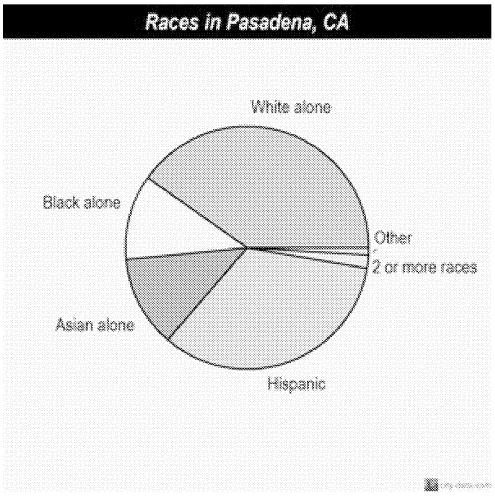
Furthermore, increased density can affect risk. For example, narrower streets are more difficult for emergency service vehicles to navigate, the higher ratio of residents to emergency responders affects response times, and homes located closer together increase the chances of fires spreading.

Over the years, the City of Pasadena is experiencing a great deal of in-fill development, which is increasing the population density, creating greater service loads on the built infrastructure such as roads, water supply, sewer services and storm drains.

Population 1900 – 2004 (In Thousands)



2004 Population Demographics



- White alone - 56,077 (39.2%)
- Hispanic - 48,725 (34.1%)
- Asian alone - 17,528 (12.3%)
- Black alone - 15,709 (11.0%)
- Two or more races - 2,842 (2.0%)
- Other race alone - 665 (0.5%)
- American alone - 312 (0.2%)
- Native Hawaiian and Other Pacific Islander alone - 248 (0.2%)

Read more: http://www.city-data.com/city/Pasadena-California.html#ixzz1dv3vrwvI

Examining the reach of hazard mitigation policies to special needs populations may assist in increasing access to services and programs. FEMA's Office of Equal Rights addresses this need by suggesting that agencies and organizations planning for natural disasters identify special needs populations, make recovery centers more accessible, and review practices and procedures to remedy any discrimination in relief application or assistance.

The cost of natural hazards recovery can place an unequal financial responsibility on the general population when only a small proportion may benefit from governmental funds used to rebuild private structures. Discussions about natural hazards that include local citizen groups, insurance companies, and other public and private sector organizations can help ensure that all members of the population are a part of the decision-making processes.

Land and Development

Development in Southern California from the earliest days was a cycle of boom and bust. The Second World War however dramatically changed that cycle. Military personnel and defense workers came to Southern California to fill the logistical needs created by the war effort. The available housing was rapidly exhausted and existing commercial centers proved inadequate for the influx of people.

Immediately after the war, construction began on the freeway system, and the face of Southern California was forever changed. Home developments and shopping centers sprung up everywhere and within a few decades the central basin of Los Angeles County was virtually built out. This pushed new development further and further away from the urban center.

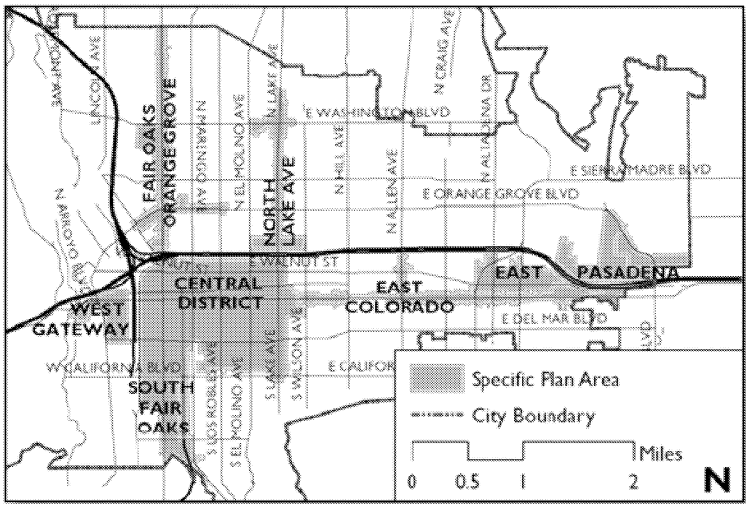
Pasadena is a "built-out" community, one in which there is very little undeveloped land. Most of the City was constructed and developed prior to World War II. New development is typically in-fill development on relatively small lots, thus it is important that such development is consistent with the surrounding area.

The City of Pasadena General Plan addresses the use and development of private land, including residential and commercial areas. This plan is one of the City's most important tools in addressing environmental challenges including transportation and air quality, growth management, conservation of natural resources, clean water, and open spaces.

The City's General Plan establishes a vision for where future growth will occur and under what conditions. It focuses on growth to the city's downtown urban core, along major corridors, and within a quarter-mile of the six light rail stations of the Gold Line that connects Pasadena to downtown Los Angeles. While focusing growth to these areas, the Plan also seeks to protect existing open space areas, residential neighborhoods, and historic buildings and districts.

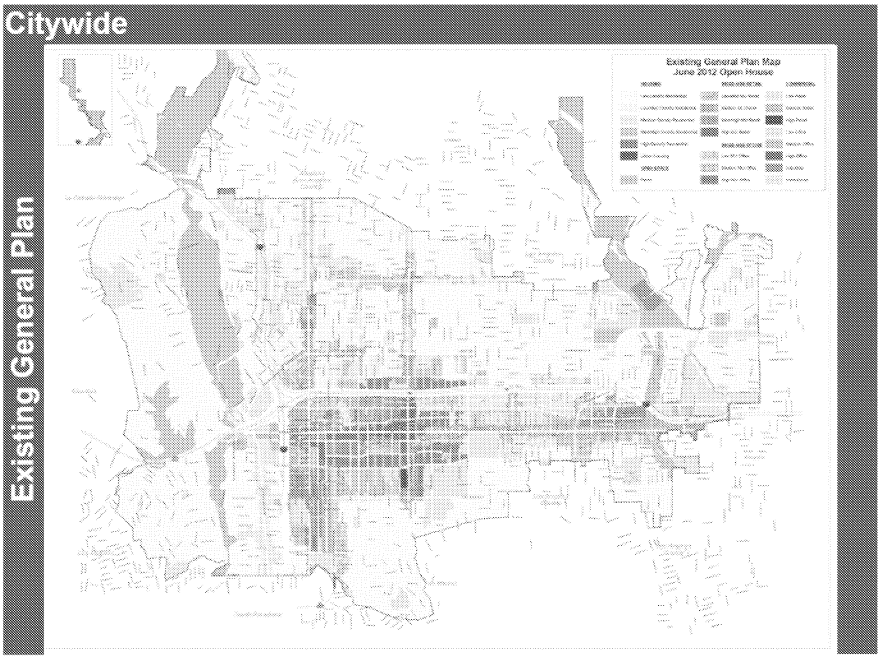
To implement this vision, the General Plan breaks down the city into specific plan areas – Central District, East Colorado, East Pasadena, Fair Oaks/Orange Grove, North Lake, South Fair Oaks, Lincoln Avenue and West Gateway. These specific areas include more detailed visions, design standards, and caps on the amount of future development. The City targeted most of the future growth in these specific plan areas and along major transit corridors, as shown in the following figure. Each specific plan area has a cap on the total amount of construction that can occur, or development allocation (dwelling units for residential use or square footage for non-residential uses).

Pasadena Specific Plan Areas



The General Plan is currently being updated, and the following figure shows the Draft Concept Land Use Plan for the City in the General Plan update:

Draft Concept Use Plan for Pasadena



From 1994 to 2011, the City issued on average 2,751 building permits each year. The most active year was 2006, when 3,000 permits were issued, and the least active was in 1996, when 2,200 permits were issued. A total of 2,500 permits were issued in 2009, while 2,735 were issued in 2011. Since the high of 2006, permit building issuance has fallen approximately 21 percent, due to the economy.

Most of the future growth is targeted in areas that are not necessarily located within areas highly susceptible to flooding, wildfires, and landslides (as discussed in the hazard profiles in Part III). However, these areas of future growth are in proximity to the highly susceptible areas and can be severely impacted during a disaster event. Additionally, some development is planned for and may take place in the identified high hazard areas. The targeted future growth areas are also susceptible to both earthquake and windstorm hazards, as these hazards affect the entire City. The City of Pasadena has in place various codes and review processes to address potential hazards and their effect on the built environment.

To address development issues, the Planning Department has engaged in activities that promote the quality of life for the citizens of the City of Pasadena. The large-scale effort is termed the City of Pasadena Neighborhood Revitalization Program, and includes neighborhood and other public facility improvements, rehabilitation of existing housing, and new housing development.

Housing and Income

In the City of Pasadena, the demand for housing outstrips the available supply, and the recent low interest rates have further fueled a pent-up demand. Demand for available housing is extremely high, with few existing homes available. Demand for low- to medium-priced homes continues to be strong.

In 1994 the City of Pasadena contained 53,000 residential units, and 5,191 units have been built throughout the City between then and 2011. The 1994 General Plan allowed for 11,038 net-new market-rate residential units at build-out, mostly allocated to the seven specific plan areas. The Growth Management Initiative limited the number of residential units that could be built in Pasadena every year. Since 2000, the City has seen an average of 377 residential units completed every year.

The following table shows the residential growth that occurred from 1994 to 2011 in the various specific plan areas, as well as other zones. It also shows the future residential growth potential based on the residential development caps for each specific plan area.

Residential Growth by Specific Plan Area, 1994-2011

Geographic Area	Total Units Constructed	Percentage of Total	Cap
SPECIFIC PLANS			
Central District Specific Plan	3,635	70%	5,095
East Colorado Specific Plan	14	0%	750
East Pasadena Specific Plan	188	4%	500
Fair Oaks/Orange Grove Specific Plan	219	4%	550
North Lake Specific Plan	5	0%	500
South Fair Oaks Specific Plan	134	3%	300
West Gateway Specific Plan	0	0%	75
Sub-Total	4,195	81%	7,770
OTHER ZONES			
Commercial and Industrial (CO, CL, IG, & PS)	27	1%	*No cap*
Multi-Family (RM 12, RM-16, RM-32, RM-48)	785	15%	*No cap*
Single Family	184	4%	*No cap*
Sub-Total	996	19%	*No cap*
TOTAL	5,191	100%	*No cap*

Source: 2011 Planning and Development Department, City of Pasadena

The General Plan Update anticipates future residential growth in the seven specific plan areas. The 2035 forecast for those areas is shown in the following table:

2035 Forecast for Housing Growth

Specific Plan Area	2035 Forecast – Housing Units
Central District	3,250
East Colorado	500
East Pasadena	1,250
Fair Oaks/Orange Grove	325
North Lake	250
South Fair Oaks	600
Lincoln Avenue	90

The median value of homes in the City of Pasadena was estimated at $286,400 (2000 Census). During the 2010 Census the median home price in Pasadena had risen to $505,000. This was down from peak prices in 2006-2007. Between 2000 and 2010 the total numbers of households in the City increased by 3,426, or 6.6 percent.

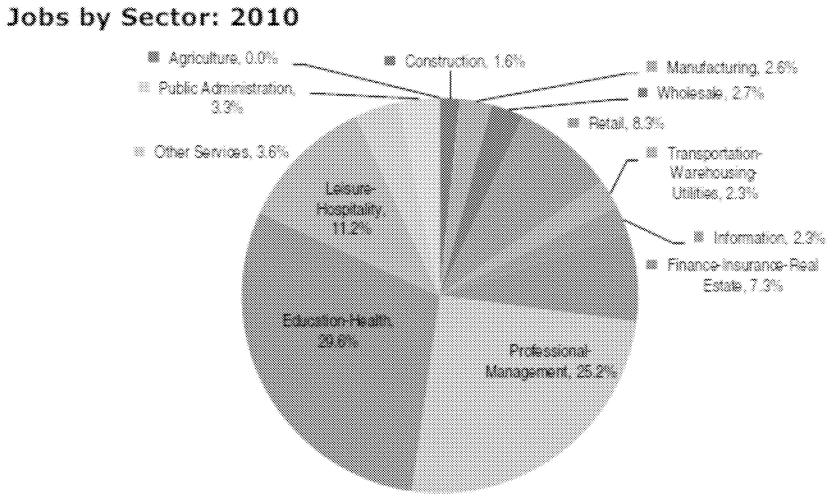
There is an increased concentration of resources and capital in City of Pasadena. The best indicator of this fact is the increasing per capita personal income in the region since the 1970s. Per capita income is an estimate of total personal income divided by the total population.

This estimate can be used to compare economic areas as a whole, but it does not reflect how the income is distributed among residents of the area being examined. The City's per capita personal income is also increasing relative to California's and the United States' average per capita incomes, resulting in a more affluent community than the average population.

Subtle but measurable changes occur in communities that increase the potential loss which may occur in a major disaster. There are a number of factors that contribute to this increasing loss potential. First, populations continue to increase, putting more people at risk within a defined geographic space. Second, inflation constantly increases the worth of real property and permanent improvements. Third, the amount of property owned per capita increases over time.

Employment and Industry

Service industries, manufacturing, and commerce are the City of Pasadena's principal employment and industrial activities. Pasadena provided over 84,000 jobs in 2000. This number peaked at 118,686 in 2007 and has now declined to 109,739.



Sources: California Employment Development Department, 2010; InfoUSA; and SCAG

Traditionally many local jobs had been involved with manufacturing, construction, retail trade, and professional and management services. Each of these areas has declined. The largest decline was in construction, which declined 33% from a high of 2,635 in 2007 to 1,744 in 2010. Manufacturing and construction have been replaced by leisure/hospitality, education/health, and professional management.

Mitigation activities are needed at the business level to ensure the safety and welfare of workers and limit damage to industrial infrastructure. Employees are highly mobile, commuting from surrounding areas to industrial and business centers. This creates a greater dependency on roads, communications, accessibility, and emergency plans to reunite people with their families. Before a natural hazard event, large and small businesses can develop strategies to prepare for natural hazards, respond efficiently, and prevent loss of life and property.

Commercial development in the City of Pasadena has followed the highs and lows of the economy. In 1994 the City contained approximately 39.9 million square-feet of non-residential space. An additional 3.7 million square-feet has been added throughout the City between 1994 and 2011.

The 1994 General Plan allowed for 21.3 million net-new non-residential square-feet, mostly allocated to the seven specific plan areas. Since 2000 the City has seen an average of 254,458 net-new non-residential square-footage completed every year. The following table shows the amount of net-new square-footage completed from 2000 to 2011:

Non-Residential Square Footage Constructed 2000-2011

Year	Total Net New Non-Residential Square Footage Constructed
2000	197,978
2001	248,717
2002	405,006
2003	239,971
2004	434,839
2005	86,769
2006	157,938
2007	377,623
2008	42,044
2009	367,899
2010	199,445
2011	262,898

The following table shows the non-residential growth that occurred from 1994 to 2011 in the various specific plan areas, as well as other zones. It also shows the future non-residential growth potential based on the residential development caps for each specific plan area.

Total Square Footage Growth by Zones, 1994-2011

Geographic Area	Total Sq Ft Constructed	% of Cap Remaining	Cap
SPECIFIC PLANS			
Central District Specific Plan	1,491,686	40%	6,217,000
East Colorado Specific Plan	399,389	11%	650,000
East Pasadena Specific Plan	58,504	2%	2,100,000
Fair Oaks/Orange Grove Specific Plan	95,759	3%	611,000
North Lake Specific Plan	52,075	1%	175,000
South Fair Oaks Specific Plan	672,914	18%	1,550,000
West Gateway Specific Plan	800	0%	800,000
Sub-Total	2,771,127	75%	12,103,000
OTHER ZONES			
Commercial and Industrial (CO, CL & IG)	310,553	8%	*No cap*
Duplex (RM-12)	0	0%	*No cap*
Multi-Family (RM-16, RM-32, RM-48)	0	0%	*No cap*
Open Space*	47,258	1%	*No cap*
Public and Semi-Public	578,306	16%	*No cap*
Single Family	0	0%	*No cap*
Single Family - Hillsides	0	0%	*No cap*
Sub-Total	936,117	25%	N/A
TOTAL	3,707,244	100%	N/A

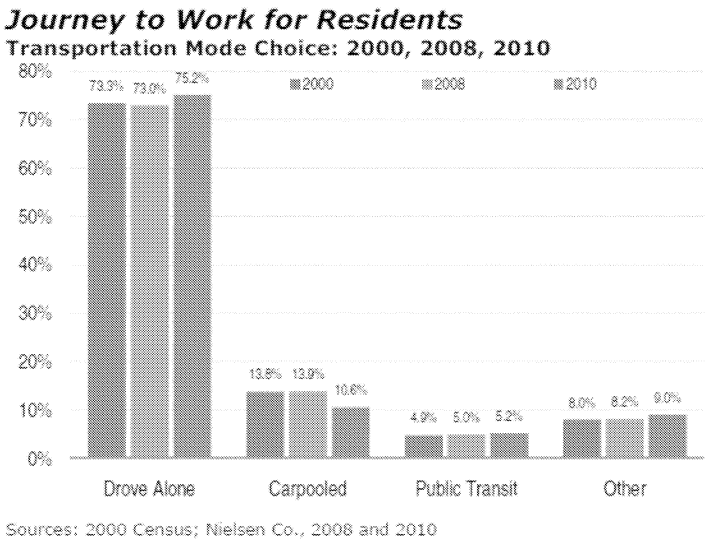
**Construction in the Open Space Zone has been limited to improvements to the Rose Bowl, new Kidspace Museum, new bathrooms at parks, new picnic shleters, and Police Department's new shooting range.*

Source: 2011 Planning and Development Department, City of Pasadena

Transportation and Commuting Patterns

The City of Pasadena is the 4th largest in the Los Angeles Metropolitan Statistical Area (LAMSA). Over the past decade, the LAMSA experienced rapid growth in employment and population which slowed considerably with the recession beginning in 2008.

Private automobiles are the dominant means of transportation in Southern California and in the City of Pasadena.



Sources: 2000 Census; Nielsen Co., 2008 and 2010

However, the City of Pasadena meets its public transportation needs through a mixture of a regional transit system (MTA), and various city contracted bus systems (ARTS). MTA provides both bus and light rail service to the City of Pasadena, and to the Los Angeles County metropolitan area. In addition to this service, the City promotes alternative transportation activities.

The City of Pasadena has included a Mobility Plan in the General Plan. The City benefits from a diverse transportation system that includes transit, bicycle, and pedestrian links as well as vehicular links. The City's local system connects with the larger regional system, and the operation of the two systems is interdependent. The Mobility Plan establishes how the City manages the local system to provide for the safe and convenient movement of people and goods. It also addressed how the City influences and manages connections with the regional transportation system.

The vision of the mobility element is to promote a livable community where people can circulate without cars. Consistent with this principle, the Mobility Plan has four primary objectives that guide how the City's transportation system is managed:

- ✓ Promote a livable and economically strong community;
- ✓ Encourage non-auto travel;
- ✓ Protect neighborhoods by discouraging traffic from passing through neighborhoods; and
- ✓ Manage multi-modal corridors to improve citywide transportation services.

With growth targeted away from neighborhoods and not the downtown area and along major transit corridors, opportunities are created to provide diverse economic, housing, and cultural places.

One of the key components of the Mobility Plan is the encouragement of non-auto modes of transportation, such as transit, bicycling, car-sharing, and walking. Increasing the use of non-auto travel options yields numerous community benefits including reduced traffic, less need for costly roadway improvement projects, a more enjoyable pedestrian environment, and improved air quality.

SECTION 3:

- Risk Assessment -

What is a Risk Assessment?

Conducting a risk assessment can provide information on the following: the location of hazards, the value of existing land and property in hazard locations, and an analysis of risk to life, property, and the environment that may result from natural hazard events.

1) Hazard Identification

This is the description of the geographic extent, the potential intensity, and the probability of occurrence of a given hazard. Maps are frequently used to display hazard identification data. The City of Pasadena identified six major hazards that affect this geographic area. These hazards include earthquakes, landslides, windstorms, floods, wildfires, and human-made hazards.

2) Profiling Hazard Events

This process describes the causes and characteristics of each hazard, how it has affected the City of Pasadena in the past, and what part of the City of Pasadena's population, infrastructure, and environment has historically been vulnerable to each specific hazard. A profile of each hazard is found in Part III.

3) Vulnerability Assessment/Inventorying Assets

This is a combination of hazard identification with an inventory of the existing (or planned) property development(s) and population(s) exposed to a hazard. Critical facilities are of particular concern because these entities provide essential products and services to the general public that are necessary to preserve the welfare and quality of life in the City and to fulfill important public safety, emergency response, and/or disaster recovery functions.

4) Risk Analysis

Estimating potential losses involves assessing the damage, injuries, and financial costs likely to be sustained in a geographic area over a given period of time. The two measurable components of risk analysis are the magnitude of the harm that may result and the likelihood of the harm occurring. Describing vulnerability in terms of dollar losses provides the community and the state with a common framework in which to measure the effects of hazards on assets.

After the Northridge earthquake, a series of studies were conducted by the disaster research center of the University of Delaware. These studies reviewed the impact of the

earthquakes on business recovery. The researchers found that several factors impact businesses after any major disaster. These factors are physical damage, disruption of transportation, and business inactivity (Dalhamer & Tierney 1996).

Physical damage requires repairs to the business as well as the removal of debris. Disruption of transportation can impact the local business community in three ways: employees cannot get to work, products cannot be delivered to the business, and the difficulties in transportation prevent shoppers from coming to the area. The City of Pasadena had approximately $2,425,359,000 in retail sales in 2010. A 25% loss in sales could result in an $800,000,000 loss to the local economy. This does not take into account the losses from damages to business and residences.

Dalhamer, J., & Tierney, K. (1996) "Winners and losers: Predicting business disaster recovery outcomes following the Northridge earthquake." A working paper. The University of Delaware Disaster Research Center.

5) Assessing Vulnerability/ Analyzing Development Trends

This step provides a general description of land uses and development trends within the community so that mitigation options can be considered in land use planning and future land use decisions. This plan provides comprehensive description of the character of Pasadena in the Community Profile. This description includes the geography and environment, population and demographics, land use and development, housing and community development, employment and industry, and transportation and commuting patterns. Analyzing these components of Pasadena can help in identifying potential problem areas and can serve as a guide for incorporating the goals and ideas contained in this Mitigation Plan into other community development plans.

Hazard assessments are subject to the availability of hazard-specific data. Gathering data for a hazard assessment requires a commitment of resources on the part of participating organizations and agencies. Each hazard-specific section of the Plan includes a section on hazard identification using data and information from City, county, or state agency sources.

Federal Requirements for Risk Assessment:

Recent federal regulations for hazard mitigation plans outlined in 44 CFR Part 201 include a requirement for risk assessment. This risk assessment requirement is intended to provide information that will help communities to identify and prioritize mitigation activities that will reduce losses from the identified hazards. There are six hazards profiled in the Mitigation Plan, including earthquakes, landslides, flooding, wildfires, windstorms and human-made hazards.

Federal Criteria for Risk Assessment

Section 322 Plan Requirement	How is this addressed?
Identifying Hazards	**Each hazard section includes an inventory of the best available data sources that identify hazard areas.**
Profiling Hazard Events	**Each hazard section includes documentation of the history, and causes and characteristics of the hazard in the City.**
Assessing Vulnerability: Identifying Assets	**The hazard specific sections identify vulnerabilities by hazard.**
Assessing Vulnerability: Estimating Potential Losses:	**Vulnerability assessments have been completed for the hazards addressed in the plan.**
Assessing Vulnerability: Analyzing Development Trends	**The City of Pasadena Community Profile section of this plan provides a description of the development trends in the City, including the geography and environment, population and demographics, land use and development, housing and community development, employment and industry, and transportation and commuting patterns.**

Critical Facilities and Infrastructure:

Facilities critical to government response and recovery activities (i.e. life safety and property and environmental protection) include 911 centers, emergency operations centers, police and fire stations, public works facilities, communications centers, sewer and water facilities, hospitals, bridges and roads, and shelters. Other facilities that, if damaged, could cause serious secondary impacts may also be considered "critical." A hazardous material facility is one example of this type of critical facility.

Critical and essential facilities are those facilities that are vital to the continued delivery of key government services or that may significantly impact the public's ability to recover from the emergency. These types of facilities may include local government buildings, schools, hospitals, parks, and public safety locations.

Due to the risk from earthquakes the City of Pasadena has made seismic safety a priority for all city facilities. The first major project of this effort was the seismic upgrade/retrofit of the City Hall building, which opened in 1927. Retrofitting began in 2005 and was completed in 2007. The retrofit process required extensive modifications to the building. The original basement floor was removed, and 240 friction pendulum bearings were installed between the new foundation and new basement floor slab. The City is currently developing a plan to upgrade the fire stations.

Summary:

Natural hazard mitigation strategies can reduce the impacts concentrated at large employment and industrial centers, public infrastructure, and critical facilities. Natural hazard mitigation for industries and employers may include developing relationships with

emergency management services and their employees before disaster strikes, and establishing mitigation strategies together. Collaboration among the public and private sector to create mitigation plans and actions can reduce the impacts of natural hazards.

SECTION 4:

- Multi-Hazard Goals and Action Items -

This section provides information on the process used to develop goals and action items that pertain to the six hazards addressed in the Mitigation Plan. It also describes the framework that focuses the Plan on developing successful mitigation strategies. The framework is made up of three parts: the Mission, Goals, and Action Items.

Mission:

The mission of the City of Pasadena Multi-Hazard Mitigation Plan is to promote sound public policy designed to protect citizens, critical facilities, infrastructure, private property, and the environment from natural and human-made hazards. This can be achieved by increasing public awareness, documenting the resources for risk reduction and loss-prevention, and identifying activities to guide the City towards building a safer, more sustainable community.

Goals:

The Plan goals describe the overall direction that City of Pasadena agencies, organizations, and citizens can take to minimize the impacts of natural hazards. The goals are stepping-stones between the broad direction of the mission statement and the specific recommendations that are outlined in the action items.

Action Items:

The action items are a listing of activities in which City agencies and citizens can be engaged to reduce risk. Each action item includes an estimate of the timeline for implementation. Short-term action items are activities that City agencies may implement with existing resources and authorities within one to two years. Long-term action items may require new or additional resources or authorities, and may take between one and five years (or more) to implement.

Mitigation Plan Goals:

The Plan goals help to guide direction of future activities aimed at reducing risk and preventing loss from natural hazards. The goals listed here serve as checkpoints as agencies and organizations begin implementing mitigation action items.

Protect Life and Property:

- ✓ Implement activities that assist in protecting lives by making homes, businesses, infrastructure, critical facilities, and other property more resistant to natural hazards.

- ✓ Reduce losses and repetitive damages for chronic hazard events while promoting insurance coverage for catastrophic hazards.

- ✓ Improve hazard assessment information to make recommendations for discouraging new development and encouraging preventative measures for existing development in areas vulnerable to natural hazards.

Public Awareness:

- ✓ Develop and implement education and outreach programs to increase public awareness of the risks associated with natural hazards.

- ✓ Provide information on tools, partnership opportunities, and funding resources to assist in implementing mitigation activities.

Natural Systems:

- ✓ Balance watershed planning, natural resource management, and land use planning with natural hazard mitigation to protect life, property, and the environment.

- ✓ Preserve, rehabilitate, and enhance natural systems to serve natural hazard mitigation functions.

Partnerships and Implementation:

- ✓ Strengthen communication and coordinate participation among and within public agencies, citizens, non-profit organizations, business, and industry to gain a vested interest in implementation.

- ✓ Encourage leadership within public and private sector organizations to prioritize and implement local, county, and regional hazard mitigation activities.

Emergency Services:

- ✓ Establish policy to ensure mitigation projects for critical facilities, services, and infrastructure.

- ✓ Strengthen emergency operations by increasing collaboration and coordination among public agencies, non-profit organizations, business, and industry.

- ✓ Coordinate and integrate natural hazard mitigation activities, where appropriate, with emergency operations plans and procedures.

Public Participation:

Public input during development of the Plan assisted in creating the Plan goals. Meetings with the advisory committee, stakeholder interviews, and a public workshop served the method to obtain input and identify priorities in developing goals.

On August 23, 2011, a meeting of the external stakeholders of the Multi-Hazard Mitigation Advisory Committee was held. These stakeholders were briefed on the progress of the Plan update. The attendees included representatives from public agencies, private organizations and community planning organizations. The attendees identified goals for the Plan by examining the issues and concerns they have regarding local hazards. Progress by the City departments was explained and the group discussed potential action items for the next five years.

A public workshop was held November 1, 2011, to provide the public information about the Multi-Hazard Plan update and solicit their comments. Questions included how the City intends to merge the Multi-Hazard Mitigation Plan with the five-year Capital Improvement Plan.

City of Pasadena Capabilities Assessment:

The following discussion provides an assessment of the City's regulatory, administrative, technical, and fiscal capability to carry out mitigation activities.

Regulatory Capabilities:

The City of Pasadena has several plans and programs in place that guide the City's mitigation of development in hazard-prone areas. The following table lists planning and land management tools typically used to implement hazard mitigation activities, and it indicates those that are in place in the City.

Tools for Implementing Mitigation Activities

Regulatory Tool (Ordinances, codes, plans, etc.)	Y/N	Comments
General Plan	Y	Last updated in 2004, currently going through the update planning process
Zoning Ordinance	Y	City of Pasadena Municipal Code, Zoning Title 17
Subdivision Ordinance	Y	City of Pasadena Municipal Code , Subdivisions Title 16

Site Plan Review Requirements	Y	City of Pasadena Municipal Code , Buildings and Construction Title 14 Department of Planning and Community Development, Building and Neighborhood Revitalization Division Department of Planning and Community Development, Planning Division
Growth Management Ordinance	Y	Growth Management Initiative, approved by voters in 1989
Floodplain Ordinance	Y	City of Pasadena Municipal Code, Floodplain Management Regulation Chapter 14.27
Other Special Purpose Ordinances (e.g., stormwater, steep slope, wildfire, etc.)		City of Pasadena Municipal Code , Buildings and Construction Title 14
Building Code	Y	City of Pasadena Municipal Code , Buildings and Construction Title 14, covers excavation/grading in hillside areas; Earthquake hazard reduction; fire and emergency planning; fire prevention code; flammable vegetation; vacant building/lot maintenance City of Pasadena Municipal Code, Zoning Title 17, covers Hillside Overlay District
BCEGS Rating		
Fire Department ISO Rating		
Erosion or Sediment Control Program	Y	City of Pasadena Municipal Code , Stormwater Management and Discharge Control Chapter 8.70
Stormwater Management Program	Y	City of Pasadena Municipal Code , Stormwater Management and Discharge Control Chapter 8.70 Department of Public Works
Capital Improvements Plan	Y	Department of Public Works
Economic Development Plan	Y	Economic Development Strategic Plan through Office of the City Manager
Local Emergency Operations Plan	Y	Completed in 2011 by Pasadena Fire Department
Other Special Plans	Y	Greenhouse Gas Inventory and Reduction Plan, October 2009 Specific Plans for Central District, South Fair Oaks, West Gateway, East Pasadena, East Colorado Boulevard, North Lake, and Fair Oaks/Orange Grove Various Master Development Plans
Flood Insurance Study or Other Engineering Study for Streams	Y	Department of Public Works
Elevation Certificates	Y	Department of Public Works
Other	Y	Safety Programs: Earthquake Hazard Reduction in Existing Unreinforced Masonry; Excavation and Grading in Hillside Areas; and Fire and Life Safety Protection Systems Urban Forestry Program Hazardous Vegetation Program

Comment [WK1]: Lisa D., Please confirm this.

Administrative/Technical Capabilities:

The City has several departments and agencies that have both the administrative authority and technical capabilities related to hazard mitigation and loss prevention, as identified below:

- **Pasadena Fire Department** develops, establishes, and maintains programs and procedures which provide for the protection of life, property, and the environment from the effects of fires, medical emergencies, and hazards. The Department's Fire Management Division provides overall planning, control, and management of all Fire Department activities and staff support for all divisions, including disaster services planning. The Fire Prevention Division provides for review of both new and remodeling construction plans, issuance of permits as required by City codes, periodic inspection of all occupancies within the City, annual brush surveys, and other required fire prevention activities. The Emergency Medical Services Division provides 24-hour emergency paramedic ambulance response, treatment and transportation of ill and injured persons in Pasadena, planning and staffing of medical coverage for special events, and related activities.
- **Department of Information Technology** is responsible for the development, access, and distribution of GIS data, technology, and mapping services to multiple departments, agencies, and users within City of Pasadena local government.
- **Department of Planning and Community Development** includes the Building and Neighborhood Revitalization Division and the Planning Division.
    - Building and Neighborhood Revitalization Division develops ordinances and enforces the City's zoning, housing, and environmental codes. The Building and Safety Section provides plan review and construction inspection services to enforce minimum standards to safeguard life or limb, health, property, and public welfare by regulating and controlling the design, construction, quality of materials, use and occupancy, location, and maintenance of all buildings and structures. Code Compliance Section promotes and maintains standards to preserve and enhance the quality of life in Pasadena by ensuring compliance with various regulations including building, land use, and property maintenance codes.
    - The Planning and Community Development Department's Planning Division is comprised of the Current Planning, Community Planning, and Design and Historic Preservation sections. The Planning Division staff provides services and conducts activities which guide the City's orderly development by applying the current zoning codes, facilitating development, implementing community plans, and preserving architectural and historical landmarks.
- **Department of Public Works** preserves, maintains, and enhances the City's infrastructure and natural resources and provides environmental stewardship. The Building Maintenance and Project Maintenance Division provides all general and preventive maintenance services, including capital-funded repairs and maintenance, for 53 major City buildings and approximately 130 facilities. These programs also perform a variety of construction, structural revision, and remodeling projects. The Engineering Division provides the engineering and

contract administration for street and bridge improvements, sanitary sewer and storm drain projects, street light and traffic signal systems, and park and landscape projects for the City. It administers the utility underground program for the City. This division also includes permit administration and inspection for all activities within the public right of way, response to developers as well as other agencies and the general public, coordination of activities and administration of consultant contracts, and preparation of studies and reports, legal descriptions, and other right-of-way documents and exhibits for the City Council, City Manager, and other departments.

The following table identifies the City of Pasadena personnel responsible for activities related to mitigation:

Pasadena Personnel Responsible for Mitigation Activities

Personnel Resources	Y/N	Department/Position
Planner/Engineer with knowledge of land development/land management practices	Y	Department of Planning and Community Development, Planning Division
Engineer/Professional trained in construction practices related to buildings and/or infrastructure	Y	Department of Planning and Community Development, Building and Neighborhood Revitalization Division
Planner/Engineer/Scientist with an understanding of natural hazards	Y	Department of Planning and Community Development, Planning Division Department of Public Works
Personnel skilled in GIS	Y	Department of Information Technology
Full-time Building Official	Y	Department of Planning and Community Development, Building and Neighborhood Revitalization Division
Floodplain Manager	Y	Department of Public Works
Emergency Manager	Y	Pasadena Fire Department
GIS data – Hazard Areas	Y	Department of Information Technology
GIS data – Critical Facilities	Y	Department of Information Technology
GIS data – Land Use	Y	Department of Information Technology
GIS data – Assessor's Data	Y	Department of Information Technology
Warning Systems/Services (Reverse 9-1-1, Cable Override, Outdoor Warning Signals)	Y	Pasadena Fire Department

Comment [WK2]: Lisa D., Please provide information. Not sure if Pasadena has one since there are no official FEMA floodplains in the City.

In addition to the departments/agencies described above, the table below provides a list of local, state, and federal agencies and programs that could provide technical and financial assistance for hazard mitigation actions within the City of Pasadena:

Local, State, and Federal Mitigation Resources

Local	State Agencies	Federal Agencies
Southern California Association of Governments	California Emergency Management Agency	US Army Corps of Engineers
Metropolitan Water District of Southern California	California Department of Forestry and Fire Protection	US Environmental Protection Agency (Region IX)
Rose Bowl Operating Company	California Department of Fish and Game	NASA Jet Propulsion Laboratory
	California State Lands Commission	Federal Emergency Management Agency (Region IX)
	California Department of Food and Agriculture	National Park Service
	California Department of Water Resources	USDA Natural Resources Conservation Service
	California Environmental Protection Agency	US Geological Survey
	California State Parks and Recreation Department	USDA Forest Service
	California Department of Transportation	

Fiscal Capabilities:

This section identifies the financial tools or resources that the City of Pasadena could potential use to help fund mitigation activities. These include City-specific capabilities, as well as state and federal resources. It is also important to note that funding can also be sourced from participating agencies/organizations that collaborate with the City in the implementation of mitigation actions.

Local Capabilities
A review of the City's *Comprehensive Annual Financial Report, Fiscal Year Ending June 30, 2011* resulted in the identification of a number of governmental funds, special revenue funds, internal service funds, and fiduciary funds that can be utilized for mitigation projects and activities.

- **Governmental Funds:**
  - *General Fund* is the City's primary operating fund, used to account for all general revenues of the City not specifically levied or collected for other City funds and for expenditures related to rendering general services.
  - Project Management *Capital Projects Fund* is used to account for all capital improvement projects, except for those involving the utilities, and special assessment districts, where revenues are received from grants by other governments, private parties, and transfers from other City funds.
- **Non-Major Governmental Funds – Special Revenue Funds:**
  - *Building Services Fund* is used to account for fees collected and restricted

to the operations of the Permit Center.
    - *Sewer Construction and Maintenance Fund* is used to account for revenue received from sewer use and storm drain charges restricted for the construction and maintenance of the City's sewer system.
    - *Underground Utilities Fund* accounts for revenue received from the underground surtax on sales of electric energy restricted for the extension, conversion, replacement, and repair of underground utility lines.
    - *Transportation Fund* is used to account for the use of revenue derived from the half-cent sales tax approved by voters, state gasoline tax, sales tax collected for bikeways and pedestrian facilities, and State AB2928 traffic congestion relief, all of which are restricted for construction, maintenance, preservation, and rehabilitation of the City's street and road system.
- **Non-Major Governmental Funds – Capital Projects Funds:**
    - *Charter Capital Projects Fund* is used to account for resources identified by the City Council for the acquisition, construction, replacement, or repair of municipal improvements where disbursements other than for specific municipal improvement projects can be authorized only by a majority vote of the people.
    - *New Development Impact Fund* accounts for fees received from developers of commercial and industrial facilities to be used to fund capital projects, which are made necessary in whole or part by new development.
    - *Residential Development Impact Fund* is used to account for fees received from developers of residential facilities to be used to develop park or recreational facilities.
    - *1993 Refunding and Capital Project Certificates of Participation Fund* is used to account for the financing of certain construction projects and infrastructure improvements.
    - *1996 Multi-Purpose Capital Project Certificates of Participation Fund* is used to account for the acquisition, construction, and installation of certain public facilities and capital improvements.
    - *10% Green Fee Capital Projects Fund* is used to account for capital improvements related to the development of the Arroyo Seco.
    - *2006 Lease Revenue Bond Capital Project Fund* is used to account for the financing of certain construction projects and infrastructure improvements.
    - *Pasadena Community Development Commission Fund* is used for all redevelopment and public improvement projects of the Pasadena Community Development Commission.
- **Non-Major Governmental Funds – Permanent Funds:**
    - *Pasadena Center Capital Improvement Trust Fund* is for capital improvements.
- **Internal Service Funds:**
    - *Computing and Communications Services Fund* is used to account for all operations of the Computing and Communications Division of the City Manager's Department, which includes such services as data processing, radio communications, and telephone/voice services.

- *Building Maintenance Fund* is used to account for housekeeping and structural maintenance of City buildings.

- **Fiduciary Funds:**
  - *Community Facilities District No. 1 Fund* is used to account for the funds used for the Civic Center West Project bond in accordance with the trust agreement.
  - *Open Space Assessment District Fund* is used to account for receipt and disbursement of debt service activity related to the acquisition and improvement of the Annandale Canyon Estates and adjacent property to be established as open space.

In addition to the above funds, the City has the ability to incur debt through general obligation bonds, special tax bonds, and private activities, as well as withhold spending in hazard-prone areas.

State and Federal Funding Resources
The following table provides a list of potential funding programs and resources provided by state and federal agencies/programs, which the City of Pasadena could tap into for hazard mitigation activities. Please note that the information below is not exhaustive.

State and Federal Funding Resources

Agency	Potential Programs/Grants
Department of Homeland Security – Federal Emergency Management Agency	Homeland Security Grant Program, Emergency Management Performance Grants Program, Transit Security Grant Program, Assistance to Fire Fighter Grants, Hazard Mitigation Grant Program, Pre-Disaster Mitigation Grant Program, Flood Mitigation Assistance Program, Severe Repetitive Loss Program
US Department of Housing and Urban Development	Community Development Block Grants
US Department of the Interior	US Geological Survey Research and Data Collection
US Department of Defense – US Air Force	Training Requirements Funding
US Department of Health and Human Services/California Department of Health Services	Grants for Public Health Emergency Preparedness
California Emergency Management Agency	Regional Catastrophic Preparedness Grant Program, Interoperable Emergency Communications Center Grant Program, Proposition 1B Grant, Citizens Corps Program, Metropolitan Medical Response System Program, Earthquake and Tsunami Grants Program
California Department of Housing and Community Development	Disaster Recovering Initiative

California Department of Forestry and Fire Protection	Western States WUI Fire Assistance Grant

Multi-Hazard Mitigation Plan Action Items

The Mitigation Plan identifies short- and long-term action items developed through data collection and research, and the public participation process. Mitigation Plan activities may be considered for funding through federal and state grant programs, and when other funds are made available through the City. Action items address multi-hazard and hazard-specific issues. To help ensure activity implementation, each action item includes information on the time line and coordinating organizations. Upon implementation, the coordinating organizations may look to partner organizations for resources and technical assistance.

A description of the partner organizations is provided in each of the specific hazard sections of the plan.

Coordinating Organization:
The coordinating organization is the organization that is willing and able to organize resources, find appropriate funding, or oversee activity implementation, monitoring, and evaluation. Coordinating organizations may include local, City, or regional agencies that are capable of or responsible for implementing activities and programs.

Timeline:
Action items include both short- and long-term activities. Each action item includes an estimate of the timeline for implementation. Short-term action items are activities that City agencies may implement with existing resources and authorities within one to two years. Long-term action items may require new or additional resources or authorities, and may take between one and five years (or more) to implement.

Ideas for Implementation:
Each action item includes ideas for implementing each action item.

Potential Funding Sources:
This plan describes potential funding sources to implement short-term mitigation actions. Funding for medium and longer-term activities has not yet been identified due to the uncertain timeline for the individual projects. It is expected that future funding will combine City funds and state and/or federal grant programs as listed in Appendix B.

Plan Goals Addressed:
The Plan goals addressed by each action item are included as a way to monitor and evaluate how well the Mitigation Plan is achieving its goals once implementation begins.

Constraints:
Constraints may apply to some of the action items. These constraints may be a lack

of City staff, lack of funds, or vested property rights which might expose the City to legal action as a result of adverse impacts on private property.

2005 Multi-Hazard Action Items:

Multi-hazard action items are those activities that pertain to general hazard mitigation. The following items were adopted in the original 2005 Natural Hazards Mitigation Plan:

Short-Term Activity- Multi-Hazard #l:
Integrate the goals and action items from the City of Pasadena Natural Hazard Mitigation Plan into existing regulatory documents and programs, where appropriate.

Results
In 2010 the City adopted a new ordinance which incorporated the recent changes to the State of California's Building, Fire, Development and Green Initiative codes. This was a critical step for the City of Pasadena to ensure many of the mitigation action items have a direct and lasting impact on future mitigation efforts. Other efforts include the adoption of a "Red Flag" ordinance to control parking during days when the local fire hazard is elevated.

Short-Term Activity - Multi-Hazard #2:
Identify and pursue funding to develop and implement local and City mitigation activities.

Results
From 2005 to 2010 the City aggressively sought outside funding sources. These sources were primarily provided by FEMA and the State of California. Some of the successes include a FEMA Pre-Disaster Mitigation grant, grants to improve the City public safety communications system, a grant to retrofit the City Hall complex and harden it against earthquake damage, and a grant to develop a dedicated Emergency Operations Center.

Short-Term Activity - Multi-Hazard #3:
Establish a formal role for the City of Pasadena Hazard Mitigation Advisory Committee to develop a sustainable process for implementing, monitoring, and evaluating citywide mitigation activities.

Results
Since 2005 the City of Pasadena has been implementing, monitoring, and evaluating citywide mitigation activities. This process was executed using existing 27 City public committees and commissions. Many people who serve on the Hazard Mitigation Advisory Committee also serve on other committees. Of the 27 committees, nine have been specifically tasked to oversee parts of the plan update process. These committees include: Community Development, Design, and Environmental Advisory.

Short-Term Activity - Multi-Hazard #4:
Identify, improve, and sustain collaborative programs focusing on the real estate and insurance industries, public and private sector organizations, and individuals to avoid activity that increases risk to natural hazards.

Results
This action item was limited due to constraints of budget and personnel.

Short-Term Activity - Multi-Hazard #5:
Develop public and private partnerships to foster natural hazard mitigation program coordination and collaboration in City of Pasadena.

Results
The most notable success with this item is the connection between Pasadena's capital improvement projects and hazard mitigation actions. This is especially evident in areas like the upper and lower Arroyo Seco Wash.

Short-Term Activity - Multi-Hazard #6:
Develop inventories of at-risk buildings and infrastructure and prioritize mitigation projects.

Results
Due to constraints of budget and personnel this item was not completed.

Long-Term Activity - Multi-Hazard #1:
Strengthen emergency services preparedness and response by linking emergency services with natural hazard mitigation programs, and enhancing public education on a regional scale.

Results
The greatest success in this area was the adoption of the Red Flag ordinance. This ordinance impacts several natural and manmade hazards and improves evacuation conditions during fires. It connects the City directly with local citizens to solve a serious hazard issue and is also interconnected to neighboring citizens with similar threats.

Long-Term Activity - Multi-Hazard #2:
Develop, enhance, and implement education programs aimed at mitigating natural hazards, and reducing the risk to citizens, public agencies, private property owners, businesses, and schools.

Results
Constraints of budget and personnel impacted the ability of the City to complete these goals.

Long-Term Activity - Multi-Hazard #3:
Use technical knowledge of natural ecosystems and events to link natural resource management and land use organizations to mitigation activities and technical assistance.

Results
The City of Pasadena has worked cooperatively with groups like the Pasadena Audubon Society, Arroyo and Foothills Conservancy, and the Friends of the Hahamongna to develop mitigation projects while protecting the natural environment.

Specific Hazard Action Items:

In 2005 the City of Pasadena identified five specific hazard areas including: earthquakes, floods, wildfires, landslides, and windstorms.

Earthquakes
The 2005 specific section regarding earthquakes had five action items. The first was the incorporation of new technical analysis of earthquake hazards in local planning. This was accomplished by incorporating the new earthquake standards in the California State Building Code and modifying Pasadena standards so they matched.

The action items included encouraging citizens to purchase earthquake insurance and reduce structural and nonstructural hazards in homes, schools, businesses, and government offices. The City has done this with education programs including providing speakers at public events, training sponsored by the City, and use of the City website.

The plan also identified the need to incorporate evacuation planning in future City planning. This effort has been slow as the Los Angeles County Alliance Task Force has attempted to develop a county-wide plan for emergency evacuations. The downturn in the economy also limited the action item related to identifying funding sources for retrofitting seismically vulnerable structures.

Floods
The 2005 plan had several action items related to floods as a natural hazard. Several of the items were related to identifying areas that were subject to flooding, providing warning systems, and strengthening requirements for building in flood-prone areas. Identification of potential flood areas is found in the safety element of the City of Pasadena General Plan. Since 2005 the City has developed the Pasadena Local Emergency Alert System (PLEAS), which can be used to warn citizens of a variety of hazards including flooding. The improved building standards include strengthening footings and foundations, which improve building survivability during a flood.

The City has actively worked to preserve open space in parts of the arroyos and watershed areas. This has resulted in partnership projects like the Central Arroyo Restoration Program which has improved water and stream quality. This partnership with the Arroyo Seco Foundation also resulted in the re-introduction of the native Arroyo Chub to local streams.

Wildfires
The 2005 action items for wildfires were divided between improving firefighting capabilities and educating the public with immediate and long-term mitigation activities. The City of Pasadena has developed a Red Flag ordinance to warn hillside homeowners during fire threats and clear narrow roadways to improve evacuation and response capabilities.

In 2011 the City signed a mutual aid agreement for firefighting with the U.S. Forest Service. This cooperative agreement is especially important to residents living in hillside or canyon areas. The program by the City to strengthen and replace aging water mains will greatly improve firefighting capabilities during other natural disasters such as earthquakes. To assist local property owners the City provides warning information during fire and high wind threats as well as a variety of public information and education programs.

Landslides
In 2005 the Natural Hazard Mitigation Plan identified landslides as a natural threat to the City. Mitigation action items included strengthening construction requirements while educating the public. Changes in building codes require homeowners to follow strict regulations when grading or excavating hillside properties. Other changes in the building codes increase requirements for footings and foundations further strengthening new construction in hillside areas. Related codes now require prevention of runoff during construction.

The City of Pasadena has provided information to the public regarding the prevention of landslide threats. The Planning Department website provides information about mitigation steps for residents to protect against landslides. This website also provides a supplemental planning form in the form of a checklist. This checklist provides reminders about specific code requirements and provides educational information homeowners may need to comply with these regulations.

Windstorms
The priorities in 2005 for windstorm mitigation were public education and practical steps to improve the reliability of electric utilities. Public education was accomplished through public education programs supported by the City of Pasadena Department of Water and Power website. The website provides information for property owners on how to protect their properties during windstorms.
The City has also spent the last five years working on a variety of programs to increase the reliability of power transmission. This has involved improving the power grid, emphasizing careful urban forest management, and training city employees in power interruption response procedures.

Pasadena has been cited by the American Public Power Association as an “RP3” city (Reliable Public Power Provider) from 2006 to 2011. This award is based on utility proficiency in four key areas: reliability, safety, workforce development and system improvement. http://ww2.cityofpasadena.net/waterandpower/news/ConduitApr11.pdf

2013 Mitigation Action Items:

The following goals were selected as the multi-hazard action items for 2013:

Short-Term Activity- Multi-Hazard #l:

Integrate the goals and action items from the City of Pasadena Multi-Hazard Mitigation Plan into existing regulatory documents and programs, where appropriate.

Ideas for Implementation:

Use the Mitigation Plan to help the City's General Plan institutionalize guidelines for sustainable development in all new construction and development projects according to the hazards that impact the City of Pasadena

Integrate the City's Mitigation Plan into current capital improvement plans to ensure that development plans include specific strategies for mitigation requirements.

Coordinating Organization:	Hazard Mitigation Advisory Committee
Timeline:	Ongoing
Potential Funding Sources:	Responsible departments will be directed to include the cost of this item in their department budget; also see Appendix B
Plan Goals Addressed:	Partnerships and Implementation
Constraints:	Pending funding and available personnel

Short-Term Activity - Multi-Hazard #2:

Identify and pursue funding opportunities to develop and implement local and City mitigation activities.

Ideas for Implementation:

Develop public and private partnerships for hazard mitigation activities.

Track state and federal grant programs which support location mitigation programs.

Coordinating Organization:	City Fire Dept.
Timeline:	Ongoing
Potential Funding Sources:	Responsible departments will be directed to include the cost of this item in their department budget; also see Appendix B
Plan Goals Addressed:	Partnerships and Implementation
Constraints:	Pending funding and available personnel

Short-Term Activity - Multi-Hazard #3:

Develop public and private partnerships to foster hazard mitigation program coordination and collaboration in City of Pasadena.

Ideas for Implementation:

Identify organizations within City of Pasadena that have programs or interests in hazards mitigation.

Involve private businesses throughout the City in hazard mitigation awareness and planning.

Encourage continuity planning for local businesses as part of community wide hazard mitigation efforts.

Coordinating Organization:	City Fire Department
Timeline:	Ongoing
Potential Funding Sources:	Responsible departments will be directed to include the cost of this item in their department budget; also see Appendix B
Plan Goals Addressed:	Partnerships and Implementation
Constraints:	Pending funding and available personnel

Long-Term Activity - Multi-Hazard #1:

Strengthen emergency services preparedness and response by linking emergency services with hazard mitigation programs.

Ideas for Implementation:

Ensure on-going operational planning for emergencies includes recognition and inclusion of hazard mitigation requirements.

Coordinate with neighboring jurisdictions regarding their specific hazard mitigation challenges and plans.

Coordinate the maintenance of emergency transportation routes through communication with the County Department of Public Works, neighboring jurisdictions, and the California Department of Transportation.

Coordinating Organization:	City Planning Department
Timeline:	Ongoing
Potential Funding Sources:	See Appendix B
Plan Goals Addressed:	Emergency Services
Constraints:	Pending funding and available personnel

Long-Term Activity - Multi-Hazard #2:

Establish a formal role for the City of Pasadena Hazard Mitigation Advisory Committee to develop a sustainable process for implementing, monitoring, and evaluating citywide mitigation activities.

Ideas for Implementation:

Establish clear roles for participants, meeting regularly to pursue and evaluate implementation of mitigation strategies.

Oversee implementation of the Multi-Hazard Mitigation Plan.

Monitor hazard mitigation implementation by jurisdictions and participating organizations through surveys and other reporting methods.

Develop updates for the Multi-Hazards Mitigation Action Plan based on new information.

Conduct a full review of the Multi-Hazards Mitigation Action Plan every 5 years by evaluating mitigation successes, failures, and areas that were not addressed.

Provide training for Committee members to remain current on developing issues in the natural hazard loss reduction field.

Coordinating Organization:	Hazard Mitigation Advisory Committee
Timeline:	Ongoing
Potential Funding Sources:	See Appendix B
Plan Goals Addressed:	Partnerships and Implementation
Constraints:	Pending funding and available personnel

Long-Term Activity - Multi-Hazard #3:

Develop and implement outreach programs designed to educate the public about hazard mitigation.

Ideas for Implementation:

Make the City of Pasadena Multi-Hazard Mitigation Plan available to the public by publishing the Plan electronically on the City websites.

Provide information regarding mitigation hazards and planning at events promoted by the City.

Include emergency preparedness information related to hazard mitigation in public safety information and training programs (e.g. Citizen's Academy, Pasadena Emergency

Response Team Program).

Coordinating Organization:	All City Departments
Timeline:	Ongoing
Potential Funding Sources:	See Appendix B
Plan Goals Addressed:	Public Awareness, Protect Life and Property
Constraints:	Pending funding and available personnel

Long-Term Activity - Multi-Hazard #4:

Use technical knowledge of natural ecosystems and events to link natural resource management and land use organizations to mitigation activities and technical assistance.

Ideas for Implementation:

Review ordinances that protect natural systems and resources to mitigate for natural hazards for possible enhancements.

Pursue vegetation and restoration practices that assist in enhancing and restoring the natural and beneficial functions of the watershed.

Coordinating Organization:	City Planning Department
Timeline:	Ongoing
Potential Funding Sources:	See Appendix B
Plan Goals Addressed:	Natural Systems
Constraints:	Pending funding and available personnel

Long-Term Activity - Multi-Hazard #5:

Develop a long-term approach to monitoring hazard mitigation planning by conducting meetings of the Hazard Mitigation Advisory Committee annually.

Ideas for Implementation:

Review mitigation efforts from the past six months for effectiveness.

Identify changes in regulations, regional planning, or technology which may impact ongoing mitigation plans or programs.

Prepare an annual report to the City Manager regarding Multi-Hazard mitigation efforts in the City of Pasadena.

Coordinating Organization:	Hazard Mitigation Advisory Committee
Timeline:	Ongoing
Potential Funding Sources:	See Appendix B

Plan Goals Addressed: Natural Systems
Constraints: Pending funding and available personnel

2005 Crosswalk Comments:

Every hazard mitigation plan is evaluated by the California Emergency Management Agency. The evaluation is done using a written rubric which is call the "Crosswalk." Upon submission to CalEMA for review, every plan is judged against certain standards contained within this document.

The 2005 evaluators discussed the importance of describing in narrative form the vulnerabilities of the built environment to identified hazards. This was included in specific action items for earthquakes, landslides and flooding. The improvement of building ordinances has resulted in structures more resilient against these hazards. The measures include strengthening requirements for footings and foundations, increasing requirements for roof construction, and replacing structures in the Arroyo Seco Wash areas. These are described in the specific hazard sections.

SECTION 5:

- Plan Maintenance -

The plan maintenance section of this document details the formal process that will ensure that the City of Pasadena Multi-Hazard Mitigation Plan remains an active and relevant document. The plan maintenance process includes a schedule for monitoring and evaluating the Plan annually and producing a Plan revision every five years. This section describes how the City will integrate public participation throughout the plan maintenance process. Finally, this section includes an explanation of how City of Pasadena government intends to incorporate the mitigation strategies outlined in this Plan into existing planning mechanisms such as the City General Plan, Capital Improvement Plans, and Building and Safety Codes.

Monitoring and Implementing the Plan

Plan Adoption:

The City Council will be responsible for adopting the City of Pasadena Multi-Hazard Mitigation Plan. This governing body has the authority to promote sound public policy regarding natural hazards. Once the updated plan is completed it will be submitted to the California Emergency Management Agency (CalEMA). Upon approval by CalEMA the will be submitted to the Federal Emergency Management Agency (FEMA) for review. Upon acceptance by FEMA, City of Pasadena will have an approved Multi-Hazard Plan and be eligible for federal hazard mitigation grant program funds.

Coordinating Body:

A City of Pasadena Hazard Mitigation Advisory Committee will be responsible for coordinating implementation of Plan action items and undertaking the formal review process.

Convener:

The City Council will adopt the City of Pasadena Multi-Hazard Mitigation Plan, and the Hazard Mitigation Advisory Committee will take joint responsibility for Plan implementation with City departments. The City Manager, or designee, will serve as a convener to facilitate the Hazard Mitigation Advisory Committee meetings, and will assign tasks necessary for implementation. The committee shall meet annually.

Implementation through Existing Programs:

The City of Pasadena addresses statewide planning goals and legislative requirements through its General Plan, Capital Improvement Plans, and City Building and Safety Codes. The Multi-Hazard Mitigation Plan provides a series of recommendations. Many

of these are closely related to the goals and objectives of existing planning programs. This allows the City of Pasadena the opportunity to implement recommended mitigation action items through existing programs and procedures.

The City of Pasadena Building Division is responsible for administering the Building & Safety Codes. The committee will work with the various City Departments to review, develop and ensure Building & Safety Codes that are adequate to mitigate or present damage by natural hazards.

The goals and action items in the Mitigation Plan may be achieved through activities recommended in the City's Capital Improvement Plans (CIP). Various City departments develop CIP plans, and review them on an annual basis. Upon annual review of the CIPs, the Hazard Mitigation Advisory Committee will work with the City departments to identify areas that the Hazard Mitigation Plan action items are consistent with CIP planning goals and integrate them where appropriate.

Within six months of formal adoption of the Mitigation Plan, the recommendations listed above will be incorporated into the process of existing planning mechanisms at the City level. The meetings of the Hazard Mitigation Advisory Committee will provide an opportunity for committee members to report back on the progress made on the integration of mitigation planning elements into City planning documents and procedures.

Economic Analysis of Mitigation Projects:

FEMA's approaches to identify the costs and benefits associated with natural hazard mitigation strategies, measures, or projects fall into two general categories: benefit/cost analysis and cost-effectiveness analysis.

Conducting benefit/cost analysis for a mitigation activity can assist communities in determining whether a project is worth undertaking now, in order to avoid disaster-related damages later.

Cost-effectiveness analysis evaluates how best to spend a given amount of money to achieve a specific goal. Determining the economic feasibility of mitigating natural hazards can provide decision-makers with an understanding of the potential benefits and costs of an activity, as well as a basis upon which to compare alternative projects.

During the current economic downturn it may be challenging to use these methods due to the many needs requiring funding. The City of Pasadena will continue to use the FEMA approach balanced by the money available for any type of projects.

Evaluating and Updating the Plan:

Formal Review Process

The City of Pasadena Multi-Hazard Mitigation Plan will be evaluated on an annual basis

to determine the effectiveness of programs, and to reflect changes in land development or programs that may affect mitigation priorities. The evaluation process includes a firm schedule and time line, and identifies the local agencies and organizations participating in Plan evaluation.

The convener or designee will be responsible for contacting the Hazard Mitigation Advisory Committee members and organizing the annual meeting. Committee members and City departments will be responsible for monitoring and evaluating the progress of the mitigation strategies in the Plan.

The committee will review the goals and action items to determine their relevance to changing situations in the City, as well as changes in state or federal policy, and to ensure they are addressing current and expected conditions. The committee will also review the risk assessment portion of the Plan to determine if this information should be updated or modified, given any new available data. The coordinating organizations responsible for the various action items will report on the status of their projects, the success of various implementation processes, difficulties encountered, success of coordination efforts, and which strategies should be revised.

Continued Public Involvement

Pasadena is dedicated to involving the public directly in review and updates of the Hazard Mitigation Plan. The Hazard Mitigation Advisory Committee members are responsible for the annual review and update of the Plan.

The public will also have the opportunity to provide feedback about the Plan. Copies of the Plan will be kept at all of the appropriate agencies in the City. The adopted plan will be posted online. In addition, information on how to obtain copies of the Plan and any proposed changes will be posted on the City website. This site will also contain an email address and phone number to which people can direct their comments and concerns.

A public meeting will also be held after each annual evaluation or when deemed necessary by the Hazard Mitigation Advisory Committee. The meetings will provide the public a forum for which they can express its concerns, opinions, or ideas about the Plan. The City Public Information Officer will be responsible for using City resources to publicize the annual public meetings and maintain public involvement through the public access channel, web page, and newspapers.

Part III:

Hazard-Specific Information

SECTION 1:
- EARTHQUAKE -

Why Are Earthquakes a Threat to the City of Pasadena?

The most recent significant earthquake event affecting Southern California was the January 17, 1994, Northridge Earthquake. At 4:31 A.M. on Monday, January 17, a moderate but very damaging earthquake with a magnitude of 6.7 struck the San Fernando Valley. In the following days and weeks, thousands of aftershocks occurred, causing additional damage to affected structures.

Fifty-seven people were killed and more than 1,500 people seriously injured. For days afterward, thousands of homes and businesses were without electricity; tens of thousands had no gas; and nearly 50,000 had little or no water. Approximately 15,000 structures were moderately to severely damaged, leaving thousands of people temporarily homeless. Some 66,500 buildings were inspected. Nearly 4,000 were severely damaged, and over 11,000 were moderately damaged. Several collapsed bridges and overpasses created commuter havoc on the freeway system. Extensive damage was caused by ground shaking, but earthquake-triggered liquefaction and dozens of fires also caused additional severe damage. This extremely strong ground motion in large portions of Los Angeles County resulted in record economic losses.

However, the earthquake occurred early in the morning on a holiday, and this circumstance considerably reduced the potential effects. Many collapsed buildings were unoccupied, and most businesses were not yet open. Even so, the direct and indirect economic losses ran into the tens of billions of dollars.

Historical and geological records show that California has a long history of seismic events. Southern California is probably best known for the San Andreas Fault, a 400-mile long fault running from the Mexican border to an offshore point west of San Francisco. Geologic studies show that over the past 1,400 to 1,500 years large earthquakes have occurred at about 130-year intervals on the southern San Andreas Fault. As the last large earthquake on the southern San Andreas occurred in 1857, that section of the fault is considered a likely location for an earthquake within the next few decades.

Although the most famous of the faults, the San Andreas, is capable of producing an earthquake with a magnitude of 8+ on the Richter scale, some of the “lesser” faults have the potential to inflict greater damage on the urban core of the Los Angeles Basin. Seismologists believe that a 6.0 earthquake on the Newport-Inglewood area would result in far more death and destruction than a “great” quake on the San Andreas, because the San Andreas is relatively remote from the urban centers of Southern California.

The two largest faults in the Pasadena area are the Sierra Madre Fault, a reverse fault on the north boundary of the City, and the Raymond Fault, a left lateral strike-slip fault that extends into the southern and eastern areas of the City. A rupture of either fault would result in major damage to the City. Nearby faults include the Verdugo, Hollywood, Whittier, and Elysian Park fault zones. Any of these faults have the potential to cause serious damage to Pasadena.

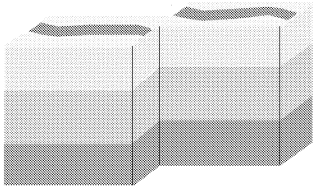
To better understand the earthquake hazard, the scientific community has looked at historical records and accelerated research on those faults that are the sources of the earthquakes occurring in the Southern California region. Historical earthquake records can generally be divided into records of the pre-instrumental period and the instrumental period. In the absence of instrumentation, the detection of earthquakes is based on observations and felt reports, and is dependent upon population density and distribution. Since California was sparsely populated in the 1800s, the detection of pre-instrumental earthquakes is relatively difficult.

However, two very large earthquakes, the Fort Tejon in 1857 (7.9) and the Owens Valley in 1872 (7.6) are evidence of the tremendously damaging potential of earthquakes in Southern California. In more recent times, two 7.3 earthquakes struck Southern California, in Kern County (1952) and Landers (1992). The damage from these four large earthquakes was limited because they occurred in areas which were sparsely populated at the time they happened. The seismic risk is much more severe today than in the past because the population at risk is in the millions, rather than a few hundred or a few thousand persons.

Causes and Characteristics of Earthquakes in Southern California

Earthquake Faults

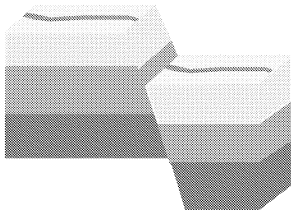
A fault is a fracture between blocks of the earth's crust where either side moves relative to the other along a parallel plane to the fracture.



Strike-Slip Fault

Strike-slip

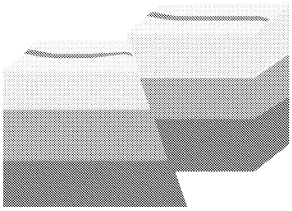
Strike-slip faults are vertical or almost vertical rifts where the earth's plates move mostly horizontally. From the observer's perspective, if the opposite block looking across the fault moves to the right, the slip style is called a right lateral fault; if the block moves left, the shift is called a left lateral fault.



Normal Fault

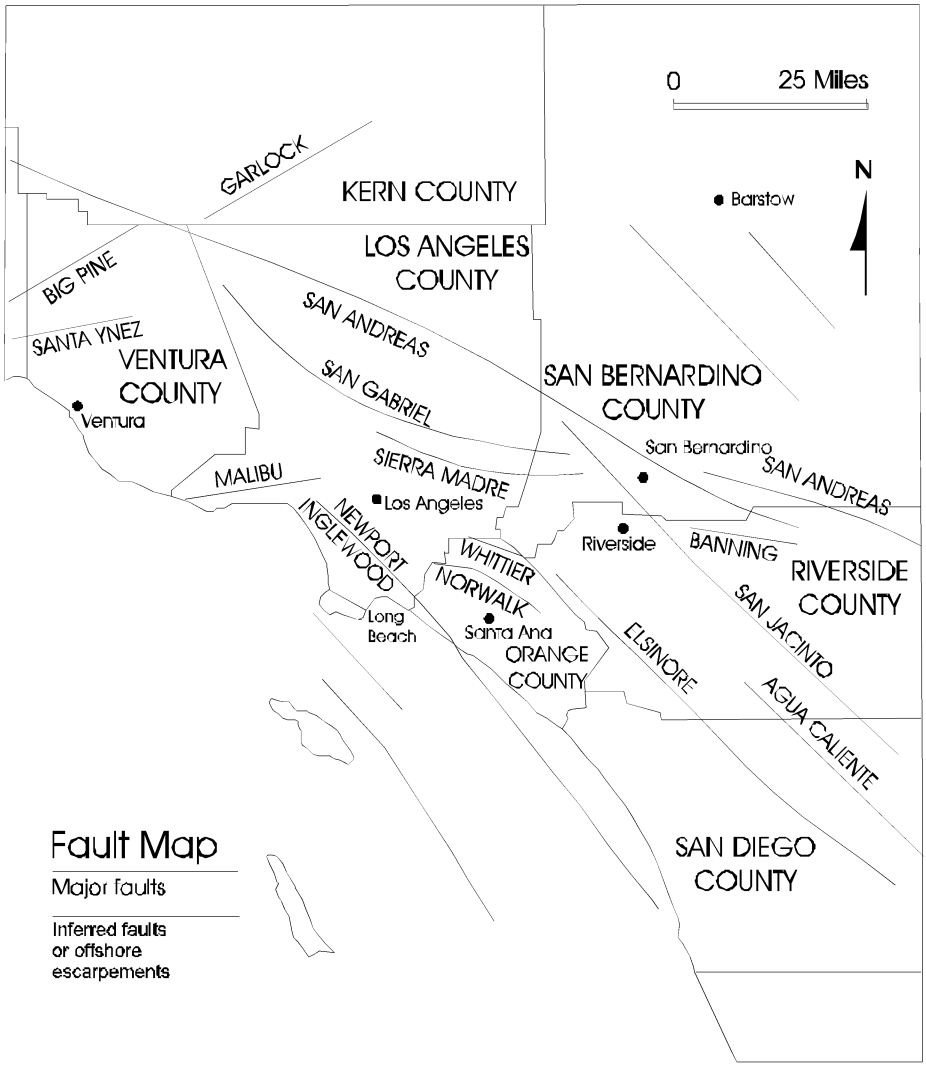
Dip-slip

Dip-slip faults are slanted fractures where the blocks mostly shift vertically. If the earth above an inclined fault moves down, the fault is called a normal fault, but when the rock above the fault moves up, the fault is called a reverse fault. Thrust faults have a reverse fault with a dip of 45 ° or less.

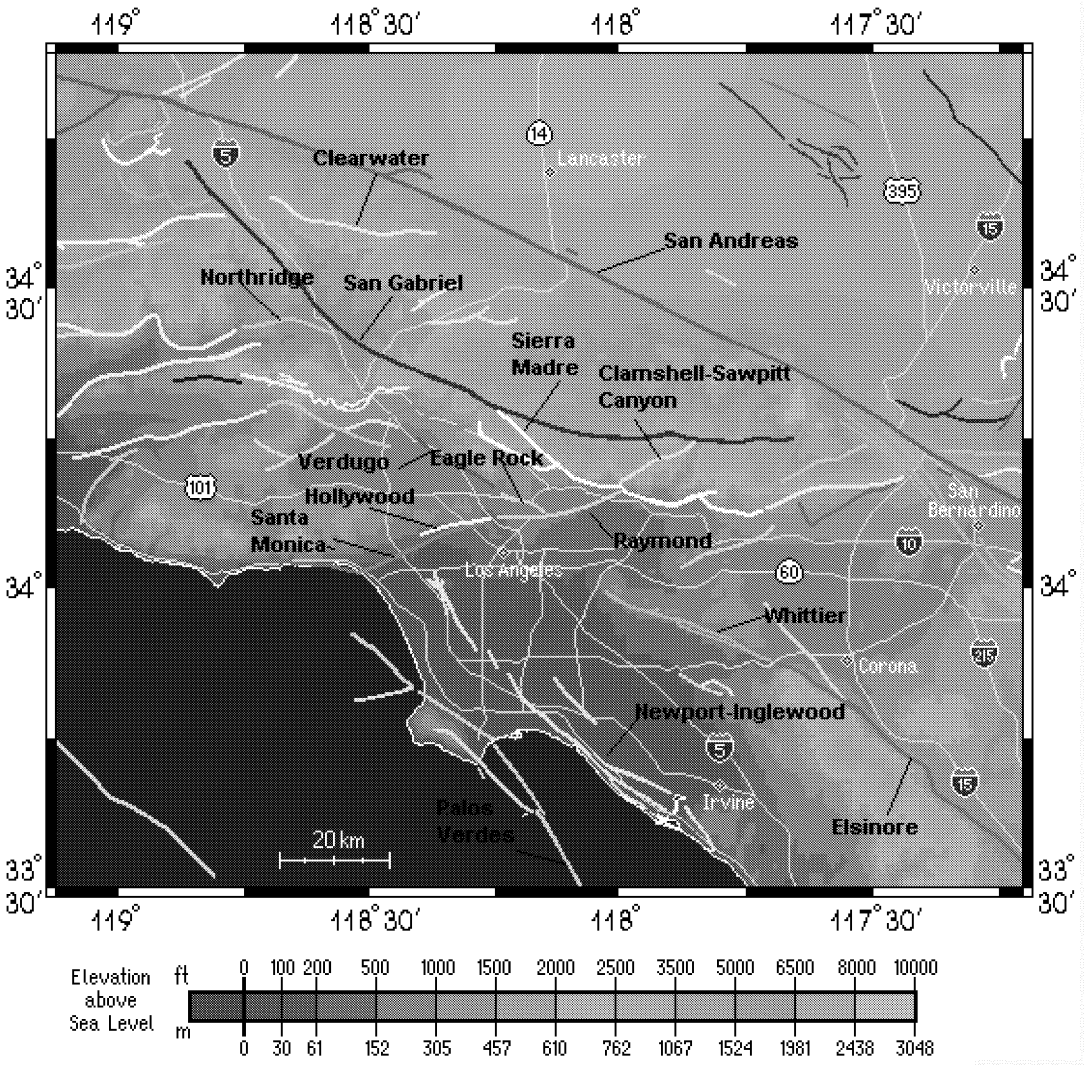


Thrust Fault

Southern California Earthquake Faults

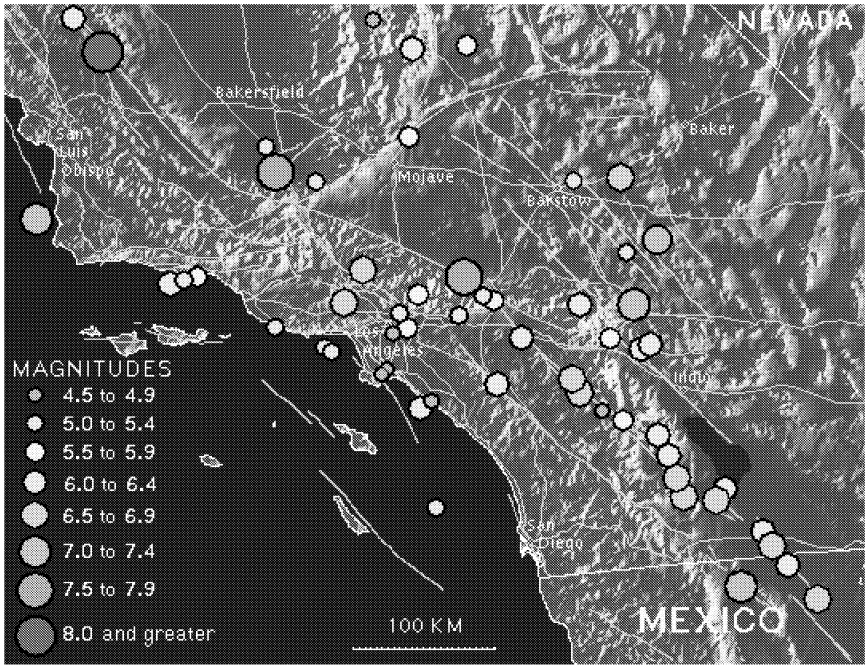


Major Faults – Los Angeles Region



Map: Southern California Earthquake Data Center

Major Earthquakes in Southern California since 1812



Dr. Kerry Sieh of Cal Tech has investigated the San Andreas Fault at Pallett Creek. "The record at Pallett Creek shows that rupture has recurred about every 130 years, on average, over the past 1500 years. But actual intervals have varied greatly, from less than 50 years to more than 300. The physical cause of such irregular recurrence remains unknown." Damage from a great quake on the San Andreas would be widespread throughout Southern California.

Earthquake-Related Hazards

Ground shaking, landslides, liquefaction, and amplification are the specific hazards associated with earthquakes. The severity of these hazards depends on several factors, including soil and slope conditions, proximity to the fault, earthquake magnitude, and the type of earthquake.

Ground Shaking:

Ground shaking is the motion felt on the earth's surface caused by seismic waves generated by the earthquake. It is the primary cause of earthquake damage. The strength of ground shaking depends on the magnitude of the earthquake, the type of fault, and distance from the epicenter (where the earthquake originates). Buildings on poorly consolidated and thick soils will typically see more damage than buildings on consolidated soils and bedrock.

Earthquake-Induced Landslides:

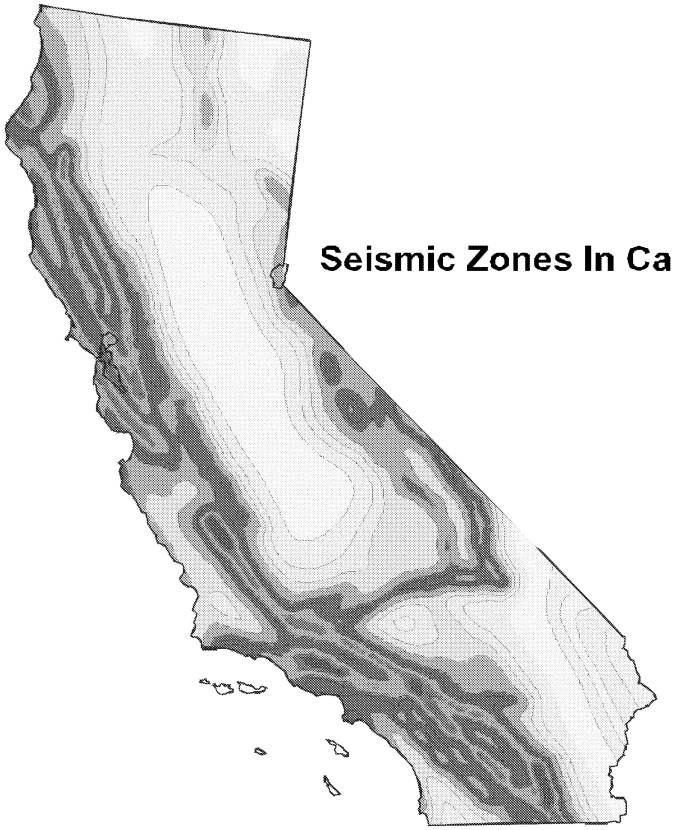
Earthquake-induced landslides are secondary earthquake hazards that occur from ground shaking. They can destroy the roads, buildings, utilities, and other critical facilities necessary to respond and recover from an earthquake. Many communities in Southern California have a high likelihood of encountering such risks, especially in areas with steep slopes.

Liquefaction:

Liquefaction occurs when ground shaking causes wet granular soils to change from a solid state to a liquid state. This results in the loss of soil strength and the soil's ability to support weight. Buildings and their occupants are at risk when the ground can no longer support these buildings and structures. Many communities in Southern California are built on ancient river bottoms and have sandy soil. In some cases this ground may be subject to liquefaction, depending on the depth of the water table.

Amplification:

Soils and soft sedimentary rocks near the earth's surface can modify ground shaking caused by earthquakes. One of these modifications is amplification. Amplification increases the magnitude of the seismic waves generated by the earthquake. The amount of amplification is influenced by the thickness of geologic materials and their physical properties. Buildings and structures built on soft and unconsolidated soils can face greater risk. Amplification can also occur in areas with deep sediment filled basins and on ridge tops.



Darker Shaded Areas indicate Greater Potential Shaking

Source: USGS Website

Abridged Modified Mercalli Intensity Scale

Intensity Value and Description		Average Peak Velocity (cm/sec)	Average Peak Acceleration (g = gravity)
	Not felt except by a very few under especially favorable circumstances (I Rossi-Forel scale). Damage potential: None.	<0.1	<0.0017
II.	Felt only by a few persons at rest, especially on upper floors of high-rise buildings. Delicately suspended objects may swing. (I to II Rossi-Forel scale). Damage potential: None.		
III.	Felt quite noticeably indoors, especially on upper floors of buildings, but many people do not recognize it as an earthquake. Standing automobiles may rock slightly. Vibration like passing of truck. Duration estimated. (III Rossi-Forel scale). Damage potential: None.		
IV.	During the day felt indoors by many, outdoors by few. At night some awakened. Dishes, windows, doors disturbed; walls make creaking sound. Sensation like a heavy truck striking building. Standing automobiles rocked noticeably. (IV to V Rossi-Forel scale). Damage potential: None. Perceived shaking: Light.	1.1 – 3.4	0.014 - 0.039
V.	Felt by nearly everyone, many awakened. Some dishes, windows, and so on broken; cracked plaster in a few places; unstable objects overturned. Disturbances of trees, poles, and other tall objects sometimes noticed. Pendulum clocks may stop. (V to VI Rossi-Forel scale). Damage potential: Very light. Perceived shaking: Moderate.	3.4 – 8.1	0.039-0.092
VI.	Felt by all, many frightened and run outdoors. Some heavy furniture moved, few instances of fallen plaster and damaged chimneys. Damage slight. (VI to VII Rossi-Forel scale). Damage potential: Light. Perceived shaking: Strong.	8.1 - 16	0.092 -0.18
VII.	Everybody runs outdoors. Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable in poorly built or badly designed structures; some chimneys broken. Noticed by persons driving cars. (VIII Rossi-Forel scale). Damage potential: Moderate. Perceived shaking: Very strong.	16 - 31	0.18 - 0.34
VIII.	Damage slight in specially designed structures; considerable in ordinary substantial buildings with partial collapse; great in poorly built structures. Panel walls thrown out of frame structures. Fall of chimneys, factory stacks, columns, monuments, and walls. Heavy furniture overturned. Sand and mud ejected in small amounts. Changes in well water. Persons driving cars disturbed. (VIII+ to IX Rossi-Forel scale). Damage potential: Moderate to heavy. Perceived shaking: Severe.	31 - 60	0.34 - 0.65
IX.	Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb; great in substantial buildings with partial collapse. Buildings shifted off foundations. Ground cracked conspicuously. Underground pipes broken. (IX+ Rossi-Forel scale). Damage potential: Heavy. Perceived shaking: Violent.	60 - 116	0.65 - 1.24
X.	Some well-built wooden structures destroyed; most masonry and frame structures destroyed; ground badly cracked. Rails bent. Landslides considerable from river banks and steep slopes. Shifted sand and mud. Water splashed, slopped over banks. (X Rossi-Forel scale). Damage potential: Very heavy. Perceived shaking: Extreme.	> 116	> 1.24
XI.	Few, if any, (masonry) structures remain standing. Bridges destroyed. Broad fissures in ground. Underground pipelines completely out of service. Earth slumps and land slips in soft ground. Rails bent greatly.		
XII.	Damage total. Waves seen on ground surface. Lines of sight and level distorted. Objects thrown into air.		

Earthquake Hazard Assessment

Hazard Identification:

In California, many agencies are focused on seismic safety issues: the State's Seismic Safety Commission, the Applied Technology Council, California Emergency Management Agency (CalEMA), United States Geological Survey, Cal Tech, and the California Geological Survey, as well as a number of universities and private foundations.

These organizations, in partnership with other state and federal agencies, have undertaken a rigorous program in California to identify seismic hazards and risks including active fault identification, bedrock shaking, tsunami inundation zones, ground motion amplification, liquefaction, and earthquake induced landslides. Seismic hazard maps have been published and are available for many communities in California through the State Division of Mines and Geology.

The following descriptions of earthquake faults, the probable recurrence rate, and the estimated severity of a potential earthquake were developed by the Working Group on California Earthquake Probabilities (WGCEP) sponsored by the US and California Geological Surveys.

San Andreas Fault Zone:

The San Andreas fault is the principal boundary between the Pacific and North American plates, and as such, it is considered the "Master Fault" because it has frequent (geologically speaking), large earthquakes, and it controls the seismic hazard in southern California. The fault extends over 1,000 miles (1,600 kilometers) from near Cape Mendocino in northern California to the Salton Sea region in southern California. At its closest approach, the San Andreas fault is approximately 21 miles (33 km) north of Pasadena.

Large faults, such as the San Andreas fault, are generally divided into segments in order to evaluate their future earthquake potential. The segments are generally defined at discontinuities along the fault that may affect the rupture length. In central and southern California, the San Andreas fault zone is divided into five segments named, from north to south, the Cholame, Carrizo, Mojave, San Bernardino Mountains, and Coachella Valley segments.

Each segment is assumed to have a characteristic slip rate (rate of movement averaged over time), recurrence interval (time between moderate to large earthquakes), and displacement (amount of offset during an earthquake). While this methodology has some value in predicting earthquakes, historical records and studies of prehistoric earthquakes show that it is possible for more than one segment to rupture during a large quake or for ruptures to overlap into adjacent segments.

The last major earthquake on the southern portion of the San Andreas Fault was the 1857 Fort Tejon (M 8) event. This is the largest earthquake reported in California. The 1857 surface rupture broke the Cholame, Carrizo, and Mojave segments, resulting in displacements of as much as 27 feet (9 meters) along the rupture zone. These fault segments are thought to have an incident recurrence interval of between 104 and 296 years.

The Mojave segment of the San Andreas fault is 83 miles (133 km) long, extending from approximately Three Points southward to just northwest of Cajon Creek, at the southern limit of the 1857 rupture. Scientists estimate a recurrence interval of 150 years for this segment. The Mojave segment is estimated to be capable of producing a magnitude 7.1 earthquake. Earthquake researchers believe this segment has a 26 percent probability of rupturing sometime between 1994 and 2024.

The San Bernardino Mountains segment extends approximately 49 miles (78 km) from Cajon Creek to the San Gorgonio Pass. This segment is a structurally complex zone that is poorly understood, and for which there are scant data on fault behavior. It has been estimated there is a probable recurrence interval on this fault of approximately 146 years. This fault segment is estimated capable of producing a magnitude 7.3 earthquake. If this fault segment ruptures together with the Mojave and Coachella Valley segments, higher ground motions would be expected. In 1994 the WGCEP (1995) calculated that this fault segment had a 28 percent probability of rupturing sometime in the next 30 years.

The Coachella Valley segment is about 71 miles (114 km) long and extends from San Gorgonio Pass to the Salton Sea. This segment has not produced any large surface-rupturing earthquakes in historic times (Sieh and Williams, 1990). Paleoseismic studies suggest that the last surface-rupturing earthquake on this segment occurred around 1680. The data also suggest that during the 1680 earthquake, and the one prior to that, in 1450, both the Coachella Valley and San Bernardino Mountain segments ruptured simultaneously.

The WGCEP derived a recurrence interval for this fault of approximately 220 years. This segment is thought capable of producing a magnitude 7.4 earthquake. The WGCEP (1995) also calculated a 22 percent probability that this fault segment will generate an earthquake sometime between 1994 and 2024.

Sierra Madre Fault:

The Sierra Madre fault zone is a north-dipping reverse fault zone approximately 47 miles (75 km) long that extends along the southern flank of the San Gabriel Mountains from San Fernando to San Antonio Canyon, where it continues southeastward as the Cucamonga fault. The Sierra Madre fault has been divided into five segments, and each segment seems to have a different rate of activity.

The northwestern-most segment of the Sierra Madre fault (the San Fernando segment) ruptured in 1971, causing the M_w 6.7 San Fernando (or Sylmar) earthquake. As a result of this earthquake, the Sierra Madre fault has been known to be active. In the 1980s,

Crook and others (1987) studied the Transverse Ranges using general geologic and geomorphic mapping, coupled with a few trenching locations, and suggested that the segments of the Sierra Madre fault east of the San Fernando segment have not generated major earthquakes in several thousands of years, and possibly as long as 11,000 years. By California's definitions of active faulting, most of the Sierra Madre fault would therefore be classified as not active. The segment in Los Angeles County is active and may generate an earthquake in the future.

Verdugo Fault:

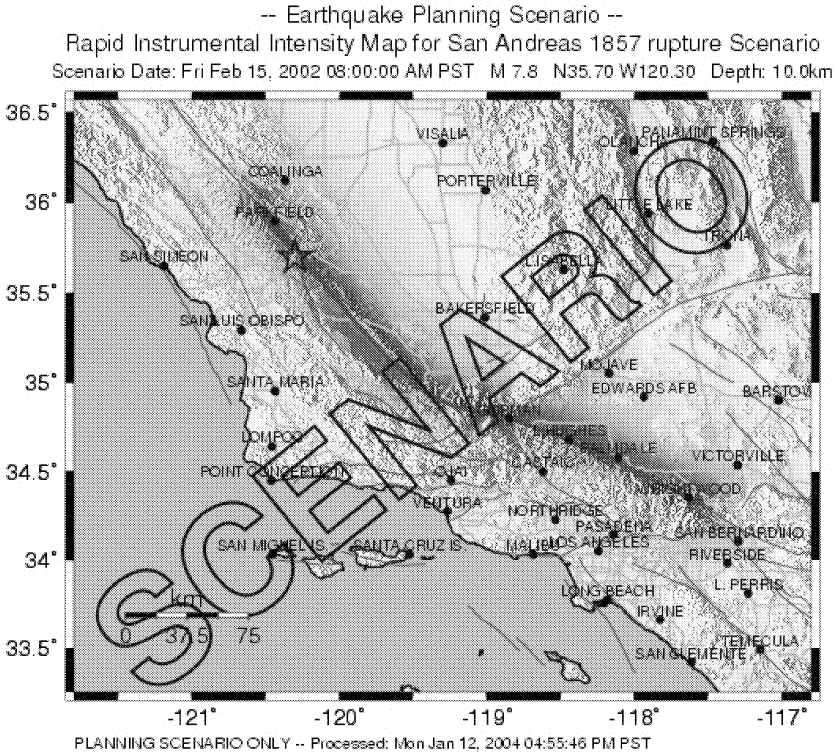
The Verdugo fault is a 13-mile (21 km) long, southeast-striking fault that that lies along the southern flank of the Verdugo Mountains, near Burbank. Earthquake researchers have interpreted this fault as both a reverse fault and a left-lateral strike-slip fault. Results of these studies suggest that the Verdugo fault changes in character from a reverse fault adjacent to the Pacoima Hills, to a normal fault at the southwest edge of the Verdugo Mountains. Vertical separation on the fault is at least 1,000 meters. The fault's recurrence interval is unknown.

Raymond Fault:

The Raymond fault is a left-lateral, strike-slip fault about 13 miles (20 km) long that extends across the San Gabriel Valley, including southern Pasadena. The fault is arcuate in shape, trending east-west in its western section, and east-northeast in its eastern section. The fault produces a very obvious south-facing scarp along much of its length, which led many geologists to favor reverse-slip as the predominant sense of fault motion. However, left-deflected channels, shutter-ridges, sag ponds, and pressure ridges indicate that the Raymond fault is predominantly a left-lateral strike slip fault. Research indicates that the Raymond fault may rupture alone or together with other nearby faults, such as the Hollywood fault. The recurrence rate is uncertain.

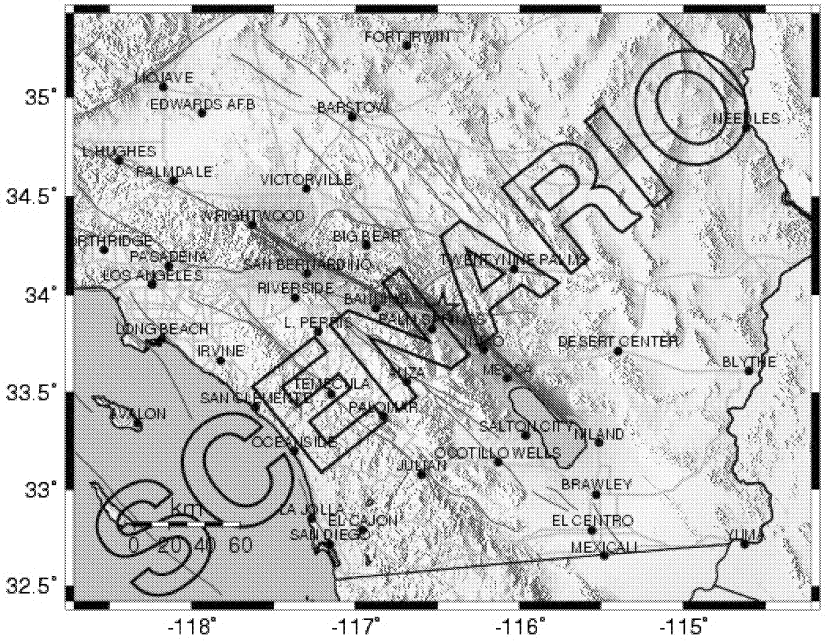
The Raymond fault appears to transfer slip southward from the Sierra Madre fault zone to other fault systems. This sense of motion is confirmed by the seismological record, especially the mainshock and aftershock sequence to the 1988 Pasadena earthquake of local magnitude (M_L) 5.0 that probably occurred on this fault (Jones et al., 1990; Hauksson and Jones, 1991).

The Seismic Hazards Mapping Act, passed in 1990, addresses non-surface fault rupture earthquake hazards, including liquefaction and seismically-induced landslides. The State Department of Conservation operates the Seismic Mapping Program for California. Extensive information is available at their website:
http://gmw.consrv.ca.gov/shmp/index.htm



PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	*<.17*	*.17-1.4*	*1.4-3.9*	*3.9-9.2*	*9.2-18*	18-34	34-65	65-124	>124
PEAK VEL.(cm/s)	<0.1	0.1-1.1	1.1-3.4	3.4-8.1	8.1-16	*16-31*	*31-60*	*60-116*	*>116*
INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

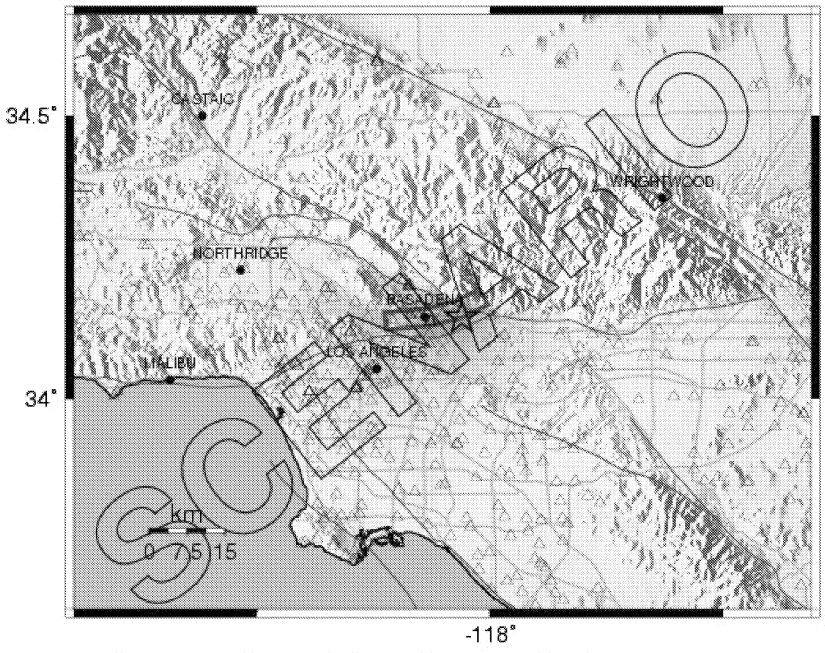
-- Earthquake Planning Scenario --
Rapid Instrumental Intensity Map for San Andreas southern rupture Scenario
Scenario Date: Wed Nov 14, 2001 04:00:00 AM PST M 7.4 N33.92 W116.47 Depth: 10.0km



PLANNING SCENARIO ONLY -- Processed: Mon Jan 12, 2004 10:55:42 AM PST

PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	*<.17*	*.17-1.4*	*1.4-3.9*	*3.9-9.2*	*9.2-18*	18-34	34-65	65-124	>124
PEAK VEL.(cm/s)	<0.1	0.1-1.1	1.1-3.4	3.4-8.1	8.1-16	*16-31*	*31-60*	*60-116*	*>116*
INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

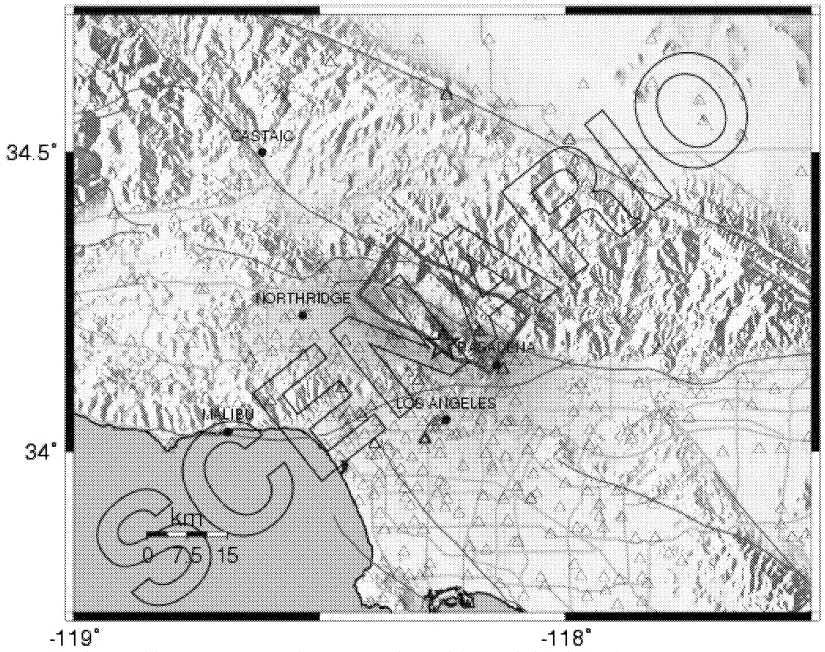
-- Earthquake Planning Scenario --
Rapid Instrumental Intensity Map for Raymond Fault M6.5 Scenario
Scenario Date: Thu Apr 4, 2002 09:15:00 AM PST M 6.5 N34.14 W118.06 Depth: 13.0km



PLANNING SCENARIO ONLY -- Processed: Wed Jul 7, 2004 10:51:50 PM PDT

PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	*<.17*	*.17-1.4*	*1.4-3.9*	*3.9-9.2*	*9.2-18*	18-34	34-65	65-124	>124
PEAK VEL.(cm/s)	<0.1	0.1-1.1	1.1-3.4	3.4-8.1	8.1-16	*16-31*	*31-60*	*60-116*	*>116*
INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

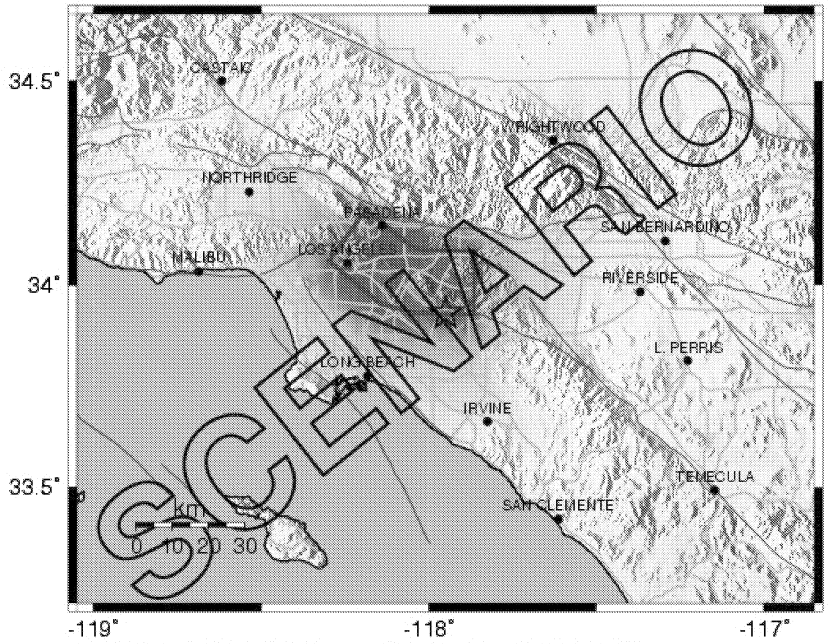
-- Earthquake Planning Scenario --
Rapid Instrumental Intensity Map for Verdugo Fault M6.7 Scenario
Scenario Date: Tue Oct 30, 2001 04:00:00 AM PST M 6.7 N34.18 W118.25 Depth: 6.0km



PLANNING SCENARIO ONLY -- Processed: Wed Jul 7, 2004 11:01:41 PM PDT

PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	*<.17*	*.17-1.4*	*1.4-3.9*	*3.9-9.2*	*9.2-18*	18-34	34-65	65-124	>124
PEAK VEL.(cm/s)	<0.1	0.1-1.1	1.1-3.4	3.4-8.1	8.1-16	*16-31*	*31-60*	*60-116*	*>116*
INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

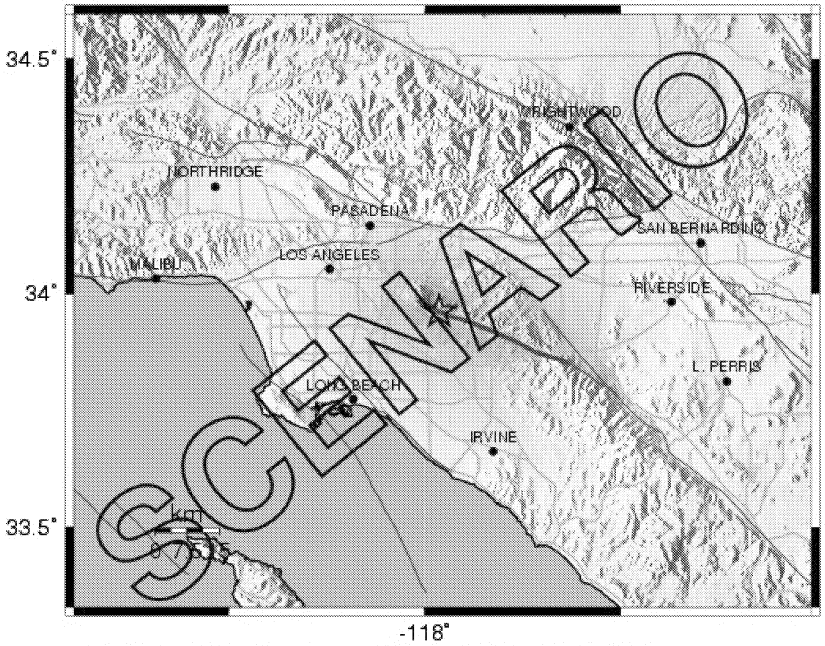
-- Earthquake Planning Scenario --
Rapid Instrumental Intensity Map for Puente Hills Scenario
Scenario Date: Sat Jan 11, 2003 04:00:00 AM PST M 7.1 N33.93 W117.95 Depth: 12.5km



PLANNING SCENARIO ONLY -- Processed: Mon Jan 12, 2004 11:54:00 AM PST

PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	*<.17*	*.17-1.4*	*1.4-3.9*	*3.9-9.2*	*9.2-18*	18-34	34-65	65-124	>124
PEAK VEL.(cm/s)	<0.1	0.1-1.1	1.1-3.4	3.4-8.1	8.1-16	*16-31*	*31-60*	*60-116*	*>116*
INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

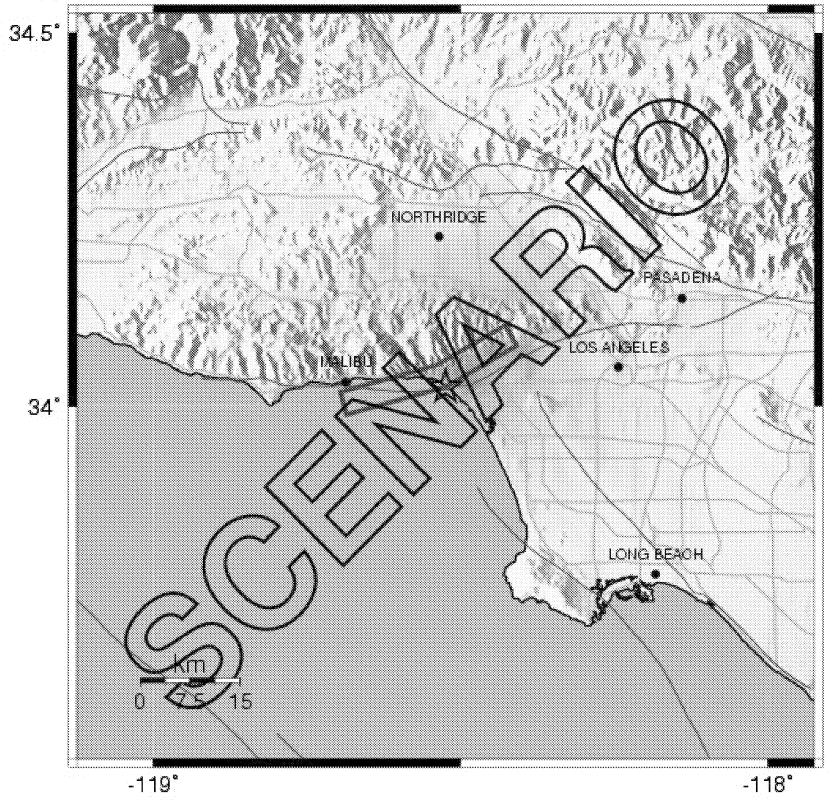
-- Earthquake Planning Scenario --
Rapid Instrumental Intensity Map for Whittier M6.8 Fault Scenario
Scenario Date: Mon Mar 11, 2002 04:00:00 AM PST M 6.8 N33.96 W117.96 Depth: 10.0km



PLANNING SCENARIO ONLY -- Processed: Mon Jan 12, 2004 11:36:25 AM PST

PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	*<.17*	*.17-1.4*	*1.4-3.9*	*3.9-9.2*	*9.2-18*	18-34	34-65	65-124	>124
PEAK VEL.(cm/s)	<0.1	0.1-1.1	1.1-3.4	3.4-8.1	8.1-16	*16-31*	*31-60*	*60-116*	*>116*
INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

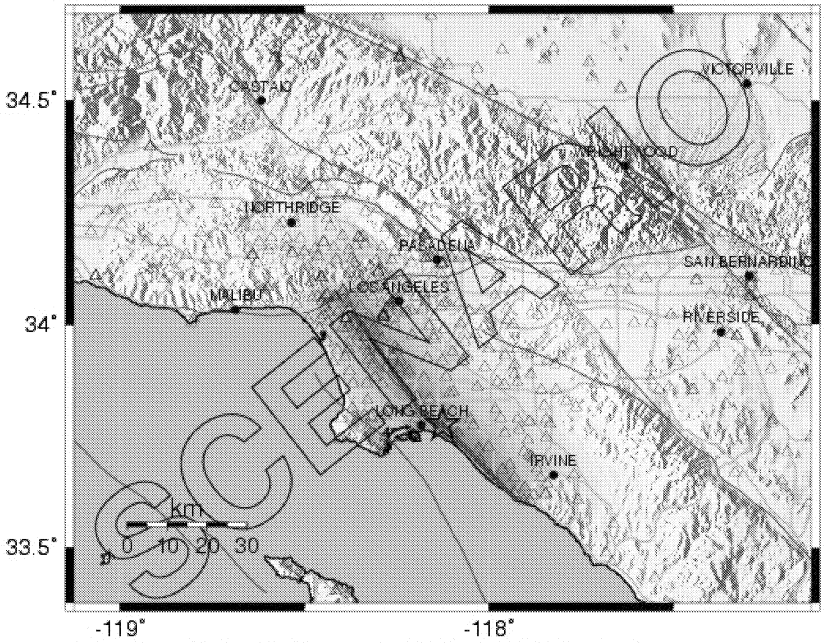
-- Earthquake Planning Scenario --
Rapid Instrumental Intensity Map for Santa Monica M6.6 Scenario
Scenario Date: Mon Jul 16, 2001 05:00:00 AM PDT M 6.6 N34.03 W118.52 Depth: 13.0km



PLANNING SCENARIO ONLY -- Processed: Mon Jan 12, 2004 12:10:17 PM PST

PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	*<.17*	*.17-1.4*	*1.4-3.9*	*3.9-9.2*	*9.2-18*	18-34	34-65	65-124	>124
PEAK VEL.(cm/s)	<0.1	0.1-1.1	1.1-3.4	3.4-8.1	8.1-16	*16-31*	*31-60*	*60-116*	*>116*
INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

-- Earthquake Planning Scenario --
Rapid Instrumental Intensity Map for Newport-Inglewood M6.9 Scenario
Scenario Date: Fri Aug 3, 2001 05:00:00 AM PDT M 6.9 N33.78 W118.13 Depth: 6.0km



PLANNING SCENARIO ONLY -- Processed: Wed Jul 7, 2004 10:40:47 PM PDT

PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	*<.17*	*.17-1.4*	*1.4-3.9*	*3.9-9.2*	*9.2-18*	18-34	34-65	65-124	>124
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INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

Vulnerability Assessment:

The effects of earthquakes span a large area, and large earthquakes occurring in many parts of the Southern California region would probably be felt throughout the region. However, the degree to which the earthquakes are felt, and the damages associated with them, may vary. At risk from earthquake damage are large stocks of old buildings and bridges; many high-tech and hazardous materials facilities; extensive sewer, water, and natural gas pipelines; earth dams; petroleum pipelines; and other critical facilities and private property located in the county. The relative or secondary earthquake hazards, which are liquefaction, ground shaking, amplification, and earthquake-induced landslides, can be just as devastating as the earthquake.

The California Geological Survey has identified areas most vulnerable to liquefaction. Liquefaction occurs when ground shaking causes wet granular soils to change from a solid state to a liquid state. This results in the loss of soil strength and the soil's ability to support weight. Buildings and their occupants are at risk when the ground can no longer support these buildings and structures.

Southern California has many active landslide areas, and a large earthquake could trigger accelerated movement in these slide areas, in addition to jarring loose other unknown areas of landslide risk.

Risk Analysis:

Risk analysis is the third phase of a hazard assessment. Risk analysis involves estimating the damage and costs likely to be experienced in a geographic area over a period of time. Factors included in assessing earthquake risk include population and property distribution in the hazard area, the frequency of earthquake events, landslide susceptibility, buildings, infrastructure, and disaster preparedness of the region. This type of analysis can generate estimates of the damages to the region due to an earthquake event in a specific location. FEMA's software program, HAZUS, uses mathematical formulas and information about building stock, local geology and the location and size of potential earthquakes, economic data, and other information to estimate losses from a potential earthquake. The HAZUS software is available from FEMA at no cost.

For greater Southern California there are multiple worst case scenarios, depending on which fault might rupture, and which communities are in proximity to the fault. But damage will not necessarily be limited to immediately adjoining communities. Depending on the hypocenter of the earthquake, seismic waves may be transmitted through the ground to unsuspecting communities. In the Northridge 1994 earthquake, Santa Monica suffered extensive damage, even though there was a range of mountains between it and the origin of the earthquake.

Damages for a large earthquake almost anywhere in Southern California are likely to run into the billions of dollars. Although building codes are some of the most stringent in the world, tens of thousands of older existing buildings were built under much less rigid

codes. California has laws affecting unreinforced masonry buildings (URM's) and although many building owners have retrofitted their buildings, hundreds of pre-1933 buildings still have not been brought up to current standards. As of 2000, the City of Pasadena had 416 unreinforced masonry buildings, which the City has since been retrofitting.

Besides unreinforced buildings the City has been working to improve the condition of soft story buildings. Soft story buildings are multi-story structures with open spaces like store windows or ground floor parking garages. These types of buildings are vulnerable to a condition called soft story collapse. This is where an inadequately-braced building cannot withstand the lateral stress of an earthquake and collapses. In 2006 the City of Pasadena commissioned a study to identify soft story buildings. The purpose in identifying them is to include these potential hazards in the City Emergency Operations Plan.

Non-structural bracing of equipment and contents is often the most cost-effective type of seismic mitigation. Inexpensive bracing and anchoring may be the most cost effective way to protect expensive equipment. Non-structural bracing of equipment and furnishings will also reduce the chance of injury for the occupants of a building.

Community Earthquake Issues

What is Susceptible to Earthquakes?

Earthquake damage occurs because humans have built structures that cannot withstand severe shaking. Buildings, airports, schools, and lifelines (highways and utility lines) suffer damage in earthquakes and can cause death or injury to humans. The welfare of homes, major businesses, and public infrastructure is very important. Addressing the reliability of buildings, critical facilities, and infrastructure, and understanding the potential costs to government, businesses, and individuals as a result of an earthquake, are challenges faced by the City.

Dams:

There are a total of 103 dams in Los Angeles County, owned by 23 agencies or organizations, ranging from the Federal government to Home Owner Associations. These dams hold billions of gallons of water in reservoirs. Releases of water from the major reservoirs are designed to protect Southern California from flood waters and to store domestic water.

Seismic activity can compromise the dam structures, and the resultant flooding could cause catastrophic flooding. Following the 1971 Sylmar earthquake, the Lower Van Norman Dam showed signs of structural compromise, and tens of thousands of persons had to be evacuated until the dam could be drained. The Devils Gate Dam is currently partially filled with sediment and mud. A major earthquake resulting in the failure of this

dam would not result in immediate catastrophic flooding. It would compromise the ability of the dam to function as a flood management device during the next rainy season.

Buildings:

The built environment is susceptible to damage from earthquakes. Buildings that collapse can trap and bury people. Lives are at risk and the cost to clean up the damages is great. In most California communities, including the City of Pasadena, many buildings were built before 1993 when building codes were not as strict. Recent changes in the Pasadena building codes regarding the use of sheer wall techniques have helped to protect new construction.

Infrastructure and Communication:

Residents in the City of Pasadena commute frequently by automobiles and public transportation such as buses and light rail. An earthquake can greatly damage bridges and roads, hampering emergency response efforts and the normal movement of people and goods.

Damaged infrastructure strongly affects the economy of the community because it disconnects people from work, school, food, and leisure, and separates businesses from their customers and suppliers.

Ground shaking and amplification can cause pipes to break open, power lines to fall, roads and railways to crack or move, and radio and telephone communication to cease. Disruption to transportation makes it especially difficult to bring in supplies or services. Lifelines need to be usable after an earthquake to allow for rescue, recovery, and rebuilding efforts and to relay important information to the public.

Disruption of Critical Services:

Critical facilities include police stations, fire stations, hospitals, shelters, and other facilities that provide important services to the community. These facilities and their services need to be functional after an earthquake event.

Businesses:

Seismic activity can cause great loss to businesses, both large-scale corporations and small retail shops. When a company is forced to stop production for just a day, the economic loss can be tremendous, especially when its market is at a national or global level. Seismic activity can create economic loss that presents a burden to large and small shop owners who may have difficulty recovering from their losses.

Forty percent of businesses that close during a disaster do not reopen afterwards, and another twenty-five percent fail within one year, according to the Federal Emergency Management Agency (FEMA). Similar statistics from the United States Small Business

Administration indicate that over ninety percent of businesses that close during a disaster fail within two years after being struck.

Individual Preparedness:

Because the potential for earthquake occurrences and earthquake related property damage is relatively high in the City of Pasadena, increasing individual preparedness is a significant need. Strapping down heavy furniture, water heaters, and expensive personal property, as well as being earthquake insured, and anchoring buildings to foundations are just a few steps individuals can take to prepare for an earthquake.

Death and Injury:

Death and injury can occur both inside and outside of buildings due to collapsed buildings falling equipment, furniture, debris, and structural materials. Downed power lines and broken water and gas lines can also endanger human life,

Fire:

Downed power lines or broken gas mains can trigger fires. When fire stations suffer building or lifeline damage, quick response to extinguish fires is less likely. Furthermore, major incidents will demand a larger share of resources, and initially smaller fires and problems will receive little or insufficient resources in the initial hours after a major earthquake event. Loss of electricity may cause a loss of water pressure in some communities, further hampering firefighting ability.

Debris:

After damage to a variety of structures, much time is spent cleaning up brick, glass, wood, steel or concrete building elements, office and home contents, and other materials. Developing a strong debris management strategy is essential in post-disaster recovery. Occurrence of a disaster does not exempt the City of Pasadena from compliance with AB 939 regulations.

Existing Mitigation Activities

Existing mitigation activities include current mitigation programs and activities that are being implemented by county, regional, state, or federal agencies or organizations.

City of Pasadena Codes:

Implementation of earthquake mitigation policy most often takes place at the local government level. The City of Pasadena Building and Safety Division enforces building codes pertaining to earthquake hazards.

The following sections of the UBC address the earthquake hazard:

1605, 1 (Distribution of Horizontal Sheer);
1605. 2 (Stability against Overturning);
1626 (Seismic);
1605. 3 (Anchorage); and
1632, 1633, 1633.9 deal with specific earthquake hazards.

The City of Pasadena Planning Department enforces the zoning and land use regulations relating to earthquake hazards.

Generally, these codes seek to discourage development in areas that could be prone to flooding, landslide, wildfire and/or seismic hazards and, where development is permitted, to ensure that the applicable construction standards are met. Developers in hazard-prone areas may be required to retain a qualified professional engineer to evaluate level of risk on the site and recommend appropriate mitigation measures.

The City of Pasadena Building Code sets the minimum design and construction standards for new buildings. In 2010, the City of Pasadena adopted the most recent seismic standards in its building code, which requires that new buildings be built at a higher seismic standard. These changes put the City in compliance with new California earthquake standards. Changes include stronger ordinances for footings/foundations and increased sheer wall requirements.

Since 1968 the City of Pasadena has required that site-specific seismic hazard investigations be performed for new essential facilities, major structures, hazardous facilities, and special occupancy structures such as schools, hospitals, and emergency response facilities.

Earthquake Mitigation Action Items

The Earthquake mitigation action items provide guidance on suggesting specific activities that agencies, organizations, and residents in the City of Pasadena can undertake to reduce risk and prevent loss from earthquake events. Each action item is followed by ideas for implementation, which can be used by the steering committee and local decision makers in pursuing strategies for implementation.

Short Term -Earthquake # l:

Partner with the California Institute of Technology (located in Pasadena) to identify advances in earthquake effects modeling.

Ideas for Implementation:

Use the latest advances in understanding the effects of earthquakes in urban areas to improve local standards and requirements for earthquake resistant private construction.

Use CalTech's understanding of the impact of earthquake's on municipal infrastructure to harden critical systems necessary for earthquake recovery efforts.

Coordinating Organization:	Planning and Public Works Departments
Timeline:	2 years
Potential Funding Sources:	Responsible departments will be directed to include the cost of this item in their department budget; also see Appendix B
Plan Goals Addressed:	Partnerships and Implementation, Protect Life and Property
Constraints:	Pending Funding and Available Personnel

Short Term -Earthquake # 2:

Incorporate all earthquake evacuation planning developed by the Los Angeles County Emergency Alliance, Sheriff's Department, and Mutual Aid Area C into the City of Pasadena Emergency Operations Plan.

Ideas for Implementation:

Conduct a review to determine if any changes have been made to area-wide evacuation plans.

Integrate any Los Angeles County evacuation routes data into the City of Pasadena Emergency Operations Plan.

Coordinating Organization:	The City of Pasadena Department Police and Fire Departments.
Timeline:	1 year
Potential Funding Sources:	Responsible departments will be directed to include the cost of this item in their department budget; also see Appendix B
Plan Goals Addressed:	Emergency Services
Constraints:	Pending Funding and Available Personnel

Long Term -Earthquake # 1:

Encourage purchase of earthquake hazard insurance.

Ideas for Implementation:

Provide earthquake insurance information to the City of Pasadena residents.

Coordinate with the State of California program to produce and distribute earthquake insurance information.

Coordinating Organization:	Hazard Mitigation Advisory Committee
Timeline:	Ongoing
Potential Funding Sources:	See Appendix B
Plan Goals Addressed:	Protect Life and Property, Public Awareness
Constraints:	Pending funding and available personnel

Long Term -Earthquake # 2:

Conduct seismic evaluations of critical facilities in the City of Pasadena to identify vulnerabilities of buildings and infrastructure.

Ideas for Implementation:

Coordinate with CalTech staff to identify structures based on their use, construction type, and potential risk to failure during earthquakes.

Provide information to private building owners on potential risks from earthquake damage and options for mitigating these affects.

Coordinating Organization:	City Public Works & Planning Departments
Timeline:	5 years
Potential Funding Sources:	See Appendix B
Plan Goals Addressed:	Protect Life and Property, Emergency Services
Constraints:	Pending funding and available personnel

Long Term -Earthquake # 3:

Evaluate, repair or replace rubble walls in the Arroyo Seco Park Area.

Ideas for Implementation:

Evaluate all rubble walls in the Arroyo Seco Park Area.

Repair or replace the walls to make them resistant to earthquake and floods.

Coordinating Organization:	City Planning Department
Timeline:	5 years
Potential Funding Sources:	See Appendix B
Plan Goals Addressed:	Protect Life and Property, Emergency Services
Constraints:	Pending funding and available personnel

Earthquake Resource Directory

Local and Regional Resources:

Los Angeles County Public Works Department

Level: County Hazard: Multi http://ladpw.org

900 S. Fremont Ave.

Pasadena, CA 91803 Ph: 626-458-5100 Fx:

Notes: The Los Angeles County Department of Public Works protects property and promotes public safety through Flood Control, Water Conservation, Road Maintenance, Bridges, Buses and Bicycle Trails, Building and Safety, Land Development, Waterworks, Sewers, Engineering, Capital Projects and Airports

Southern California Earthquake Center (SCEC)

Level: Regional Hazard: Earthquake www.scec.org

3651 Trousdale Parkway Suite 169

Los Angeles, CA 90089-0742 Ph: 213-740-5843 Fx: 213/740-0011

Notes: The Southern California Earthquake Center (SCEC) gathers new information about earthquakes in Southern California, integrates this information into a comprehensive and predictive understanding of earthquake phenomena, and communicates this understanding to end-users and the general public in order to increase earthquake awareness, reduce economic losses, and save lives.

State Resources:

California Department of Transportation (CalTrans)

Level: State Hazard: Multi http://www.dot.ca.gov/

120 S. Spring Street

Los Angeles, CA 90012 Ph: 213-897-3656 Fx:

Notes: CalTrans is responsible for the design, construction, maintenance, and operation of the California State Highway System, as well as that portion of the Interstate Highway System within the state's boundaries. Alone and in partnership with Amtrak, CalTrans is also involved in the support of intercity passenger rail service in California.

California Resources Agency

Level: State Hazard: Multi http://resources.ca.gov/

1416 Ninth Street Suite 1311

Sacramento, CA 95814 Ph: 916-653-5656 Fx:

Notes: The California Resources Agency restores, protects and manages the state's natural, historical and cultural resources for current and future generations using solutions based on science, collaboration and respect for all the communities and interests involved.

California Division of Mines and Geology (DMG)

Level: State Hazard: Multi www.consrv.ca.gov/cgs/index.htm

801 K Street MS 12-30

Sacramento, CA 95814 Ph: 916-445-1825 Fx: 916-445-5718

Notes: The California Geological Survey develops and disseminates technical information and advice on California's geology, geologic hazards, and mineral resources.

California Department of Conservation: Southern California Regional Office

Level: State Hazard: Multi www.consrv.ca.gov

655 S. Hope Street #700

Los Angeles, CA 90017-2321 Ph: 213-239-0878 Fx: 213-239-0984

Notes: The Department of Conservation provides services and information that promote environmental health, economic vitality, informed land-use decisions and sound management of our state's natural resources.

California Planning Information Network

Level: State Hazard: Multi www.calpin.ca.gov

Notes: The Governor's Office of Planning and Research (OPR) publishes basic information on local planning agencies, known as the California Planners' Book of Lists. This local planning information is available on-line with new search capabilities and up-to-the- minute updates.

California Emergency Management Agency (CalEMA, formerly OES)

Level: State Hazard: Multi www.calema.ca.gov

3650 Schriever Ave.

Mather, CA 95655 Ph: 916 845- 8510 Fx: 916 845- 8511

Notes: CalEMA coordinates overall state agency response to major disasters in support of local government. The office is responsible for assuring the state's readiness to respond to and recover from natural, manmade, and war-caused emergencies, and for assisting local governments in their emergency preparedness, response and recovery efforts.

Federal and National Resources:

Building Seismic Safety Council (BSSC)

Level: National Hazard: Earthquake www.bssconline.org

1090 Vermont Ave., NW Suite 700

Washington, DC 20005 Ph: 202-289-7800 Fx: 202-289-109

Notes: The Building Seismic Safety Council (BSSC) develops and promotes building earthquake risk mitigation regulatory provisions for the nation.

Federal Emergency Management Agency, Region IX

Level: Federal Hazard: Multi www.fema.gov

1111 Broadway Suite 1200

Oakland, CA 94607 Ph: 510-627-7100 Fx: 510-627-7112

Notes: The Federal Emergency Management Agency is tasked with responding to, planning for, recovering from, and mitigating against disasters.

Federal Emergency Management Agency, Mitigation Division

Level: Federal Hazard: Multi www.fema.gov/fima/planhowto.shtm

500 C Street, S.W.

Washington, D.C. 20472 Ph: 202-566-1600 Fx:

Notes: The Mitigation Division manages the National Flood Insurance Program and oversees FEMA's mitigation programs. It has a number of programs and activities which provide citizens Protection, with flood insurance; Prevention, with mitigation measures and Partnerships, with communities throughout the country.

United States Geological Survey

Level: Federal Hazard: Multi http://www.usgs.gov/

345 Middlefield Road

Menlo Park, CA 94025 Ph: 650-853-8300 Fx:

Notes: The USGS provides reliable scientific information to describe and understand the Earth; minimize loss of life and property from natural disasters; manage water, biological, energy, and mineral resources; and enhance and protect our quality of life.

Western States Seismic Policy Council (WSSPC)

Level: Regional Hazard: Earthquake www.wsspc.org/home.html

125 California Avenue Suite D201, #1

Palo Alto, CA 94306 Ph: 650-330-1101 Fx: 650-326-1769

Notes: WSSPC is a regional earthquake consortium funded mainly by FEMA. Its website is a great resource, with information clearly categorized - from policy to engineering to education.

Institute for Business & Home Safety

Level: National Hazard: Multi http://www.ibhs.org/

4775 E. Fowler Avenue

Tampa, FL 33617 Ph: 813-286-3400 Fx: 813-286-9960

Notes: The Institute for Business & Home Safety (IBHS) is a nonprofit association that engages in communication, education, engineering and research. The Institute works to reduce deaths, injuries, property damage, economic losses and human suffering caused by natural disasters.

Publications:

"Land Use Planning for Earthquake Hazard Mitigation: Handbook for Planners"
Wolfe, Myer R. et. al., (1986) University of Colorado, Institute of Behavioral Science, National Science Foundation.
This handbook provides techniques that planners and others can utilize to help mitigate for seismic hazards, It provides information on the effects of earthquakes, sources on risk assessment, and effects of earthquakes on the built environment. The handbook also gives examples on application and implementation of planning techniques to be used by local communities.
Contact: Natural Hazards Research and Applications Information Center
Address: University of Colorado, 482 UCB,
Boulder, CO 80309-0482
Phone: (303) 492-6818
Fax: (303) 492-2151
Website: http://www,colorado.edu/UCB/Research/IBS/hazards

"Public Assistance Debris Management Guide", FEMA (July 2000).
The Debris Management Guide was developed to assist local officials in planning, mobilizing, organizing. and controlling large-scale debris clearance, removal, and disposal operations, Debris management is generally associated with post-disaster recovery. While it should be compliant with local and county emergency operations plans, developing strategies to ensure strong debris management is a way to integrate debris management within mitigation activities. The "Public Assistance Debris Management Guide" is available in hard copy or on the FEMA website.

SECTION 2:
- FLOODS -

Why are Floods a Threat to the City of Pasadena?

The unpredictable seasonal range in rainfall that is typical of coastal Southern California, coupled with geographic and geologic conditions, makes Los Angeles County and Pasadena vulnerable to flooding, erosion, and mudflows during the winter storm season. Flood disaster in recent years, such as 1969, 1978, 1980, 1983, 1992, 1995, and 1998, have caused an increases awareness of the potential for public and private loses, particularly in the highly urbanized parts of floodplains and alluvial fans. Flooding poses a threat to life and safety and can cause severe damage to public and private property.

Los Angeles County is the largest county by population in California, with over 10 million residents. Experts predict the County will continue to add citizens over the next 10 years. This will result in an increase in new development and thus impervious surfaces such as asphalt. Water that used to be absorbed into the ground will become runoff to downstream areas. To date, this has not been an issue in the City of Pasadena, but unless strict guidelines are in place, it could become one in the future, as a result of pressure to site new development in flood prone areas.

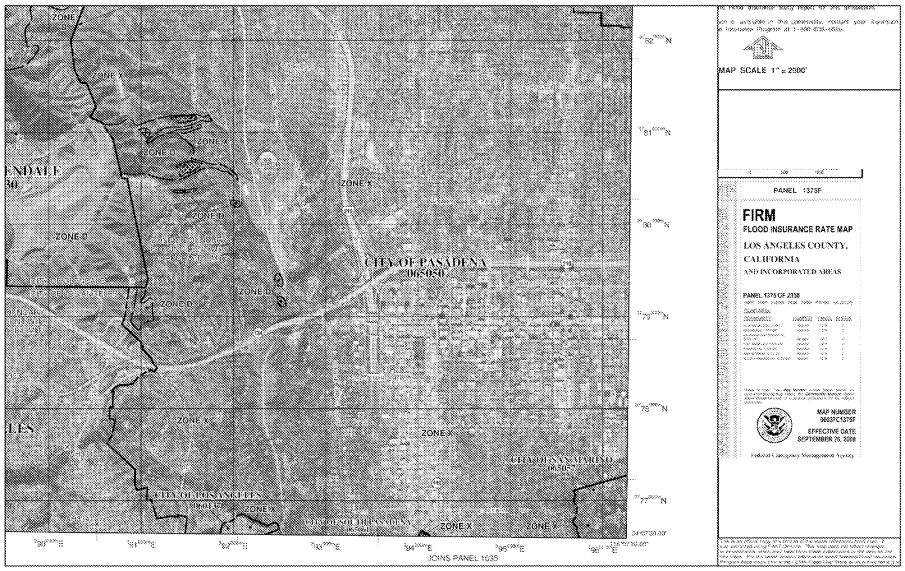
Two main north-to-south flowing stream systems drain in the Pasadena area. The Arroyo Seco Wash runs along the western edge of the City of Pasadena, while Eaton Canyon Creek and Eaton Wash drain the eastern side of the City.

History of Flooding in the City of Pasadena:

According to FEMA (1986), flooding damage in the Pasadena area has generally been lower than in other areas of Los Angeles County because of its (up to now) relatively undeveloped state in the upper watershed areas. Nevertheless, several canyons near the Pasadena area, including Eaton, Zachau, Rubio, and Shields canyons, have flooded in the past, impacting areas downstream.

No portions of the City of Pasadena are within a 100-year floodplain identified by the Federal Emergency Management Agency (FEMA). As shown on FEMA map Community Number 065050, the entire City is in Zone D, for which no floodplain management regulations are required. Therefore, there are no structures within the flow of the 100-year flood.

FEMA FIRM Map showing City of Pasadena



Storm events are likely to generate debris flows in the upper reaches of the watershed. Debris-laden water may move at relatively slow speeds of 3 to 5 miles per hour, but it can cause much damage along its way. Debris flows often occur in areas recently burned by wildfires, where vegetation has not yet formed a protective ground cover that helps keep the soil in place. Furthermore, the oils in the plants native to Southern California, when burned, react with the soils, making them water-repellant. As a result, less rainwater than usual infiltrates the ground, and instead makes its way down-slope as runoff, carrying ashes and other burned debris with it.

There are a number of rivers in the Southern California region, but the river with the best recorded history is the Los Angeles River. The flood history of the Los Angeles River is generally indicative of the flood history of much of Southern California.

Records show that since 1811, the Los Angeles River has flooded 30 times, on average once every 6.1 years. But averages are deceiving, for the Los Angeles basin goes through periods of drought and then periods of above average rainfall. Between 1889 and 1891 the river flooded every year, and from 1941 to 1945, the river flooded 5 times. Conversely, from 1896 to 1914, a period of 18 years, and again from 1944 to 1969, a period of 25 years, the river did not have serious floods.

While the City of Pasadena is 6 miles east of Los Angeles, it is not so far away as to not be affected by the heavy rains that brought flooding to Los Angeles. In addition, the towering mountains that give the Los Angeles region its spectacular views also bring a great deal of rain out of the storm clouds that pass through. Because the mountains are so

steep, the rainwater moves rapidly down the slopes and across the coastal plains on its way to the ocean.

The Santa Monica, Santa Susana, and Verdugo Mountains which surround three sides of the valley seldom reach heights above three thousand feet. The western San Gabriel Mountains, in contrast, have elevations of more than seven thousand feet. These higher ridges often trap eastern moving winter storms. Although downtown Los Angeles averages just fifteen inches of rain a year, some mountain peaks in the San Gabriels receive more than forty inches of precipitation annually.

Naturally, this rainfall moves rapidly downstream, often with severe consequences for anything in its path. In extreme cases, flood-generated debris flows will roar down a canyon at speeds near 40 miles per hour with a wall of mud, debris, and water tens of feet high.

In Southern California, stories of floods, debris flows, persons buried alive under tons of mud and rock, and persons swept away to their death in a river flowing at thirty-five miles an hour are without end. No catalog of chaos could contain all the losses suffered by man and his possessions from the region's rivers and streams.

Pasadena has had serious floods throughout its history. A February 1914 flood killed 43 citizens, destroyed 30 homes, and resulted in nearly 10 million dollars in damage. This was followed by a second major flood in 1916. During the 1920s the County of Los Angeles and the City of Pasadena began developing a flood management strategy for the Arroyo Seco wash area. The first step was building the Devil's Gate Dam, completed in 1920. By 1935, a channelization project called the Arroyo Seco Parkway was under construction.

While the channels were being completed another storm and flood struck the city. The March 4, 1938, flooding caused heavy damage to the park areas near the Rose Bowl, including the complete loss of the Pasadena municipal golf course. The Rose Bowl was protected by the recently completed flood control channels. The cost to the city was $850,000.

A storm in 1932 resulted in $90,000 damage which required a loan from the State of California to pay for the repairs. Storms in 1943 caused additional losses including damage to the flood control channels. The City of Pasadena decided to continue with flood control mitigation by strengthening the existing projects and extending their length.

A recurring problem has been sediment buildup in the Devil's Gate basin. The 1932 Montrose wildfire sent large amounts of sediment into the basin, requiring removal. After the 1943 storm season, the problem of sediment building up behind the dam was again addressed by the City.

What Factors Create Flood Risk?

Flooding:

Occurs when climate, geology, and hydrology combine to create conditions where water flows outside of its usual course. In the City of Pasadena, geography and climate may combine to create seasonal flooding conditions.

Winter Rainfall:

Over the last 125 years, the average annual rainfall in Los Angeles is 14.9 inches. But the term "average" means very little as the annual rainfall during this time period has ranged from only 4.35 inches in 2001-2002 to 38.2 inches in 1883-1884. In fact, in only fifteen of the past 125 years has the annual rainfall been within plus or minus 10% of the 14.9 inch average. And in only 38 years has the annual rainfall been within plus or minus 20% of the 14.9 inch average. This makes the Los Angeles basin a land of extremes in terms of annual precipitation.

The City of Pasadena is in the western region of the San Gabriel Valley. It is in close proximity to the San Gabriel Mountains, which increases the collection of rainwater.

Geography and Geology:

The greater Los Angeles Basin is the product of rainstorms and erosion for millennia. Most of the mountains that ring the valleys and coastal plain are deeply fractured faults and, as they (the mountains) grew taller, their brittle slopes were continually eroded. Rivers and streams carried boulders, rocks, gravel, sand, and silt down these slopes to the valleys and coastal plain. In places these sediments are as much as twenty thousand feet thick.

Much of the coastal plain rests on the ancient rock debris and sediment washed down from the mountains. This sediment can act as a sponge, absorbing vast quantities of rain in those years when heavy rains follow a dry period. But like a sponge that is near saturation, the same soil fills up rapidly when a heavy rain follows a period of relatively wet weather. So even in some years of heavy rain, flooding is minimal because the ground is relatively dry. The same amount of rain following a wet period of time can cause extensive flooding.

The greater Los Angeles basin is, for all intents and purposes, built-out. This leaves precious little open land to absorb rainfall. This lack of open ground forces water to remain on the surface and rapidly accumulate. If it were not for the massive flood control system with its concrete lined river and stream beds, flooding would be a much more common occurrence. And the tendency is towards even less and less open land. In-fill building is becoming a much more common practice in many areas. Developers tear down an older home which typically covers up to 40% of the lot size and replace it with three or four town homes or apartments which may cover 90-95% of the lot.

Another potential source of flooding is "asphalt creep." The street space between the curbs of a street is a part of the flood control system. Water leaves property and accumulates in the streets, where it is directed towards the underground portion of the flood control system. The carrying capacity of the street is determined by the width of the street and the height of the curbs along the street. Often, when streets are being resurfaced, a one- to two-inch layer of asphalt is laid down over the existing asphalt. This added layer of asphalt subtracts from the rated capacity of the street to carry water. Thus the original engineered capacity of the entire storm drain system is marginally reduced over time. Subsequent re-paving of the street will further reduce the engineered capacity even more.

Flood Terminology

Floodplain:

A floodplain is a land area adjacent to a river, stream, lake, estuary, or other water body that is subject to flooding. This area, if left undisturbed, acts to store excess flood water. The floodplain is made up of two sections: the floodway and the flood fringe.

100-Year Flood:

The 100-year flooding event is the flood having a one percent chance of being equaled or exceeded in magnitude in any given year. Contrary to popular belief, it is not a flood occurring once every 100 years. The 100-year floodplain is the area adjoining a river, stream, or watercourse covered by water in the event of a 100-year flood.

Floodway:

The floodway is one of two main sections that make up the floodplain. Floodways are defined for regulatory purposes. Unlike floodplains, floodways do not reflect a recognizable geologic feature. For NFIP purposes, floodways are defined as the channel of a river or stream, and the overbank areas adjacent to the channel. The floodway carries the bulk of the flood water downstream and is usually the area where water velocities and forces are the greatest. NFIP regulations require that the floodway be kept open and free from development or other structures that would obstruct or divert flood flows onto other properties.

The City of Pasadena regulations prohibit all development in the floodway. The NFIP floodway definition is "*the channel of a river or other watercourse and adjacent land areas that must be reserved in order to discharge the base flood without cumulatively increasing the water surface elevation more than one foot.*" Floodways are not mapped for all rivers and streams but are generally mapped in developed areas.

Flood Fringe:

The flood fringe refers to the outer portions of the floodplain, beginning at the edge of the floodway and continuing outward. Generally, the flood fringe is defined as "*the land*

area which is outside of the stream flood way but is subject to periodic inundation by regular flooding." This is the area where development is most likely to occur, and where precautions to protect life and property need to be taken.

Development:

For floodplain ordinance purposes, development is broadly defined by the City of Pasadena Zoning Ordinance to mean *"any manmade change to improved or unimproved real estate, including but not limited to buildings or other structures, mining, dredging, filling, grading, paving, excavation, or drilling operations located within the area of special flood hazard."* The definition of development for floodplain purposes is generally broader and includes more activities than the definition of development used in other sections of local land use ordinances.

Base Flood Elevation (BFE):

The term "Base Flood Elevation" refers to the elevation (normally measured in feet above sea level) that the base flood is expected to reach. Base flood elevations can be set at levels other than the 100-year flood. Some communities choose to use higher frequency flood events as their base flood elevation for certain activities, while using lower frequency events for others. For example, for the purpose of storm water management, a 25-year flood event might serve as the base flood elevation; while the 500-year flood event may serve as base flood elevation for the tie down of mobile homes. The regulations of the NFIP focus on development in the 100-year floodplain.

Characteristics of Flooding:

Two types of flooding primarily affect the City of Pasadena: riverine flooding and urban flooding (see descriptions below). In addition, any low-lying area has the potential to flood. The flooding of developed areas may occur when the amount of water generated from rainfall and runoff exceeds a storm water system's capability to remove it.

Riverine Flooding:

Riverine flooding is the overbank flooding of rivers and streams. The natural processes of riverine flooding add sediment and nutrients to fertile floodplain areas. Flooding in large river systems typically results from large-scale weather systems that generate prolonged rainfall over a wide geographic area, causing flooding in hundreds of smaller streams, which then drain into the major rivers.

Shallow area flooding is a special type of riverine flooding. FEMA defines shallow flood hazards as areas that are inundated by the 100-year flood with flood depths of only one to three feet. These areas are generally flooded by low-velocity sheet-flows of water.

Urban Flooding:

As land is converted from fields or woodlands to roads and parking lots, it loses its ability to absorb rainfall. Urbanization of a watershed changes the hydrologic systems of the basin. Heavy rainfall collects and flows rapidly on impervious concrete and asphalt surfaces. The water moves from the clouds, to the ground, and into streams at a much faster rate in urban areas than in fields or woodlands. Adding these elements to the hydrological systems can result in flood waters that rise very rapidly and peak with violent force.

Over 50 percent of the area in the City of Pasadena has a high concentration of impermeable surfaces that either collect water, or concentrate the flow of water in unnatural channels. During periods of urban flooding, streets can become swift moving rivers, and basements can fill with water. Storm drains often back up with vegetative debris causing additional localized flooding.

Dam Failure Flooding:

Loss of life and damage to structures, roads, and utilities may result from a dam failure. Economic losses can also result from a lowered tax base and lack of utility profits. These effects would certainly accompany the failure of one of the major dams in the City of Pasadena. There are a total of 2 dams and 22 reservoirs in the City of Pasadena holding 110 million of gallons of water. Because dam failure can have severe consequences, FEMA requires that all dam owners develop Emergency Action Plans (EAP) for warning, evacuation, and post-flood actions. Although there may be coordination with county officials in the development of the EAP, the responsibility for developing potential flood inundation maps and facilitation of emergency response is the responsibility of the dam owner.

There are two major dams located in or upstream from the Pasadena area, the Devil's Gate Reservoir and the Eaton Canyon Reservoir. These dams are owned by the Los Angeles County Department of Public Works and are located along the Arroyo Seco and Eaton Canyon Creek tributary stream systems, respectively.

The Devil's Gate Dam flood inundation path shows that the floodway of the Arroyo Seco would contain most of the water. Since this area is largely undeveloped and used primarily for recreation purposes, the risk posed by this hazard could be considered low.

The Eaton Canyon Dam inundation path shows that, on its southern reaches, some developed areas would be impacted. The risk posed by this hazard could be considered low.

Debris Flows:

Debris flows are another flood-related hazard that can affect certain parts of the SoCal region. Debris flows typically occur in mountain canyons and foothills of the San Gabriel Mountains. However, any hilly or mountainous area with intense rainfall and the proper geologic conditions may experience one of these sudden and devastating events.

Debris flows are often referred to as landslides or mudflows. They occur in areas with steep hillsides during periods of intense rainfall. This problem can be exacerbated when hillsides are bare following brush fires. As the slide continues it can increase in speed and begin carrying items like boulders, trees, and cars. These slides can be difficult to control and can cause serious damage to property and lives.

The Effect of Development on Floods

When structures or fill are placed in the floodway or floodplain, water is displaced. Development raises the river levels by forcing the river to compensate for the flow space obstructed by the inserted structures and/or fill. When structures or materials are added to the floodway or floodplain and no fill is removed to compensate, serious problems can arise. Flood waters may be forced away from historic floodplain areas. As a result, other existing floodplain areas may experience flood waters that rise above historic levels.

Displacement of only a few inches of water can mean the difference between no structural damage occurring in a given flood event, and the inundation of many homes, businesses, and other facilities. Careful attention should be given to development that occurs within the floodway to ensure that structures are prepared to withstand base flood events.

In highly urbanized areas, increased paving can lead to an increase in volume and velocity of runoff after a rainfall event, exacerbating the potential flood hazards. Care should be taken in the development and implementation of storm water management systems to ensure that these runoff waters are dealt with effectively.

Identification of Flood-Prone Areas and Local Building Codes

Flood maps and Flood Insurance Studies (FIS) are often used to identify flood-prone areas. Maps of potential flood areas are found in the FEMA Digital Flood Insurance Rate Maps (DFIRM). The Pasadena DFIRM map is found in the FEMA DFIRM electronic data base Panel # 1375F. In the City of Pasadena, the National Flood Insurance Program (NFIP) and related building code regulations went into effect on March 1, 1978. NFIP regulations (44 Code of Federal Regulations (CFR) Chapter 1, Section 60, 3) require that all new construction in floodplains must be elevated at or above base flood level.

Flood Insurance Programs

The City of Pasadena has participated in the National Flood Insurance Program (NFIP) since 1984 (City ID#065050). The NFIP was established in 1968 as a means of providing low-cost flood insurance to the nation's flood-prone communities. The NFIP also reduces flood losses through regulations that focus on building codes and sound floodplain management. This program offers flood insurance to private property owners living near flood-prone areas.

Repetitive Loss Properties

Repetitive loss properties are those for which two or more losses of at least $1,000 each have been paid under the NFIP within any 10-year period since 1978. Severe repetitive loss properties are residential properties that have at least four NFIP payments over $5,000 each with the cumulative amount exceeding $20,000 or that have at least two separate claims payments with the cumulative amount exceeding the market value of the building.

The City of Pasadena has two repetitive loss properties, both residential properties. One property has two claims and is located on the southern boundary of Eaton Canyon Park. The other property has three claims and is located just west of the Rose Bowl.

Hazard Assessment

Hazard Identification:

Hazard identification is the first phase of flood-hazard assessment. Identification is the process of estimating: (1) the geographic extent of the floodplain, that is, the area at risk from flooding; (2) the intensity of the flooding that can be expected in specific areas of the floodplain; and (3) the probability of occurrence of flood events. This process usually results in the creation of a floodplain map. Floodplain maps provide detailed information that can assist jurisdictions in making policies and land-use decisions.

How Flood Hazard Maps for the City of Pasadena Were Developed:

FEMA mapped the 100-year and 500-year floodplains through the Flood Insurance Study (FIS) in conjunction with the United States Army Corps of Engineers (USACE) in August of 1987. There were previous studies done, including a Housing and Urban Development (HUD) study, which mapped the floodplain in March of 1978. This is when the City of Pasadena initially entered into the NFIP. The county has updated portions of the USACE and FEMA maps through smaller drainage studies in the county since that time.

Vulnerability Assessment:

Vulnerability assessment is the second step of flood-hazard assessment. It combines the floodplain boundary, generated through hazard identification, with an inventory of the property within the floodplain. Understanding the population and property exposed to natural hazards will assist in reducing risk and preventing loss from future events. Because site-specific inventory data and inundation levels given for a particular flood event (10-year, 25-year, 50-year, 100-year, 500-year) are not readily available, calculating a community's vulnerability to flood events is not straightforward. The amount of property in the floodplain, as well as the type and value of structures on those properties, should be calculated to provide a working estimate for potential flood losses.

Risk Analysis:

Risk analysis is the third and most advanced phase of a hazard assessment. It builds upon the hazard identification and vulnerability assessment. A flood risk analysis for the City of Pasadena should include two components: (1) the life and value of property that may incur losses from a flood event (defined through the vulnerability assessment); and (2) the number and type of flood events expected to occur over time. Within the broad components of a risk analysis, it is possible to predict the severity of damage from a range of events. Flow velocity models can assist in predicting the amount of damage expected from different magnitudes of flood events.

The data used to develop these models is based on hydrological analysis of landscape features. Changes in the landscape, often associated with human development, can alter the flow velocity and the severity of damage that can be expected from a flood event.

Using GIS technology and flow velocity models, it is possible to map the damage that can be expected from flood events over time. It is also possible to pinpoint the effects of certain flood events on individual properties. At the time of publication of this Plan, data was insufficient to conduct a risk analysis for flood events in the City of Pasadena.

However, the current mapping projects will result in better data that will assist in understanding risk. This Plan includes recommendations for building partnerships that will support the development of a flood risk analysis in the City of Pasadena.

Community Flood Issues

What is Susceptible to Damage during a Flood Event?

The largest impact on communities from flood events is the loss of life and property. During certain years, property losses resulting from flood damage are extensive. Development in the floodplains of the City of Pasadena will continue to be at risk from flooding because flood damage occurs on a regular basis throughout the county. Property loss from floods strikes both private and public property. There have been no floods in Pasadena during the past 25 years.

Property Loss Resulting from Flooding Events:

The type of property damage caused by flood events depends on the depth and velocity of the flood waters. Faster moving flood waters can wash buildings off their foundations and sweep cars downstream. Pipelines, bridges, and other infrastructure can be damaged when high waters combine with flood debris. Extensive damage can be caused by basement flooding and landslide damage related to soil saturation from flood events. Most flood damage is caused by water saturating materials susceptible to loss (i.e. wood, insulation, wallboard, fabric, furnishings, floor coverings, and appliances). In many cases, flood damage to homes renders them unlivable.

Manufactured Homes:

Statewide, the 1996 floods destroyed 156 housing units. Of those units, 61 % were mobile homes and trailers. Many older manufactured home parks are located in floodplain areas. Manufactured homes have a lower level of structural stability than stick-built homes, and must be anchored to provide additional structural stability during flood events. Because of confusion in the late 1980s resulting from multiple changes in NFIP regulations, there are some communities that do not actively enforce anchoring requirements.
Lack of enforcement of manufactured home construction standards in floodplains can contribute to severe damages from flood events.

According to the City of Pasadena Planning Division, the mobile home parks listed below have some portion of their property in the 100-year floodplain. The safety of these parks and their compliance with land use planning and building codes, as well as FEMA NFIP requirements, warrants further investigation.

Business/Industry:

Flood events impact businesses by damaging property and by interrupting business. Flood events can cut off customer access to a business as well as close a business for repairs. A quick response to the needs of businesses affected by flood events can help a community maintain economic vitality in the face of flood damage. Responses to business damages can include funding to assist owners in elevating or relocating flood-prone business structures.

Public Infrastructure:

Publicly owned facilities are a key component of daily life for all citizens of the county. Damage to public water and sewer systems, transportation networks, flood control facilities, emergency facilities, and offices can hinder the ability of the government to deliver services. Government can take action to reduce risk to public infrastructure from flood events, as well as craft public policy that reduces risk to private property from flood events.

Roads:

During natural hazard events, or any type of emergency or disaster, dependable road connections are critical for providing emergency services. Roads systems in the City of Pasadena are maintained by multiple jurisdictions. Federal, state, county, and city governments all have a stake in protecting roads from flood damage. Road networks often traverse floodplain and floodway areas. Transportation agencies responsible for road maintenance are typically aware of roads at risk from flooding.

Bridges:

Bridges are key points of concern during flood events because they are important links in road networks, river crossings, and they can be obstructions in watercourses, inhibiting the flow of water during flood events. The bridges in the City of Pasadena are state, county, city, or private owned. A state-designated inspector must inspect all state, county, and city bridges every two years; but private bridges are not inspected and can be very dangerous. The inspections are rigorous, looking at everything from seismic capability to erosion and scour.

Storm Water Systems:

Local drainage problems are common throughout the City of Pasadena. There is a drainage master plan, and City of Pasadena Public Works staff is aware of no local drainage threats. The problems are often present where storm water runoff enters culverts or goes underground into storm sewers. Inadequate maintenance can also contribute to the flood hazard in urban areas.

Water/Wastewater Treatment Facilities:

The City of Pasadena is a part of the Sanitation Districts of Los Angeles County. The Sanitation Districts are a confederation of independent special districts serving about 5 million people in Los Angeles County. There are no wastewater treatment facilities in the City.

Water Quality:

Environmental quality problems include bacteria, toxins, and pollution.

Existing Flood Mitigation Activities

The City of Pasadena has a five-year strategic plan from 2011 to 2016 to improve the flood management capabilities of the Hahamongna Watershed and Upper and Lower Arroyo Seco park areas. This is being accomplished by strengthening and improving current flood control systems, improving the capabilities of the catch basins, and studying the impact of sediment buildup behind the Devil's Gate Dam.

Acquisition and Protection of Open Space in the Floodplain:

Current efforts to increase public open space in the City of Pasadena have been paired with the need to restore and preserve natural systems that provide wildlife habitat and help to mitigate flood events. Public parks and publicly owned open spaces can provide a buffer between flood hazards and private property.

Water Districts:

All of the water districts in the City of Pasadena are in the process of replacing old cast iron pipes with more ductile iron pipes, which will be more resilient in disaster situations. During a disaster, water districts in the region work together to provide water for the City of Pasadena citizens. For example, the Pasadena Department of Water and Power has built inter-ties with the Metropolitan Water District for emergency situations.

Riparian Areas:

Riparian areas are important transitional areas that link water and land ecosystems. Vegetation in riparian areas is dependent on stream processes, such as flooding, and often is composed of plants that require large amounts of water, such as willows and cottonwood trees. Healthy vegetation in riparian buffers can reduce streamside erosion. During flood events, high water can cause significant erosion. Population growth and development have strained the land and water resources, and the community has responded by supporting various improvement projects, such as the Hahamongna Watershed.

Wastewater Management:

The City of Pasadena is a part of the Sanitation Districts of Los Angeles County. The Sanitation Districts are a confederation of independent special districts serving about 5 million people in Los Angeles County. There are no wastewater treatment facilities in the City.

Wetlands:

Many floodplain and stream-associated wetlands absorb and store storm water flows, which reduces flood velocities and stream bank erosion. Preserving these wetlands reduces flood damage and the need for expensive flood control devices such as levees. When the storms are over, many wetlands augment summer stream flows by slowly releasing the stored water back to the stream system. Wetlands are highly effective at removing nitrogen, phosphorous, heavy metals, and other pollutants from water. For this reason, artificial wetlands are often constructed for cleaning storm water runoff and for tertiary treatment (polishing) of wastewater.

Storm Water Systems:

There are a variety of surface water management providers in the county that manage water quality and storm water runoff from new development, the primary one being the Los Angeles County Department of Public Works. The City of Pasadena has a multi-year plan to examine all storm drains within the City. The goal is to improve the drains' capacity to handle runoff. The City is also upgrading the curb and gutter systems.

Flood Management Projects:

Flood management structures can assist in regulating flood levels by adjusting water flows upstream of flood-prone areas. There are a total of 2 dams in or above the City of Pasadena and 22 storage reservoirs in the Pasadena Water and Power service area with a total volume capacity of nearly 110 million gallons. The dams are managed by the County of Los Angeles Department of Public Works.

Community Issues Summary

The City of Pasadena works to mitigate problems regarding flood issues when they arise. However, funding, time and manpower are often unavailable, causing the problems to go unresolved. Some areas in the City of Pasadena may be more susceptible to flooding issues, mainly urban/heavy rainfall runoff. Since the 1920s the City of Pasadena has improved the flood management capabilities of the Arroyo Seco wash area and made great strides in restoring the natural condition of the interface regions throughout these parks.

Flood Mitigation Action Items

The flood mitigation action items provide direction on specific activities that organizations and residents in the City of Pasadena can undertake to reduce risk and prevent loss from flood events. Each action item is followed by ideas for implementation, which can be used by the steering committee and local decision makers in pursuing strategies for implementation.

Short-Term – Flood #l:

Analyze potential flood properties or locations within the City of Pasadena and identify appropriate and feasible mitigation options.

Ideas for Implementation:

Identify appropriate and feasible mitigation activities for potential flood properties.

Encourage and assist property owners to engage in mitigation activities.

Coordinating Organization:	Hazard Mitigation Advisory Committee Public Works
Timeline:	1-2 years
Potential Funding Sources:	Responsible departments will be directed to include the cost of this item in their department budget; also see Appendix B
Plan Goals Addressed:	Protect Life and Property, Partnerships and Implementation
Constraints:	Pending Funding and Available Personnel

Short-Term – Flood #2:

Recommend revisions to requirements for development within potential flood areas. Include private property owners and developers in reviewing development standards.

Ideas for Implementation:

Evaluate elevation requirements for new residential and nonresidential structures in the unincorporated floodplain area.

Provide opportunities for private property owners and developers to offer suggestions and feedback on standards for development in potential flood areas.

Coordinating Organization:	Public Works & Planning & Community Development Departments
Timeline:	2 years
Potential Funding Sources:	Responsible departments will be directed to include the cost of this item in their department budget; also see Appendix B
Plan Goals Addressed:	Protect Life and Property
Constraints:	Pending Funding and Available Personnel

Long-Term – Flood #1:

Encourage development of strategies to preserve open space for flood mitigation, fish habitat, and water quality in the floodplain.

Ideas for Implementation:

Conduct biannual reviews of existing flood and water use management projects.

Promote regional partnerships between flood mitigation, fish habitat, and water quality enhancement organizations and programs.

Identify sites where environmental restoration work can benefit flood mitigation, fish habitat, and water quality.

Coordinating Organization:	Public Works & LA County Department of Public Works
Timeline:	5 years
Potential Funding Sources:	See Appendix B
Plan Goals Addressed:	Natural Systems, Protect Life and Property
Constraints:	Pending Funding and Available Personnel

Long-Term – Flood #2:

Identify surface water drainage obstructions within the City of Pasadena.

Ideas for Implementation:

Prepare an inventory of major urban drainage problems, and identify causes and potential mitigation actions for urban drainage problem areas.

Use this list to establish priorities for maintenance and removal of mud and debris.

Coordinating Organization:	Public Works
Timeline:	5 years
Potential Funding Sources:	See Appendix B
Plan Goals Addressed:	Protect Life and Property
Constraints:	Pending Funding and Available Personnel

Long-Term -Flood# 3:

Improve water management and flood control efforts in the Hahamongna Watershed and Arroyo Seco park areas. Protect and restore natural habitats where practical.

Ideas for Implementation:

Replace aging storm drains.

Monitor sediment buildup and remove as necessary.

Restore natural habitats near flood basins.

Raise park roadways where necessary to improve the flow of water downstream.

Coordinating Organization:	Public Works Department
Timeline:	2 years
Potential Funding Sources:	See Appendix B
Plan Goals Addressed:	Partnerships and Implementation , Protect Life and Property, protect the environment
Constraints:	Pending Funding and Available Personnel

Long-Term -Flood # 4:

Upgrade the City storm drain system. The City of Pasadena has many miles of storm drains, some of which are over 30 years old. Normal use combined with frequent seismic

events can gradually weaken the system and result in failures during periods of heavy water flow.

Ideas for Implementation:

Continue annual sewer inspections.

Restore/replace any damaged section of the sewer system.

Coordinating Organization:	Public Works Department
Timeline:	2 years
Potential Funding Sources:	See Appendix B
Plan Goals Addressed:	Partnerships and Implementation , Protect Life and Property
Constraints:	Pending Funding and Available Personnel

Long-Term -Flood # 5:

Repair and replace the raised concrete gutters and curbs in the City. The gutters and curbs are critical for directing runoff during flooding conditions. They protect vehicles and pedestrians as well as structures during flooding events. Gutters and curbs are often damaged or displaced by tree roots.

Ideas for Implementation:

Continue annual inspections.

Restore/replace any damaged portions of the curb or gutter system.

Coordinating Organization:	Planning and Public Works Departments
Timeline:	2 years
Potential Funding Sources:	See Appendix B
Plan Goals Addressed:	Partnerships and Implementation , Protect Life and Property
Constraints:	Pending Funding and Available Personnel

Flood Resource Directory

The following resource directory lists the resources and programs that can assist county communities and organizations. The resource directory will provide contact information for local, county, regional, state, and federal programs that deal with natural hazards.

County Resources:

Los Angeles County Public Works Department
900 S. Fremont Ave.
Alhambra, CA 91803
Ph: 626-458-5100

Sanitation Districts of Los Angeles County
1955 Workman Mill Road
Whittier, CA 90607
Ph: 562-699-7411 x2301

State Resources:

California Emergency Management Agency (CalEMA, formerly OES)
3650 Schriever Ave.
Mather, CA 95655
Ph: 916 845- 8510
Fx: 916 845- 8511

California Resources Agency
1416 Ninth Street, Suite 1311
Sacramento, CA 95814
Ph: 916-653-5656

California Department of Water Resources (DWR)
1416 9th Street
Sacramento, CA 95814
Ph: 916-653-6192

California Department of Conservation: Southern California Regional Office
655 S. Hope Street, #700
Los Angeles, CA 90017-2321
Ph: 213-239-0878
Fx: 213-239-0984

Federal Resources and Programs:

Federal Emergency Management Agency (FEMA)
FEMA provides maps of flood hazard areas, various publications related to flood mitigation, funding for flood mitigation projects, and technical assistance, FEMA also operates the National Flood Insurance Program. FEMA' s mission is to reduce loss of life and property and protect the nation's critical infrastructure from all types of hazards through a comprehensive, risk-based, emergency management program of mitigation, preparedness, response and recovery.

Federal Emergency Management Agency, Region IX
1111 Broadway, Suite 1200
Oakland, CA 94607
Ph: 510-627-7100
Fx: 510-627-7112

Federal Emergency Management Agency, Mitigation Division
500 C Street, S.W.
Washington, D.C. 20472
Ph: 202-566-1600

FEMA' s List of Flood Related Websites
This site contains a long list of flood related Internet sites from "American Heritage Rivers" to "The Weather Channel" and is a good starting point for flood information on the Internet.
Contact: Federal Emergency Management Agency, Phone: (800) 480-2520
Website: http://www.fema.gov/nfip/related.htm

National Flood Insurance Program (NFIP)
In Southern California many cities lie within flood zones as defined in FEMA Flood Maps. The City of Pasadena is not a community within a designated flood zone. Flood insurance is available to citizens in communities that adopt and implement NFIP building standards. The standards are applied to development that occurs within a delineated floodplain, a drainage hazard area, and properties' within 250 feet of a floodplain boundary. These areas are depicted on federal Flood Insurance Rate Maps available through the county.
National Floodplain Insurance Program (NFIP)
500 C Street, S.W.
Washington, D.C. 20472
Ph: 202-566-1600

The Floodplain Management Association
The Floodplain Management website was established by the Floodplain Management Association (FMA) to serve the entire floodplain management community. It includes full-text articles, a calendar of upcoming events, a list of positions available, an index of publications available free or at nominal cost, a list of associations, a list of firms and consultants in floodplain management, an index of newsletters dealing with flood issues

(with hypertext links if available), a section on the basics of floodplain management, a list of frequently asked questions (FAQs) about the Website, and a catalog of Web links.
Floodplain Management Association
P.O. Box 50891
Sparks, NV 89435-0891
Ph: 775-626-6389
Fx: 775-626-6389

The Association of State Floodplain Managers
The Association of State Floodplain Managers is an organization of professionals involved in floodplain management, flood hazard mitigation, the National Flood Insurance Program, and flood preparedness, warning, and recovery. ASFPM fosters communication among those responsible for flood hazard activities, provides technical advice to governments and other entities about proposed actions or policies that will affect flood hazards, and encourages flood hazard research, education, and training. The ASFPM Web site includes information on how to become a member, the organization's constitution and bylaws, directories of officers and committees, a publications list, information on upcoming conferences, a history of the association, and other useful information and Internet links.
Contact: The Association of State Floodplain Managers
Address: 2809 Fish Hatchery Road, Madison, WI 53713 Phone: (608) 274-0123
Website: http://www.floods.org

National Weather Service
The National Weather Service provides flood watches, warnings, and informational statements for rivers in the City of Pasadena.
National Weather Service
520 North Elevar Street
Oxnard, CA 93030
Ph: 805-988- 6615

Office of Hydrology, National Weather Service
The National Weather Service s Office of Hydrology (OH) and its Hydrological Information Center offer information on floods and other aquatic disasters, This site offers current and historical data including an archive of past flood summaries, information on current hydrologic conditions, water supply outlooks, an Automated Local Flood Warning Systems Handbook, Natural Disaster Survey Reports, and other scientific publications on hydrology and flooding.
National Weather Service, Office of Hydrologic Development
1325 East West Highway, SSMC2
Silver Spring, MD 20910
Ph: 301-713-1658
Fx: 301-713-0963

National Resources Conservation Service (NRCS), US Department of Agriculture
NRCS provides a suite of federal programs designed to assist state and local governments and landowners in mitigating the impacts of flood events. The Watershed Surveys and

Planning Program and the Small Watershed Program provide technical and financial assistance to help participants solve natural resource and related economic problems on a watershed basis. The Wetlands Reserve Program and the Flood Risk Reduction Program provide financial incentives to landowners to put aside land that is either a wetland resource, or that experiences frequent flooding. The Emergency Watershed Protection Program (EWP) provides technical and financial assistance to clear debris from clogged waterways, restore vegetation, and stabilizing riverbanks. The measures taken under EWP must be environmentally and economically sound and generally benefit more than one property.
National Resources Conservation Service
14th and Independence Ave., SW, Room 5105-A
Washington, DC 20250
Ph: 202-720-7246
Fx: 202-720-7690

USGS Water Resources
This web page offers current US water news; extensive current (including real-time) and historical water data; numerous fact sheets and other publications; various technical resources; descriptions of ongoing water survey programs; local water information; and connections to other sources of water information.
USGS Water Resources
6000 J Street Placer Hall
Sacramento, CA 95819-6129
Ph: 916-278-3000
Fx: 916-278-3070

Bureau of Reclamation
The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public. The Bureau provides leadership and technical expertise in water resources development and in the efficient use of water through initiatives including conservation, reuse, and research. It protects the public and the environment through the adequate maintenance and appropriate operation of Reclamation's facilities and manages Reclamation's facilities to fulfill water user contracts and protect and/or enhance conditions for fish, wildlife, land, and cultural resources.
Mid-Pacific Regional Office
Federal Office Building
2800 Cottage Way
Sacramento CA 95825-1898
Ph: 916- 978-5000
Fax 916- 978-5599
http://www.usbr.gov/

Army Corps of Engineers
The Corps of Engineers administers a permit program to ensure that the nation's waterways are used in the public interest. Any person, firm, or agency planning to work in waters of the United States must first obtain a permit from the Army Corps of

Engineers. The Corps is responsible for the protection and development of the nation's water resources, including navigation, flood control, energy production through hydropower management, water supply storage and recreation.
US Army Corps of Engineers
P.O. Box 532711
Los Angeles, CA 90053- 2325
Ph: 213-452- 3921

Other National Resources:

American Public Works Association
2345 Grand Boulevard, Suite 500
Kansas City, MO 64108-2641
Ph: 816-472-6100
Fx: 816-472-1610

Publications:

NFlP Community Rating System Coordinator's Manual
Indianapolis, IN.
This informative brochure explains how the Community Rating System works and what the benefits are to communities. It explains in detail the CRS point system, and what activities communities can pursue to earn points. These points then add up to the "rating" for the community, and flood insurance premium discounts are calculated based upon that "rating " The brochure also provides a table on the percent discount realized for each rating (1-10). Instructions on how to apply to be a CRS community are also included.
Contact: NFIP Community Rating System
Phone: (800) 480-2520 or (317) 848-2898
Website: http://www.fema.gov/nfip/crs

Floodplain Management: A Local Floodplain Administrator's Guide to the NFlP
This document discusses floodplain processes and terminology. It contains floodplain management and mitigation strategies, as well as information on the NFIP, CRS, Community Assistance Visits, and floodplain development standards.
Contact: National Flood Insurance Program Phone: (800) 480-2520
Website: http://www.fema.gov/nfip/

Flood Hazard Mitigation Planning: A Community Guide, (June 1997).
Massachusetts Department of Environmental Management.
This informative guide offers a 10-step process for successful flood hazard mitigation. Steps include: map hazards, determine potential damage areas, take an inventory of facilities in the flood zone, determine what is or is not being done about flooding, identify gaps in protection, brainstorm alternatives and actions, determine feasible actions, coordinate with others, prioritize actions, develop strategies for implementation, and adopt and monitor the plan.

Contact: Massachusetts Flood Hazard Management Program Phone: (617) 626-1250
Website: http://www.magnetstate.ma.us/dem/programs/mitigate

Reducing Losses in High Risk Flood Hazard Areas: A Guidebook for Local Officials, (February 1987), FEMA-116.
This guidebook offers a table on actions that communities can take to reduce flood losses. It also offers a table with sources for floodplain mapping assistance for the various types of flooding hazards. There is information on various types of flood hazards with regard to existing mitigation efforts and options for action (policy and programs, mapping, regulatory, non-regulatory). Types of flooding which are covered include alluvial fan, areas behind levees, areas below unsafe dams, coastal flooding, flash floods, fluctuating lake level floods, ground failure triggered by earthquakes, ice jam flooding, and mudslides.
Contact: Federal Emergency Management Agency Phone: (800) 480-2520
Website: http://www.fema.gov

SECTION 3:

- LANDSLIDES -

Why are Landslides a Threat to City of Pasadena?

Landslides are a serious geologic hazard in almost every state in America. Nationally, landslides cause 25 to 50 deaths each year. The best estimates of direct and indirect costs of landslide damage in the United States range between $1 and $2 billion annually. As a seismically active region, California has had a significant number of locations impacted by landslides. Some landslides result in private property damage, while other landslides impact transportation corridors, fuel and energy conduits, and communication facilities. They can also pose a serious threat to human life.

Landslides can be broken down into two categories: (1) rapidly-moving (generally known as debris flows), and (2) slow-moving. Rapidly-moving landslides or debris flows present the greatest risk to human life, and people living in or traveling through areas prone to rapidly moving landslides are at increased risk of serious injury. Slow-moving landslides can cause significant property damage, but are less likely to result in serious human injuries.

The History of Landslides in Southern California:

1994 Northridge, California, Earthquake Landslides:

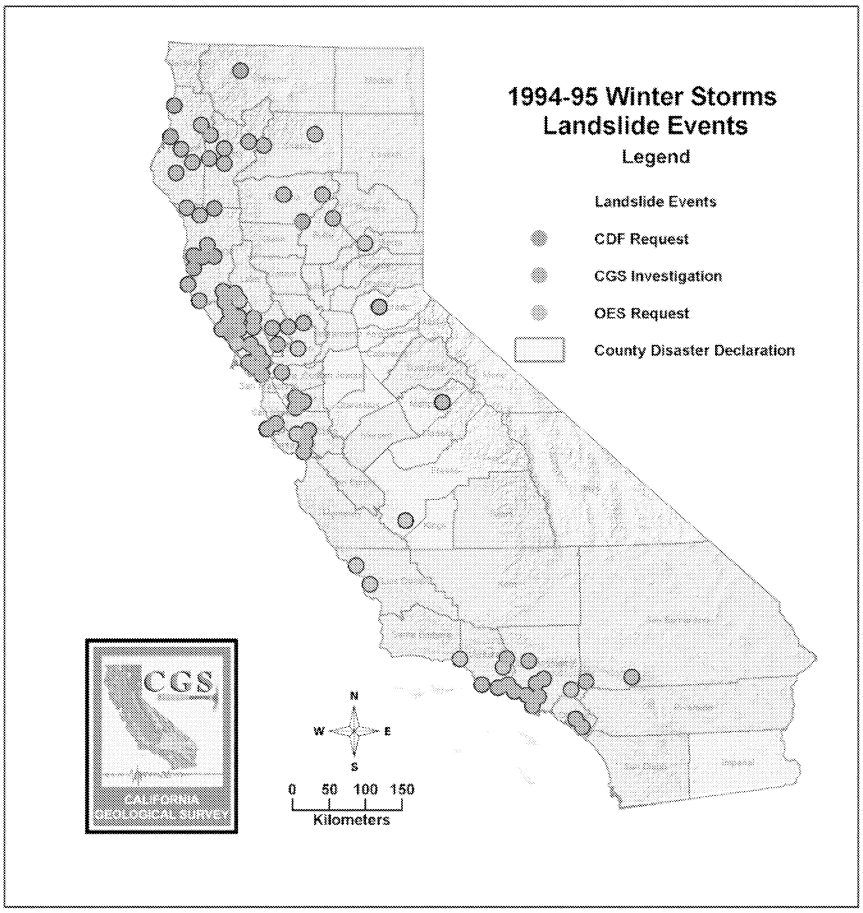
As a result of the magnitude 6.7 Northridge, California, earthquake, more than 11,000 landslides occurred over an area of 10,000 km^2. Most were in the Santa Susana Mountains and in mountains north of the Santa Clara River Valley. They destroyed dozens of homes, blocked roads, and damaged oil-field infrastructure.

March 1995 Los Angeles and Ventura Counties, Southern California:

Above normal rainfall triggered damaging debris flows, deep-seated landslides, and flooding. Several deep-seated landslides were triggered by the storms, the most notable of which was the La Conchita landslide, which in combination with a local debris flow, destroyed or badly damaged 11 to 12 homes in the small town of La Conchita, about 20 km west of Ventura. There also was widespread debris-flow and flood damage to homes, commercial buildings, and roads and highways in areas along the Malibu coast that had been devastated by wildfire 2 years before.

According to the 2010 State of California Multi-Hazard Mitigation Plan, there were two state- and federally-declared landslide disasters in Los Angeles County in those winter storms of 1994-1995, as shown in the figure below:

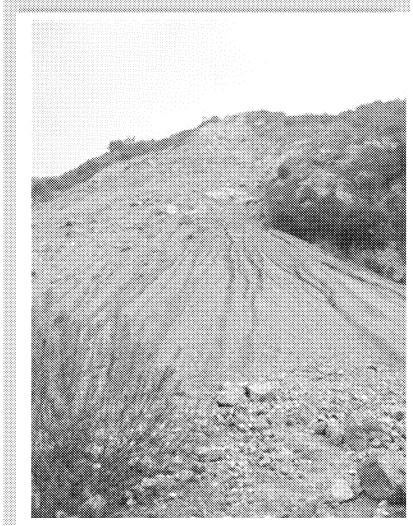
1994-1995 Winter Storms Landslide Events

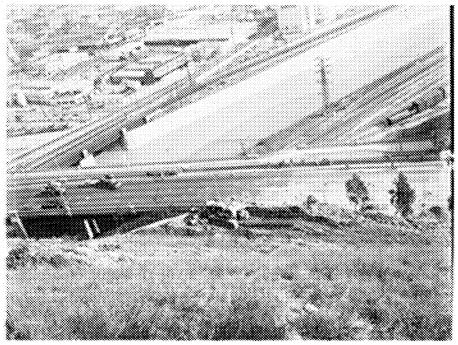


More specific to the City of Pasadena, there have been a number of landslides in the past. These include the following:

- December 2010 landslide on Avenue 64.
- 2009 Station Fire in Arroyo Seco – Arroyo Seco is one of many steep canyons burned in the 160,000-acre Station Fire of August-September 2009. This area experienced several large debris flows during the first winter storm season after the fire.
- 2005 landslide on Mount Wilson Toll Road in Eaton Canyon – destroyed 50 yards of road.
- 1958 Pasadena Freeway landslide.

Effects of Landslides





Landslide Characteristics

What is a Landslide?

A landslide is defined as the movement of a mass of rock, debris, or earth down a slope. Landslides are a type of "mass wasting" which denotes any down-slope movement of soil and rock under the direct influence of gravity. The term "landslide" encompasses events such as rock falls, topples, slides, spreads, and flows. Landslides can be initiated by rainfall, earthquakes, volcanic activity, changes in groundwater, disturbance and change of a slope by man-made construction activities, or any combination of these factors. Landslides can also occur underwater, causing tidal waves and damage to coastal areas. These landslides are called "submarine landslides."

The size of a landslide usually depends on the geology and the initial cause of the landslide. Landslides vary greatly in their volume of rock and soil; the length, width, and depth of the area affected; frequency of occurrence; and speed of movement. Some characteristics that determine the type of landslide are slope of the hillside, moisture content, and the nature of the underlying materials. Landslides are given different names, depending on the type of failure and their composition and characteristics.

Slides move in contact with the underlying surface. These movements include rotational slides, where sliding material moves along a curved surface, and translational slides, where movement occurs along a flat surface. These slides are generally slow-moving and can be deep. Slumps are small rotational slides that are generally shallow.

Slow-moving landslides can occur on relatively gentle slopes and can cause significant property damage, but are far less likely to result in serious injuries than rapidly-moving landslides.

Failure of a slope occurs when the force that is pulling the slope downward (gravity) exceeds the strength of the earth materials that compose the slope. They can move slowly (millimeters per year) or can move quickly and disastrously, as is the case with debris-flows. Debris-flows can travel down a hillside with speeds up to 200 miles per hour (though more commonly, 30-50 miles per hour), depending on the slope angle, water content, and type of earth and debris in the flow. These flows are initiated by heavy, usually sustained periods of rainfall but sometimes can happen as a result of short bursts of concentrated rainfall in susceptible areas. Burned areas charred by wildfires are particularly susceptible to debris flows, given certain soil characteristics and slope conditions.

What is a Debris Flow?

A debris or mud flow is a river of rock, earth and other materials, including vegetation that is saturated with water. This high percentage of water gives the debris flow a very rapid rate of movement down a slope. Debris flows often have speeds greater than 20 mile per hour, and many times they can move much faster. This high rate of speed makes debris flows extremely dangerous to people and property in its path.

Landslide Events and Impacts:

Landslides are a common hazard in California. Weathering and the decomposition of geologic materials produce conditions conducive to landslides, and human activity further exacerbates many landslide problems. Many landslides are difficult to mitigate, particularly in areas of large historic movement with weak underlying geologic materials. As communities continue to modify the terrain and influence natural processes, it is important to be aware of the physical properties of the underlying soils as they, along with climate, create landslide hazards. Proper planning cannot completely eliminate the threat of landslides to the safety of people, property, and infrastructure; however, without proper planning, landslide hazards will be even more common and more destructive.

The increasing scarcity of build-able land, particularly in urban areas, increases the tendency to build on geologically marginal land. Additionally, hillside housing developments in Southern California are prized for the view lots that they provide.

Rock falls occur when blocks of material come loose on steep slopes. Weathering, erosion, or excavations, such as those along highways, can cause falls where the road has been cut through bedrock. They are fast-moving with the materials free-falling or bouncing down the slope. In falls, material is detached from a steep slope or cliff. The volume of material involved is generally small, but large boulders or blocks of rock can cause significant damage.

Earth flows are plastic or liquid movements in which land mass (e.g. soil and rock)

breaks up and flows during movement. Earthquakes often trigger flows. Debris flows normally occur when a landslide moves downslope as a semi-fluid mass scouring, or partially scouring, soils from the slope along its path. Flows typically move rapidly and increase in volume as they carve out the channel. Flows often occur during heavy rainfall. They can occur on gentle slopes and can move rapidly for large distances.

Landslide Conditions:

Landslides are often triggered by periods of heavy rainfall. Earthquakes, subterranean water flow, and excavations may also trigger landslides. Certain geologic formations are more susceptible to landslides than others. Human activities, including development near steep slopes, can increase susceptibility to landslide events. Landslides on steep slopes are more dangerous because movements can be rapid.

Although landslides are a natural geologic process, the incidence of landslides and their impacts on people can be exacerbated by human activities. Grading for road construction and development can increase slope steepness. Grading and construction can decrease the stability of a hill slope by adding weight to the top of the slope, removing support at the base of the slope, and increasing water content. Other human activities affecting landslides include excavation, drainage and groundwater alterations, and changes in vegetation.

Wildland fires in hills covered with chaparral are often a precursor to debris flows in burned-out canyons. The extreme heat of a wildfire can create a soil condition in which the earth becomes impervious to water by creating a waxy-like layer just below the ground surface. Since the water cannot be absorbed into the soil, it rapidly accumulates on slopes, often gathering loose particles of soil in to a sheet of mud and debris. Debris flows can often originate miles away from unsuspecting persons and approach them at a high rate of speed with little warning.

Natural Conditions:

Natural processes can cause landslides or re-activate historical landslide sites. The removal or undercutting of shoreline-supporting material along bodies of water by currents and waves produces countless small slides each year. Seismic tremors can trigger landslides on slopes historically known to have landslide movement. Earthquakes can also cause additional failure (lateral spreading) that can occur on gentle slopes above steep streams and riverbanks.

Particularly Hazardous Landslide Areas:

Locations at risk from landslides or debris flows include areas with one or more of the following conditions:

- ✓ On or close to steep hills;
- ✓ Steep road-cuts or excavations;

- ✓ Existing landslides or places of known historic landslides (such sites often have tilted power lines, trees tilted in various directions, cracks in the ground, and irregular-surfaced ground);
- ✓ Steep areas where surface runoff is channeled, such as below culverts, V -shaped valleys, canyon bottoms, and steep stream channels;
- ✓ Fan-shaped areas of sediment and boulder accumulation at the outlets of canyons; and
- ✓ Canyon areas below hillside and mountains that have recently (within 1-6 years) been subjected to a wildland fire.

Impacts of Development:

Although landslides are a natural occurrence, human impacts can substantially affect the potential for landslide failures in City of Pasadena. Proper planning and geotechnical engineering can be exercised to reduce the threat of safety of people, property, and infrastructure.

Excavation and Grading:
Slope excavation is common in the development of home sites or roads on sloping terrain. Grading these slopes 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:
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 in landslide prone locations can result in damaging landslides.

Ineffective storm water 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, ponding, 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:
Removing vegetation from very steep slopes can increase landslide hazards. Areas that experience wildfire and land clearing for development may have long periods of increased landslide hazard. Also, certain types of ground cover have a much greater need for constant watering to remain green. Changing away from native ground cover plants

may increase the risk of landslide.

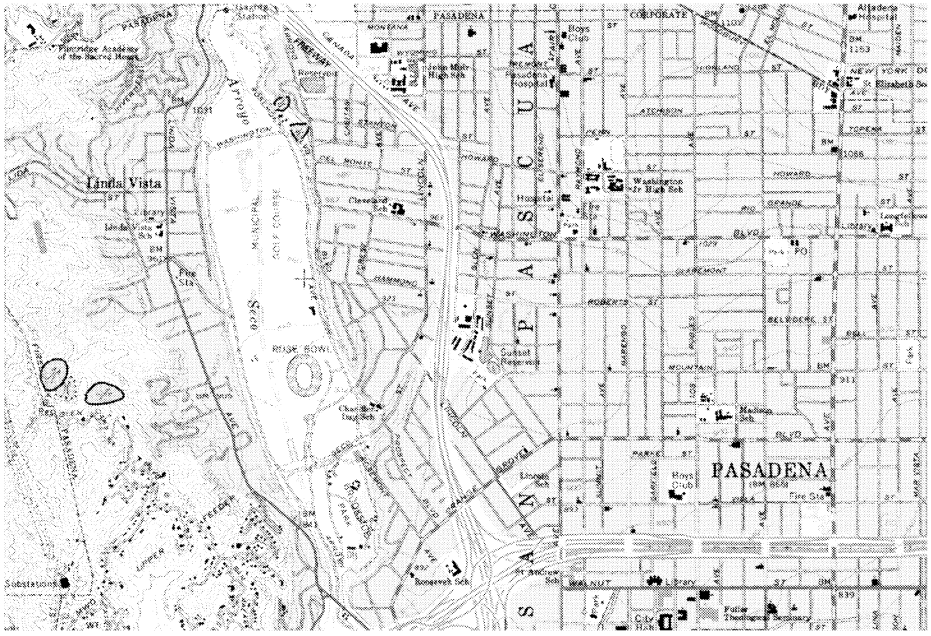
Landslide Hazard Assessment

Hazard Identification:

Identifying hazardous locations is an essential step towards implementing more informed mitigation activities. The City's mountain and foothill areas are vulnerable to slope instability. Steep-sided slopes along the Arroyo Seco and other incised drainages may also be locally susceptible to slope instability. Further, most of the residential construction in the foothills of Pasadena occurred prior to the development and enforcement of stronger grading codes in the 1970s, as well as before the heightened awareness of slope stability issues that has resulted from the periodic intense rainstorms of the last 30 years. Consequently, there are older residences built in or near natural drainage courses and steep slopes that may be at risk from slope failures. Older developments along the top of the Arroyo Seco bluffs may also be locally susceptible.

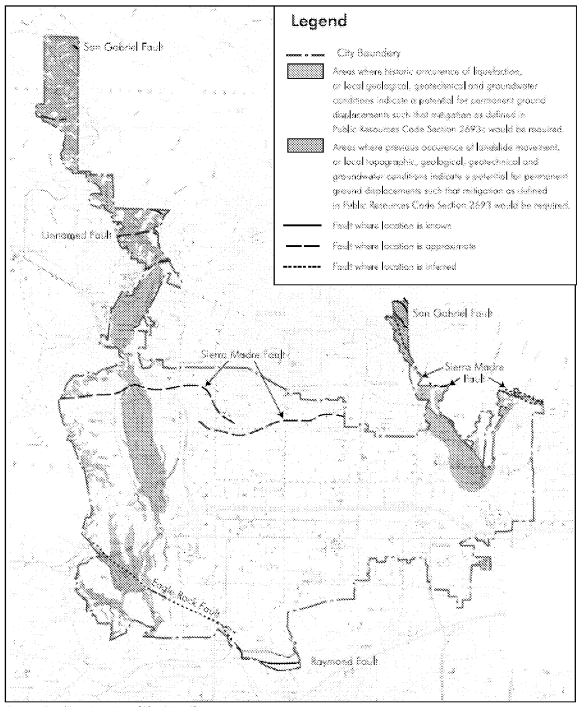
The U.S. and State of California Geological Survey organizations have identified landslide areas they have evaluated as dormant. These are areas with a history of landslide activity but have been inactive in the recent past. These dormant areas are in the hills directly west of the Rose Bowl and can be seen below as yellow marks in a close-up snapshot of a 2007 California Geological Survey map:

Pasadena Landslide Areas



The City's 2002 General Plan includes a figure showing areas where either previous occurrences of landslide movement, or local topographic, geological, geotechnical, or groundwater conditions indicate a potential for permanent ground displacements requiring mitigation. These areas are shown in blue in the following figure:

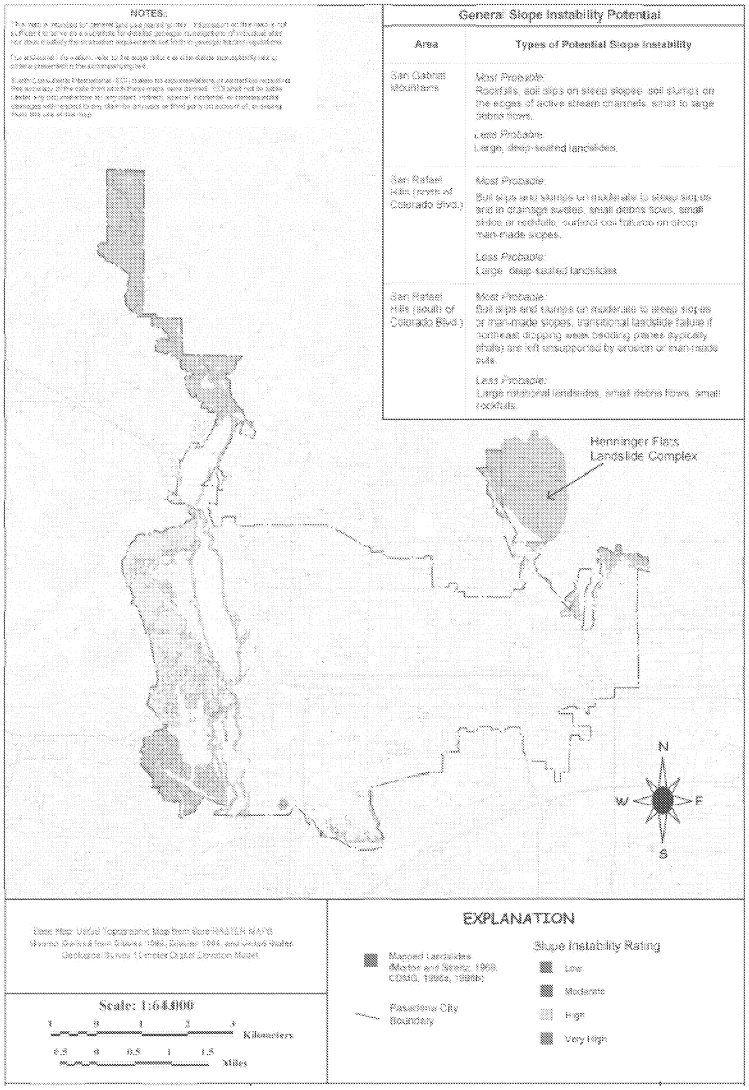
Pasadena Areas Susceptible to Landslides



Source: City of Pasadena General Plan Safety Element
Prepared by Earth Consultants International, August 2002.

The Technical Background Report developed for the 2002 General Plan Safety Element included a figure showing slope instability and provided information about potential slope instability types for three areas: San Gabriel Mountains, San Rafael Hills (north of Colorado Boulevard), and San Rafael Hills (south of Colorado Boulevard). The figure may be found on the following page and shows past mapped landslides in pink.

Slope Instability and Past Landslides in Pasadena



Statewide landslide patterns of occurrence repeat themselves during winter seasons with heavy rainfall, which generally coincide with El Niño Southern Oscillation in the Pacific Ocean. Every few years, warm equatorial waters are driven northward, bringing moisture-laden air that results in more frequent and severer winter storms in California. The added weight of rain-saturated hill slopes, combined with the weakening of slopes

caused by the pressure which groundwater exerts on porous hillside materials, can trigger slope failure.

Landslides are common throughout the San Gabriel Mountains, particularly near the range front, where rock weakened by fracturing, shearing, and crushing along the numerous fault zones is present. This weakness in the rock fabric, combined with the moderate to extremely steep slopes that have resulted from rapid uplift of the mountains, are important elements that create the setting for the development of slope failures. Similar conditions are present in the San Rafael Hills, where rocks are highly weathered and slope gradients of 30 degrees or steeper are common.

The City's hillsides are vulnerable to slope instability due primarily to the fractured, crushed, and weathered condition of the bedrock, as well as the steep terrain. Over-steepened slopes along the large drainage channels are also locally susceptible. The probability of large bedrock landslides occurring is relatively low; therefore, the source of potential losses due to slope instability arises primarily from the occurrence of smaller slope failures in the form of small slides, slumps, soil slips, debris flows, and rockfalls.

Vulnerability and Risk:

Vulnerability assessment for landslides will assist in predicting how different types of property and population groups will be affected by a hazard. Data that includes specific landslide-prone and debris flow locations in the city can be used to assess the population and total value of property at risk from future landslide occurrences.

The potential for slope failure is dependent on many factors and their interrelationships. Some of the most important factors include slope height, slope steepness, sheer strength, and orientation of weak layers in the underlying geologic unity, as well as pore water pressures. Joints and shears, which weaken the rock fabric, allow penetration of water leading to deeper weathering of the rock along with increasing the pore pressures, increasing the plasticity of weak clays, and increasing the weight of the landmass. For engineering of earth materials, these factors are combined in calculations to determine if a slope meets a minimum safety standard. The generally accepted standard is a factor of safety of 1.5 or greater (where 1.0 is equilibrium, and less than 1.0 is failure).

Although existing landslides are not widespread in the area, it is probable that many of the steeper hillsides do not meet the minimum factor of safety and slope stabilization may be needed if development reaches these areas.

Natural slopes, graded slopes, or graded/natural slope combinations must meet these minimum engineering standards where they impact planned homes, subdivisions, or other types of developments. Slopes adjacent to areas where the risk of economic losses from landslides is small, such as parks and mountain roadways, are often allowed a lesser factor of safety.

While a quantitative vulnerability assessment (an assessment that describes number of lives or amount of property exposed to the hazard) has not yet been conducted for City of

Pasadena landslide events, there are many qualitative factors that point to potential vulnerability. Landslides can impact major transportation arteries, blocking residents from essential services and businesses.

Past landslide events have caused major property damage or significantly impacted city residents, and continuing to map city landslide and debris flow areas will help in preventing future loss.

Factors included in assessing landslide risk include population and property distribution in the hazard area, the frequency of landslide or debris flow occurrences, slope steepness, soil characteristics, and precipitation intensity. This type of analysis could generate estimates of the damages to the city due to a specific landslide or debris flow event. At the time of publication of this plan, data was insufficient to conduct a risk analysis and the software needed to conduct this type of analysis was not available.

Community Landslide Issues

What is Susceptible to Landslides?

Landslides can affect utility services, transportation systems, and critical lifelines. Communities may suffer immediate damages and loss of service. Disruption of infrastructure, roads, and critical facilities may also have a long-term effect on the economy. Utilities, including potable water, wastewater, telecommunications, natural gas, and electric power, are all essential to service community needs. Loss of electricity has the most widespread impact on other utilities and on the whole community. Natural gas pipes may also be at risk of breakage from landslide movements as small as an inch or two.

Roads and Bridges:

It is not cost-effective to mitigate all slides because of limited funds and the fact that some historical slides are likely to become active again even with mitigation measures. The City Roads Division alleviates problem areas by grading slides, and by installing new drainage systems on the slopes to divert water from the landslides. This type of response activity is often the most cost-effective in the short-term, but is only temporary. Unfortunately, many property owners are unaware of slides and the dangers associated with them.

Lifelines and Critical Facilities:

Lifelines and critical facilities should remain accessible, if possible, during a natural hazard event. The impact of closed transportation arteries may be increased if the closed road or bridge is critical for hospitals and other emergency facilities. Therefore, inspection and repair of critical transportation facilities and routes is essential and should receive high priority. Losses of power and phone service are also potential consequences of landslide events.

Due to heavy rains, soil erosion in hillside areas can be accelerated, resulting in loss of soil support beneath high voltage transmission towers in hillsides and remote areas. Flood events can also cause landslides, which can have serious impacts on gas lines that are located in vulnerable soils.

Landslide Mitigation Activities

Landslide mitigation activities include current mitigation programs and activities that are being implemented by local or city organizations.

Landslide Building/Zoning Codes:

The City of Pasadena Municipal Code addresses development on steep slopes in subsection 17.48. This section outlines standards for steep slope hazard areas on slopes of 20 percent or more. Generally, the ordinance requires soils and engineering geologic studies for developments proposed on slopes of 20 percent or greater. Building code changes designed to improve building survivability during earthquakes have also provided mitigation improvements for landslides. The changes requiring deeper footings and stronger foundations for new construction will protect these structures during landslides.

Community Issues Summary

Landslides can present a problem in the City of Pasadena, and may impact the city's infrastructure as well as private property.

Landslide Mitigation Action Items

The landslide mitigation action items provide direction on specific activities that the city, organizations, and residents in City of Pasadena can undertake to reduce risk and prevent loss from landslide events. Each action item is followed by ideas for implementation, which can be used by the steering committee and local decision makers in pursuing strategies for implementation.

Short Term - Landslide #l:

Improve knowledge of landslide hazard areas and understanding of vulnerability and risk to life and property in hazard-prone areas. Increase coordination between City Departments regarding landslide risk areas.

Ideas for Implementation:

Conduct an annual review of potential landslide areas in the City of Pasadena.

Provide private property owners maps of possible risk areas.

Coordinating Organization:	Hazard Mitigation Advisory Committee
Timeline:	1-2 Years
Potential Funding Sources:	Responsible departments will be directed to include the cost of this item in their department budget; also see Appendix B
Plan Goals Addressed:	Protect Life and Property
Constraints:	Pending Funding and Available Personnel

Short Term - Landslide #2:

Identify safe evacuation routes in high-risk debris flow and landslide areas.

Ideas for Implementation:

Identify potential debris removal resources.

Increase participation in regional committee planning for emergency transportation routes.

Identify and publicize information regarding emergency transportation routes.

Coordinating Organization:	Transportation Department Hazard Mitigation Advisory Committee
Timeline:	1-3 Years
Potential Funding Sources:	Responsible departments will be directed to include the cost of this item in their department budget; also see Appendix B
Plan Goals Addressed:	Protection of life and more efficient response of emergency personnel.
Constraints:	Pending Funding and Available Personnel

Long Term - Landslide #l:

Review local ordinances regarding building and development in landslide prone areas.

Ideas for Implementation:

Review local ordinances for building in potential landslide areas based on proposed development plans and current environmental conditions.

Create committee of local stakeholders to study the issues and make recommendations to staff.

Coordinating Organization:	Building and Safety Division
Timeline:	Ongoing

Potential Funding Sources:	See Appendix B
Plan Goals Addressed:	Protect Life and Property
Constraints:	Pending Funding and Available Personnel

Landslide Resource Directory

County Resources:

Los Angeles County Department of Public Works
900 S. Freemont Avenue
Alhambra, CA 91803
Ph: 626-458-5100

State Resources:

California Department of Conservation: Southern California Regional Office
655 S. Hope Street, #700
Los Angeles, CA 90017-2321
Ph: 213-239-0878
Fax: 213-239-0984

California Division of Mines and Geology
801 K Street
Sacramento, CA 95814
Ph: 916-445-1825
Fax: 916-445-5718

California Division of Forestry
1416 9th Street
PO Box 944246
Sacramento, CA 94244-2460
Ph: 916-653-5123

California Department of Water Resources
1416 9th Street
Sacramento, CA 95814
Ph: 916-653-6192

California Emergency Management Agency (CalEMA, formerly OES)
3650 Schriever Ave.
Mather, CA 95655
Ph: 916-845-8510
Fax: 916-845-8511

California Department of Transportation (Cal Trans)
120 S. Spring Street
Los Angeles, CA 90012
Ph: 213-897-3656

Federal Resources and Programs:

Federal Emergency Management Agency (FEMA) – Region IX
1111 Broadway, Suite 1200
Oakland, CA 94607
Ph: 510-627-7100
Fax: 510-627-7112

Natural Resource Conservation Service (NRCS)
PO Box 2890
Washington, DC 20013
Ph: 202-690-2621

US Geological Survey, National Landslide Information Center
345 Middlefield Road
Menlo Park, CA 94025
Ph: 650-853-8300

Publications:

Olshansky, Robert B., Planning for Hillside Development (1996) American Planning Association.
This document describes the history, purpose, and functions of hillside development and regulation and the role of planning, and provides excerpts from hillside plans, ordinances, and guidelines from communities throughout the US.

Olshansky, Robert B. & Rogers, J. David, Unstable Ground: Landslide Policy in the United States (1987) Ecology Law Quarterly.
This is about the history and policy of landslide mitigation in the US.

Public Assistance Debris Management Guide (July 2000) Federal Emergency Management Agency.
The Debris Management Guide was developed to assist local officials in planning, mobilizing, organizing, and controlling large-scale debris clearance, removal, and disposal operations. Debris management is generally associated with post-disaster recovery. While it should be compliant with local and city emergency operations plans, developing strategies to ensure strong debris management is a way to integrate debris management within mitigation activities. The Guide is available in hard copy or on the FEMA website.

USGS Landslide Program Brochure. National Landslide Information Center (NLIC), United States Geologic Survey.
The brochure provides good, general information in simple terminology on the importance of landslide studies and a list of databases, outreach, and exhibits maintained by the NLLC. The brochure also includes information on the types and causes of landslides, rock falls, and earth flows.

SECTION 4:
- WILDFIRE -

Why are Wildfires a Threat to the City of Pasadena?

For thousands of years, fires have been a natural part of the ecosystem in southern California. However, wildfires present a substantial hazard to life and property in communities built within or adjacent to hillsides and mountainous areas. There is a huge potential for losses due to wildland/urban interface fires in southern California. The City of Pasadena is located along the San Gabriel mountain chain.

Besides the topography there are other factors which increase the threat of wildfires. The extended droughts characteristic of California's Mediterranean climate result in large areas of dry vegetation that provide fuel for wildland fires. Furthermore, the native vegetation typically has a high oil content that makes it highly flammable. The area is also intermittently impacted by Santa Ana winds, the hot, dry winds that blow across southern California in the spring and late fall.

A wildfire that consumes thousands of acres of vegetated property can overwhelm local emergency response resources. Often when a wildland fire encroaches onto the built environment, multiple ignitions develop as a result of "branding," the term for wind transport of burning cinders over a distance of a mile or more. If ignited structures sustain and transmit the fire from one building to the next, a catastrophic fire can ensure. Insurance carriers consider fire a catastrophe if it triggers at least $25 million in claims or more than 1,000 individual claims. The Oakland Hills firestorm of October 1991 was such an event.

Firestorms, especially in areas of wildland-urban interfaces, can be particularly dangerous and complex, posing a severe threat to public and firefighter safety and causing devastating losses of both life and property. Continuous planning, preparedness, and education are required to reduce the fire hazard potential and to limit the destruction caused by fires. The areas of Pasadena/Altadena lost 121 homes in the 1993 Kinneloa fire, pointing up the need for continued vigilance in the area of wildfire mitigation.

Historic Fires in Southern California:

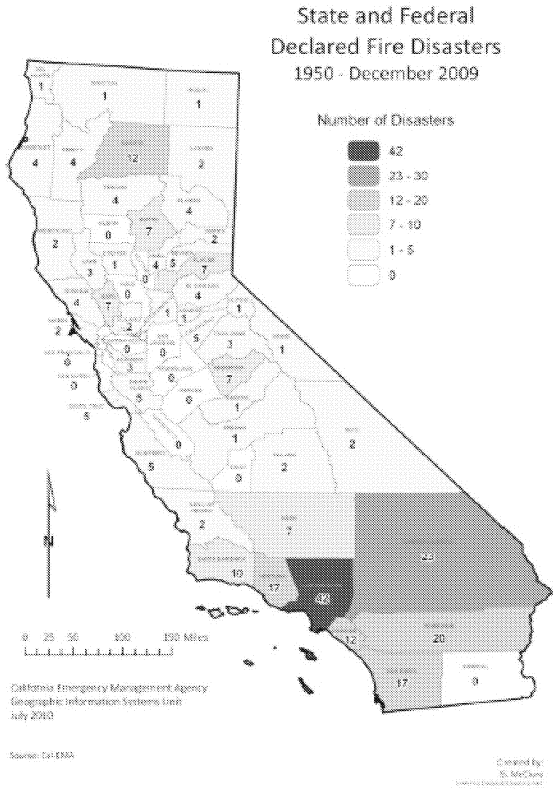
Large fires have been part of the Southern California landscape for millennia. Written documents reveal that during the 19th century human settlement of Southern California altered the fire regime of coastal California by increasing the fire frequency. This was an era of very limited fire suppression, and yet like today, large crown fires covering tens of thousands of acres were not uncommon. One of the largest fires in Los Angeles County (60,000 acres) occurred in 1878, and the largest fire in Orange County's history, in 1889, was over half a million

acres. In 1970 the Clampitt fire destroyed over 100,000 acres in Los Angeles County.

In recent Los Angeles County history, the worst fire was the Station Fire, which burned from August to October of 2009. This was an arson fire that burned 160,500 acres, destroyed over 200 structures, and killed two firefighters. The fire started in the La Canada Flintridge area, burned northwest, and then turned east. It was the 10th largest fire in California history.

According to the 2010 State of California Multi-Hazard Mitigation Plan, there have been 42 state- and federally-declared wildfire disasters in Los Angeles County between 1950 and December 2009, as shown in the above figure. Of the 20 most disastrous wildfires in the state (based on the number of structures destroyed), three have occurred in Los Angeles County, including the Bel Air Fire in November 1961, Topanga Fire in November 1993, and Sayre Fire in November 2008.

State and Federal Declared Disasters, 1950-December 2009



More specific to the City of Pasadena, there have been several wildfires in the past. These include the following:

- April 2008 – 350-acre wildfire near Pasadena forced the evacuation of 300 households
- Kinneloa Fires of 1993 in Pasadena and Altadena

Wildfire Characteristics

There are three categories of fire interface: The classic wildland/urban interface exists where well-defined urban and suburban development presses up against open expanses of wildland areas. The mixed wildland/urban interface is characterized by isolated homes, subdivisions, and small communities situated predominantly in wildland settings. The occluded wildland/urban interface exists where islands of wildland vegetation occur inside a largely urbanized area.

Certain conditions must be present for significant interface fires to occur. The most common conditions include the following: hot, dry and windy weather; the inability of fire protection forces to contain or suppress the fire; the occurrence of multiple fires that overwhelm committed resources; and a large fuel load (dense vegetation). Once a fire has started, several conditions influence its behavior, including fuel topography, weather, drought and development.

Southern California has two distinct areas of risk for wildland fire. The foothills and lower mountain areas are most often covered with scrub brush or chaparral. These lower elevations covered with chaparral create one type of exposure. The higher elevations of Southern California's mountains are another risk area, typically being heavily forested.

Additional factors can combine to increase the fire threat. The magnitude of the 2003 Southern California fires was the result of three primary factors: (1) severe drought, accompanied by a series of storms that produced thousands of lightning strikes and windy conditions; (2) an infestation of bark beetles that has killed thousands of mature trees; and (3) a high density of the forest caused by changes in land management strategies.

The Interface:

One challenge Southern California faces regarding the wildfire hazard is from the increasing number of houses being built on the urban/wildland interface. Every year the growing population has expanded further and further into the hills and mountains, including forest lands. The increased "interface" between urban/suburban areas and the open spaces created by this expansion has produced a significant increase in threats to life and property from fires and has pushed existing fire protection systems beyond original or current design and capability.

Property owners in the interface ignore the problems and threats they face. Therefore, many owners have done very little to manage or offset fire hazards or risks on their own

property. Furthermore, human activities increase the incidence of fire ignition and potential damage.

Fuel:

Fuel is the material that feeds a fire and is a key factor in wildfire behavior. Fuel is classified by volume and by type. Volume is described in terms of "fuel loading," or the amount of available vegetative fuel.

The type of fuel also influences wildfire. Chaparral is a primary fuel of Southern California wildfires. Chaparral habitat ranges in elevation from near sea level to over 5,000' in Southern California. Chaparral communities experience long dry summers and receive most of their annual precipitation from winter rains. Although chaparral is often considered as a single species, there are two distinct types: hard chaparral and soft chaparral. Within these two types are dozens of different plants, each with its own particular characteristics.

Fire has been important in the life cycle of chaparral communities for over 2 million years; however, the true nature of the "fire cycle" has been subject to interpretation. In a period of 750 years, it generally thought that fire occurs once every 65 years in coastal drainages and once every 30 to 35 years inland.

The vegetation of chaparral communities has evolved to a point where it requires fire to spawn regeneration. Many species invite fire through the production of plant materials with large surface-to-volume ratios and volatile oils, as well as through periodic die-back of vegetation. These species have further adapted to possess special reproductive mechanisms following fire. Several species produce vast quantities of seeds which lie dormant until fire triggers germination. The parent plant which produces these seeds defends itself from fire by a thick layer of bark, which allows enough of the plant to survive so that the plant can crown sprout following the blaze.

In general, chaparral community plants have adapted to fire through the following methods: a) fire-induced flowering; b) bud production and sprouting subsequent to fire; c) in-soil seed storage and fire-stimulated germination; and d) on-plant seed storage and fire-stimulated dispersal.

An important element in understanding the danger of wildfire is the availability of diverse fuels in the landscape, such as natural vegetation, manmade structures and combustible materials. A house surrounded by brushy growth rather than cleared space allows for greater continuity of fuel and increases the fire's ability to spread. After decades of fire suppression, "dog-hair" thickets have accumulated, which enable high intensity fires to flare and spread rapidly.

Topography:

Topography influences the movement of air, thereby directing a fire course. For example, if the percentage of uphill slope doubles, the rate of spread in wildfire will

likely double. Gulches and canyons can funnel air and act as chimneys, which intensify fire behavior and cause the fire to spread faster. Solar heating of dry, south-facing slopes produces up-slope drafts that can complicate fire behavior. Unfortunately, hillsides with hazardous topographic characteristics are also desirable residential areas in many communities. This underscores the need for wildfire hazard mitigation and increased education and outreach to homeowners living in interface areas.

The Pasadena area encompasses grass- and brush-covered hillsides that facilitate the rapid spread of fire. In some portions of the City, there is significant topographic relief. The highest point in the northwestern portion of the study area, in the Los Angeles National Forest, is nearly 1,400 feet higher in elevation than the areas immediately at the base of the mountains. Traffic in urban areas and long travel distances in rural hillside areas often hinder fire department response time.

Weather:

Weather patterns combined with certain geographic locations can create a favorable climate for wildfire activity. Areas where annual precipitation is less than 30 inches per year are extremely fire susceptible. High-risk areas in Southern California share a hot, dry season in late summer and early fall when high temperatures and low humidity favor fire activity. The Santa Ana winds, which are heated by compression as they flow down to Southern California from Utah, create a particularly high risk, as they can rapidly spread what might otherwise be a small fire.

The Pasadena area typically has mild winters that lead to an annual growth of grasses and plants. This vegetation dries out during the hot summer months and is exposed to Santa Ana wind conditions in the fall. Winds in excess of 40 miles per hour are typical; gusts in excess of 100 miles per hour may occur locally. In the Pasadena area, these winds tend to travel from north to south. However, when combined with winds generated from burning vegetation, wind direction is likely to be extremely erratic.

Drought:

Recent concerns about the effects of climate change, particularly drought, are contributing to concerns about wildfire vulnerability. The term drought is applied to a period in which an unusual scarcity of rain causes a serious hydrological imbalance.

Unusually dry winters, or significantly less rainfall than normal, can lead to relatively drier conditions and leave reservoirs and water tables lower. Drought leads to problems with irrigation and may contribute to additional fires, or additional difficulties in fighting fires.

Development:

Growth and development in scrubland and forested areas is increasing the number of human-made structures in Southern California interface areas. Wildfire has an effect on development, yet development can also influence wildfire. Owners often prefer homes

that are private, have scenic views, are nestled in vegetation and use natural materials. A private setting may be far from public roads, or hidden behind a narrow, curving driveway. These conditions, however, make evacuation and firefighting difficult. The scenic views found along mountain ridges can also mean areas of dangerous topography. Natural vegetation contributes to scenic beauty, but it may also provide a ready trail of fuel leading a fire directly to the combustible fuels of the home itself.

Wildfire Hazard Assessment

Hazard Identification:

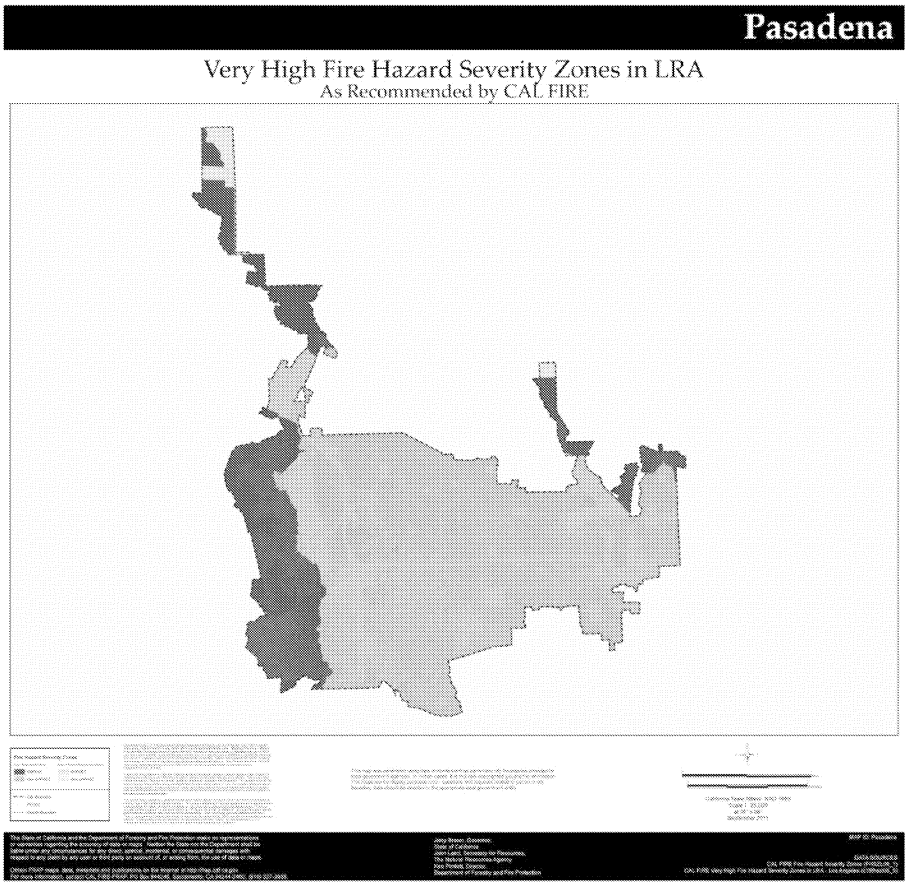
Wildfire hazard areas are commonly identified in regions of the wildland/urban interface. Ranges of the wildfire hazard are further determined by the ease of fire ignition due to natural or human conditions and the difficulty of fire suppression. The wildfire hazard is also magnified by several factors related to fire suppression/control such as the surrounding fuel load, weather, topography, and property characteristics. Generally, hazard identification rating systems are based on weighted factors of fuels, weather and topography.

In 2009, the State of California adopted the law in Govt. Codes 51175-51189. In these actions, they had the State Fire Marshall create a statewide fire model. In the fire model, the state ranks areas' fire risk as moderate, high, or very high. Fire Hazard Severity Zone (FHSZ) maps are created by the California Department of Forestry and Fire Protection (Cal Fire) and updated periodically. The maps identify areas where a wildfire is more likely to occur. The primary factors used to identify FHSZs are:

- Predominant vegetation type (vegetation is the fuel for a wildfire)
- Terrain (severity of the slopes)
- Fire history (past fires are good predictors of future fires)
- Weather patterns (high winds, low humidity, and high temperature)

In combination, these factors are used within a scientific model to depict geographic areas prone to wildfire. The figure below shows the location of Very High Fire Hazard Severity Zones in the City of Pasadena, identified in red, as defined by Cal Fire in September 2011. The VHFHSZ is the most severe fire hazard zone and contains the area most susceptible to full exposure to flames and embers during a wildfire.

Very High Fire Hazard Severity Zones in Pasadena



In addition to the VHFHSZ maps, Cal Fire has also developed a State Fire Threat map showing the ratings of wildland fire threat based on the combination of potential fire behavior (fuel rank) and expected fire frequency (how often an area burns) under severe conditions. These two factors combine to create four threat classes ranging from moderate to extreme. Fire frequency is derived from 50 years of fire history data, and fire behavior is derived from fuels and terrain data.

Fire Threat in the State of California

Vulnerability and Risk:

Southern California residents are served by a variety of local fire departments as well as county, state and federal fire resources. Data that includes the location of interface areas in the county can be used to assess the population and total value of property at risk from wildfire and direct these fire agencies in fire prevention and response.

Key factors included in assessing wildfire risk include ignition sources, building materials and design, community design, structural density, slope, vegetative fuel, fire occurrence and weather, as well as occurrences of drought.

The National Wildland/Urban Fire Protection Program has developed the Wildland/Urban Fire Hazard Assessment Methodology tool for communities to assess their risk to wildfire. For more information on wildfire hazard assessment refer to http://www.Firewise.org.

Community Wildfire Issues

What is Susceptible to Wildfire?

Growth and Development in the Interface:

The hills and mountainous areas of Southern California are considered to be interface areas. The development of homes and other structures is encroaching onto the wildlands and is expanding the wildland/urban interface. The interface neighborhoods are characterized by a diverse mixture of varying housing structures, development patterns, ornamental and natural vegetation, and natural fuels.

In the event of a wildfire, vegetation, structures, and other flammables can merge into unwieldy and unpredictable events. Factors important to the fighting of such fires include access, firebreaks, proximity of water sources, distance from a fire station, and available firefighting personnel and equipment. Reviewing past wildland/urban interface fires shows that many structures are destroyed or damaged for one or more of the following reasons:

- ✓ Combustible roofing material;
- ✓ Wood construction;
- ✓ Structures with no defensible space;
- ✓ Fire department with poor access to structures;
- ✓ Subdivisions located in heavy natural fuel types;
- ✓ Structures located on steep slopes covered with flammable vegetation;
- ✓ Limited water supply; and
- ✓ Winds over 30 miles per hour.

Road Access:

Road access is a major issue for all emergency service providers. As development encroaches into the rural areas of the county, the number of houses without adequate turn-around space is increasing. In many areas, there is not adequate space for emergency vehicle turn-arounds in single-family residential neighborhoods, causing emergency workers to have difficulty doing their jobs because they cannot access houses. As fire trucks are large, firefighters are challenged by narrow roads and limited access, when there is inadequate turn-around space, the fire fighters can only work to remove the occupants, but cannot safely remain to save the threatened structures.

Water Supply:

Firefighters in remote and rural areas are faced by limited water supply and lack of hydrant taps. Rural areas are characteristically outfitted with small diameter pipe water systems, inadequate for providing sustained firefighting flows.

Interface Fire Education Programs and Enforcement:

Fire protection in urban/wildland interface areas may rely heavily more on the landowner's personal initiative to take measures to protect his or her own property. Therefore, public education and awareness may play a greater role in interface areas. In those areas with strict fire codes, property owners who resist maintaining the minimum brush clearances may be cited for failure to clear brush.

The Need for Mitigation Programs:

Continued development into the interface areas will have growing impacts on the wildland/urban interface. Periodically, the historical losses from wildfires in Southern California have been catastrophic, with deadly and expensive fires going back decades. The continued growth and development increases the public need for natural hazards mitigation planning in Southern California.

Wildfire Mitigation Activities

Existing mitigation activities include current mitigation programs and activities that are being implemented by county, regional, state, or federal agencies or organizations.

Local Programs:

In Southern California there are dozens of independent local fire departments as well as large county-wide consolidated fire districts. Although each district or department is responsible for fire-related issues in specific geographic areas, they work together to keep Southern California residents safe from fire. Although fire agencies work together to fight urban/wildland interface fires, each separate agency may have a somewhat different set of codes to enforce for mitigation activities.

The fire departments and districts provide essential public services in the communities they serve and their duties far surpass extinguishing fires. Most of the districts and departments provide other services to their jurisdictions, including Emergency Medical Services who can begin treatment and stabilize sick and injured patients in emergency situations. All of the fire service providers in the county are dedicated to fire prevention and use their resources to educate the public to reduce the threat of the fire hazard, especially in the wildland/urban interface. Fire prevention professionals throughout the county have taken the lead in providing many useful and educational services to Southern California residents, such as:

- ✓ Home fire safety inspection;
- ✓ Assistance developing home fire escape plans;
- ✓ Business Inspections;
- ✓ Pasadena Emergency Response Training (PERT);
- ✓ Fire cause determination;
- ✓ Counseling for juvenile fire-setters;
- ✓ Teaching fire prevention in schools;
- ✓ Coordinating educational programs with other agencies, hospitals and schools; and
- ✓ Answering citizens' questions regarding fire hazards.

The Threat of Urban Conflagration:

Although communities without an urban/wildland interface are much less likely to experience a catastrophic fire, in Southern California there is a scenario where any community might be exposed to an urban conflagration similar to the fires that occurred following the 1906 San Francisco earthquake. Large fires following an earthquake in an urban region are relatively rare phenomena, but have occasionally been of catastrophic proportions. The two largest peace-time urban fires in history, 1906 San Francisco and 1923 Tokyo, were both caused by earthquakes.

The fact that fire following earthquake has been little researched or considered in the United States is particularly surprising when one realizes that the conflagration in San Francisco after the 1906 earthquake was the single largest urban fire, and the single largest earthquake loss, in U.S. history. The loss over three days of more than 28,000 buildings within an area of 12 km^2 was staggering: $250 million in 1906 dollars, or about $5 billion at today's prices.

The 1989 Loma Prieta Earthquake, the 1991 Oakland hills fire, and Japan's Fukushima all demonstrate the possibility of a large fire, such as a fire following an earthquake, developing into a conflagration. In the United States, all the elements that would hamper fire-fighting capabilities are present: density of wooden structures, limited personnel and equipment to address multiple fires, debris blocking the access of fire-fighting equipment, and a limited water supply.

Fire Codes:

The Pasadena Fire Department shall enforce the brush clearance requirements specified in the Uniform Fire Code (2012 Edition). The Fire Code requirements include:

- ✓ Remove all flammable vegetation or other combustible growth within 30 feet of any structure, or in areas determined to be high hazard, the brush shall be cleared a minimum of 100 feet from any structure. Single trees, ornamental shrubbery, or cultivated ground covers may be permitted provided they are maintained in such a manner that they do not easily transmit fire from the vegetation to the structure.

- ✓ For areas considered extremely hazardous, the inspecting fire officer, with the approval of the Fire Chief, may require an additional 100 feet of clearance for a total of 200 feet minimum away from any structure,

- ✓ For trees taller than 18 feet, lower branches shall be pruned with a minimum clearance of 6 feet from the ground. Dead branches shall be removed or pruned from living trees. Dead braches shall not be allowed within 10 feet of woodpiles or stacked wood.

- ✓ Woodpiles or stacked wood shall not be allowed within 30 feet of a structure. Flammable vegetation shall not be allowed within 10 feet of woodpiles or stacked wood.

- ✓ All dead leaves and flammable debris shall be removed from roofs and rain gutters.

- ✓ All chimneys and fireplaces shall be equipped with an approved metal or non-flammable spark arrestor consisting of a screen of ½ inch or smaller mesh.

There have been recent changes in the City of Pasadena Building Codes which should also improve fire safety. The use of wood roofs or exterior wall coverings has been prohibited. Sheer wall regulations designed to improve earthquake survivability will also improve fire safety to structures. The improved earthquake standards for direct vent, sealed combustion gas stoves can help prevent the spread of fire after an earthquake.

It is the philosophy of the Pasadena Fire Department to prevent catastrophic brush fires through comprehensive code enforcement efforts and, when necessary, a rapid response of properly trained and equipped firefighters. Successfully preventing fires requires a partnership between the community and the Pasadena Fire Department to maintain the hill areas free of hazardous brush and combustible vegetation.

Other Mitigation Programs and Activities:

Improvements in firefighting techniques and equipment are important mitigation activities. The Los Angeles County Fire Department has retrofitted more than 100 fire engines with fire retardant foam capability, and the City of Pasadena has two fire engines

with fire retardant foam capability. An agreement between the City of Pasadena and the US Forest Service for joint firefighting operations for area fires has also been approved.

Prescribed Burning:
The health and condition of a forest will determine the magnitude of wildfire. If fuels such as dead vegetation, fallen limbs, and dead trees are allowed to accumulate over long fire can move more quickly and destroy everything in its path. The results are more catastrophic than if the fuels are periodically eliminated. CalFire has a program with the US Forest Service for prescribed burning.

Firewise:
Firewise is a program developed within the National Wildland/ Urban Interface Fire Protection Program and it is the primary federal program addressing interface fire. It is administered through the National Wildfire Coordinating Group whose extensive list of participants includes a wide range of federal agencies. The program is intended to empower planners and decision-makers at the local level. Through conferences and information dissemination, Firewise increases support for interface wildfire mitigation by educating professionals and the general public about hazard evaluation and policy implementation techniques. Firewise offers online wildfire protection information and checklists, as well as listings of other publications, videos, and conferences.

Wildfire Mitigation Action Items

As stated in the Federal Wildland Fire Policy, **"***The problem is not one of finding new solutions to an old problem but of implementing known solutions.* Deferred decision making is as much a problem as the fires themselves. If history is to serve us in the resolution of the wildland/urban interface problem, we must take action on these issues now. To do anything less is to guarantee another review process in the aftermath of future catastrophic fires."

The wildfire mitigation action items provide direction on specific activities that organizations and residents in Pasadena can undertake to reduce risk and prevent loss from wildfire events. Each action item is followed by ideas for implementation, which can be used by local decision makers in pursuing strategies for implementation.

Short-Term –Wildfire #l:

Enhance emergency services to increase the efficiency of wildfire response and recovery activities.

Ideas for Implementation:

Continue to develop Fire Watch programs and increase reporting stations/communications equipment (such as additional fire-reporting phone lines) for better access and coverage.

Continue to develop and increase training and outreach programs.

Enhance internal and external notification systems that include all at-risk urban/wildland interface residents in the jurisdiction in order to contact them during evacuations.

Coordinating Organization:	Pasadena Fire Department
Timeline:	2 years
Potential Funding Sources:	Responsible departments will be directed to include the cost of this item in their department budget; also see Appendix B
Plan Goals Addressed:	Emergency Services
Constraints:	Pending funding and available personnel

Short-Term – Wildfire #2:

Develop alternative firefighting water sources and continue efforts to improve the survivability of the water main system within the City of Pasadena.

Ideas for Implementation

Ensure that all water storage systems are supported by portable generators incase regular power sources are interrupted.

Continue to harden all water storage facilities and delivery systems.

Coordinating Organization:	Pasadena Fire, Public Works and Water Department
Timeline:	2 years
Potential Funding Sources:	Responsible departments will be directed to include the cost of this item in their department budget; also see Appendix B
Plan Goals Addressed:	Protect Life and Property
Constraints:	Pending funding and available personnel

Long-Term –Wildfire #l:

Encourage development and dissemination of maps relating to the fire hazard to educate and assist builders and homeowners in wildfire mitigation activities. Improved mapping will also assist emergency services during a wildfire response.

Ideas for Implementation:

Continually update wildland/urban interface maps.

Post maps online for residents living in potential wildfire threat zones.

Conduct seasonal mapping surveys of potential wildfire interface regions.

Coordinating Organization:	Pasadena Fire Department
Timeline:	1-3 years
Potential Funding Sources	See Appendix B
Plan Goals Addressed:	Protect Life and Property
Constraints:	Pending funding and available personnel

Long-Term – Wildfire #2:

Enhance outreach and education programs aimed at mitigating wildfire hazards and reducing or preventing the exposure of citizens, public agencies, private property owners and businesses to natural hazards.

Ideas for Implementation:

Continue the hiring of fire prevention and education personnel to oversee education programs;

Continue to train in all areas of fire prevention;

Visit urban interface neighborhoods and rural areas and conduct education and outreach activities;

Conduct specific community-based demonstration projects of fire prevention and mitigation in the urban interface;

Establish neighborhood "drive-through" activities that pinpoint site-specific mitigation activities.

Perform public outreach and information activities at fire stations. Fire stations can hold open houses and allow the public to visit, see the equipment and discuss wildfire mitigation with the station crews.

Coordinating Organization:	Pasadena Fire Department
Timeline:	Ongoing
Potential Funding Sources	See Appendix B
Plan Goals Addressed:	Protect Life and Property, Public Awareness
Constraints:	Pending funding and available personnel

Long-Term – Wildfire #3:

Encourage implementation of wildfire mitigation activities in a manner consistent with the goals of promoting sustainable ecological management and community stability.

Ideas for Implementation:

Employ mechanical thinning to abate the risk of catastrophic fire and restore the more natural regime of high frequency, low-intensity burns. Prescribed burning can provide benefit to ecosystems by thinning hazardous vegetation and restoring ecological diversity to areas homogenized by the use of native plants.

Encourage homeowners to clear trimmings, trees, brush and other debris completely from sites when performing routine maintenance and landscaping to reduce fire risk.

Enhance programs to coordinate and monitor adjacent areas who utilize prescribed burning techniques.

Coordinating Organization:	Pasadena Fire Department
Timeline:	Ongoing
Potential Funding Sources	See Appendix B
Plan Goals Addressed:	Natural Systems
Constraints:	Pending funding and available personnel

Wildfire Resource Directory

Local Resources:

The Pasadena Fire Department is responsible for fire suppression on all private lands within the City of Pasadena. The Pasadena Fire Department constantly monitors the fire hazard in the City and has ongoing programs for investigation and alleviation of hazardous situations. Firefighting resources in the immediate Pasadena area include Pasadena Fire Department Station Numbers 31 to 39 (with the exception of Station No. 35, which does not exist). Staffing at these stations is as follows:

4 crew members per each ladder truck
4 crew members per each engine company
2 crew members per rescue ambulance

Pasadena has mutual aid and automatic aid agreements with adjacent cities, the County of Los Angeles, and the US Forestry Service. These agreements obligate the departments to help each other under pre-defined circumstances. Automatic aid agreements obligate the nearest fire company to respond to a fire regardless of the jurisdiction. Mutual aid agreements obligate fire department resources to respond outside of their district upon request for assistance. The Pasadena Fire Department is party to an agreement that authorizes calls for emergency response to be dispatched through the Verdugo Joint Fire Communications Center. Jurisdictions that are responsible for fire suppression in areas adjacent to Pasadena include:

US Forest Service
Los Angeles County Fire Department
City of Los Angeles
City of Glendale
City of Sierra Madre
City of Arcadia
City of San Marino
City of South Pasadena
City of Burbank
City of Monrovia
City of Monterey Park
City of Alhambra
City of San Gabriel

Numerous other agencies are available to assist the City if needed. Several federal agencies have roles in fire hazard mitigation, response, and recovery, Including:

Fish and Wildlife Service
National Park Service
US Forest Service
Bureau of Land Management
Bureau of Indian Affairs

Office of Aviation Services
National Weather Service
National Association of State Foresters
California Department of Forestry

The State Office of Emergency Services can be called upon for further aid if necessary, as can federal agencies, including:

Department of Agriculture
Department of the Interior
Department of Defense (in extreme cases)

Private companies and individuals may also assist.

County Resources:

Los Angeles County Fire Department
1320 N. Eastern Ave.
Los Angeles, CA. 90063
Telephone: (323).881-2411
http://www.lacofd.org/default.htm

State Resources:

California Division of Forestry & Fire Protection
1416 9th Street
PO Box 944246
Sacramento California 94244-2460
(916)653-5123
http://www.fire.ca.gov/php/index.php

Office of the State Fire Marshal (OSFM)
1131 "S" Street
Sacramento, CA 95814
PO Box 944246
Sacramento, CA 94244-2460
Tel. (916) 445-8200
Fax. (916) 445-8509

Federal Resources and Programs:

Federal Wildland Fire Policy: Wildland/Urban Interface Protection
This is a report describing federal policy and interface fire. Areas of needed improvement are identified and addressed through recommended goals and actions.
http://www.fs.fed.us/land/wdfire7c.htm

National Fire Protection Association (NFPA)
This is the principal federal agency involved in the National Wildland/Urban Interface Fire Protection Initiative. NFPA has information on the Initiatives programs and documents.
Public Fire Protection Division
1 Battery March Park.
P.O. Box 9101
Quincy, MA 02269-9101
Phone: (617) 770-3000

National Interagency Fire Center (NIFC)
The NIFC in Boise, Idaho is the nation's support center for wildland firefighting. Seven federal agencies work together to coordinate and support wildland fire and disaster operations. These agencies include the Bureau of Indian Affairs, Bureau of Land Management, Forest Service, Fish and Wildlife Service, National Park Service, National Weather Service and Office of Aircraft
National Interagency Fire Center
3833 S. Development Ave.
Boise, Idaho 83705
(208) 387-5512
http://www.nifc,gov/

United States Fire Administration (USFA) of the Federal Emergency Management Agency (FEMA)
As an entity of the Federal Emergency Management Agency, the mission of the USFA is to reduce life and economic losses due to fire and related emergencies through leadership, advocacy, coordination and support.
USFA, Planning Branch, Mitigation Directorate
16825 S. Seton Ave.
Emmitsburg, MD 21727
(301) 447-1000
http://www.fema.gov/hazards/fires/wildfires.shtm - Wildfire Mitigation
http://www.usfa.fema.gov/index.htm - U.S. Fire Administration

Additional Resources:

Firewise - The National Wildland/Urban Interface Fire program
Firewise maintains a Website designed for people who live in wildfire prone areas, but it also can be of use to local planners and decision makers. The site offers online wildfire protection information and checklists, as well as listings of other publications, videos and conferences.
Firewise
1 Battery March Park.
P.O. Box 9101
Quincy, MA 02269-9101
Phone: (617) 770-3000
http://www.firewise.org/

Publications:

National Fire Protection Association Standard 299: Protection of Life and Property from Wildfire, National Wildland/Urban Interface Fire Protection Program, (1991), National Fire Protection Association, Washington, D.
This document, developed by the NFPA Forest and Rural Fire Protection Committee, provides criteria for fire agencies, land use planners, architects, developers and local governments to use in the development of areas that may be threatened by wildfire. To obtain this resource:
National Fire Protection Association Publications
(800) 344-3555
http://www.nfpa.org or http://www.firewise.org

An International Collection of Wildland- Urban Interface Resource Materials (Information Report NOR- 344). Hirsch, K., Pinedo, M., & Greenlee, J. (1996). Edmonton, Alberta: Canadian Forest Service.
This is a comprehensive bibliography of interface wildfire materials. Over 2,000 resources are included, grouped under the categories of general and technical reports, newspaper articles and public education materials. The citation format allows the reader to obtain most items through a library or directly from the publisher. The bibliography is available in hard copy or diskette at no cost. It is also available in downloadable PDF form.

Canadian Forest Service, Northern Forestry Centre, I-Zone Series
Phone: (780) 435-7210
http://www.prefire.ucfpl.ucop.edu/uwibib.htm

Wildland/Urban Interface Fire Hazard Assessment Methodology.
National Wildland/Urban Interface Fire Protection Program, (1998).
NFPA, Washington, D.C.
Firewise (NFPA Public Fire Protection Division)
Phone: (617) 984-7486
http://www.firewise.org

Fire Protection in the Wildland/Urban Interface: Everyone's Responsibility.
National Wildland/Urban Interface Fire Protection Program, (1998). Washington, D.
Firewise (NFPA Public Fire Protection Division)
Phone: (617) 984-7486
http://www.firewise, org

SECTION 5:
- WINDSTORMS -

Why are Windstorms a Threat to the City of Pasadena?

Severe windstorms pose a significant risk to life and property in the region by creating conditions that disrupt essential systems such as public utilities, telecommunications, and transportation routes. High winds can and do occasionally cause tornado-like damage to local homes and businesses. Severe windstorms can present a very destabilizing effect on the dry brush that covers local hillsides and urban wildland interface areas. High winds can have destructive impacts, especially to trees, power lines, and other utility services.

Windstorm Characteristics in Southern California:

Santa Ana Winds and Tornado-Like Wind Activity:

Based on local history, most incidents of high winds in the City of Pasadena are the result of the Santa Ana wind conditions. While high impact incidents are not frequent in the area, significant Santa Ana Wind events and sporadic tornado activity have been known to negatively impact the local community.

What are Santa Ana Winds?

Santa Ana winds are generally defined as warm, dry winds that blow from the east or northeast (offshore). These winds occur below the passes and canyons of the coastal ranges of Southern California and in the Los Angeles basin. Santa Ana winds often blow with exceptional speed in the Santa Ana Canyon (the canyon from which it derives its name). Forecasters at the National Weather Service offices in Oxnard and San Diego usually place speed minimums on these winds and reserve the use of "Santa Ana" for winds greater than 25 knots. These winds accelerate to speeds of 35 knots as they move through canyons and passes, with gusts to 50 or even 60 knots.

The complex topography of southern California, combined with various atmospheric conditions, creates numerous scenarios that may cause widespread or isolated Santa Ana events. Commonly, Santa Ana winds develop when a region of high pressure builds over the Great Basin (the high plateau east of the Sierra Mountains and west of the Rocky Mountains, including most of Nevada and Utah). Clockwise circulation around the center of this high pressure area forces air down-slope from the high plateau.

The air warms as it descends toward the California coast at the rate of 5 degrees Fahrenheit per 1000 feet due to compressional heating. Thus, compressional heating provides the primary source of warming. The air is dry since it originated in the desert, and it dries out even more as it is heated.

These regional winds typically occur from October to March and, according to most accounts, are named either for the Santa Ana River Valley where they originate or for the Santa Ana Canyon southeast of Lost Angeles, where they pick up speed.

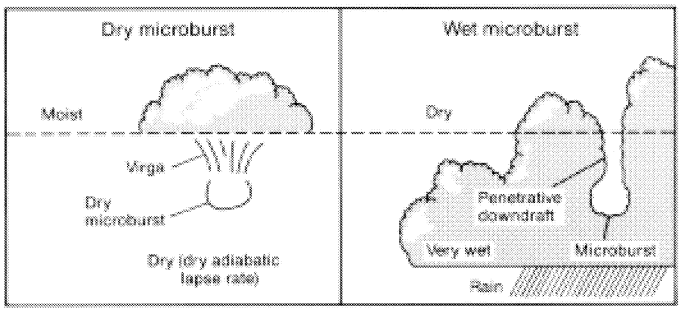
Tornados:

Tornados are spawned when there is warm, moist air near the ground; cool air aloft; and winds that speed up and change direction. An obstruction, such as a house, in the path of the wind causes it to change direction. This change increases pressure on parts of the house, and the combination of increased pressures and fluctuating wind speeds creates stresses that frequently cause structural failures.

Severe wind events are infrequent but possible in Los Angeles County. Waterspouts occur off the coast and several small tornados have occurred. One of the most serious tornados was a tornado that struck the City of Hawthorne on September 30, 1983. Roofs were torn off eight homes and sixty other homes were damaged. Three people were injured.

Microbursts:

Microbursts are strong, damaging winds which strike the ground and often give the impression a tornado has struck. They frequently occur during intense thunderstorms. The origin of a microburst is downward moving air from a thunderstorm's core. But unlike a tornado, they affect only a rather small area.

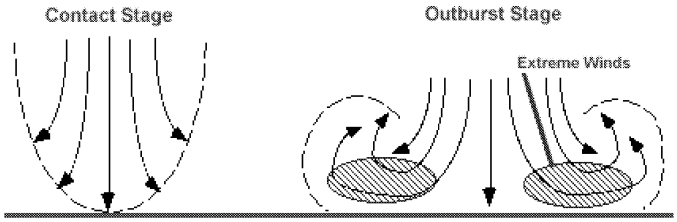


University of Chicago storm researcher Dr. Ted Fujita first coined the term "downburst" to describe strong, downdraft winds flowing out of a thunderstorm cell that he believed were responsible for the crash of Eastern Airlines Flight 66 in June of 1975.

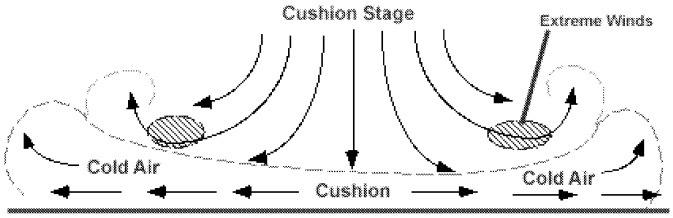
A downburst is a straight-direction surface wind in excess of 39 miles per hour caused by a small-scale, strong downdraft from the base of convective thundershowers and thunderstorms.

During Dr. Fujita's investigations into the phenomena, he defined two sub-categories of downbursts: the larger macrobursts and small microbursts.

Macrobursts are downbursts with winds up to 117 miles per hour which spread across a path greater than 2.5 miles wide at the surface and which last from 5 to 30 minutes. The microburst, on the other hand, is confined to an even smaller area, less than 2.5 miles in diameter from the initial point of downdraft impact. An intense microburst can result in damaging winds near 170 miles per hour and often lasts for less than five minutes.



Downbursts of all sizes descend from the upper regions of severe thunderstorms when the air accelerates downward through either exceptionally strong evaporative cooling or by very heavy rain, which drags dry air down with it. When the rapidly descending air strikes the ground, it spreads outward in all directions, like a fast-running faucet stream hitting the bottom of the sink.



When the microburst wind hits an object on the ground such as a house, garage, or tree, it can flatten the buildings and strip limbs and branches from the tree. After striking the ground, the powerful outward running gust can wreak further havoc along its path.

Damage associated with a microburst is often mistaken for the work of a tornado, particularly directly under the microburst. However, damage patterns away from the impact area are characteristic of straight line winds rather than the twisted pattern of tornado damage.

Tornados, like those that occur every year in the Midwest and Southeast portions of the United States, are a rare phenomenon in most of California, with most tornado-like activity coming from microbursts.

Local History of Windstorm Events:

The City of Pasadena has had several strong windstorms which resulted in local damages and power outages. Two of the most notable were the windstorms in 2006 and 2010. On January 23, 2006, a windstorm struck the City with winds up to 70 mph. Over 30 trees were toppled and power was disrupted to many residents. On April 20, 2010, a windstorm struck the Pasadena area. Trees and power lines were knocked down.

On December 1, 2011, the San Gabriel Valley was struck by a freak windstorm which caused over $40 million in damage. The City of Pasadena had nearly $25 million in damage. Portions of the City were without power for days, and debris clean-up lasted for over a month.

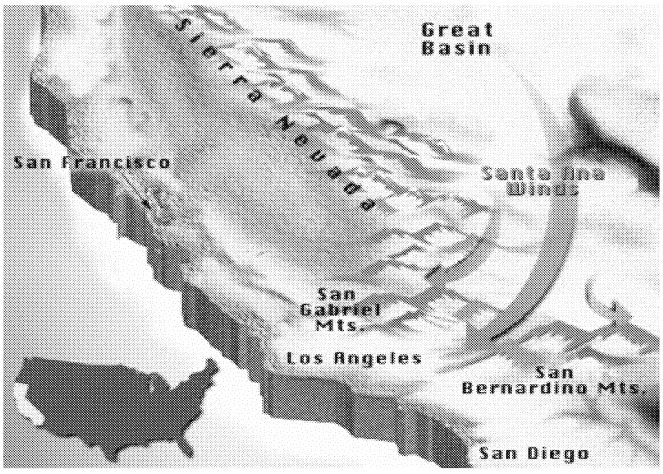
Windstorm Hazard Assessment

Hazard Identification:

A windstorm event in the region can range from short-term microburst activity lasting only minutes to a long-duration Santa Ana wind condition which may last for several days. This was the case in a January 2003 Santa Ana wind event. Windstorms in the City of Pasadena and surrounding area can cause extensive damage including the destruction of tree strands, road and highway infrastructure, and critical utility facilities.

With an analysis of the high wind and tornado events as depicted, we can deduce the common windstorm impact areas, including the effect on life, property, utilities, infrastructure, and transportation. Additionally, if a windstorm disrupts power to local residential communities, the American Red Cross and City resources might be called upon for care and shelter duties. Displacing residents and utilizing City resources for shelter staffing and disaster cleanup can cause an economic hardship on the community.

Santa Ana Wind Illustration



The above illustration shows the direction of the Santa Ana winds as they travel from the stable, high pressure weather system called the Great Basin through the canyons and towards the low pressure system off the Pacific. Clearly, the City of Pasadena is in the direct path of the ocean bound Santa Ana winds.

Community Windstorm Issues

What is Susceptible to Windstorms?

Life and Property:

Based on the history of the region, windstorm events can be expected, perhaps annually, across widespread areas of the region. Obviously, the City and surrounding region can be adversely impacted during a windstorm event. This can result in the involvement in the City of Pasadena's emergency response personnel during a wide-ranging windstorm or microburst tornadic activity.

Both residential and commercial structures with weak reinforcement are susceptible to damage. Wind pressure can create a direct and frontal assault on a structure, pushing walls, doors, and windows inward. Conversely, passing currents can create lift suction forces that pull building components and surfaces outward. With extreme wind forces, the roof or entire building can fail, causing considerable damage.

Debris carried along by extreme winds can directly contribute to loss of life and indirectly to the failure of protective building envelopes, siding, or walls. When severe windstorms strike a community, downed trees, power lines, and damaged property can be major hindrances to emergency response and disaster recovery.

The Beaufort Scale, as illustrated below, illustrates the effect that varying wind speed can have on sea swells and structures.

BEAUFORT SCALE

Beaufort Force	Speed (mph)	Wind Description - State of Sea - Effects on Land
0	Less 1	Calm - Mirror-like - Smoke rises vertically
1	1-3	Light - Air ripples look like scales; No crests of foam - Smoke drift shows direction of wind, but wind vanes do not
2	4-7	Light Breeze - Small but pronounced wavelets; Crests do not break - Wind vanes move; Leaves rustle; You can feel wind on the face
3	8-12	Gentle Breeze - Large Wavelets; Crests break; Glassy foam; A few whitecaps - Leaves and small twigs move constantly; Small, light flags are extended
4	13-18	Moderate Breeze - Longer waves; Whitecaps - Wind lifts dust and loose paper; Small branches move
5	19-24	Fresh Breeze - Moderate, long waves; Many whitecaps; Some spray - Small trees with leaves begin to move
6	25-31	Strong Breeze - Some large waves; Crests of white foam; Spray - Large branches move; Telegraph wires whistle; Hard to hold umbrellas
7	32-38	Near Gale - White foam from breaking waves blows in streaks with the wind - Whole trees move; Resistance felt walking into wind
8	39-46	Gale - Waves high and moderately long; Crests break into spin drift, blowing foam in well-marked streaks - Twigs and small branches break off trees; Difficult to walk
9	47-54	Strong Gale - High waves with wave crests that tumble; Dense streaks of foam in wind; Poor visibility from spray - Slight structural damage
10	55-63	Storm - Very high waves with long, curling crests; Sea surface appears white from blowing foam; Heavy tumbling of sea; Poor visibility - Trees broken or uprooted; Considerable structural damage
11	64-73	Violent Storm - Waves high enough to hide small and medium sized ships; Sea covered with patches of white foam; Edges of wave crests blown into froth; Poor visibility - Seldom experienced inland; Considerable structural damage
12	>74	Hurricane - Sea white with spray. Foam and spray render visibility almost non-existent - Widespread damage. Very rarely experienced on land.

Source: http://www.compuweather.com/decoder-charts.html

Utilities:

Historically, falling trees have been the major cause of power outages in the region. Windstorms such as strong microbursts and Santa Ana Wind conditions can cause flying debris and downed utility lines. For example, tree limbs breaking in winds of only 45 mph can be thrown over 75 feet. As such, overhead power lines can be damaged even in relatively minor windstorm events. Falling trees can bring electric power lines down to the pavement, creating the possibility of lethal electric shock. Rising population growth and new infrastructure in the region creates a higher probability for damage to occur from windstorms as more life and property are exposed to risk.

Infrastructure:

Windstorms can damage buildings, power lines, and other property and infrastructure due to falling trees and branches. During wet winters, saturated soils cause trees to become less stable and more vulnerable to uprooting from high winds.

Windstorms can result in collapsed or damaged buildings or blocked roads and bridges, damaged traffic signals, streetlights, and parks, among others. Roads blocked by fallen trees during a windstorm may have severe consequences to people who need access to emergency services. Emergency response operations can be complicated when roads are blocked or when power supplies are interrupted.

Industry and commerce can suffer losses from interruptions in electric services and from extended road closures. They can also sustain direct losses to buildings, personnel, and other vital equipment. There are direct consequences to the local economy resulting from windstorms related to both physical damages and interrupted services.

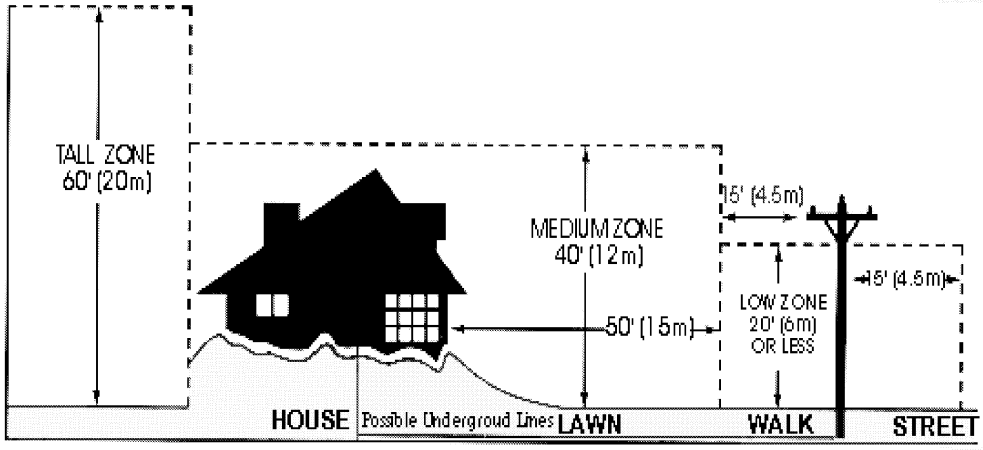
Increased Fire Threat:

Perhaps the greatest danger from windstorm activity in Southern California comes from the combination of the Santa Ana winds with the major fires that occur every few years in the urban/wildland interface. With the Santa Ana winds driving the flames, the speed and reach of the flames is even greater than in times of calm wind conditions. The higher fire hazard raised by a Santa Ana wind condition requires that even more care and attention be paid to proper brush clearances on property in the wildland/urban interface areas.

Transportation:

Windstorm activity can have an impact on local transportation in addition to the problems caused by downed trees and electrical wires blocking streets and highways. During periods of extremely strong Santa Ana winds, major highways can be temporarily closed to truck and recreational vehicle traffic. However, typically these disruptions are not long-lasting, nor do they carry a severe long-term economic impact on the region.

Existing Windstorm Mitigation Activities



As stated, one of the most common problems associated with windstorms is power outage. High winds commonly occur during winter storms, and can cause trees to bend, sag, or fail (tree limbs or entire trees), coming into contact with nearby distribution power lines. Fallen trees can cause short-circuiting and conductor overloading. Wind-induced damage to the power system causes power outages to customers, incurs cost to make repairs, and in some cases can lead to ignitions that start wild land fires.

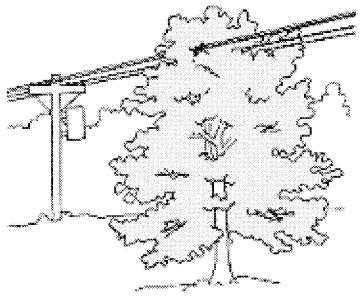
One of the strongest and most widespread existing mitigation strategies pertains to tree clearance. Currently, California State Law requires utility companies to maintain specific clearances (depending on the type of voltage running through the line) between electric power lines and all vegetation.

Enforcement of the following California Public Resource Code Sections provides guidance on tree pruning regulations:

4293: Power Line Clearance Required
4292: Power Line Hazard Reduction
4291: Reduction of Fire Hazards around Buildings
4171: Public Nuisances

The following pertain to tree pruning regulations and are taken from the California Code of Regulations:

Title 14: Minimum Clearance Provisions
Sections: 1250 – 1258
General Industry Safety Orders
Title 8: Group 3: Articles 12, 13, 36, 37, 38
California Penal Code: Section 385



Finally, the following California Public Utilities commission section has additional guidance:

California Public Utilities Commission
General Order 95: Rule 35

Homeowner Liability:

Failure to allow a utility company to comply with the law can result in liability to the homeowner for damages or injuries resulting from a vegetation hazard. Many insurance companies do not cover these types of damages if the policy owner has refused to allow the hazard to be eliminated.

The power companies, in compliance with the above regulations, collect data about tree failures and their impact on power lines. This mitigation strategy assists the power company in preventing future tree failures. From the collection of this data, the power company can advise residents as to the most appropriate vegetative planting and pruning procedures. The local electric utility, Southern California Edison, provides extensive information on trees and power lines at their website: www.sce.com.

Windstorm Mitigation Action Items

The windstorm mitigation action items provide direction on specific activities that organizations and residents in the City of Pasadena can undertake to reduce risk and prevent loss from windstorm events. Each action item is followed by ideas for implementation, which can be used by the Hazard Mitigation Advisory Committee and local decision makers in pursuing strategies for implementation.

Short-Term - Windstorm #1:

Provide public warning during periods when high winds are forecast for the area.

Ideas for Implementation:

Provide warnings on the City website

Provide public service announcements to the media.

Coordinating Organization:	Fire Dept**.** Office of Emergency Management
Timeline:	Ongoing
Potential Funding Sources:	Responsible departments will be directed to include the cost of this item in their department budget; also see Appendix B
Plan Goals Addressed:	Enhance public safety
Constraints:	Pending Funding and Available Personnel

Long-Term - Windstorm #1:

Assist private property owners regarding windstorm mitigation activities.

Ideas for Implementation:

Provide information on the City website about annual tree maintenance programs to limit damage from falling debris including tree trimming and debris removal.

Provide information on the City website regarding property protection strategies to limit damage from windstorms.

Coordinating Organization:	Public Works & City PIO
Timeline:	Ongoing
Potential Funding Sources	See Appendix B
Plan Goals Addressed:	Enhance public safety
Constraints:	Pending Funding and Available Personnel

Long -Term -Windstorm# 2:

Upgrade the current utility pole system in the City. The City of Pasadena is gradually moving electrical utilities underground. Pasadena has 14,000 wooden utility poles, many of which are over 30 years old.

Ideas for Implementation:

Continue annual inspections.

Restore/replace any worn or damaged power poles.

Coordinating Organization:	Water and Power Department
Timeline:	Annual
Potential Funding Sources	See Appendix B

Plan Goals Addressed:	Partnerships and Implementation , Protect Life and Property
Constraints:	Pending Funding and Available Personnel

Windstorm Resource Directory

State Resources:

California Division of Forestry & Fire Protection
1416 9th Street
PO Box 944246
Sacramento California 94244-2460
(916) 653-5123
http://www.fire.ca.gov/php/index.php

Federal Resources and Programs:

National Weather Service
Los Angeles/Oxnard Weather Forecast Office
520 North Elevar Street
Oxnard, CA 93030
Forecast and weather info: (805) 988-6610
Administrative issues: (805) 988-6615
E-mail: Webmaster.LOX@noaa.gov
http://weather.noaa.gov/

Additional Resources:

International Society of Arboriculture.
P.O. Box 3129
Champaign, IL 61826-3129
Phone: (217) 355-9411
Fax: (217) 355-9516
Web: www.isa-arbor.com
E-mail: isa@isa-arbor.com

Publications:

WINDSTORMS: Protect Your Family and Property from the Hazards of Violent Windstorms
http://emd.wa.gov/5-prep/trng/pubed/Windstrm.pdf

Preparing Your Home for Severe Windstorms is available from
http://www.chubb.com/personal/html/helpful_tips_home_windstorm.html

SECTION 6:
- HUMAN THREATS -

Why are Human-Made Disasters a Threat to the City of Pasadena?

The City of Pasadena is in one of the most densely populated urban areas in the United States. This proximity offers tremendous economic, social, and cultural advantages and opportunities. It also presents Pasadena a series of potential human made disasters and emergencies which can impact the community. These threats can be divided into four areas: accidents, criminal acts, terrorism and disease.

History of Human-Made Disasters in Southern California:

In the past one hundred years, Southern California has suffered from many disasters from accidents, criminal acts, terrorism, and disease. Some of the most infamous incidents include:

Accidents:
Some of the most noteworthy southern California accidents in recent history have involved transportation. In 1978 and 1986 commercial airlines collided with private planes. The 1978 crash involved a PSA jet inbound to San Diego airport. The 1986 mid-air crash involved an Aero Mexico 737 jet with a small plane over Cerritos. Both crashes were determined to be pilot error and resulted in the total loss of the passengers as well as the loss of numerous persons on the ground.

The 2003 Santa Monica Promenade auto crash involved an elderly driver crashing his car on a street which had been closed for a street fair. Ten people were killed and 63 injured. Southern California has also had several major mass transportation accidents involving the Metrolink commuter system. In 2008, a Metrolink train crashed head-on into a Union Pacific freight train in Chatsworth, resulting in 25 fatalities.

Criminal Acts:
Pasadena residents were victimized in the 1984 arson fire at the Oles Home Center which resulted in four fatalities. One of the worst criminal acts in the past ten years involved a crash of two Metrolink trains in 2005 in Glendale. This crash resulted in 11 fatalities and nearly 200 injuries. The crash was caused by a subject who parked his truck in the tracks in front of the oncoming trains. The driver was convicted of 22 counts of murder. Los Angeles has also been the scene of several riots, including the 1992 “Rodney King” riot.

Terrorism:
Like every major urban area, Los Angeles has been the target of repeated terrorist threats. The first major terrorist attack was the bombing of the Los Angeles Times

building in 1921 by two disgruntled members of a trade union; the attack resulted in 21 fatalities.

The Los Angeles International Airport has also been the target of terrorism. In 1974, a subject known as the "Alphabet Bomber" committed a series of arson fires and bombing attacks on the homes of government officials, culminating with placing a bomb in a locker at the airport, resulting in four fatalities. In 1999 an Algerian immigrant was intercepted entering the United States. The suspect was part of the "Millennium" bomb plot intended by several terrorist groups to strike targets around the world. He was carrying explosives and plans for an attack on Los Angeles International Airport. Following the 9/11 attacks federal authorities intercepted a plot to fly a hijacked airliner into buildings in downtown Los Angeles. In 2002 an Egyptian national attacked the ticket counter of El Al Airlines, killing three people before being shot by a security guard.

Disease:
Disease in urban areas is a constant and evolving threat. In the past century the United States and specifically Los Angeles have been struck by pandemic outbreaks. In 1918 the Spanish Flu, a form of the H1N1 swine flu, killed between 50 and 100 million people worldwide. In the United States the flu simultaneously originated in the Midwest and New England and rapidly moved across the country killing thousands on the west coast.

Among the greatest threats to urban areas are pandemics which originate from animals and are transmitted to humans through a process called zoonasis. Examples of diseases which are zoonatic include Ebola, anthrax, and Lassa fever. Of greatest concern to urban areas are influenza strains such the avian flu (H5N1) and swine flu (H1N1). In 1971 and 2002 the southwestern United States, from California to Texas, was struck by an avian flu strain called Exotic Newcastle Disease. This disease spread rapidly and devastated the commercial poultry industry.

Characteristics of Major HM Disasters in Southern California:

Major human-made disasters tend to occur in areas with high population density and a high level of personal interaction. The significance of population density can be illustrated by the fact that a private plane that crashes on a ranch in Mojave Desert has a far lower probability of injuring local residents than a plane which strikes a neighborhood near downtown Los Angeles.

The level of interaction also plays an important part. Areas where large crowds are interacting in economic, commercial, or social activities are natural places where human-made disasters can occur. The larger the numbers of people present, the greater the number of potential interactions. These interactions can result in accidents as well as provide attractive targets for criminals and terrorists.

Human-Made Hazard Assessment

Hazard Identification:

There are four areas which pose a significant threat to the City of Pasadena: transportation disasters, terrorism, civil unrest, and disease.

Transportation Disasters:
Pasadena has three types of threats from transportation systems: air crash, local freeways, and the light rail system which passes through the city. All of Los Angeles County is vulnerable to air disasters. There are numerous airports, handling both large commercial destinations and local aviation, within a flight short distance of the City. An aircraft damaged by a midair collision and suffering engine failure could strike the City. In 2002 a Cesena 172 private airplane crashed in Alhambra after running out of fuel.

The City of Pasadena has the 210 freeway from downtown Los Angeles to the north and Interstate 5 to the west. A truck accident with a hazardous materials spill could result in the release of a toxic cloud. The Gold Line light rail system passes through the City with a stop in the downtown area. This close proximity with passengers, pedestrians, and street traffic make this a potential hazard for the city.

Terrorism:
It is unlikely that Pasadena will be targeted by international terrorist groups. It is very possible that a local community could be targeted by individuals claiming allegiance to international terrorist groups. The LAX Alphabet Bomber Muharem Kurbegovich recently wrote from prison he now claims allegiance to the Al Qaeda terrorist organization. Terrorist acts by individuals against less protected targets could become more common in the next ten years.

Civil Unrest:
Civil unrest seems to be occurring more frequently as problems of unemployment and a lack of economic growth spread across the country. The downtown area of Los Angeles is a frequent site of demonstrations due to the presence of government buildings. It is conceivable that a demonstration could turn to violence and begin spreading into neighboring communities. Criminal street gangs often use the necessity for police to concentrate resources as an opportunity to commit criminal acts in neighboring cities.

Pandemics:
The Centers for Disease Control and the Los Angeles County Health Department have considered the impact of pandemic influenza outbreaks on urban areas in the United States. The rapid transmission of influenza could result in the closure of local schools and a reduced ability to provide basic City services including public safety.

Vulnerability Assessment/ Risk Analysis:

Transportation Disasters:
The greatest threat for a transportation disaster is related to the Metro Gold Line due to the proximity of the light rail tracks and cars to pedestrians and vehicular traffic.

Terrorism:
Pasadena is vulnerable to terrorist acts by local individuals who may claim allegiance with international terrorist groups.

Civil Unrest:
An infinite number of factors can precipitate civil unrest. These variables can also cause an incident to spread to areas that were not the origin point for the unrest.

Pandemics:
The ease of transmission couple with the virility of emerging contagions makes every community in major urban areas especially vulnerable to pandemics.

Human Threats Mitigation Action Items

Short-Term – Transportation #1:

Develop contingency plans for responding to a light rail accident in the downtown area.

Ideas for Implementation:

Develop and coordinate planning with Mutual Aid Area C for light rail accident involving mass casualties.

Coordinating Organization:	Pasadena Police and Fire Departments
Timeline:	1-2 years
Potential Funding Sources:	Responsible departments will be directed to include the cost of this item in their department budget; also see Appendix B
Plan Goals Addressed:	Protect Life and Property, Public Awareness
Constraints:	Pending Funding and Available Personnel

Short-Term –Terrorism #2:

Develop contingency plans for responding to a terrorist incident in Pasadena.

Ideas for Implementation:

Develop and coordinate planning with Mutual Aid Area C for terrorist events involving mass casualties.

Coordinating Organization:	Pasadena Police and Fire Departments
Timeline:	1-2 years
Potential Funding Sources:	Responsible departments will be directed to include the cost of this item in their department budget; also see Appendix B
Plan Goals Addressed:	Protect Life and Property, Public Awareness
Constraints:	Pending Funding and Available Personnel

Short-Term –Civil Unrest #3:

Develop contingency plans for responding to a terrorist incident in Pasadena.

Ideas for Implementation:

Develop and coordinate planning with Mutual Aid Area C for civil unrest events involving mass arrests.

Provide mobile field force training for Pasadena police officers.

Coordinating Organization:	Pasadena Police and Fire Departments
Timeline:	1-2 years
Potential Funding Sources:	Responsible departments will be directed to include the cost of this item in their department budget; also see Appendix B
Plan Goals Addressed:	Protect Life and Property, Public Awareness
Constraints:	Pending Funding and Available Personnel

Short-Term – Pandemics #4:

Develop contingency plans for responding to a pandemic outbreak involving Pasadena.

Ideas for Implementation:

Develop and coordinate planning with LA County Department of Health for distribution of medicines.

Prepare a plan for reducing City services due to sickness.

Prepare an operational plan for coordination of efforts with the local school district.

Coordinating Organization:	Pasadena Public Health Dept., Police and Fire Departments, City Manager's Office
Timeline:	1-2 years
Potential Funding Sources:	Responsible departments will be directed to include the cost of this item in their department budget; also see Appendix B
Plan Goals Addressed:	Protect Life and Property, Public Awareness
Constraints:	Pending Funding and Available Personnel

Long-Term – Mass Casualty Incidents #1:

Develop contingency plans for responding to a mass casualty event involving Pasadena.

Ideas for Implementation:

Develop and coordinate planning with LA County Mutual Aid Area C.

Prepare a plan with local hospitals and the Los Angeles Coroner's office .

Prepare an operational plan for coordination of efforts with the local school district.

Coordinating Organization:	Pasadena Police and Fire Departments City Manager's Office
Timeline:	1-2 years
Potential Funding Sources	See Appendix B
Plan Goals Addressed:	Protect Life and Property, Public Awareness
Constraints:	Pending Funding and Available Personnel

Human Threats Resource Directory

Local Resources:

The Pasadena Fire Department is responsible for fire suppression on all private lands within the City of Pasadena. The Pasadena Fire Department constantly monitors the fire hazard in the City and has ongoing programs for investigation and alleviation of hazardous situations. Firefighting resources in the immediate Pasadena area include the Pasadena Fire Department Stations and response capabilities from neighboring mutual aid cities.

The Pasadena Police Department is responsible for police services in the City. They provide 24 hour uniform patrol response as well as a wide variety of associated services, including traffic control and criminal investigations. The department actively participates in Los Angeles County Mutual Aid Area C, which provides immediate personnel and equipment resources during unusual occurrences.

The Metro light rail system is policed by the Los Angeles County Sheriff's Department Metrolink Division. Federal law enforcement resources are coordinated by the Los Angeles field office of the FBI. Intelligence information related to terrorism is shared by local cities and coordinated through the LA Regional Terrorism Early Warning system. The Los Angeles County Emergency Operations Center is jointly operated by the Los Angeles Sheriff's Department and the Los Angeles County Office of Emergency Services.

County Resources:

Los Angeles Sheriff's Department
4700 Ramona Blvd.
Monterey Park, Ca. 91754
800-698-8255

Los Angeles County Fire Department
1320 Eastern Ave.
Los Angeles, Ca.
323-881-2455

Federal Resources:

Federal Bureau of Investigation
Los Angeles Field Office
11000 Wilshire Boulevard
Suite 1700
Los Angeles, CA 90024
Phone: (310) 477-6565
Fax: (310) 996-3359

Part IV: Appendices

Appendix A: Cost Benefit Analysis Discussion

Economic Analysis of Natural Hazard Mitigation Projects

Benefit/cost analysis is a key mechanism used by CalEMA, the Federal Emergency Management Agency (FEMA), and other state and federal agencies in evaluating hazard-mitigation projects, and is required by the Robert T. Stafford Disaster Relief and Emergency Assistance Act, Public Law 93-288, as amended.

This appendix outlines several approaches for conducting economic analyses of natural-hazard-mitigation projects. It describes the importance of implementing mitigation activities, different approaches to economic analysis of mitigation strategies, and methods to calculate costs and benefits associated with mitigation strategies. Information in this section is derived in part from The Interagency Hazards Mitigation Team, State Hazard Mitigation Plan, (Oregon State Police, Office of Emergency Management, 2000), and Federal Emergency Management Agency (FEMA) Publication 331, Report on Costs and Benefits of Natural Hazard Mitigation.

This section is not intended to provide a comprehensive description of benefit/cost analysis, nor is it intended to provide the details of economic-analysis methods that can be used to evaluate local projects. It is intended to (1) raise benefit/cost analysis as an important issue, and (2) provide some background on how economic analysis can be used to evaluate mitigation projects.

Why Evaluate Mitigation Strategies?

Mitigation activities reduce the cost of disasters by minimizing property damage, injuries, and the potential for loss of life, and by reducing emergency response costs, which would otherwise be incurred.

Evaluating natural-hazard mitigation provides decision makers with an understanding of the potential benefits and costs of an activity, as well as a basis on which to compare alternative projects. Evaluating mitigation projects is a complex and difficult undertaking that is influenced by many variables.

First, natural disasters affect all segments of the community including individuals, businesses, and public services such as fire, police, utilities, and schools. Second, although some of the direct and indirect costs of disaster damages are measurable, some of the costs are nonfinancial and difficult to quantify in dollars. Third, many of the impacts of such events produce “ripple-effects” throughout the community, greatly increasing the disaster’s social and economic consequences.

Economic-Analysis Approaches

The approaches used to identify the costs and benefits associated with natural-hazard-mitigation strategies, measures, or projects fall into two general categories: benefit/cost analysis and cost-effectiveness analysis. The distinction between the two methods is the way in which the relative costs and benefits are measured. Additionally, there are varying approaches to assessing the value of mitigation for public-sector and private-sector activities.

Benefit/Cost Analysis
Benefit/cost analysis is used in natural-hazards mitigation to show if the benefits to life and property protected through mitigation efforts exceed the cost of the mitigation activity. Conducting benefit/cost analysis for a mitigation activity can assist communities in determining whether a project is worth undertaking now, in order to avoid disaster-related damages later. Benefit/cost analysis is based on calculating the frequency and severity of a hazard and avoiding future damages and risk.

In benefit/cost analysis, all costs and benefits are evaluated in terms of dollars, and a net benefit/cost ratio is computed to determine whether a project should be implemented (i.e., if net benefits exceed net costs, the project is worth pursuing). A project must have a benefit/cost ratio greater than 1 in order to be funded.

Cost-Effectiveness Analysis
Cost-effectiveness analysis evaluates how best to spend a given amount of money to achieve a specific goal. This type of analysis, however, does not necessarily measure costs and benefits in terms of dollars. Determining the economic feasibility of mitigating natural hazards can also be organized according to the perspective of those with an economic interest in the outcome. Hence, economic-analysis approaches are covered for both public and private sectors as follows.

Investing in public-sector mitigation activities. Evaluating mitigation strategies in the public sector is complicated because it involves estimating all of the economic benefits and costs regardless of who realizes them, potentially by a large number of people and economic entities. Some benefits cannot be evaluated monetarily, but still affect the public in profound ways. Economists have developed methods to evaluate the economic feasibility of public decisions that involve a diverse set of beneficiaries and nonmarket benefits.

Investing in private-sector mitigation activities. Private-sector mitigation projects may occur on the basis of one of two approaches: it may be mandated by a regulation or standard, or it may be economically justified on its own merits. A building or landowner, whether a private entity or a public agency, required to conform to a mandated standard, may consider the following options:

1. Request cost sharing from public agencies;
2. Dispose of the building or land either by sale or demolition;
3. Change the designated use of the building or land and change the hazard-mitigation compliance requirement; or
4. Evaluate the most feasible alternatives and initiate the most cost-effective hazard-mitigation alternative.

The sale of a building or land triggers another set of concerns. For example, real estate disclosure laws can be developed that require sellers of real property to disclose known defects and deficiencies in the property, including earthquake weaknesses and hazards, to prospective purchasers. Correcting deficiencies can be expensive and time consuming, but their existence can prevent the sale of the

building. Conditions of a sale regarding the deficiencies and the price of the building can be negotiated between a buyer and seller.

Conducting an Analysis

Benefit/cost analysis and cost-effectiveness analysis are important tools in evaluating whether to implement a mitigation activity. A framework for evaluating alternative mitigation activities is outlined below:

1. **Identify the alternatives:** Alternatives for reducing risk from natural hazards can include structural projects to enhance disaster resistance, education and outreach, and acquisition or demolition of exposed properties, among others. Different mitigation projects can assist in minimizing risk to natural hazards, but do so at varying economic costs.

2. **Calculate the costs and benefits:** Choosing economic criteria is essential to systematically calculating costs and benefits of mitigation projects and selecting the most appropriate alternative. Potential economic criteria to evaluate alternatives include the following:

   - **Determine the project cost.** This may include initial project-development costs, and repair and operating costs of maintaining projects over time.

   - **Estimate the benefits.** Projecting the benefits or cash flow resulting from a project can be difficult. Expected future returns from the mitigation effort depend on the correct specification of the risk and the effectiveness of the project, which may not be well known. Expected future costs depend on the physical durability and potential economic obsolescence of the investment. This is difficult to project. These considerations will also provide guidance in selecting an appropriate salvage value. Future tax structures and rates must be projected. Financing alternatives must be researched, and they may include retained earnings, bond and stock issues, and commercial loans.

   - **Consider costs and benefits to society and the environment.** These are not easily measured, but can be assessed through a variety of economic tools including existence-value or contingent-value theories. These theories provide quantitative data on the value people attribute to physical or social environments. Even without hard data, however, impacts of structural projects to the physical environment or to society should be considered when implementing mitigation projects.

   - **Determine the correct discount rate.** Determination of the discount rate can just be the risk-free cost of capital, but it may include the decision maker's time preference and also a risk premium. Inflation should also be considered for inclusion.

3. **Analyze and Rank the Alternatives:** Once costs and benefits have been quantified, economic-analysis tools can rank the alternatives. Two methods for determining the best alternative given varying costs and benefits include net present value and internal rate of return.

    - **Net present value.** Net present value is the value of the expected future returns of an investment minus the value of expected future cost expressed in today's dollars. If the net present value is greater than the project costs, the project may be determined to be feasible for implementation. Selecting the discount rate, and identifying the present and future costs and benefits of the project calculates the net present value of projects.

    - **Internal rate of return.** Using the internal-rate-of-return method to evaluate mitigation projects provides the interest-rate equivalent to the dollar returns expected from the project. Once the rate has been calculated, it can be compared to rates earned by investing in alternative projects. Projects may be feasible to implement when the internal rate of return is greater than the total costs of the project.

Once mitigation projects are ranked on the basis of economic criteria, decision makers can consider other factors, such as risk; project effectiveness; and economic, environmental, and social returns in choosing the appropriate project for implementation.

Economic Returns of Natural-Hazard Mitigation

The estimation of economic returns that accrue to buildings or landowners as a result of natural-hazard mitigation is difficult. Owners evaluating the economic feasibility of mitigation should consider reductions in physical damages and financial losses. A partial list follows:

- Building damages avoided
- Content damages avoided
- Inventory damages avoided
- Rental-income losses avoided
- Relocation and disruption expenses avoided
- Proprietor's income losses avoided

These parameters can be estimated using observed prices, costs, and engineering data. The difficult part is to correctly determine the effectiveness of the hazard-mitigation project and the resulting reduction in damages and losses. Equally as difficult is assessing the probability that an event will occur. The damages and losses should only include those that will be borne by the owner. The salvage value of the investment can be important in determining economic feasibility. Salvage value becomes more important as the time horizon of the owner declines. This is important because most businesses depreciate assets over a period of time.

Related Costs from Natural Hazards
Property owners should also assess changes in a broader set of factors that can change as a result of a large natural disaster. These are usually termed "indirect" effects, but they can have a very direct effect on the economic value of the owner's building or land. They can be positive or negative, and include changes in the following:

- Commodity and resource prices
- Availability of resource supplies
- Commodity- and resource-demand changes
- Building and land values
- Capital availability and interest rates
- Availability of labor
- Economic structure
- Infrastructure
- Regional exports and imports
- Local, state, and national regulations and policies
- Insurance availability and rates

Changes in the resources and industries listed above are more difficult to estimate and require models that are structured to estimate total economic impacts. Total economic impacts are the sum of direct and indirect economic impacts. Total-economic-impact models are usually not combined with economic-feasibility models. Many models exist to estimate total economic impacts of changes in an economy.

Decision makers should understand the total economic impacts of natural disasters in order to calculate the benefits of a mitigation activity. This suggests that understanding the local economy is an important first step in being able to understand the potential impacts of a disaster, and the benefits of mitigation activities.

Local Model for Mitigation Implementation
A January 30, 2013, memorandum to the City Manager from the Director of Public Works demonstrates a local model for mitigation implementation:

"On February 4, the City of Pasadena will begin the seismic retrofit and rehabilitation of Fire Station 39, located at 50 Avenue 64. The fire station, originally constructed in 1952, will receive seismic improvements and a full interior remodel which, when completed in fall of 2013, will provide a structurally sound and updated fire station facility in southwest Pasadena.

The project involves the seismic retrofit and interior remodel of the existing station building, accessibility and technology upgrades, and construction of a patio deck and emergency generator room. Life safety enhancements include fire sprinkler and alarm systems.

The Department of Public Works, Design and Historic Preservation Section of the Planning Department, and the design team worked with Pasadena Heritage to develop a design that retains the historic exterior of the building while improving energy efficiency

and public access to the station. The retrofit will achieve compliance with state structural requirements for essential facilities, helping to ensure the station remains functional after a seismic event. The rehabilitation also meets the requirements for Leadership in Energy and Environmental Design (LEED) Silver Certification.

The $1,781,000 construction project funded by City Capital Improvement Project Funds, will be undertaken by local general contractor Mallcraft Inc., starting with interior demolition, followed by installation of seismic improvements to the facility and interior improvements. Exterior improvements to the brick building façade will be accomplished in concert with State preservation guidelines that retains the historic exterior of the structure. The Department of Public Works will manage the construction project.

Additional Considerations

Conducting an economic analysis for potential mitigation activities can assist decision makers in choosing the most appropriate strategy for their community to reduce risk and prevent loss from natural hazards. Economic analysis can also save time and resources from being spent on inappropriate or unfeasible projects. Several resources and models are listed on the following page that can assist in conducting an economic analysis for natural-hazard-mitigation activities.

Benefit/cost analysis is complicated, and the numbers may divert attention from other important issues. It is important to consider the qualitative factors of a project associated with mitigation that cannot be evaluated economically. There are alternative approaches to implementing mitigation projects.

Many communities are looking toward developing multi-objective projects. The multi-objective strategy can integrate natural-hazard mitigation with projects related to watersheds, environmental planning, community economic development, and small-business development, among others. Incorporating natural-hazard mitigation with other community projects can increase the viability of project implementation.

STAPLEE Worksheets

Goals: City of Pasadena
Objectives: Short- and Long-Term Multi-Hazard Action Items

STAPLEE Criteria	S (Social)		T (Technical)			A (Administrative)			P (Political)			L (Legal)			E (Economic)				E (Environmental)				
Considerations → for Alternative Actions ↓	Community Acceptance	Effect on Segment of Population	Technical Feasibility	Long-term Solution	Secondary Impacts	Staffing	Funding Allocated	Maintenance/ Operations	Political Support	Local Champion	Public Support	State Authority	Existing Local Authority	Potential Legal Challenge	Benefit of Action	Cost of Action	Contributes to Economic Goals	Outside Funding Required	Effect on Land/Water	Effect on Endangered Species	Effect on HAZMAT/Waste Sites	Consistent with Community Environmental Goals	Consistent with Federal Laws
STA-MH#1	+	+	+	+	+	-	-	-	-	-	+	+	+	-	+	-	+	-	+	+	n/a	+	+
STA-MH#2	+	+	+	-	-	-	-	-	+	-	+	+	+	-	+	-	+	-	n/a	n/a	n/a	+	+
STA-MH#3	+	+	+	+	+	-	-	-	+	-	+	+	+	-	+	-	+	-	+	+	+	+	+
LTA-MH#1	+	+	+	+	+	-	-	-	-	-	+	+	+	-	+	-	+	-	+	+	+	+	+
LTA-MH#2	+	+	+	+	+	-	-	-	-	-	+	+	+	-	+	-	+	-	+	+	+	+	+
LTA-MH#3	+	+	+	+	+	-	-	-	-	-	+	+	+	-	+	-	+	-	+	+	+	+	+
LTA-MH#4	+	+	-	+	+	-	-	-	-	-	+	+	+	-	+	-	+	-	+	+	+	+	+
LTA-MH#5	+	+	+	+	+	-	-	-	-	-	+	+	+	-	+	-	+	-	+	+	+	+	+

Goals: City of Pasadena
Objectives: Short- and Long-Term Earthquake Action Items

STAPLEE Criteria	S (Social)		T (Technical)			A (Administrative)			P (Political)			L (Legal)			E (Economic)				E (Environmental)				
Considerations → for Alternative Actions ↓	Community Acceptance	Effect on Segment of Population	Technical Feasibility	Long-Term Solution	Secondary Impacts	Staffing	Funding Allocated	Maintenance/ Operations	Political Support	Local Champion	Public Support	State Authority	Existing Local Authority	Potential Legal Challenge	Benefit of Action	Cost of Action	Contributes to Economic Goal	Outside Funding Required	Effect on Land/Water	Effect on Endangered Species	Effect on HAZMAT/Waste Sites	Consistent with Community Environmental Goals	Consistent with Federal Laws
STE#1	+	+	+	+	+	-	-	-	-	-	+	+	+	-	+	-	+	-	+	+	+	+	+
STE#2	+	+	-	+	+	-	-	-	-	-	+	+	+	-	+	-	+	-	n/a	n/a	n/a	n/a	n/a
LTE#1	+	+	+	+	+	-	-	-	-	-	+	+	+	-	+	-	+	-	+	+	+	+	+
LTE#2	+	+	-	-	-	-	-	-	-	-	+	+	+	-	+	-	+	-	n/a	n/a	n/a	n/a	n/a
LTE#3	+	+	+	+	+	-	-	-	-	-	+	+	+	-	+	-	+	-	+	+	+	+	+

Goals: City of Pasadena
Objectives: Short- and Long-Term Flood Action Items

STAPLEE Criteria	S (Social)		T (Technical)			A (Administrative)			P (Political)			L (Legal)			E (Economic)				E (Environmental)				
Considerations → for Alternative Actions ↓	Community Acceptance	Effect on Segment of Population	Technical Feasibility	Long-Term Solution	Secondary Impacts	Staffing	Funding Allocated	Maintenance/ Operations	Political Support	Local Champion	Public Support	State Authority	Existing Local Authority	Potential Legal Challenge	Benefit of Action	Cost of Action	Contributes to Economic Goals	Outside Funding Required	Effect on Land/Water	Effect on Endangered Species	Effect on HAZMAT/Waste Sites	Consistent with Community Environmental Goals	Consistent with Federal Laws
STF#1	+	+	+	+	+	-	-	-	-	-	+	+	+	-	-	-	+	-	+	+	+	+	+
STF#2	+	+	+	+	+	-	-	-	-	-	+	+	+	-	-	-	+	-	+	+	+	+	+
LTF#1	+	+	+	+	+	-	-	-	-	-	+	+	+	-	-	-	+	-	+	+	+	+	+
LTF#2	+	+	+	+	+	-	-	-	-	-	+	+	+	-	-	-	+	-	+	+	+	+	+
LTF#3	+	+	+	+	+	-	-	-	-	-	+	+	+	-	-	-	+	-	+	+	+	+	+
LTF#4	+	+	+	+	+	-	-	-	-	-	+	+	+	-	-	-	+	-	+	+	+	+	+
LTF#5	+	+	+	+	+	-	-	-	-	-	+	+	+	-	-	-	+	-	+	+	+	+	+

Goals: City of Pasadena
Objectives: Short- and Long-Term Landslide Action Items

STAPLEE Criteria	S (Social)		T (Technical)			A (Administrative)			P (Political)			L (Legal)			E (Economic)				E (Environmental)				
Considerations → for Alternative Actions ↓	Community Acceptance	Effect on Segment of Population	Technical Feasibility	Long-Term Solution	Secondary Impacts	Staffing	Funding Allocated	Maintenance/ Operations	Political Support	Local Champion	Public Support	State Authority	Existing Local Authority	Potential Legal Challenge	Benefit of Action	Cost of Action	Contributes to Economic Goals	Outside Funding Required	Effect on Land/Water	Effect on Endangered Species	Effect on HAZMAT/Waste Sites	Consistent with Community Environmental Goals	Consistent with Federal Laws
STL#1	+	+	+	+	+	-	-	-	-	-	+	+	+	-	-	-	+	-	+	+	+	+	+
STL#2	+	+	+	+	+	-	-	-	-	-	+	+	+	-	-	-	+	-	+	+	+	+	+
LTL#1	+	+	+	+	+	-	-	-	-	-	+	+	+	-	-	-	+	-	+	+	+	+	+

Goals: City of Pasadena
Objectives: Short- and Long-Term Wildfire Action Items

STAPLEE Criteria	S (Social)		T (Technical)			A (Administrative)			P (Political)			L (Legal)			E (Economic)				E (Environmental)				
Considerations → for Alternative Actions ↓	Community Acceptance	Effect on Segment of Population	Technical Feasibility	Long-Term Solution	Secondary Impacts	Staffing	Funding Allocated	Maintenance/ Operations	Political Support	Local Champion	Public Support	State Authority	Existing Local Authority	Potential Legal Challenge	Benefit of Action	Cost of Action	Contributes to Economic Goals	Outside Funding Required	Effect on Land/Water	Effect on Endangered Species	Effect on HAZMAT/Waste Sites	Consistent with Community Environmental Goals	Consistent with Federal Laws
STWF#1	+	+	+	+	+	-	-	-	-	-	+	+	+	-	-	-	+	-	+	+	+	+	+
STWF#2	+	+	+	+	+	-	-	-	-	-	+	+	+	-	-	-	+	-	+	+	+	+	+
LTWF#1	+	+	+	+	+	-	-	-	-	-	+	+	+	-	-	-	+	-	+	+	+	+	+
LTWF#2	+	+	+	+	+	-	-	-	-	-	+	+	+	-	-	-	+	-	+	+	+	+	+
LTWF#3	+	+	+	+	+	-	-	-	-	-	+	+	+	-	-	-	+	-	+	+	+	+	+

Goals: City of Pasadena
Objectives: Short- and Long-Term Windstorm Action Items

STAPLEE Criteria	S (Social)		T (Technical)			A (Administrative)			P (Political)			L (Legal)			E (Economic)				E (Environmental)				
Considerations → for Alternative Actions ↓	Community Acceptance	Effect on Segment of Population	Technical Feasibility	Long-term Solution	Secondary Impacts	Staffing	Funding Allocated	Maintenance/ Operations	Political Support	Local Champion	Public Support	State Authority	Existing Local Authority	Potential Legal Challenge	Benefit of Action	Cost of Action	Contributes to Economic Goals	Outside Funding Required	Effect on Land/Water	Effect on Endangered Species	Effect on HAZMAT/Waste Sites	Consistent with Community Environmental Goals	Consistent with Federal Laws
STWS#1	+	+	+	+	+	-	-	-	-	-	+	+	+	-	+	-	+	-	+	+	+	+	+
LTWS#1	+	+	+	+	+	-	-	-	-	-	+	+	+	-	+	-	+	-	+	+	+	+	+
LTWS#2	+	+	+	+	+	-	-	-	-	-	+	+	+	-	+	-	+	-	+	+	+	+	+

Goals: City of Pasadena
Objectives: Short- and Long-Term Human Threats Action Items

STAPLEE Criteria	S (Social)		T (Technical)			A (Administrative)			P (Political)			L (Legal)			E (Economic)				E (Environmental)				
Considerations → for Alternative Actions ↓	Community Acceptance	Effect on Segment of Population	Technical Feasibility	Long-term Solution	Secondary Impacts	Staffing	Funding Allocated	Maintenance/ Operations	Political Support	Local Champion	Public Support	State Authority	Existing Local Authority	Potential Legal Challenge	Benefit of Action	Cost of Action	Contributes to Economic Goals	Outside Funding Required	Effect on Land/Water	Effect on Endangered Species	Effect on HAZMAT/Waste Sites	Consistent with Community Environmental Goals	Consistent with Federal Laws
STHT#1	+	+	+	+	+	-	-	-	-	-	+	+	+	-	+	-	+	-	+	+	+	+	+
STHT#2	+	+	+	+	+	-	-	-	-	-	+	+	+	-	+	-	+	-	+	+	+	+	+
STHT#3	+	+	+	+	+	-	-	-	-	-	+	+	+	-	+	-	+	-	+	+	+	+	+
STHT#4	+	+	+	+	+	-	-	-	-	-	+	+	+	-	+	-	+	-	+	+	+	+	+
LTHT#1	+	+	+	+	+	-	-	-	-	-	+	+	+	-	+	-	+	-	+	+	+	+	+

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Appendix B: Potential Grant Funding

- *Below are some useful resources for additional grant funding that the city might want to consider applying for in achieving its mitigation goals and objectives:*

GRANT NAME	*AGENCY*	*PURPOSE*	*CONTACT*
Pre-Disaster Mitigation Program (PDM)	U.S. Department of Homeland Security, Federal Emergency Management Agency (FEMA)	To provide funding for States, and communities for cost-effective hazard mitigation activities which complement a comprehensive hazard mitigation program and reduce injuries, loss of life, and damage and deconstruction of property.	FEMA 500 C. Street, SW Washington, DC 20472 Phone: (202)646-4621 www.fema.gov
Hazard Mitigation Grant Program	U.S. Department of Homeland Security, Federal Emergency Management Agency (FEMA)	To prevent future losses of lives and property due to disasters; to implement State and local hazard mitigation plans; to enable mitigation measures to be implemented during immediate recovery from disasters; and to provide funding for previously identified mitigation measures to benefit the disaster area.	FEMA 500 C. Street, SW Washington, DC 20472 Phone: (202)646-4621 www.fema.gov
Flood Mitigation Assistance Program (RFC)	U.S. Department of Homeland Security, Federal Emergency Management Agency (FEMA)	To help states and communities plan and carry out activities designed to reduce the risk of flood damage to structures insurable under NFIP.	FEMA 500 C. Street, SW Washington, DC 20472 Phone: (202)646-4621 www.fema.gov
Repetitive Flood claims Program (RFC)	U.S. Department of Homeland Security, Federal Emergency Management Agency (FEMA)	To assist States and communities and reduce flood damages to insured properties that have had one or more claims to NFIP.	FEMA 500 C. Street, SW Washington, DC 20472 Phone: (202)646-4621 www.fema.gov
Severe Repetitive Loss (SRL) Program	U.S. Department of Homeland Security, Federal Emergency Management Agency (FEMA)	To provide funding to reduce or eliminate the long-term risk of flood damage to severe repetitive loss structures insured under the NFIP.	FEMA 500 C. Street, SW Washington, DC 20472 Phone: (202)646-4621 www.fema.gov
Emergency Management Performance Grants (EMPG)	U.S. Department of Homeland Security, Federal Emergency Management Agency (FEMA)	To encourage the development of comprehensive emergency management at the State and local level and to improve emergency management planning, preparedness, mitigation, response and recovery capabilities.	FEMA 500 C. Street, SW Washington, DC 20472 Phone: (202)646-4621 www.fema.gov
Community Development Grant Program (CDBG)	U.S. Department of Housing and Urban Development	To develop viable urban communities by providing decent housing and a suitable living environment. Principally for low-to-moderate income individuals.	HUD 451 7th Street, SW Washington, DC 20410-7000 Phone: (202) 708-3587 www.hud.gov
Public Assistance Program (PA)	U.S. Department of Homeland Security, Federal Emergency Management Agency (FEMA)	To provide supplemental assistance to States, local governments, and certain nonprofit organizations to alleviate suffering and hardship resulting from major disasters or emergencies declared by the President. Under Section 406, Public Assistance funds may be used to mitigate the impact of future disasters.	FEMA 500 C. Street, SW Washington, DC 20472 Phone: (202)646-4621 www.fema.gov
Flood control Works/Emergency Rehabilitation	U.S. Department of Defense, Army Corps of Engineers	To assist in the repairs and restoration of public works damaged by flood, extraordinary wind, wave or water action.	USACE 20 Massachusetts Avenue, NW Washington, DC 20314 Phone: (202) 761-0001 www.usace.army.mil
Emergency Watershed Protection	U.S. Department of Agriculture, Natural Resource Conservation Service	To provide emergency technical and financial assistance to install or repair structures that reduce runoff and prevent soil erosion to safeguard life and property.	NRCS PO Box 2890 Washington, DC 20013 Phone: (202) 720-3527 www.nrcs.usda.gov

Watershed Protection and Flood Prevention	U.S. Department of Agriculture, Natural Resource Conservation Service	To provide technical and financial assistance in planning and executing works of improvement to protect, develop, and use of land and water resources in small watersheds.	NRCS PO Box 2890 Washington, DC 20013 Phone: (202) 720-3527 www.nrcs.usda.gov
Land and Water Conservation Fund Grants	U.S. Department of the Interior, National Park Service	To acquire and develop outdoor recreation areas and facilities for the general public, to meet current and future needs.	NPS PO Box 37217 Washington, DC 20013-7127 Phone: (202) 565-1200 www.nps.gov
Disaster Mitigation and Technical Assistance Grants	US Department of commerce, Economic Development Administration	To help States and localities to develop and/or implement a variety of disaster mitigation strategies.	EDA Herbert C. Hoover Building Washington, DC 20230 Phone: (800) 345-1222 www.eda.gov
Pre-Disaster Mitigation Loan Program	US Small Business Administration	To make low-interest, fixed rate loans eligible for small businesses for the purpose of implementing mitigation measures to protect business property from damage that may be caused by future disasters.	SBA 1110 Vermont Avenue, NW, 9th Floor Washington, DC 20005 Phone: (202) 606-4000 www.sba.gov
Watershed Surveys and Planning	U.S. Department of Agriculture, Natural Resource Conservation Service	To provide planning assistance to Federal, state and local agencies for the development or coordination of water and related land resources and programs in watersheds and river basins.	NRCS PO Box 2890 Washington, DC 20013 Phone: (202) 720-3527 www.nrcs.usda.gov
Clean Water Act Section 319 Grants	US Environmental Protection Agency	To implement non-point source programs, including support for the non-structural watershed resource restoration activities.	EPA Ariel Rios Building 1200 Pennsylvania Avenue, NW Washington, DC 20460 Phone: (202) 272-0167 www.epa.gov
National Earthquake Hazards Reduction Program (NEHERP)	U.S. Department of Homeland Security, Federal Emergency Management Agency (FEMA)	To mitigate earthquake losses that can occur in many parts of the nation, providing earth science data and assessments essential for warning of imminent damaging earthquakes, land-use planning, engineering design, and emergency preparedness decisions.	FEMA 500 C. Street, SW Washington, DC 20472 Phone: (202)646-4621 www.fema.gov
Assistance to Firefighters Grant	U.S. Department of Homeland Security, Federal Emergency Management Agency (FEMA)	Competitively awarded project grants to provide direct assistance, on a competitive basis, to fire departments for the purpose of protecting the health and safety of the public and firefighting personnel against fire and fire-related hazards.	FEMA 500 C. Street, SW Washington, DC 20472 Phone: (202)646-4621 www.fema.gov
Fire Management Assistance Grants	U.S. Department of Homeland Security, Federal Emergency Management Agency (FEMA)	To provide project grants and the provision of specialized services for the mitigation, management, and control of fires that threatens such destruction as would constitute a major disaster.	FEMA 500 C. Street, SW Washington, DC 20472 Phone: (202)646-4621 www.fema.gov
Emergency Streambank and Shoreline Protection	U.S. Department of Defense, Army Corps of Engineers	To prevent erosion damages to public facilities by the emergency construction or repair of streambank and shoreline protection works.	USACE 20 Massachusetts Avenue, NW Washington, DC 20314 Phone: (202) 761-0001 www.usace.army.mil
Small Flood Control Projects	U.S. Department of Defense, Army Corps of Engineers	To reduce flood damages through small flood control projects not specifically authorized by Congress.	USACE 20 Massachusetts Avenue, NW Washington, DC 20314 Phone: (202) 761-0001 www.usace.army.mil

*Rural Fire Assistance (RFA_*	Fish and Wildlife Service	To implement the National Fire Plan by increasing firefighter safety and enhancing the knowledge and fire protection capability of rural and volunteer fire departments by providing basic wild land firefighting supplies and equipment.	US Department of Health and Human Services 200 Independence Avenue, SW Washington, DC 20201 HHH Building Grants.gov www.grants.gov
FY 12 ESAR-VHP Continuation	US Department of Health and Human Services	To integrate Medical, Public Health, Preparedness and Response training with registration of Volunteer Health Professionals	US Department of Health and Human Services Office of the Assistant Secretary for Pre4paredness and Response 395 E. St., SW Suite 1075 Washington, DC 20201 Phone: (202) 245-0961
FY 2012 Disaster Relief Opportunity	Economic Development Administration	The EAA program provides recipients with flexible tools to develop and implement regionally based long term economic development strategies in response to major Federally declared disasters. Through this program, EDA can support the development of disaster recovery strategies and recovery implementation, including infrastructure improvements and by using revolving loan funds.	Seattle Regional Office Jackson Federal Building 915 Second Avenue, Room 1890 Seattle, WA 98174 Phone: (206) 220-7699
"Good Practices" Manual Providing Guidance for Reducing the Risk of Floods Using Natural-Resource Based Techniques	US Department of Health and Human Services Agency for International Development	The Office of Foreign Disaster Assistance has a mandate to save lives, alleviate suffering and reduce the social and economic impacts of disasters. While the disasters that OFDA responds to result from a variety of causes, flooding is the most frequent hazard eliciting a response from OFDA in an average year. Responding to natural disasters is OFDA's primary role, but OFDA also provides support to vulnerable communities in developing	US Department of Health and Human Services Office of the Assistant Secretary for Pre4paredness and Response 395 E. St., SW Suite 1075 Washington, DC 20201

		strategies to mitigate the effects of recurrent natural disasters.	Phone: (202) 245-0961
Extension Integrated Pest management Coordination and Support	National Institute of Food and Agriculture (USDA)	To support research on pest management where facilities and practices safeguard and prevent environmental impacts. Routine renovation, rehabilitation, or revitalization of physical facilities, including the acquisition and installation of equipment, where such activity is limited in scope and intensity.	Phone: (202) 401-5048 www.nifa.usda.gov

Appendix C: Acronyms

Federal Acronyms

AASHTO	American Association of State Highway and Transportation Officials
ATC	Applied Technology Council
b/ca	benefit/cost analysis
BFE	Base Flood Elevation
BLM	Bureau of Land Management
BSSC	Building Seismic Safety Council
CDBG	Community Development Block Grant
CFR	Code of Federal Regulations
CRS	Community Rating System
EDA	Economic Development Administration
EPA	Environmental Protection Agency
ER	Emergency Relief
EWP	Emergency Watershed Protection (NRCS Program)
FAS	Federal Aid System
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
FMA	Flood Mitigation Assistance (FEMA Program)
FTE	Full Time Equivalent
GIS	Geographic Information System
GNS	Institute of Geological and Nuclear Sciences (International)
GSA	General Services Administration
HAZUS	Hazards U.S.
HMGP	Hazard Mitigation Grant Program
HMST	Hazard Mitigation Survey Team
HUD	Housing and Urban Development (United States, Department of)
IBHS	Institute for Business and Home Safety
ICC	Increased Cost of Compliance
IHMT	Interagency Hazard Mitigation Team
NCDC	National Climate Data Center
NFIP	National Flood Insurance Program
NFPA	National Fire Protection Association
NHMP	Natural Hazard Mitigation Plan (also known as “409 Plan”)
NIBS	National Institute of Building Sciences
NIFC	National Interagency Fire Center
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPS	National Park Service
NRCS	Natural Resources Conservation Service
NWS	National Weather Service
SBA	Small Business Administration
SEAO	Structural Engineers Association of Oregon
SHMO	State Hazard Mitigation Officer
TOR	Transfer of Development Rights

UGB	Urban Growth Boundary
URM	Unreinforced Masonry
USACE	United States Army Corps of Engineers
USBR	United States Bureau of Reclamation
USDA	United States Department of Agriculture
USFA	United States Fire Administration
USFS	United States Forest Service
USGS	United States Geological Survey
WSSPC	Western States Seismic Policy Council

California Acronyms

A&W	Alert and Warning
AA	Administering Areas
AAR	After Action Report
ARC	American Red Cross
ARP	Accidental Risk Prevention
ATC20	Applied Technology Council20
ATC21	Applied Technology Council21
BCP	Budget Change Proposal
BSA	California Bureau of State Audits
CAER	Community Awareness & Emergency Response
CalARP	California Accidental Release Prevention
CalBO	California Building Officials
CalEMA	California Emergency Management Agency (formerly OES)
CalEPA	California Environmental Protection Agency
CalREP	California Radiological Emergency Plan
CALSTARS	California State Accounting Reporting System
CalTrans	California Department of Transportation
CBO	Community Based Organization
CD	Civil Defense
CDF	California Department of Forestry and Fire Protection
CDMG	California Division of Mines and Geology
CEC	California Energy Commission
CEPEC	California Earthquake Prediction Evaluation Council
CESRS	California Emergency Services Radio System
CHIP	California Hazardous Identification Program
CHMIRS	California Hazardous Materials Incident Reporting System
CHP	California Highway Patrol
CLETS	California Law Enforcement Telecommunications System
CSTI	California Specialized Training Institute
CUEA	California Utilities Emergency Association
CUPA	Certified Unified Program Agency
DAD	Disaster Assistance Division (of CalEMA)
DFO	Disaster Field Office
DGS	California Department of General Services
DHSRHB	California Department of Health Services, Radiological Health Branch

DO	Duty Officer
DOC	Department Operations Center
DOE	Department of Energy (U.S.)
DOF	California Department of Finance
DOJ	California Department of Justice
DPA	California Department of Personnel Administration
DPIG	Disaster Preparedness Improvement Grant
DR	Disaster Response
DSA	Division of the State Architect
DSR	Damage Survey Report
DSW	Disaster Service Worker
DWR	California Department of Water Resources
EAS	Emergency Alerting System
EDIS	Emergency Digital Information System
EERI	Earthquake Engineering Research Institute
EMA	Emergency Management Assistance
EMI	Emergency Management Institute
EMMA	Emergency Managers Mutual Aid
EMS	Emergency Medical Services
EOC	Emergency Operations Center
EOP	Emergency Operations Plan
EPA	Environmental Protection Agency (U.S.)
EPEDAT	Early Post Earthquake Damage Assessment Tool
EPI	Emergency Public Information
EPIC	Emergency Public Information Council
ESC	Emergency Services Coordinator
FAY	Federal Award Year
FDAA	Federal Disaster Assistance Administration
FEAT	Governor's Flood Emergency Action Team
FEMA	Federal Emergency Management Agency
FFY	Federal Fiscal Year
FIR	Final Inspection Reports
FIRESCOPE	Firefighting Resources of So. Calif Organized for Potential Emergencies
FMA	Flood Management Assistance
FSR	Feasibility Study Report
FY	Fiscal Year
GIS	Geographical Information System
HAZMAT	Hazardous Materials
HAZMIT	Hazardous Mitigation
HAZUS	Hazards United States (an earthquake damage assessment prediction tool)
HAD	Housing and Community Development
HEICS	Hospital Emergency Incident Command System
HEPG	Hospital Emergency Planning Guidance
HIA	Hazard Identification and Analysis Unit
HMEP	Hazardous Materials Emergency Preparedness
HMGP	Hazard Mitigation Grant Program
IDE	Initial Damage Estimate

IA	Individual Assistance
IFG	Individual & Family Grant (program)
IRG	Incident Response Geographic Information System
IPA	Information and Public Affairs (of CalEMA)
LAN	Local Area Network
LEMMA	Law Enforcement Master Mutual Aid
LEPC	Local Emergency Planning Committee
MARAC	Mutual Aid Regional Advisory Council
MHID	Multi-Hazard Identification
MOU	Memorandum of Understanding
NBC	Nuclear, Biological, Chemical
NEMA	National Emergency Management Agency
NEMIS	National Emergency Management Information System
NFIP	National Flood Insurance Program
NOAA	National Oceanic and Atmospheric Association
NPP	Nuclear Power Plant
NSF	National Science Foundation
NWS	National Weather Service
OA	Operational Area
OASIS	Operational Area Satellite Information System
OCC	Operations Coordination Center
OCD	Office of Civil Defense
OEP	Office of Emergency Planning
OES	California Governor's Office of Emergency Services (now CalEMA)
OSHPD	Office of Statewide Health Planning and Development
OSPR	Oil Spill Prevention and Response
PA	Public Assistance
PC	Personal Computer
PDA	Preliminary Damage Assessment
PIO	Public Information Office
POST	Police Officer Standards and Training
PPA/CA	Performance Partnership Agreement/Cooperative Agreement (FEMA)
PSA	Public Service Announcement
PTAB	Planning and Technological Assistance Branch
PTR	Project Time Report
RA	Regional Administrator (CalEMA)
RADEF	Radiological Defense (program)
RAMP	Regional Assessment of Mitigation Priorities
RAPID	Railroad Accident Prevention & Immediate Deployment
RDO	Radiological Defense Officer
RDMHC	Regional Disaster Medical Health Coordinator
REOC	Regional Emergency Operations Center
REPI	Reserve Emergency Public Information
RES	Regional Emergency Staff
RIMS	Response Information Management System
RMP	Risk Management Plan
RPU	Radiological Preparedness Unit (CalEMA)

RRT	Regional Response Team
SAM	State Administrative Manual
SARA	Superfund Amendments & Reauthorization Act
SAVP	Safety Assessment Volunteer Program
SBA	Small Business Administration
SCO	California State Controller's Office
SEMS	Standardized Emergency Management System
SEPIC	State Emergency Public Information Committee
SLA	State and Local Assistance
SONGS	San Onofre Nuclear Generating Station
SOP	Standard Operating Procedure
SWEPC	Statewide Emergency Planning Committee
TEC	Travel Expense Claim
TRU	Transuranic
TTT	Train the Trainer
UPA	Unified Program Account
UPS	Uninterrupted Power Source
USAR	Urban Search and Rescue
USGS	United States Geological Survey
WC	California State Warning Center
WAN	Wide Area Network
WIPP	Waste Isolation Pilot Project

Appendix D: Glossary

Acceleration	The rate of change of velocity with respect to time. Acceleration due to gravity at the earth's surface is 9.8 meters per second squared. That means that every second that something falls toward the surface of the Earth, its velocity increases by 9.8 meters per second.
Asset	Any human-made or natural feature that has value, including, but not limited to, people; buildings; infrastructure like bridges, roads, and sewer and water systems; lifelines like electricity and communication resources; or environmental, cultural, or recreational features like parks, dunes, wetlands, or landmarks.
Base Flood	Flood that has a 1% probability of being equaled or exceeded in any given year. Also known as the 100-year flood.
Base Flood Elevation (BFE)	Elevation of the base flood in relation to a specified datum, such as the National Geodetic Vertical Datum of 1929. The Base Flood Elevation is used as the standard for the National Flood Insurance Program.
Bedrock	The solid rock that underlies loose material, such as soil, sand, clay, or gravel.
Building	A structure that is walled and roofed, principally above ground and permanently affixed to a site. The term includes a manufactured home on a permanent foundation on which the wheels and axles carry no weight.
Coastal High Hazard Area	Area, usually along an open coast, bay, or inlet, that is subject to inundation by storm surge and, in some instances, wave action caused by storms or seismic sources.
Coastal Zones	The area along the shore where the ocean meets the land as the surface of the land rises above the ocean. This land/water interface includes barrier islands, estuaries, beaches, coastal wetlands, and land areas having direct drainage to the ocean.
Community Rating System (CRS)	A National Flood Insurance Program (NFIP) program that provides incentives for NFIP communities to complete activities that reduce flood hazard risk. When the community completes specified activities, the insurance premiums of policyholders in these communities are reduced.
Computer-Aided Design And Drafting (CADD)	A computerized system enabling quick and accurate electronic 2-D and 3-D drawings, topographic mapping, site plans, and profile/cross-section drawings.
Contour	A line of equal ground elevation on a topographic (contour) map.
Critical facility	Facilities that are critical to the health and welfare of the population and that are especially important following hazard events. Critical facilities include, but are not limited to, shelters, police and fire stations, and hospitals.

Debris	The scattered remains of assets broken or destroyed in a hazard event. Debris caused by a wind or water hazard event can cause additional damage to other assets.
Digitize	To convert electronically points, lines, and area boundaries shown on maps into x, y coordinates (e.g., latitude and longitude, universal transverse mercator (UTM), or table coordinates) for use in computer applications.
Displacement Time	The average time (in days) that a building's occupants typically must operate from a temporary location while repairs are made to the original building due to damages resulting from a hazard event.
Duration	How long a hazard event lasts.
Earthquake	A sudden motion or trembling that is caused by a release of strain accumulated in or along the edge of earth's tectonic plates.
Erosion	Wearing away of the land surface by detachment and movement of soil and rock fragments during a flood or storm or over a period of years through the action of wind, water, or other geologic processes.
Erosion Hazard Area	Area anticipated to be lost to shoreline retreat over a given period of time. The projected inland extent of the area is measured by multiplying the average annual long-term recession rate by the number of years desired.
Essential facility	Elements that are important to ensure full recovery of a community or state following a hazard event. These include government functions; major employers; banks; schools; and certain commercial establishments such as grocery stores, hardware stores, and gas stations.
Extent	The size of an area affected by a hazard or hazard event.
Extra-tropical Cyclone	Cyclonic storm events like Nor'easters and severe winter low-pressure systems. Both West and East coasts can experience these nontropical storms that produce gale-force winds and precipitation in the form of heavy rain or snow. These cyclonic storms, commonly called Nor'easters on the East Coast because of the direction of the storm winds, can last for several days and can be very large—1,000-mile wide storms are not uncommon.
Fault	A fracture in the continuity of a rock formation caused by a shifting or dislodging of the earth's crust, in which adjacent surfaces are differentially displaced parallel to the plane of fracture.
Federal Emergency Management Agency (FEMA)	Independent agency created in 1978 to provide a single point of accountability for all Federal activities related to disaster mitigation and emergency preparedness, response, and recovery.

Fire Potential Index (FPI)	Developed by the U.S. Geological Survey and the U.S. Forest Service to assess and map fire-hazard potential over broad areas. Based on such geographic information, national policymakers and on-the-ground fire managers established priorities for prevention activities in the defined area to reduce the risk of managed-fire and wildfire ignition and spread. Prediction of fire hazard shortens the time between fire ignition and initial attack by enabling fire managers to pre-allocate and stage suppression forces to high fire risk areas.
Flash Flood	A flood event occurring with little or no warning in which water levels rise at an extremely fast rate.
Flood	A general and temporary condition of partial or complete inundation of normally dry land areas from (1) the overflow of inland or tidal waters, (2) the unusual and rapid accumulation or runoff of surface waters from any source, or (3) mudflows or the sudden collapse of shoreline land.
Flood Depth	Height of the flood water surface above the ground surface.
Flood Elevation	Elevation of the water surface above an established datum (e.g., National Geodetic Vertical Datum of 1929, North American Vertical Datum of 1988), or Mean Sea Level.
Flood Hazard Area	The area shown to be inundated by a flood of a given magnitude on a map.
Flood Insurance Rate Map (FIRM)	Map of a community, prepared by the Federal Emergency Management Agency (FEMA), that shows both the special flood-hazard areas and the risk premium zones applicable to the community.
Flood Insurance Study (FIS)	A study that provides an examination, evaluation, and determination of flood hazards and, if appropriate, corresponding water-surface elevations in a community or communities.
Floodplain	Any land area, including a watercourse, susceptible to partial or complete inundation by water from any source.
Frequency	A measure of how often events of a particular magnitude are expected to occur. Frequency describes how often a hazard of a specific magnitude, duration, and/or extent typically occurs, on average. Statistically, a hazard with a 100-year recurrence interval is expected to occur once every 100 years on average, and would have a 1% chance—its probability—of happening in any given year. The reliability of this information varies depending on the kind of hazard being considered.
Fujita Scale of Tornado Intensity	Rates tornadoes with numeric values from F0 to F5 (based on tornado windspeed and damage sustained). An F0 indicates minimal damage such as broken tree limbs or signs, while an F5 indicates severe damage sustained.
Functional Downtime	The average time (in days) during which a function (business or service) is unable to provide its services due to a hazard event.

Geographic Area Impacted	The physical area in which the effects of the hazard are experienced.
Geographic Information Systems (GIS)	A computer software application that relates physical features on the earth to a database to be used for mapping and analysis.
Ground Motion	The vibration or shaking of the ground during an earthquake. When a fault ruptures, seismic waves radiate, causing the ground to vibrate. The severity of the vibration increases with the amount of energy released and decreases with the distance from the causative fault or epicenter, but soft soils can further amplify ground motions.
Hazard	A source of potential danger or adverse condition. Hazards in this series will include naturally occurring events such as floods, earthquakes, tornadoes, tsunami, coastal storms, landslides, and wildfires that strike populated areas. A natural event is a hazard when it has the potential to harm people or property.
Hazard Event	A specific occurrence of a particular type of hazard.
Hazard Identification	The process of identifying hazards that threaten an area.
Hazard Mitigation	Sustained actions taken to reduce or eliminate long-term risk from hazards and their effects.
Hazard Profile	A description of the physical characteristics of hazards and a determination of various descriptors including magnitude, duration, frequency, probability, and extent. In most cases, a community can most easily use these descriptors when they are recorded and displayed as maps.
HAZUS (Hazards U.S.)	A GIS-based nationally standardized earthquake loss-estimation tool developed by FEMA.
Hurricane	An intense tropical cyclone, formed in the atmosphere over warm ocean areas, in which wind speeds reach 74-miles-per-hour or more and blow in a large spiral around a relatively calm center or “eye.” Hurricanes develop over the north Atlantic Ocean, northeast Pacific Ocean, or the south Pacific Ocean east of 160°E longitude. Hurricane circulation is counterclockwise in the Northern Hemisphere and clockwise in the Southern Hemisphere.
Hydrology	The science of dealing with the waters of the earth. A flood discharge is developed by a hydrologic study.

Infrastructure	Refers to the public services of a community that have a direct impact on the quality of life. Infrastructure includes communication technology such as phone lines or Internet access, vital services such as public water supplies and sewer-treatment facilities, and includes an area's transportation system such as airports, heliports; highways, bridges, tunnels, roadbeds, overpasses, railways, bridges, rail yards, depots; and waterways, canals, locks, seaports, ferries, harbors, drydocks, piers and regional dams.
Intensity	A measure of the effects of a hazard event at a particular place.
Landslide	Downward movement of a slope and materials under the force of gravity.
Lateral Spreads	Lateral spreads develop on gentle slopes and entail the sidelong movement of large masses of soil as an underlying layer liquefies in a seismic event. The phenomenon that occurs when ground shaking causes loose soils to lose strength and act like viscous fluid. Liquefaction causes two types of ground failure: lateral spread and loss of bearing strength.
Liquefaction	Results when the soil supporting structures liquefies. This can cause structures to tip and topple.
Lowest Floor	Under the National Flood Insurance Program (NFIP), the lowest floor of the lowest enclosed area (including the basement) of a structure.
Magnitude	A measure of the strength of a hazard event. The magnitude (also referred to as severity) of a given hazard event is usually determined using technical measures specific to the hazard.
Mitigation Plan	A systematic evaluation of the nature and extent of vulnerability to the effects of natural hazards typically present in the state and includes a description of actions to minimize future vulnerability to hazards.
National Flood Insurance Program (NFIP)	Federal program created by Congress in 1968 that makes flood insurance available in communities that enact minimum floodplain-management regulations in 44 CFR §60.3.
National Geodetic Vertical Datum of 1929 (NGVD)	Datum established in 1929 and used in the National Flood Insurance Program (NFIP) as a basis for measuring flood, ground, and structural elevations, previously referred to as Sea Level Datum or Mean Sea Level. The Base Flood Elevations shown on most of the Flood Insurance Rate Maps issued by the Federal Emergency Management Agency (FEMA) are referenced to NGVD.
National Weather Service (NWS)	Prepares and issues flood, severe-weather, and coastal-storm warnings and can provide technical assistance to federal and state entities in preparing weather and flood-warning plans.
Nor'easter	An extra-tropical cyclone producing gale-force winds and precipitation in the form of heavy snow or rain.

Outflow	Outflows follow water inundation creating strong currents that rip at structures and pound them with debris, and erode beaches and coastal structures.
Planimetric	Describes maps that indicate only human-made features like buildings.
Planning	The act or process of making or carrying out plans; the establishment of goals, policies, and procedures for a social or economic unit.
Probability	A statistical measure of the likelihood that a hazard event will occur.
Recurrence Interval	The time between hazard events of similar size in a given location. It is based on the probability that the given event will be equaled or exceeded in any given year.
Repetitive Loss Property	A property that is currently insured for which two or more National Flood Insurance Program (NFIP) losses (occurring more than 10 days apart) of at least $1,000 each have been paid within any 10-year period since 1978.
Replacement Value	The cost of rebuilding a structure. This is usually expressed in terms of cost per square foot, and reflects the present-day cost of labor and materials to construct a building of a particular size, type, and quality.
Richter Scale	A numerical scale of earthquake magnitude devised by seismologist C.F. Richter in 1935.
Risk	The estimated impact that a hazard would have on people, services, facilities, and structures in a community; the likelihood of a hazard event 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 a specific type of hazard event. It also can be expressed in terms of potential monetary losses associated with the intensity of the hazard.
Riverine	Of or produced by a river.
Scale	A proportion used in determining a dimensional relationship; the ratio of the distance between two points on a map and the actual distance between the two points on the earth's surface.
Scarp	A steep slope.
Scour	Removal of soil or fill material by the flow of flood waters. The term is frequently used to describe storm-induced, localized conical erosion around pilings and other foundation supports where the obstruction of flow increases turbulence.
Seismicity	Describes the likelihood of an area being subject to earthquakes.
Special Flood Hazard Area (SFHA)	An area in a floodplain having a 1% or greater chance of flood occurrence in any given year (100-year floodplain); represented on Flood Insurance Rate Maps by darkly shaded areas with zone designations that include the letter A or V.

Stafford Act	The Robert T. Stafford Disaster Relief and Emergency Assistance Act, PL 100-107 was signed into law November 23, 1988 and amended the Disaster Relief Act of 1974, PL 93-288. The Stafford Act is the statutory authority for most federal disaster-response activities, especially as they pertain to the Federal Emergency Management Agency (FEMA) and its programs.
State Hazard Mitigation Officer (SHMO)	The representative of state government who is the primary point of contact with Federal Emergency Management Agency (FEMA), other state and federal agencies, and local units of government in the planning and implementation of pre- and post-disaster mitigation activities.
Storm Surge	Rise in the water surface above normal water level on the open coast due to the action of wind stress and atmospheric pressure on the water surface.
Structure	Something constructed. (See also Building)
Substantial Damage	Damage of any origin sustained by a structure in a Special Flood Hazard Area whereby the cost of restoring the structure to its before-damaged condition would equal or exceed 50% of the market value of the structure before the damage.
Super Typhoon	A typhoon with maximum sustained winds of 150 mph or more.
Surface Faulting	The differential movement of two sides of a fracture; in other words, the location where the ground breaks apart. The length, width, and displacement of the ground characterize surface faults.
Tectonic Plate	Torsionally rigid, thin segments of the earth's lithosphere that may be assumed to move horizontally and adjoin other plates. It is the friction between plate boundaries that cause seismic activity.
Topographic	Characterizes maps that show natural features and indicate the physical shape of the land using contour lines. These maps may also include human-made features.
Tornado	A violently rotating column of air extending from a thunderstorm to the ground.
Tropical cyclone	A generic term for a cyclonic, low-pressure system over tropical or subtropical waters.
Tropical Depression	A tropical cyclone with maximum sustained winds of less than 39 mph.
Tropical Storm	A tropical cyclone with maximum sustained winds greater than 39 mph and less than 74 mph.
Tsunami	A great sea wave produced by submarine earth movement or volcanic eruption.
Typhoon	A special category of tropical cyclone peculiar to the western North Pacific Basin, frequently affecting areas in the vicinity of Guam and the North Mariana Islands. Typhoons with maximum sustained winds attaining or exceeding 150 mph are called super typhoons.

Vulnerability	Describes how exposed or susceptible to damage an asset is. 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. If an electric substation is flooded, it will affect not only the substation itself, but a number of businesses as well. Often, indirect effects can be much more widespread and damaging than direct ones.
Vulnerability Assessment	The extent of injury and damage that may result from a hazard event of a given intensity in a given area. The vulnerability assessment should address impacts of hazard events on the existing and future built environment.
Water Displacement	When a large mass of earth on the ocean bottom sinks or uplifts, the column of water directly above it is displaced, forming the tsunami wave. The rate of displacement, motion of the ocean floor at the epicenter, the amount of displacement of the rupture zone, and the depth of water above the rupture zone all contribute to the intensity of the tsunami.
Wave Run-up	The height that the wave extends up to on steep shorelines, measured above a reference level (the normal height of the sea, corrected to the state of the tide at the time of wave arrival).
Wildfire	An uncontrolled fire spreading through vegetative fuels, exposing and possibly consuming structures.
Zone	A geographical area shown on a Flood Insurance Rate Map (FIRM) that reflects the severity or type of flooding in the area.

Appendix E: Charts and Maps