Hazard Mitigation Plan
City of Santa Monica, CA

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Primary Point of Contact

Paul Weinberg
Emergency Services Coordinator
Santa Monica Office of Emergency Management
333 Olympic Drive,
Santa Monica, CA 90401
310 458 8686 (Office)
paul.weinberg@smgov.net

City of Santa Monica
Natural Hazards Mitigation Plan

TABLE OF CONTENTS

EXECUTIVE SUMMARY

Five -Year Action Plan Matrix

The City of Santa Monica Natural Hazards 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 City of Santa Monica in reducing risk and preventing loss from future natural hazard events. The action items address multi-hazard issues, as well as activities for earthquakes, landslides, flooding, tsunamis, wildfires and severe windstorms/thunderstorms.

How is the Plan Organized?

The Mitigation Plan contains a five-year action plan matrix, background on the purpose and methodology used to develop the mitigation plan, a profile of City of Santa Monica, sections on six natural hazards that occur within the City, and a number of appendices. All of the sections are described in detail in section 1.1, the plan introduction.

Planning Process

The City of Santa Monica has been working on the LHMP since the initial OES DMA2K training workshop in June of 2003. The City's Emergency Services Coordinator attended the three-day workshop. Upon returning, the LHMP was put on the agenda of the City-wide Department Heads meeting in July, and a LHMP working group and steering committee was established. The working group began addressing a strategy for the development of the Plan immediately. The Santa Monica City Council approved the creation of the LHMP in September of 2003. Work on the Plan continued over the next year in a number of committees throughout the City. These committees included:

- Department Head Meetings
- The Emergency Operations Center Team
- The Public Information Team
- The Disaster Recovery Organization
- Several Department staff meetings from most City Departments
- Local Hazard Mitigation Planning Committee

Who Participated in Developing the Plan?

The City of Santa Monica Natural Hazards Mitigation Action Plan is the result of a collaborative effort between City of Santa Monica 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 a public workshop and survey were conducted to include City of Santa Monica residents in plan development. A project Steering Committee guided the process of developing the plan.

The Steering Committee was comprised of representatives from:

City of Santa Monica Building and Safety
City of Santa Monica Fire Department
City of Santa Monica Finance
City of Santa Monica Police Department
City of Santa Monica Information Systems
City of Santa Monica GIS
City of Santa Monica Planning
City of Santa Monica Disaster Recovery Organization
City of Santa Monica Rent Control
City of Santa Monica Human Services Administration
City of Santa Monica Community and Cultural Services
City of Santa Monica City Manager's Office
City of Santa Monica Airport
City of Santa Monica City TV
Santa Monica Red Cross

What is the Plan Mission?

The mission of the City of Santa Monica Natural Hazards 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.

What are the Plan Goals?

The plan goals describe the overall direction that City of Santa Monica 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.

Goal #1: Increase Public Awareness of Local Hazards

Description: Increase public awareness and understanding, support, and demand for hazard mitigation.

Objectives:

- Heighten public awareness of the full range of natural hazards they may face.
- Educate the public on actions they can take to prevent or reduce the loss of life and/or property from all hazards.

- Publicize and encourage the adoption of appropriate hazard mitigation measures.

Goal #2: Protection of Lives and Property

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

Objectives:

- Advise public about health and safety precautions to protect from injury and loss.
- Warning and communication technologies to mitigate damage from natural hazards.
- Reduce damage to enhance protection of dangerous areas during hazardous events.
- Protect critical facilities and services.
- Ensure Emergency Services and critical facilities are included in mitigation strategies.

Goal #3: Promote Sustainable Living

Description: Promote development in a sustainable manner.

Objectives:

- Incorporate hazard mitigation into long-range planning and development activities.
- Promote beneficial use of hazardous areas while expanding open space and recreational opportunities.
- Utilize regulatory approaches to prevent creation of future hazards to life and property.

Goal #4: Partnerships and Implementation

Description: Build and support local partnerships to continuously become less vulnerable to natural hazards.

Objectives:

- Build and support local partnerships with stakeholders in the community.
- Build a cadre of committed volunteers to safeguard the community before, during, and after a disaster.
- Build hazard mitigation concerns into City planning and budgeting process.

Goal #5: Strengthen Emergency Services Capability

Description: Establish policies and procedures to ensure mitigation projects for critical facilities, services, and infrastructure.

Objectives:

- Provide training to City and non-City departments on mitigation programs and techniques that could be incorporated into a variety of projects.
- Strengthen emergency operations by increasing collaboration and coordination among public agencies, non-profit organizations, business, and industry.

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 (see Appendix B). The matrix includes the following information 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 time line 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.

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:

1. Emergency Services Capability
2. Partnerships and Implementation
3. Promote Sustainable Living
4. Protection of Lives and Property
5. Public Awareness of Local Hazards

Partner Organizations. The Partner organizations are not listed with the individual action items or in the plan matrix. Partner organizations are listed in Appendix A, of this plan and are agencies or public/private sector organizations that may be able to assist in the implementation of action items by providing relevant resources to the coordinating organization. The partner organizations listed in the Resource Directory of the City of Santa Monica Natural Hazards Mitigation Plan are potential partners recommended by the project steering committee, but 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 Santa Monica Natural Hazards 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 Santa Monica 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.

A City of Santa Monica Hazard Mitigation Advisory Committee will be responsible for coordinating implementation of Plan action items and undertaking the formal review process. The existing Disaster Recovery Group, which is comprised of the Hazard Mitigation Executive Committee, will be responsible for on-going plan implementation, monitoring and evaluation.

- The section of the Local Hazard Mitigation Plan that details the procedures for monitoring and evaluating the Plan has been clarified. Pages 47-50 have been revised to clearly demonstrate that the Local Hazard Mitigation Plan Committee (formerly the Disaster Recovery Office) will continue to meet quarterly to update and evaluate the Local Hazard Mitigation Plan and the progress of its goals and objectives. The Emergency Services Coordinator and the Legislative Liaison have the lead in convening these quarterly meetings, and will continue to update, revise, and evaluate the Plan and its progress. This committee is made up of the Emergency Services Coordinator, the City Manager's Legislative Liaison, a Finance Department Representative, and a City Building Engineer, among others. This group has been meeting monthly since the 1994 Northridge Earthquake, to monitor all of the FEMA projects that stemmed from that earthquake. The Committee will continue to focus on mitigative progress in the City and specifically on FEMA related projects such as the 2005 Pre Disaster Mitigation Grant Program, of which Santa Monica has applied for funding to seismically retrofit two City owned parking structures.

Plan Adoption

Adoption of the Natural Hazard Mitigation Plan by the local jurisdiction's governing body is one of the prime requirements for approval of the plan. The Santa Monica City Council adopted the Santa Monica Local Hazard Mitigaiton Plan during the September 28th, 2004 City Council Meeting. The adopted resolution is included as an attachment to the Plan. The local agency 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 Natural Hazard Mitigation Plan will be significant in the future growth and development of the community.

Convener

The City Council has adopted the City of Santa Monica Natural Hazard Mitigation Plan, and the Hazard Mitigation Advisory Committee will take responsibility for plan implementation. The co-chairs 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 Natural Hazard Advisory Committee Members. This will include the Disaster Recovery Organization as the main steering committee for Plan maintenance.

Implementation through Existing Programs

The City of Santa Monica addresses statewide planning goals and legislative requirements through its General Plan, Capital Improvement Plans, and City Building & Safety Codes. The Natural 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 Santa Monica 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.

Formal Review Process

The City of Santa Monica Natural Hazards 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 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 Santa Monica is dedicated to involving the public directly in the continual review and updates of the Hazard Mitigation Plan. Copies of the plan will be catalogued and made available at city hall and at all City operated public libraries. The plan also includes the address and the phone number of the City Planning Division, responsible for keeping track of public comments on the Plan.

Priority	Mitigation Action Item	Responsible Organization(s)	Timeline	Plan Goals Addressed				
				Emergency Services Capability	Partnerships and Implementation	Promote Sustainable Living	Protection of Lives and Property	Public Awareness of Local Hazards
High	**1. Identify Funds for Mitigation***:* Identify and pursue funds to develop and implement local and county mitigation activities.	Planning Finance Fire	On-going	√	√		√	
Open	**2. Integrate LHMP into Existing Programs, Ordinances, Building Codes:** Integrate the goals and action items from the Local Hazard Mitigation Plan into existing regulatory documents and programs, including local ordinances and building codes, where appropriate. Assess feasibility of gas shut-off valve ordinance as required by other regional jurisdictions. (Based on 300+ gas leaks following the Northridge earthquake.)	Planning	Long-term		√	√	√	
High	**3. Critical Information Systems:** Design and implement a protection program for the critical information systems infrastructure, including telephones, computers, radio, 911 services, information systems, and backup systems.	ISD	Long-term	√			√	
High	**4. Increase Public Awareness of Hazards and Disaster Preparedness***:* Design and implement a comprehensive campaign of public awareness and preparedness of local natural hazards, using media, print, radio, and the internet.	Fire	Long-term	√	√		√	√
Open	**5. Strengthen Evacuation Plans for City Facilities***:* Continue to strengthen and develop evacuation plans, policies and procedures for City facilities located throughout Santa Monica.	Risk Management Fire	On-going	√			√	
Open	**6. Public Alert and Notification:** Assess feasibility of a public alert and notification system for disasters.	Fire Police	Long-term	√			√	

Section 1 – Mitigation Action Plan

1.1 Introduction

Emergencies and disasters cause death or leave people injured or displaced, cause significant damage to our communities, businesses, public infrastructure and our environment, and cost tremendous amounts in terms of response and recovery dollars and economic loss.

Hazard mitigation reduces or eliminates losses of life and property. After disasters, repairs and reconstruction are often completed in such a way as to simply restore to pre-disaster conditions. Such efforts expedite a return to normalcy; however, the replication of pre-disaster conditions results in a cycle of damage, reconstruction, and repeated damage. Hazard mitigation ensures that such cycles are broken and that post-disaster repairs and reconstruction result in a reduction in hazard vulnerability.

While we cannot prevent disasters from happening, their effects can be reduced or eliminated through a well-organized public education and awareness effort, preparedness and mitigation. For those hazards which cannot be fully mitigated, the community must be prepared to provide efficient and effective response and recovery.

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. Natural 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 of Santa Monica.

The plan provides a set of action items to reduce risk from natural hazards through education and outreach programs and to foster the development of partnerships, and 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 Mitigation Plan:

(1) Establish a basis for coordination and collaboration among agencies and the public in City of Santa Monica;
(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 Plans.

Whom Does the Mitigation Plan Affect?

The City of Santa Monica's Natural Hazards Mitigation Plan affects entire city and provides a framework for planning for natural hazards. The resources and background information in the plan are 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 we 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 Governor's Office of Emergency Services (OES) 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, state, and administers forest practices regulations, including landslide n1itigation, 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; and

$ 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, 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 Santa Monica 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:

Past/On-going Mitigation Activities

Santa Monica Disaster Recovery Group

Since the 1994 Northridge earthquake, the City Of Santa Monica has worked closely with FEMA and OES on several disaster recovery and hazard mitigation projects. Resulting from damages sustained in the Northridge earthquake, the City Of Santa Monica has received approximately $100 million dollars in disaster recovery and mitigation funds. These funds have been applied to several projects throughout the City. These projects included:

- Extensive improvements to the City's sewer system
- Retrofitting of several parking structures throughout Santa Monica
- The Miles Playhouse restoration project

The Disaster Recovery Group continues to meet regularly, and will be the organization responsible for maintenance of the Local Hazard Mitigation Plan.

Throughout the development of the LHMP, members of the executive planning committee attended staff meetings of several City Departments. The purpose of these meetings was to 1) discuss the development of the LHMP, 2) get input on potential mitigation actions, and 3) catalog past and on-going mitigation steps in Santa Monica. Below is a table of such mitigation actions.

Table 1.1 Past/On-going Mitigation Actions

DEPARTMENT	**MITIGATION STEPS**
City Attorney	• Resolutions/Emergency Declarations prepared ahead of time • Deed restriction disclosure • Litigation • Subdivision regulation • Tax incentives • Transfer of development rights
City Managers Office/ ISD/Risk Management	• Media Strategy Working Group (PIT Crew) • Disaster Recovery Office • Smoke alarms • Risk and vulnerability mapping • Sprinklers • Insurance/ disaster insurance • Evacuation plans • Evacuation routes • Regular Evacuation Drills • Internal Emergency Rosters
CCD/ Bayside District/ Civic Auditorium/ Comm. Programs/ Cultural Affairs/ Human Services/ Open Space Management	• Emergency shelters
Clerk	• Document Storage
EPWM/ Engineering& Architecture/ Environmental Programs/ Maintenance Management/ Solid Waste Management/ Utilities	Civil Engineering & Architecture • Routine public works inspections • Palisades Bluffs Stabilization Effort • Buffer spaces around buildings • Erosion control landscaping • Fire resistant landscaping • Greenbelts • Wildland management • Windbreaks

	• Hazardous materials container tie downs Utilities • Water Infrastructure Reliability study • Adequate fire fighting water supply • Capital improvement planning • Debris catch basins • Retention basins • Storm drains • Underground utility lies • Proper signage for hazardous materials • Minimal storage of flammable liquids • Fire Extinguisher Checks • Route restrictions • Shelter in place education and training • Site community warning systems • Auxiliary power source • Emergency water and sewer • Coastal zone management
Finance	
Fire/ Emergency Management	• Disaster Assistance Response Training • Regular briefings to the Executive Team on Plan Refinement • Emergency plans for critical facilities • Emergency public information materials • Emergency food and water • Emergency communications • Emergency operations plans • Evacuation plans • Evacuation routes • Evacuation plans for special needs populations • Hazard analysis/ hazard information systems • Public education • Research • Hazardous materials training/ enhanced equipment • Disaster Assistance Response Training (DART) & Red Cross CPR/ First Aid classes • Sand sandbags those who live and work in Santa Monica, to mitigate potential flood damage. • Public private partnerships • Risk and vulnerability mapping

	• Staffing and training of Response Personnel
Human Resources	• Safety training for all employees • Regular contract with EAP program • Emergency contact forms
PCD/Building& Safety City Planning/Transportation/ Traffic	• Flood proofing • Building codes • Building inspections • Increased insulation • Increased roof pitch • Manufactured housing tie-downs • Non-combustible building materials • Roof bracing • Roof sprinklers • Structural connectors • Better building design and engineering • Better facility design • Drainage systems • Housing density • Minimal roof overhang • Proper egress • Reduced use of glass • Adequate roads w/ vehicular access • Comprehensive planning and zoning ordinances
Police	• Evacuation Drills • Site Security
Rent Control/ Housing and Building	• Routine residential and housing inspections/citations/etc. • Seismic retrofit requirement • City Ordinances • Acquisition of property • Building maintenance

Input from the Steering Committee

The Hazard Mitigation Advisory Committee convened about every 6 to 8 weeks (a total of 8 meetings) to guide development of the Mitigation Plan. The committee played an integral role in developing the mission, goals, and action items for the mitigation plan. The committee consisted of representatives of public and private agencies and organizations in City of Santa Monica, including:

City of Santa Monica Building and Safety
City of Santa Monica Fire Department
City of Santa Monica Finance
City of Santa Monica Police Department
City of Santa Monica Information Systems
City of Santa Monica GIS
City of Santa Monica Planning
City of Santa Monica Disaster Recovery Organization
City of Santa Monica Rent Control
City of Santa Monica Human Services Administration
City of Santa Monica Community and Cultural Services
City of Santa Monica City Manager's Office
City of Santa Monica Airport
City of Santa Monica City TV
Santa Monica Red Cross

Review of Existing Plans, Studies, Reports, and Technical Documents

During the development of the Santa Monica Local Hazard Mitigation Plan, the Planning Committee and specifically the Co-Chairs, spend a significant amount of time incorporating all relevant information from existing Plans, Studies, Reports, and Technical Documents; in order to develop the Local Hazard Mitigation Plan. This review process included not only reading through the relevant plans and other documents, but also meeting individually with several City Departments (detailed in the proceeding chart). Information from relevant documents was collected by the Co-Chairs of the Local Hazard Mitigation Plan Committee. Information was also presented to the Local Hazard Mitigation Planning Committee from interviews with technical experts. Research and interview were conducted with local University researchers in disaster preparedness and through conversations with other technical experts. These interviews are described in the preceding chart as well.

Plans that were thoroughly reviewed include:

- Santa Monica General Plan
- Santa Monica Safety Element
- Santa Monica SEMS/ Multi Hazard Functional Plan
- Santa Monica Sustainable City Plan

- Santa Monica Tsunami Plan
- Emergency Plan for the Santa Monica Water Treatment Faciltiies
- Geotechnical Reports detailing the Bluffs Mitigation Projects (available upon request)

City of Santa Monica staff examined existing mitigation plans from around the country, current FEMA hazard mitigation planning standards (386 series) and the State of California Natural Hazards Mitigation Plan Guidance.

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

Clackamas County (Oregon) Natural Hazards Mitigation Plan
Six County (Utah) Association of Governments
Upper Arkansas Area Risk Assessment and Hazard Mitigation Plan
Urbandale-Polk County, Iowa Plan
Hamilton County, Ohio Plan
Natural Hazard Planning Guidebook from Butler County, Ohio
City of Austin, Hazard Mitigation Plan

Hazard specific research: City of Santa Monica staff collected data and compiled research on six hazards: earthquakes, landslides, flooding, tsunamis, wildfires and severe windstorms/thunderstorms. Research materials came from state agencies including OES, and CDF. The City of Santa Monica staff conducted research by referencing historical local newspapers, interviewing long time residents, long time City of Santa Monica employees and locating City of Santa Monica information in historical documents. The City of Santa Monica staff identified current mitigation activities, resources and programs, and potential action items from research materials and stakeholder interviews.

The Local Hazard Mitigation Planning Committee hired a Graduate Student Intern from the UCLA School of Public Policy, to assist with the Plan. This Graduate Student worked closely with the Center For Disaster Studies at the Graduate School of Public Health at UCLA, in developing the Plan. Extensive research and interviews were conducted with the Center for Disaster Studies at UCLA in creating the Local Hazard Mitigation Plan.

Public Inclusion

City Of Santa Monica staff facilitated a number of opportunities for public inclusion in the development of the plan, in order to gather input and ideas from Santa Monica residents and stakeholders. Beginning with the City Council meeting on September 9th, 2003, the Santa Monica community has been invited to participate in the development of the LHMP. Since September of 2003, the Santa Monica community has had numerous opportunities to provide input on mitigation activities and priorities for increasing the level of disaster preparedness and resilience.

Other opportunities for public involvement include:

- Airport Commission Meeting November 2003
- Santa Monica Red Cross Board Meeting March 2004
- Appearance on Santa Monica CityTV to publicize the Plan and request public involvement. May 2004
- Section on the Mitigation Plan added to our Disaster Assistance Response Team training. April 2004
- Staffed a booth at the Santa Monica Festival, the community's annual gathering of sustainable living ideas and agencies. Distributed 300 flyers about the Mitigation Plan to attendees.
- LHMP was discussed at monthly meetings of volunteer groups for the Santa Monica Fire Department.
- Created and disseminated an Information Flyer about the LHMP throughout the City. The flyer was also posted on the City's website and listed a telephone and email contact for public input. Flyer was also available at City Hal, Red Cross, Community Centers, Libraries, and other locations throughout Santa Monica.
- An on-line survey was developed to assist the community in 1) learning about the Plan, and 2) to offer input on priorities and action items contained in the Plan. The survey is posted on the City's homepage.

Table 1.3 Public Inclusion

Title	Comment	Date
Exeuctive Committee met on for final review of revisions on 2/22/2005		
Executive Committee Members met with City of Santa Monica Engineering Dept. to gather additional information per FEMA request, about Landslides. Met with David Britton, the City of Santa Monica's Principal Civil Engineer, on 2/11/2005.		
Local Hazard Mitigaiton Plan Executive Committee	Met on 1/8/2005 to discuss FEMAs recommended changes	
Local Hazard Mitigation Plan Executive Committee	Review of Plan by the Executive Planning Committee.	7/29/2004
Met with Fire Chief regarding action items	Met with Fire Chief Jim Hone to discuss action items re: public awareness.	7/28/2004

Chief Information Officer teleconference	Discussion with Jory Wolf, Chief Info Systems Officer for Santa Monica regarding development of alternate information systems in emergencies.	7/27/2004
Meet with Emergency Volunteer Air Corps	Monthly meeting of airport volunteer group. Mitigation Plan was discussed.	7/21/2004
Los Angeles Art Institute	Met with students at the Los Angeles Art Institute, in Santa Monica. The Local Hazard Mitigation Plan will be a project that a group of 6 students will undertake, as a client/ student endeavor. They will be tasked with creating a public education/ awareness campaign regarding emergency preparedness in Santa Monica. They will produce a campaign slogan, log, posters, and web information.	7/19/2004
Public Information Team Meeting	Monthly meeting of the City's public information team. The Plan's progress was discussed. Ideas for increasing participation in online survey were covered.	7/12/2004
Telephone discussion with Applied Fluids Eng.	Telephone discussion with Phil Watts of Applied Fluids Engineering, a tsunami engineering research firm. We discussed the tsunami threat to Santa Monica and re-establishing the tsunami-working group.	7/7/2004
Meeting with Lt. of Operations for SMPD	Paul Weinberg met with LT. of Operations for the Santa Monica Police Department to discuss the LHMP.	6/29/2004
Meeting with Fire Chief/ Mayor Richard Bloom	Met with Fire Chief and Mayor Richard Bloom discussing the LHMP.	6/24/2004
Met with UCLA Graduate Student Assistant	Met with student assistant to work on Plan. Will collaborate with Center for Disasters at UCLA School of Public Health.	6/24/2004
Fire Department Chief Officer's meeting	LHMP was presented to the Fire Chiefs for discussion.	6/3/2004
Local Hazard Mitigation Plan Executive Committee	Meeting of the Executive Committee for the LHMP. Discussion of Goals and Action Items.	6/2/2004

Local Hazard Mitigation Planning Committee meeting	Meeting of the full working group of the LHMP. Goals and Action Items were discussed.	5/26/2004
Meeting with Fire Chief Jim Hone	Meeting between Paul Weinberg and Santa Monica Fire Chief Jim Hone. The overall goals and action items for the Santa Monica Fire Department were discussed.	5/22/2004
Co Chairs meeting	Kate Vernez and Paul Weinberg met for one hour to discuss the next steps and to prepare for upcoming meeting with the entire planning committee. The hiring of a Graduate Student Intern was discussed and is moving forward. The new goals and action items were also discussed in preparation for full committee meeting.	5/17/2004
LHMP Public Info Team Meeting	Public Info Team meeting. List of LHMP survey recipients was developed.	5/11/2004
Santa Monica Festival	The Santa Monica Festival is an annual event i town which focuses on the environment and sustainable living practices. Approximately 15,000 people attend the festival throughout the day. Members of the Local Hazard Mitigation Planning Committee staffed a booth and distributed approximately 1,000 flyers about the LHMP.	5/1/2004
DART Class Disaster Assistance Response Training	Free Disaster Assistance Response Training for those who live and work in Santa Monica. This is an 8-hour course. During the class, the LHMP is discussed at length.	4/24/2004
Earthquake Recovery Group meeting	Monthly meeting of earthquake recovery group. This group has been the steering committee for the LHMP. The next few months' strategy was discussed.	4/22/2004
Paul Weinberg appears on CITY TV to discuss Plan	Co-Chair Paul Weinberg appears on CITY TV local cable station. A six-minute interview about the LHMP and how the public can be involved. This program will daily for two	4/22/2004

	weeks.	
Public Information Team Meeting	Public Information Team meeting. Monthly meeting of PIT Crew. LHMP was discussed. The public education survey for the LHMP was distributed and team members were asked to suggest community stakeholders to participate in survey. The new LHMP flyer was introduced. This flyer describes the LHMP and will be available throughout the City. The LHMP information was also posted on the City Website's homepage.	4/19/2004
Co Chairs meeting	Executive meeting between Paul Weinberg and Kate Vernez to go over the Plan's progress and set the strategy for the upcoming month.	4/15/2004
Meeting with CITY TV Director about Pledge Drive	Paul Weinberg and Robin Gee met to discuss this year's annual "Employees Emergency Preparedness Pledge Drive". We will take the opportunity this year to publicize the LHMP during the month of April as we implement the pledge drive.	3/29/2004
Disaster Recovery Office Meeting	DRO is the steering committee for the LHMP.	3/18/2004
Meeting with Insightlink Communications	Meeting with Lauren Meister of the Insightlink Communication Company. We discussed the development of public information survey to inform Santa Monica residents, businesses, and community organizations of the LHMP	3/18/2004
Staff meeting for Community and Cultural Services	Briefing the CCS on the LHMP requirements and exchanged mitigation steps and ideas.	3/17/2004
Public Information Team Meeting	PIT Crew discusses ways to publicize the LHMP in Santa Monica.	3/15/2004

Environmental and Public Works Dpt. Staff Meeting	Kate Vernez and Paul Weinberg attended the Departmental Staff meeting for the public works department in Santa Monica. At this meeting, a presentation was made regarding the Plan. Ideas were exchanged, and a draft "survey" document was developed.	3/10/2004
Santa Monica Red Cross	Paul Weinberg spoke at the Santa Monica Red Cross chapter regarding the Red Cross' role in the City's emergency preparedness and response plans. The development of the local hazard mitigation plan was discussed. A summary of existing hazards in the City was covered, and potential mitigation strategies were listed.	3/8/2004
test/ training Vrisk	Vrisk Training- Intro to website	3/8/2004
Disaster Recovery Office Monthly Meeting	The Disaster Recovery Group has been addressing the LHMP since July of 2004. This group is the main planning committee behind the LHMP team.	2/19/2004
Local Hazard Mitigation Plan/ EOC Team Meeting	The first LHMP meeting of 2004 was held in the council chambers. The meeting re-affirmed the City's commitment to completing the Plan by the November 2004 deadline. In the spirit of citywide involvement, a guest speaker was invited to talk about departmental cooperation. Former Governor Michael Dukakis spoke about public service and cooperation. An outline of the LHMP was distributed to all attendees. There were close to 75 people in attendance.	2/13/2004
PIT Crew Meeting	Public Information Team is composed of City staff from each Department and the Bayside District agency. This group meets monthly to discuss events in town and methods of disseminating public information. The LHMP was discussed. We are working on a	2/9/2004

	survey for the PIT crew of how to disseminate info regarding the LHMP.	
PIT Crew Meetings	The PIT Crew in Santa Monica is the Public Information Team, comprised of City employees from several City Departments, which meet monthly to discuss events in Santa Monica, and how the City involves the public. The development of the Local Hazard Mitigation Plan was introduced at this meeting, and the assistance of the PIT Crew in this endeavor will be of use.	1/12/2004
Disaster Recovery Office Meeting	Monthly Disaster Recovery Office Meeting; Primary strategy for LHMP is discussed	12/5/2003
Airport Commission	The Santa Monica Fire Chief, Administrative Captain and Emergency Services Coordinator made a presentation to the Santa Monica Airport Commission. The Emergency Services Coordinator introduced the development of the Local Hazard Mitigation Plan to the commission and answered a number of questions regarding the development of the plan.	11/24/2003
City Council Meeting on September 9, 2003	The development of the Local Hazard Mitigation Plan was approved on consent at the City Council Meeting. The staff report regarding this consent action is posted on the Santa Monica City homepage.	9/9/2003
Department Head Meeting	The Fire Chief introduced the Plan and it's requirements at the monthly Department Head meeting. A committee of City employees was created following that meeting.	7/1/2003

OES Workshop on Mitigation Plan Requirements	Four members of the executive hazard mitigation planning committee attended a workshop held by CA OES detailing the requirements of the Plan.	6/6/2003

State and federal guidelines and requirements for mitigation plans:

Following are the Federal requirements for approval of a Natural Hazard Mitigation Plan:

- Open public involvement, with public meetings that introduce the process and project requirements.
- The public must be afforded opportunities for involvement in: identifying and assessing risk, drafting a plan, and public involvement in 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 local 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 & objectives, including proposed strategies, programs & 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 All Hazard Mitigation Plan into other planning mechanisms.
- Formal adoption by the City Council.
- Plan Review by both State OES and FEMA

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

Public Involvement

The City of Santa Monica has been publicizing the creation of the Local Hazard Mitigation Plan since the summer of 2003. The creation of the Plan was approved by City Council in September of 2003. An information flyer was created and disseminated throughout town, requesting public participation. City of Santa Monica staff administered a web-based survey to generate public input into the plan. The survey will provide a valuable resource in generating community input for the Plan. The survey will also assist us in addressing the natural hazard concerns of people who live and work in Santa Monica.

The resources and information cited in the mitigation plan provide a strong local perspective and help identify strategies and activities to make City of Santa Monica more disaster resilient.

How Is the Plan 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 natural hazards mitigation plan that remains current and relevant to City of Santa Monica.

The mitigation plan is organized in three sections. Section 1 contains an executive summary, introduction, City profile, risk assessment, mitigation goals and action items, and plan maintenance. Section 2 contains the six natural hazard sections and Section 3 includes the appendices. Each section of the plan is described below.

Section 1 - Mitigation Action Plan

Executive Summary: Five-Year Action Plan

The Five-Year Action Plan provides an overview of the mitigation plan mission, goals, and action items. The plan action items are included in this section, and address multi-hazard issues, as well as activities that can be implemented to reduce risk and prevent loss from future natural hazard events.

1.1 Introduction

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

1.2 Community Profile

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

1.3 Risk Assessment

This section provides information on hazard identification, vulnerability and risk associated with natural hazards in City of Santa Monica.

1.4 Mitigation Goals

This section provides information on the process used to develop goals that cut across the five natural hazards addressed in the mitigation plan.

1.5 Mitigation Action Items

This section provides information on the action items that cut across the five natural hazards addressed in the mitigation plan.

1.6 Plan Maintenance

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

Section 2 - Hazard Specific Information

Hazard-Specific Information on the five chronic hazards are addressed in this plan. Chronic hazards occur with some regularity and may be predicted through historic evidence and scientific methods. The chronic hazards addressed in the plan include:

- 2.1 Earthquake
- 2.2 Landslide
- 2.3 Flooding
- 2.4 Tsunami
- 2.5 Wildfires
- 2.6 Severe Windstorm/Thunderstorm

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, because of the geology and terrain, earthquake, landslides, and flooding also 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, hazard causes and characteristics, hazard assessment, goals and action items, and local, state, and national resources.

Section 3 - Resources

The plan appendices are designed to provide users of the City of Santa Monica's Natural Hazards 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: Plan Resource Directory

> The resource directory includes City, regional, state, and national resources and programs that may be of technical and/or financial assistance to City of Santa Monica during plan implementation.

Appendix B: Public Participation Process

> This appendix includes specific information on the various public processes used during development of the plan.

Appendix C: Benefit Cost Analysis

> 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 D: List of 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 Santa Monica's Natural Hazards Mitigation Plan.

Appendix E: Glossary

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

1.2 Community Profile

The section is to provide a broad perspective, brief history and describes the makeup and development of the community.

Topography
Located along the Westside of Los Angeles County, the City of Santa Monica is comprised of 8.3 square miles and is boarded on three sides by the City of Los Angeles and the Pacific Ocean on the west. Santa Monica occupies a central position along the arching shoreline of Santa Monica Bay. The beach, which has grown through accretion, is several hundred feet wide—one of the widest stretches of beach in this part of southern California.

Santa Monica sits atop a coastal plain that is defined on its northern boundary by Santa Monica Canyon. This deep arroyo attracted native American settlements and then the area's first European settlement in the 1860s—a summer colony for residents of the new City of Los Angeles some twelve miles inland along the foot of the mountains. South of the canyon, the rugged terrain gives way to the gently south sloping upland of the City's north side. The land descends to a historic drainage channel that ran west to the sea along the general line of the present-day Santa Monica freeway. This drainage formed a distinctive draw that originally marked the edge of the Palisades and defined the City's southerly border. It is this collision of this south sloping upland with the southwesterly trending coastline that creates the City's most memorable topographic feature—the Palisades—a sheer cliff of fragile sandstone that rises about 100 feet above the coast that separates the northern portion of the City from the beach below.

The topography of the City's south side is considerably more complex. The broad upland occupied by the Sunset Park neighborhood rolls off gradually to the east and descends to the west into a series of parallel ridges that roll gently down into Ocean Park beach. To the south, it drops toward the historical coastal wetland of Ballona Creek. The landscape at the center of the City reflects the historic patterns created by water as it flowed from inland areas to the bay.

Climate
The climate in Santa Monica is temperate throughout the year. Average high temperatures vary between 65°F/18C to 72°F/22C from winter to summer. Summers are mild and dry, and winters are cool, with an annual average of 16 inches of precipitation.

Population/Demographics
According to the 2000 Census, Santa Monica's population is 84,084, or about 10,100 persons per square mile. Additional housing units added through June, 2002, have brought the population to around 85,686.

Senior citizens (65 years and over) comprise 14% of the city's population, and nearly half (42%) of them reported having at least one disability in 2000. Although it is home to a significant number of older people, Santa Monica is a city whose age distribution shows a significant concentration in the 22-44 age group, and has fewer youth under 19 years of age (16%) than the county average. The average Santa Monica resident is 39 years of age. According to the 1999 City of Santa Monica Homeless Population Survey, an estimated 1,037 individuals are homeless, with 72% of them being males, and 2% of the homeless being under the age of 17.

Santa Monica is unique in its household and housing cross-section. 38% of the households in Santa Monica are families, and 62% are non-family households, the reverse of the national average of 68% families and 32% non-family households. There are an average of 2.8 persons per family, and 1.8 persons per household. The 49,065 housing units in the City as of 2003 are primarily (70 %) occupied by renters as opposed to homeowners, again the reverse of the national average of 34% renters and 66% homeowners. The highest geographic concentration (28%) of households that are families with children in 2000 was in the 90402 zip code area.

The educational attainment levels of Santa Monica residents were, on average, significantly higher than for Los Angeles County and California in 2000. According to the 2000 Census, 61% of residents over the age of 25 reported having a college degree, (e.g. either an Associates degree or higher). This figure is relatively high when compared to Los Angeles County with 30% and California with 34% of the 25 and over population having college degrees.

The median household income in Santa Monica is $50,714 as of the 2000 Census. The number of households earning over $150,000 doubled between 1990 and 2000 when it reached 12% of total households. 60% of Santa Monica's employed population are employed as management, professional, and related occupations. The most popular employment industries for Santa Monica residents were educational, health & social service (18.8%), followed closely by professional, scientific & management industries (18.6%). Information services provided employment for 14.6% of residents.

Economy
Santa Monica is an economically successful city with about 16,000 businesses which collectively generate almost $8.4 billion in gross annual income. About $2.3 billion of these sales are in the retail sector. There are an estimated 71,000 jobs in Santa Monica, generating a combined payroll of around $3 billion. The Westside, including Santa Monica, also has a large resident workforce of skilled "knowledge workers". Over 60% of the 47,059 employed Santa Monica residents work in managerial, professional, and related occupations.

Industry
Whereas the smallest businesses remain larger in number, the most jobs are provided by the mid-sized companies in Santa Monica. Taxable sales for the City of Santa Monica reflect the general health of the business community, particularly the retail community, and are a substantial source of revenues

for the City. Of the three top economic categories, New Car Sales contributed 18.4%, Restaurants contributed 14.7%, and Apparel 10.4% of the $23.2 million the City earned in from taxable retail in 2001.

Tourism is a key component of the economy and lifestyle of this beachfront community. Over 3.8 million people visit the city each year from outside Los Angeles County for pleasure, vacation, or business. These visitors spend $788 million annually, and bring in hotel tax revenues of $20 million to the city. Approximately 11,500 jobs are supported by the tourist industry. Even with the recent slowdown in the tourism industry, the City’s hotel occupancy rate in its 3,500 rooms remains good, at 73%. The city is an international destination, as well as the destination for millions of day-trippers, particularly on weekends, as they throng to our clean beaches, and visit our Pier and special retail destinations such as the Third Street Promenade, Main Street, Montana Avenue, and Santa Monica Place.

Development History

Oversight of construction and development activities as well as long-range planning for Santa Monica is provided by the City's Department of Planning and Community Development (PCD). The City's long-range planning, development and growth policies are set forth in the General Plan, which contains the following 7 elements: Land Use, Circulation, Open Space, Conservation, Housing, Safety, and Noise. For certain regions of the city, Specific Plans have been developed which specify development and growth policies for each region. The Specific Plans and the Elements of the General Plan are described in more detail in Policies and Ordinances.

Plans for all proposed construction and development projects in Santa Monica must be first submitted to the PCD's Building and Safety Division for review. Building and Safety plan checkers verify that proposed projects comply with the Uniform Building Code, the City Municipal Code, State Title 24 requirements, and the Americans with Disabilities Act (ADA) requirements. Depending on the scope and nature of the project, the plans may be forwarded to the Planning and Zoning Division for further review prior to issuance of building permits. The PCD's Planning and Zoning Division is responsible for interpreting the Zoning Ordinance as well as processing development and subdivision applications, forwarding plans to the appropriate commissions or boards for review, assuring project compliance with the California Environmental Quality Act (CEQA), conducting design review of proposed buildings and provide staffing assistance to the Planning Commission, the Architectural Review Board, the Landmarks Commission and the Zoning Administrator. These commissions and boards make determinations on a variety of planning and development issues and are briefly described below:

Planning Commission - A seven member panel appointed by City Council to four year terms. The Commission meets twice monthly to review requests for development permits, conditional use permits, appeals to Zoning Administrator decisions, and planning policy matters. The Commission conducts public hearings on most of its agenda items. Within each zoning district there is a specific square footage threshold for development review. The Planning Commission reviews projects exceeding these thresholds as well as projects that require conditional use permits. Planning Commission decisions can be appealed to the City Council.

Architectural Review Board - A seven member panel appointed by City Council to four year terms. The ARB is required to include at least two registered professional architects as well as persons with expertise in conservation, recreation, design, landscaping, the arts, urban planning, cultural-historical preservation, and ecological and environmental sciences. The board meets twice monthly to review the exterior design of all buildings (except single family residences), signs and landscaping. The board was formed to ensure that new development upholds the appearance of the community and reviews proposed projects to ensure that they are compatible with the neighborhood and in compliance with landscaping and sign requirements. ARB decisions can be appealed to the City Council.

Landmarks Commission - A seven member panel appointed by City Council. Commission members include a registered architect, a local historian, an architectural historian, and a California-licensed real estate agent. The commission meets monthly and is charged with the task of designating buildings in the city as historic landmarks, designating historic districts and updating the city's historic resources inventory. Landmarks Commission decisions can be appealed to the City Council.

Zoning Administrator - The Zoning Administrator is a PCD staff member and has the authority to rule on various zoning matters such as administrative approvals, temporary use permits, performance standards permits, variances, use permits, and reduced parking permits. Discretionary Zoning Administrator decisions can be appealed to the Planning Commission.

Municipal construction and development projects are overseen by the Engineering Division of the Department of Environmental and Public Works Management. All municipal projects are subject to the same plan check process and requirements as private development.

Future Development

The City of Santa Monica recognizes that we live in a period of great environmental crisis. As a community, we need to create the basis for a more sustainable way of life both locally and globally through the safeguarding and enhancing of our resources and by preventing harm to the natural environment and human health. We are resolved that our impact on the natural environment must not jeopardize the prospects of future generations. In 1994, the City Of Santa Monica adopted the Sustainable City Program and in 2003, the Sustainable City Plan was fully adopted.

Elements of the Sustainable City Program include:

- Community and Economic Development
- Construction and Development
- Education
- Energy
- Hazardous Materials
- Housing
- Purchasing
- Solid Waste
- Stormwater & Wastewater
- Transportation
- Water

Community Goals (adopted February 11, 2003):

- Resource Management
- Environmental & Public Health
- Transportation
- Economic Development
- Open Space & Land Use
- Housing
- Community Education & Civic Participation

1.3 Risk Assessment

What is a Risk Assessment?

Conducting a risk assessment can provide information: on 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. Specifically, the three levels of a risk assessment are as follows:

1) Hazard Identification

This is the description of the geographic extent, potential intensity and the probability of occurrence of a given hazard. Maps are frequently used to display hazard identification data. The City of Santa Monica identified six major hazards that affect this geographic area. These hazards - earthquakes, landslides, flooding, tsunamis, wildfires and severe windstorms/thunderstorms - were identified through an extensive process that utilized input from the Hazard Mitigation Advisory Committee. The geographic extent of each of the identified hazards has been identified by the City of Santa Monica GIS department using the best available data.

2) Profiling Hazard Events

This process describes the causes and characteristics of each hazard, how it has affected City of Santa Monica in the past, and what part of the City of Santa Monica's population, infrastructure, and environment has historically been vulnerable to each specific hazard. A profile of each hazard discussed in this plan is provided in each hazard section. For a full description of the history of hazard specific events, please see the appropriate hazard chapter.

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 fulfill important public safety, emergency response, and/or disaster recovery functions. The critical facilities have been identified and are listed in Table 1.1 at the end of this section. A description of the critical facilities in the City is also provided in this section. In addition, this plan includes a community issues summary in each hazard section to identify the most vulnerable and problematic areas in the City, including critical facilities, and other public and private property.

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. This level of analysis involves using mathematical models. The two measurable components of risk analysis are 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. For each hazard where data was available, quantitative estimates for potential losses are included in the hazard assessment.

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 City of Santa Monica 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 City of Santa Monica 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.

Regardless of the data available for hazard assessments, there are numerous strategies the City can take to reduce risk. These strategies are described in the action items detailed in each hazard section of this Plan. Mitigation strategies can further reduce disruption to critical services, reduce the risk to human life, and alleviate damage to personal and public property and infrastructure. Action items throughout the hazard sections provide recommendations to collect further data to map hazard locations and conduct hazard assessments.

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 five hazards profiled in the mitigation plan, including earthquakes, landslides, flooding, tsunamis, and severe windstorms/thunderstorms. The Federal criteria for risk assessment and information on how the City of Santa Monica's Natural Hazard Mitigation Plan meets those criteria is outlined in Table 3-2 below.

Table 1.4 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. To the extent GIS data are available, the City developed maps identifying the location of the hazard in the City. The Executive Summary and the Risk Assessment sections of the plan include a list of the hazard maps.
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	Where data is available, the vulnerability assessment for each hazard addressed in the mitigation plan includes an inventory of all publicly owned land within hazardous areas. Each hazard section provides information on vulnerable areas in the City in the Community Issues section. Each hazard section also identifies potential mitigation strategies.
Assessing Vulnerability: Estimating Potential Losses:	The Risk Assessment Section of this mitigation plan identifies key critical facilities and lifelines in the City and includes a map of these facilities. Vulnerability assessments have been completed for the hazards addressed in the plan, and quantitative estimates were made for each hazard where data was available.
Assessing Vulnerability: Analyzing Development Trends	The City of Santa Monica 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, shelters, and shelters, 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 facilities may include: buildings such as the jail, law enforcement center, public services building, community corrections center, the courthouse, and juvenile services building and other public facilities such as schools. Table 1.2 lists the critical facilities.

Table 1.5 Critical Facilities

Name	**Facility Type**
Public Safety Facility	Emergency Response Facilities

Fire Station #1	Emergency Response Facilities
Fire Station #2	Emergency Response Facilities
Fire Station #3	Emergency Response Facilities
Fire Station #5	Emergency Response Facilities
Santa Monica City Hall	Government Facilities
Main Library	Government Facilities
St. Johns Hospital	Medical Facilities
Arcadia Water Treatment Plant	Water and Sewer
City Bus Yards	HAZMAT storage areas
City Yards	Water and Sewer
Santa Monica- UCLA Hospital	Medical Facilities
Santa Monica Airport	Airports
Arcadia Reservoir	Water and Sewer
Riveria Reservoir	Emergency Response Facilities
San Vicente Reservoir	Water and Sewer
Metropolitan Water District Water Transmission Lines	Water and Sewer
Mt. Olivette Reservoir	Water and Sewer
Santa Monica Freeway, US 10	Major Roads/Bridges
Pacific Coast Highway	Major Roads/Bridges
Santa Monica Civic Auditorium	Government Facilities
Santa Monica Animal Shelter	Government Facilities
Library- Fairview Branch	Government Facilities
Library Montana Avenue Branch	Government Facilities
Ocean Park Library Branch	Government Facilities
Harbor Patrol Office	Emergency Response Facilities
Ken Edwards Center	Other
Water Administration & Billing	Water and Sewer
Woodlawn Cemetery	Other
Clover Park	Other
Christine Emerson Reed Park	Other
Marine Park	Other
Memorial Park	Other
Virginia Park	Other
Santa Monica Unified School Dist	Child Care Facilities
Elementary School Edison	Child Care Facilities
Franklin Elementary School	Child Care Facilities
Grant Elementary School	Child Care Facilities
McKinley Elementary School	Child Care Facilities
John Muir Elementary School	Child Care Facilities

Will Rogers Elementary School	Child Care Facilities
Roosevelt Elementary School	Child Care Facilities
John Adams Middle School	Child Care Facilities
Lincoln Middle School	Child Care Facilities
Olympic High School	Child Care Facilities
Santa Monica High School	Child Care Facilities
Santa Monica Alternative School	Child Care Facilities
Crossroads School	Child Care Facilities
Santa Monica College	Child Care Facilities
Southern California Edison Company	Energy Related
Santa Monica Red Cross	Other

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.

1.4 Mitigation Goals

IFR REQUIREMENT §201.6(c)(3)(i):	[The hazard mitigation strategy shall include: a] description of mitigation goals to reduce or avoid long-term vulnerabilities to the identified hazards.
Explanation:	The community's hazard reduction goals, as reflected in the plan, along with their corresponding objectives, guide the development and implementation of mitigation measures. This section should describe what these goals are and how they were developed. The goals could be developed early in the planning process and refined based on the risk assessment findings, or developed entirely after the risk assessment is completed. They should also be compatible with the goals of the community as expressed in other community plan documents.

	Although the Rule language does not require a description of objectives, communities are highly encouraged to include a description of the objectives developed to achieve the goals so that reviewers understand the connection between goals, objectives, and activities. The goals and objectives should: - Be based on the findings of the local and State risk assessments; and - Represent a long-term vision for hazard reduction or enhancement of mitigation capabilities.

Process for Prioritization of Mitigation Goals and Action Items

During the development of the Santa Monica Local Hazard Mitigaiton Plan, the Planning Committee continually evaluated the relative merits of mitigation activities, and local conditions in order to ensure public, government, and local political support for the implementation of goals and action itmes. In addition to a thorough review of existing reports, plans, ordinances and other material, Planning Committee members met with individual departments to determine the priorities of action items. Included in these meetings were discussion of how action items should be prioritized taking into consideration the economic feasibility of activities and the related hazard assessment.

In the prioritization of the mitigation goals and action items, the planning committee evaluated the social, technical, administrative, political, legal, economic, and environmental opportunities and constraints of the identified goals and actions. Based on these considerations, the committee reached consensus on achievable goals and objective in the development of the Local Hazard Mitigation Plan.

Further, mitigation goals and action items were developed in a manner that addressed the City of Santa Monica's greatest threat from natural hazards, and incorporated such threats in order to set goals and action items that would be most effective in protecting lives and property; in relation to the hazard analysis of Santa Monica. Based on the City Of Santa Monica's geology and other factors, devastating earthquakes clearly present the highest probability of occurance and largest potential for damage and loss in terms of lives and property. Consequently, the mitigation goals and action items were developed accordingly.

The action items #1-#6 were listed in priority order. The Local Hazard Mitigation Planning Committee came to consenus regarding the prioritization based on several factors. These factors included review of relevant materials, plans, reports, and ordinances, interviews with various specialists and City Departments (as listed in the public involvement section), and consistency with the City of Santa Monica’s existing plans including the SEMS Plan and the Sustainable City Plan.

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.

Given federal funding, the Hazard Mitigation Advisory Committee used a FEMA-approved benefit/cost analysis approach to identify and prioritize mitigation action items. For other projects and funding sources, the Hazard Mitigation Advisory Committee will use other approaches to understand the costs and benefits of each action item and develop a prioritized list. For more information regarding economic analysis of mitigation action items, please see Appendix C of the Plan.

A cost-benefit review of mitigation goals and action items was conducted in a qualitative manner, during the development of prioritized goals and objectives. A qualitative assessment of benefits of mitigative actions in Santa Monica was conducted by the Planning Committee. The Committee came to consensus based on relevant factors including the high probability/ high-cost events, versus evetns that were less likely, and less significant in loss of life and property.

The following section provides an overview of the Mitigation Goals and Objectives:

Goal #1: Increase Public Awareness of Local Hazards

Description: Increase public awareness and understanding, support, and demand for hazard mitigation.

Objectives:
- Heighten public awareness of the full range of natural hazards they may face.
- Educate the public on actions they can take to prevent or reduce the loss of life and/or property from all hazards.
- Publicize and encourage the adoption of appropriate hazard mitigation measures.

Goal #2: Protection of Lives and Property

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

Objectives:
- Advise public about health and safety precautions to protect from injury and loss.
- Warning and communication technologies to mitigate damage from natural hazards.
- Reduce damage to enhance protection of dangerous areas during hazardous events.
- Protect critical facilities and services.
- Ensure Emergency Services and critical facilities are included in mitigation strategies.

Goal #3: Promote Sustainable Living

Description: Promote development in a sustainable manner.

Objectives:
- Incorporate hazard mitigation into long-range planning and development activities.
- Promote beneficial use of hazardous areas while expanding open space and recreational opportunities.
- Utilize regulatory approaches to prevent creation of future hazards to life and property.

Goal #4: Partnerships and Implementation

Description: Build and support local partnerships to continuously become less vulnerable to natural hazards.

Objectives:

- Build and support local partnerships with stakeholders in the community.
- Build a cadre of committed volunteers to safeguard the community before, during, and after a disaster.
- Build hazard mitigation concerns into City planning and budgeting process.

Goal #5: Strengthen Emergency Services Capability

Description: Establish policies and procedures to ensure mitigation projects for critical facilities, services, and infrastructure.

Objectives:

- Provide training to City and non-City departments on mitigation programs and techniques that could be incorporated into a variety of projects.

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

1.5 Mitigation Actions/Projects

IFR REQUIREMENT §201.6(c)(3)(ii):	[The mitigation strategy shall include a] section that identifies and analyzes a comprehensive range of specific mitigation actions and projects being considered to reduce the effects of each hazard with particular emphasis on new and existing buildings and infrastructure.
Explanation:	The local jurisdiction should list potential loss reduction activities it has identified in its planning process and describe its approach to evaluating these activities to select those that achieve the community's goals and objectives. Particular attention should be given to those mitigation activities that address existing and new buildings and infrastructure. Not all of the mitigation measures identified may ultimately be included in the community's plan due to prohibitive costs, scale, low benefit/cost analysis ratios, or other concerns. The process by which the community decides on particular mitigation measures must be described. The information will also be valuable as part of the alternative analysis for the National Environmental Policy Act (NEPA) review required if projects are federally funded.

This section serves to identify proposed projects in the community.

1. Identify Future Mitigation Projects and Potential Funding Sources
Description: Identify and pursue potential projects and funding sources to develop and implement local and county mitigation activities.

- Develop incentives to pursue mitigation projects
- Allocate resources to assist in mitigation projects when possible
- Partner with other organizations and agencies to identify grant programs and foundations that support mitigation activities
- Identify funds to improve the seismic performance of the sewer system at the 4th Street overpass
- Identify funds for City Yards improvement projects
- Identify funds for bluff mitigation projects

Priority: High
Responsible Organization: Planning, Finance, Fire Departments

Status: On-going
Timeline: Long-Term
Cost: TBA
Potential Funding Sources: Grants
Plan Goals Addressed: Protection of Lives and Property
Partnerships for Implementation
Emergency Services Capability

2.Integrate LHMP into Existing Programs, Ordinances, Building Codes
Description: Integrate the goals and action items from the Local Hazard Mitigation Plan into existing regulatory documents and programs, including local ordinances and building codes, where appropriate. Assess feasibility of gas shut-off valve ordinance as required by other regional jurisdictions. (Based on 300+ gas leaks following the Northridge earthquake.)

Priority: Open
Responsible Organization: Planning
Status: Proposed
Timeline: Long-Term
Cost: TBA
Potential Funding Sources: General Funds, Grants
Plan Goals Addressed: Promote Sustainable Living
Partnerships for Implementation

3. Critical Information Systems
Description: Design and implement a protection program for the critical information systems infrastructure, including telephones, computers, radio, 911 services, information systems, and backup systems.

- Continue to assess and improve radio interoperability between City departments, agencies and neighboring jurisdictions
- Enhance GIS response capability in emergencies, including building data inventory, damage assessment and evacuation planning

Priority: High
Responsible Organization: ISD
Status: Proposed
Timeline: Long-Term
Cost: TBA

Potential Funding Sources:	General Funds, Grants
Plan Goals Addressed:	Emergency Services Capability Protection of Lives and Property

4. Increase Public Awareness of Hazards and Disaster Preparedness
Description: Design and implement a comprehensive campaign of public awareness of local natural hazards and disaster preparedness techniques, using media, print, radio, Internet, lecture and hands-on training.

- Design and develop public education campaign for emergency preparedness and hazard mitigation for those who live and work in Santa Monica
- Assess the feasibility of establishing Fire Captain training position to augment public education efforts of the Police Community Relations, City Manager Office's Public Information, Fire Department and Community Cultural Services groups
- Re-establish public education in schools and the community
- Increase the number of Disaster Assistance Response Training (DART) classes for those who live and work in Santa Monica
- Expand Automated External Defribulator program

Priority:	High
Responsible Organization:	Fire Department
Status:	On-going
Timeline:	Long-Term
Cost:	TBA
Potential Funding Sources:	General Funds, Grants
Plan Goals Addressed:	Increase Public Awareness Emergency Services Capability Protection of Lives and Property

5. Strengthen Evacuation Plans for City Facilities
Description: Continue to strengthen and develop evacuation plans, policies and procedures for City facilities located throughout Santa Monica.

- Modify evacuation plans to incorporate City Public Safety agencies
- Train employees and practice City facility evacuation plans with participation by City Public Safety agencies such as Police and Fire

Priority:	Open
Responsible Organization:	Risk Management, Fire Department

Status:	On-going
Timeline:	On-going
Cost:	TBA
Potential Funding Sources:	General Funds, Grants
Plan Goals Addressed:	Protection of Lives and Property

6. Public Alert and Notification
Description: Assess feasibility of a public alert and notification system for disasters.

- Enhance notification procedures of key city staff to respond to emergencies
- Re-establish Tsunami Working Group
- Continue to study technological advances in capabilities and advances in public alert warning systems

Priority:	Open
Responsible Organization:	Police, Fire Departments
Status:	Proposed
Timeline:	Long-term
Cost:	TBA
Potential Funding Sources:	General Funds, Grants
Plan Goals Addressed:	Protection of Lives and Property Emergency Services Capability

Priority	Mitigation Action Item	Responsible Organization(s)	Timeline	Plan Goals Addressed				
				Emergency Services Capability	Partnerships and Implementation	Promote Sustainable Living	Protection of Lives and Property	Public Awareness of Local Hazards
High	**1. Identify Future Mitigation Projects and Potential Funding Sources***:* Identify projects and pursue funds to develop and implement local and county mitigation activities.	Planning Finance Fire	On-going	√	√		√	
Open	**2. Integrate LHMP into Existing Programs, Ordinances, Building Codes:** Integrate the goals and action items from the Local Hazard Mitigation Plan into existing regulatory documents and programs, including local ordinances and building codes, where appropriate. Assess feasibility of gas shut-off valve ordinance as required by other regional jurisdictions. (Based on 300+ gas leaks following the Northridge earthquake.)	Planning	Long-term		√	√	√	
High	**3. Critical Information Systems:** Design and implement a protection program for the critical information systems infrastructure, including telephones, computers, radio, 911 services, information systems, and backup systems.	ISD	Long-term	√			√	
High	**4. Increase Public Awareness of Hazards and Disaster Preparedness***:* Design and implement a comprehensive campaign of public awareness and preparedness of local natural hazards, using media, print, radio, and the internet.	Fire	Long-term				√	√
Open	**5. Strengthen Evacuation Plans for City Facilities***:* Continue to strengthen and develop evacuation plans, policies and procedures for City facilities located throughout Santa Monica.	Risk Management Fire	On-going	√	√		√	
Open	**6. Public Alert and Notification:** Assess feasibility of a public alert and notification system for disasters.	Fire Police	Long-term	√			√	

1.6 Plan Maintenance

The plan maintenance section of this document details the formal process that will ensure that the City of Santa Monica's Natural Hazards 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 Santa Monica's 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 adopted the City of Santa Monica's Natural Hazards Mitigation Plan at the City Council meeting held September 28, 2004. This governing body has the authority to promote sound public policy regarding natural hazards. Once the plan has been adopted, the City's Emergency Services Coordinator will be responsible for submitting it to the State Hazard Mitigation Officer to the Governor's Office of Emergency Services. The Governor's Office of Emergency Services will then submit the plan to the Federal Emergency Management Agency (FEMA) for review. This review will address the federal criteria outlined in FEMA Interim Final Rule 44 CFR Part 201. Upon acceptance by FEMA, the City of Santa Monica will gain eligibility for Hazard Mitigation Grant Program funds.

Coordinating Body

A City of Santa Monica's Hazard Mitigation Committee will be responsible for coordinating implementation of plan action items and undertaking the formal review process. The City Council will assign representatives from city agencies, including, but not limited to, the current Hazard Mitigation Advisory Committee members. The city has formed a Hazard Mitigation Committee that consists of members from local agencies, organizations, and citizens, and includes the following:

- City of Santa Monica Building and Safety
- City of Santa Monica Fire Department
- City of Santa Monica Finance
- City of Santa Monica Police Department
- City of Santa Monica Information Systems
- City of Santa Monica GIS
- City of Santa Monica Planning
- City of Santa Monica Disaster Recovery Organization
- City of Santa Monica Rent Control

City of Santa Monica Human Services Administration
City of Santa Monica Community and Cultural Services
City of Santa Monica City Manager's Office
City of Santa Monica Airport
City of Santa Monica City TV
Santa Monica Red Cross
California Division of Mines and Geology
Federal Emergency Management Agency
The Governor's Office of Emergency Services

In order to make this committee as broad and useful as possible, the City Administrator will engage other relevant organizations and agencies in hazard mitigation. The recommendations for adding to the Hazard Mitigation Advisory Committee include:

An elected official
A representative from the Chamber of Commerce
An insurance company representative
Community Planning Organization representatives
A representative from the City Manager's office
Representation from professional organizations such as the Home Builders Association
A representative from the South Bay Council of Governments

The Hazard Mitigation Advisory Committee will meet no less than bi-annually. Meeting dates will be scheduled once the final Hazard Mitigation Advisory Committee has been established. These meetings will provide an opportunity to discuss the progress of the action items and maintain the partnerships that are essential for the sustainability of the mitigation plan.

Convener

The City Council will adopt the City of Santa Monica's Natural Hazard Mitigation Plan, and the Hazard Mitigation Advisory Committee will take responsibility for plan implementation. The City Manager 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 Natural Hazard Advisory Committee Members.

Implementation through Existing Programs

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

The city of Santa Monica's Building & Safety Department is responsible for administering the Building & Safety Codes. In addition, the Hazard Advisory Committee will work with other agencies at the state level to review, develop and ensure Building & Safety Codes that are adequate to mitigate or present damage by natural hazards. This is to ensure that life-safety criteria are met for new construction.

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.

EVALUATING AND UPDATING THE PLAN

Formal Review Process

- The section of the Local Hazard Mitigation Plan that details the procedures for monitoring and evaluating the Plan has been clarified. Pages 47-50 have been revised to clearly demonstrate that the Local Hazard Mitigation Plan Committee (formerly the Disaster Recovery Office) will continue to meet quarterly to update and evaluate the Local Hazard Mitigation Plan and the progress of its goals and objectives. The Emergency Services Coordinator and the Legislative Liaison have the lead in convening these quarterly meetings, and will continue to update, revise, and evaluate the Plan and its progress. This committee is made up of the Emergency Services Coordinator, the City Manager's Legislative Liaison, a Finance Department Representative, and a City Building Engineer, among others. This group has been meeting monthly since the 1994 Northridge Earthquake, to monitor all of the FEMA projects that stemmed from that earthquake. The Committee will continue to focus on mitigative progress in the City and specifically on FEMA related projects such as the 2005 Pre Disaster Mitigation Grant Program, of which Santa Monica has applied for funding to seismically retrofit two City owned parking structures.

The City of Santa Monica's Natural Hazards 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 Planning Committee members and organizing the annual meeting. This person is now identified as the City of Santa Monica's Emergency Services Coordinator. The Emergency Services Coordinator will work closely with the City Manager's Office's Legislative Liaison in convening the Planning Committee meetings, and to ensure that annual reviews are conducted. The City of Santa Monica will evaluate the Local Hazard Mitigation Plan annually, beginning exactly one year from FEMA approval of the Plan.

Committee members 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.

During the first annual review of the approved Local Hazard Mitigation Plan, the Planning Committee will develop an additional 5-10 action items that are consistent with the Plan's existing goals and priorities.

The convener will assign the duty of updating the plan to one or more of the committee members. The designated committee members will have three months to make appropriate changes to the Plan before submitting it to the Hazard Committee members, and presenting it to the City Council (or other authority). The Hazard Mitigation Advisory Committee will also notify all holders of the city plan when changes have been made. Every five years the updated plan will be submitted to the State Hazard Mitigation Officer and the Federal Emergency Management Agency for review.

Continued Public Involvement

City of Santa Monica is dedicated to involving the public directly in review and updates of the Hazard Mitigation Plan. The Hazard Mitigation 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 catalogued and kept at all of the appropriate agencies in the city. The plan also includes the address and the phone number of the City's Emergency Services Coordinator, responsible for keeping track of public comments on the Plan.

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 City TV, the City's web page, and local newspapers.

Section 2 – Specific Natural Hazards

TABLE OF CONTENTS

Why Are Earthquakes a Threat to the City of Santa Monica

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 a point offshore, 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."[i]

But San Andreas is only one of dozens of known earthquake faults that criss-cross Southern California. Some of the better known faults include the Newport-Inglewood, Whittier, Chatsworth, Elsinore, Hollywood, Los Alamitos, and Palos Verdes faults. Beyond the known faults, there are a potentially large number of "blind" faults that underlie the surface of Southern California. One such blind fault was involved in the Whittier Narrows earthquake in October 1987.

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 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.

For decades, partnerships have flourished between the USGS, Cal Tech, the California Geological Survey and universities to share research and educational efforts with Californians. Tremendous earthquake mapping and mitigation efforts have been made in California in the past two decades, and public awareness has risen remarkably during this time. Major federal, state, and local government agencies and private organizations support earthquake risk reduction, and have made significant contributions in reducing the adverse impacts of earthquakes. Despite the progress, the majority of California communities remain unprepared because there is a general lack of understanding regarding earthquake hazards among Californians.

As experienced in the Northridge earthquake, a major earthquake occurring in or near the City of Santa Monica may cause many deaths and casualties, extensive property damage, fires and hazardous material spills and other ensuing hazards. The effects could be aggravated by aftershocks and by the secondary affects of fire, hazardous material/chemical accidents and possible failure of the waterways and dams. The time of day and season of the year would have a profound effect on the number of dead and injured and the amount of property damage sustained. Such an earthquake would be catastrophic in its affect upon the population and could exceed the response capabilities of the individual cities, Los Angeles County Operational Area and the State of California Emergency Services. Damage control and disaster relief support would be required from other local governmental and private organizations, and from the state and federal governments.

Extensive search and rescue operations would be required to assist trapped or injured persons. Emergency medical care, food and temporary shelter could be required by injured or displaced persons. Identification and burial of many dead persons would pose difficult problems; public health would be a major concern. Mass evacuation may be essential to save lives, particularly in areas downwind from hazardous material releases. Many families would be separated particularly if the earthquake should occur during working hours. Emergency operations could be seriously hampered by the loss of communications and damage to transportation routes within, and to and from, the disaster area and by the disruption of public utilities and services.

The economic impact on the City of Santa Monica from a major earthquake would be considerable in terms of loss of employment and loss of tax base. Also, a major earthquake could cause serious damage and/or outage of computer facilities. The loss of such facilities could curtail or seriously disrupt the operations of banks, insurance companies and other elements of the financial community. In turn, this could affect the ability of local government, business and the population to make payments and purchases.

Table 2.1   Earthquake Events in the Southern California Region

Southern California Region Earthquakes with a Magnitude 5.0 or Greater	
1769 Los Angeles Basin	1916 Tejon Pass Region
1800 San Diego Region	1918 San Jacinto
1812 Wrightwood	1923 San Bernardino Region
1812 Santa Barbara Channel	1925 Santa Barbara
1827 Los Angeles Region	1933 Long Beach
1855 Los Angeles Region	1941 Carpenteria
1857 Great Fort Tejon Earthquake	1952 Kern County
1858 San Bernardino Region	1954 W. of Wheeler Ridge
1862 San Diego Region	1971 San Fernando
1892 San Jacinto or Elsinore Fault	1973 Point Mugu
1893 Pico Canyon	1986 North Palm Springs
1894 Lytle Creek Region	1987 Whittier Narrows
1894 E. of San Diego	1992 Landers
1899 Lytle Creek Region	1992 Big Bear
1899 San Jacinto and Hemet	1994 Northridge
1907 San Bernardino Region	1999 Hector Mine
1910 Glen Ivy Hot Springs	

Source:
http://geology.about.com/gi/dynamic/offsite.htm?site=http%3A%2F%2Fpasadena.wr.usgs.gov%2Finfo%2Fcahist_eqs.html

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 earthquakes is based on observations and felt reports, and are 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 the 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.

The City of Santa Monica is in the vicinity of several known active and potentially active earthquake faults including the San Andreas which lies approximately 40 miles east of Santa Monica, the San Jacinto, Santa Monica, Whittier-Elsinore, and the northeastern end of the Newport-Inglewood Fault Zone, the source of the 1933 Long Beach earthquake, that is located within the Los Angeles Metropolitan area. New faults within the region are continuously being discovered. Scientists have identified almost 100 faults in the Los Angeles area known to be capable of a magnitude 6.0 or greater earthquake.

Clearly, as a result of Santa Monica's natural geology, the City is at risk of suffering significant losses due to earthquakes, both in terms of loss of life and injuries, as well as damage to property and the environment. The following description of earthquake risks to Santa Monica detail the threat that earthquakes pose to the community. Fortunately, since the 1994 Northridge earthquake, the City of Santa Monica has enacted strong building codes and other ordinance (as described in this plan) that will likely reduce the impacts of strong earthquakes to the community.

History of Earthquake Events in Southern California

Since seismologists started recording and measuring earthquakes, there have been tens of thousands of recorded earthquakes in Southern California, most with a magnitude below three. No community in Southern California is beyond the reach of a damaging earthquake. Table 2.1 describes the historical earthquake events that have affected Southern California.

The 1994 Northridge Earthquake

The January 17, 1994 magnitude 6.7 Northridge Earthquake (thrust fault), with its epicenter beneath Reseda, produced severe ground motions, caused 57 deaths, 9,253 injuries and left over 20,000 people displaced within the Los Angeles area. It was the most expensive disaster in the history of Santa Monica, which sustained more than $250 million in damage. More than 530 buildings, including 2,300 housing units, were red- or yellow-tagged, rendering them uninhabitable or with limited accessibility. An estimated 16,000 apartments, condominiums or houses sustained some damage and were green-tagged, or still inhabitable.

Because of the severe damage in Santa Monica, city officials implemented a number of measures to expedite recovery efforts, including a streamlined permit process and fee waivers, as well as rent increases to cover earthquake repairs in rent-controlled buildings. Funds received from the Federal Emergency Management Agency included $93.4 million for home repairs, temporary housing, infrastructure repairs and retrofitting to help lessen the effects of future disasters.

The earthquake affected almost every building on the Santa Monica College with an estimated $80 million spent on the recovery effort. Santa Monica Hospital Medical Center suffered significant damage leading to the hospital's partnership with UCLA. The hospital's pavilion and tower sustained about $15 million in immediate damage, forcing the tower's closure for nine months. All of the hospital's operations were consolidated into the pavilion.

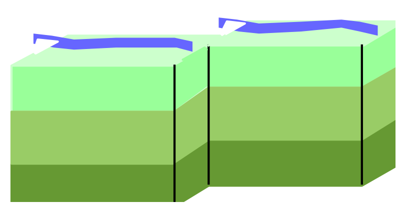
Saint John's Hospital's north wing, with its 185 beds, the hospital nursery and the neo-natal intensive care unit, sustained the most damage. Those beds and services were immediately evacuated and moved to other parts of the facility. The hospital stayed open for three days before it was forced to shut down completely because of the extensive damage. On October 3, 1994, Saint John's was fully operational minus its north wing, which was demolished. The cost of repairs totaled $32 million. In July 1998, Saint John's broke ground on a $271 million replacement project, scheduled to be finished by the year 2005. To help survive any future disasters, the new facility will have its own water supply, sewage system and communications backup system.

By February 1999, 517 of the 530 buildings that were red- or yellow-tagged had been repaired or have repair permits. The city issued more than 3,400 repair permits for earthquake damaged properties. Fifty-three buildings were demolished because of catastrophic earthquake damage.

Scientists have stated that such devastating shaking should be considered the norm near any large thrust earthquake. Recent reports from scientists of the U.S. Geological Survey and the Southern California Earthquake Center say that the Los Angeles Area could expect one earthquake every year of magnitude 5.0 or more for the foreseeable future.

Causes and Characteristics of Earthquakes in Southern California

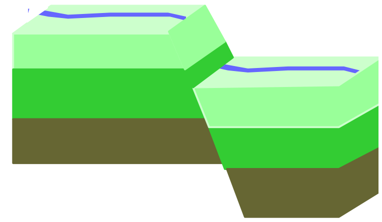
EARTHQUAKE FAULTS



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

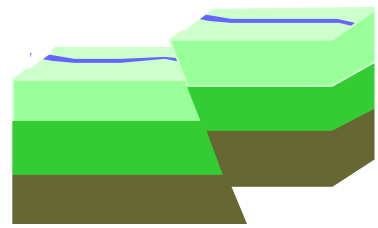
Strike-slip

Strike-slip faults are vertical or almost vertical rifts where the earth's plates move mostly horizontally. From the observers 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.



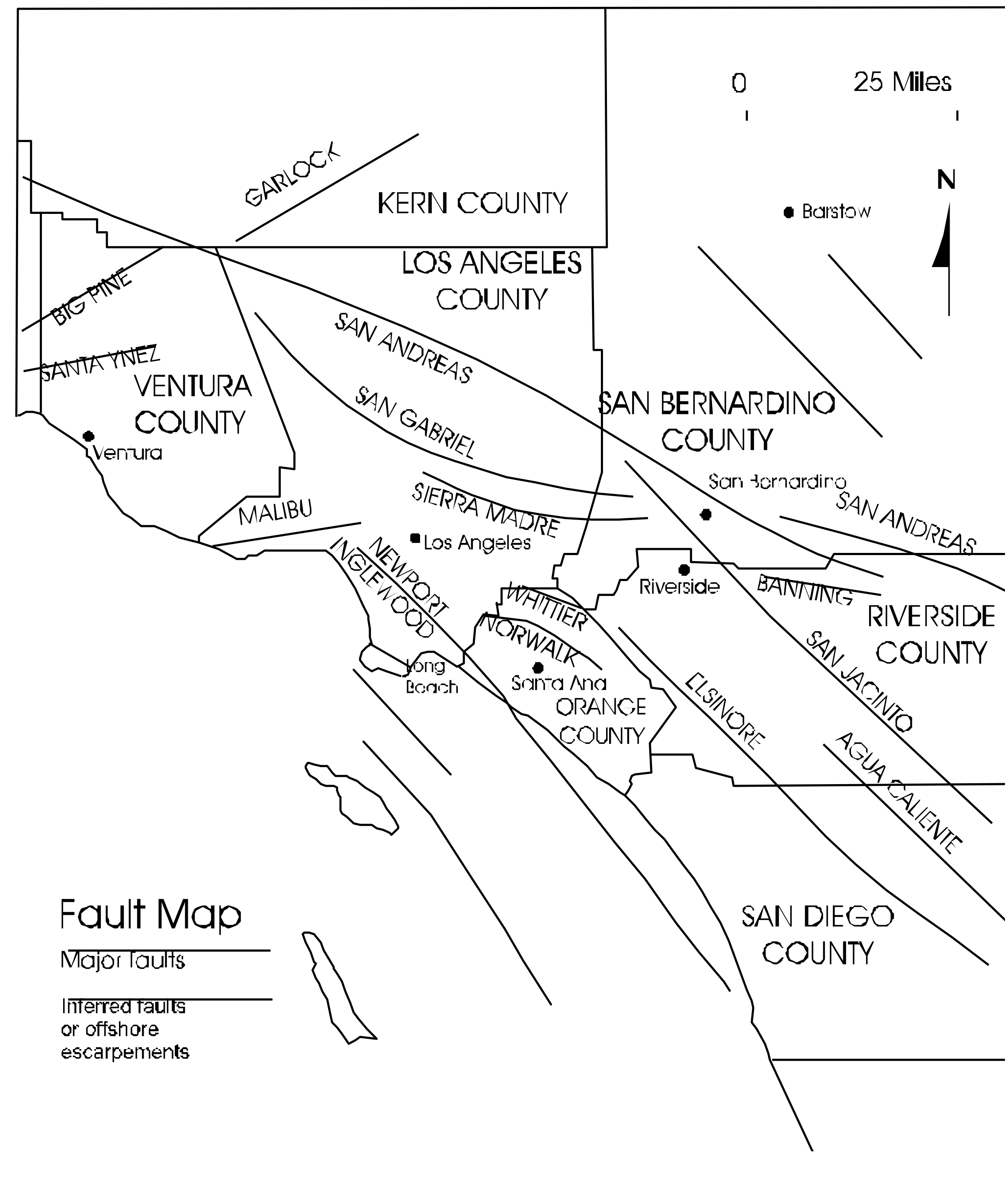
Dip-slip

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.



Map 2.1

Southern California Earthquake Fault Map



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." [ii] 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.

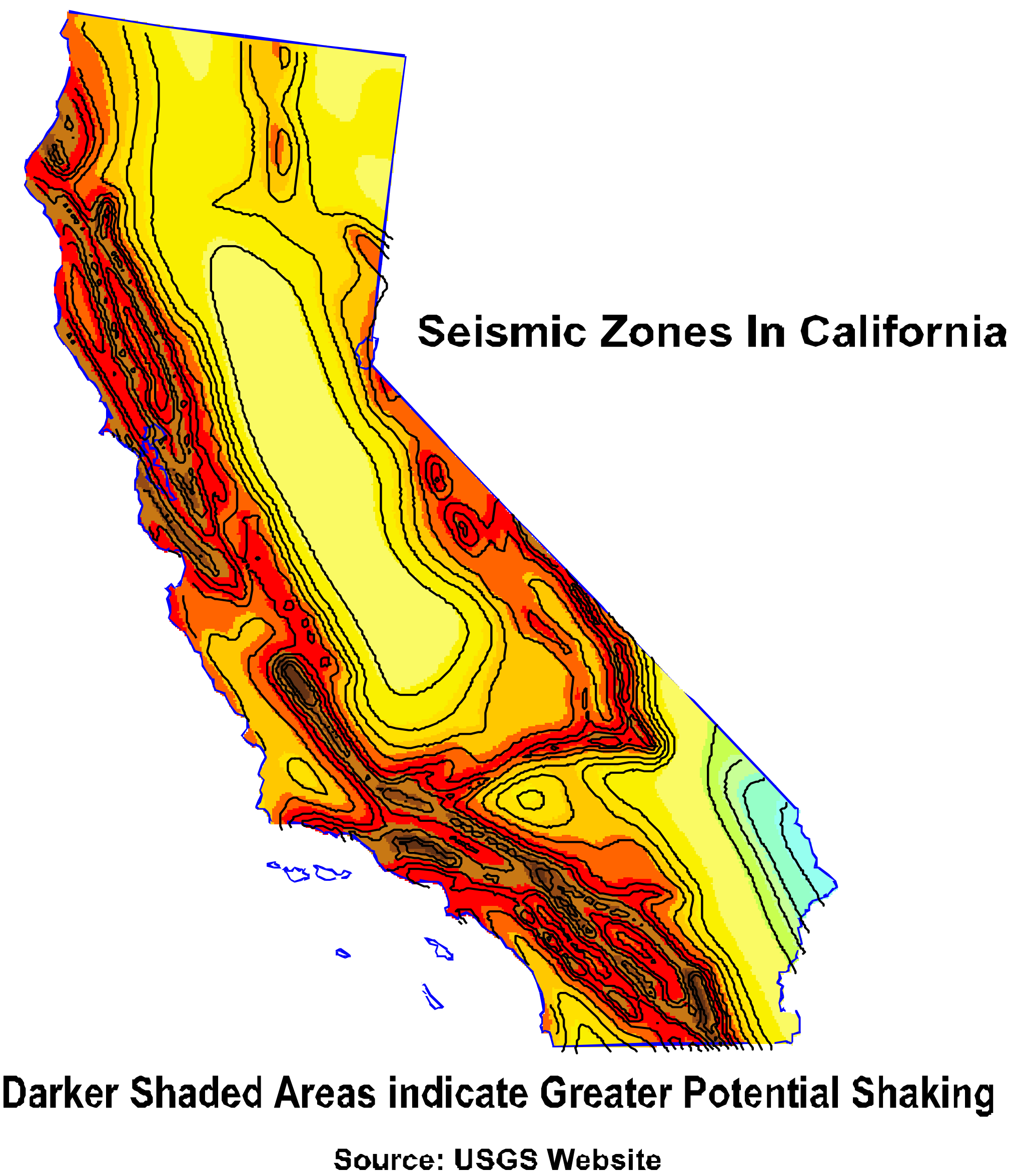
Liquefaction

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.[iii] Amplification can also occur in areas with deep sediment filled basins and on ridge tops.

Map 2.2 Seismic Zones in California



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, Governor's Office of Emergency Services, United States Geological Survey, Cal Tech, 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. Map 2.1 illustrates the known earthquake faults in Southern California.

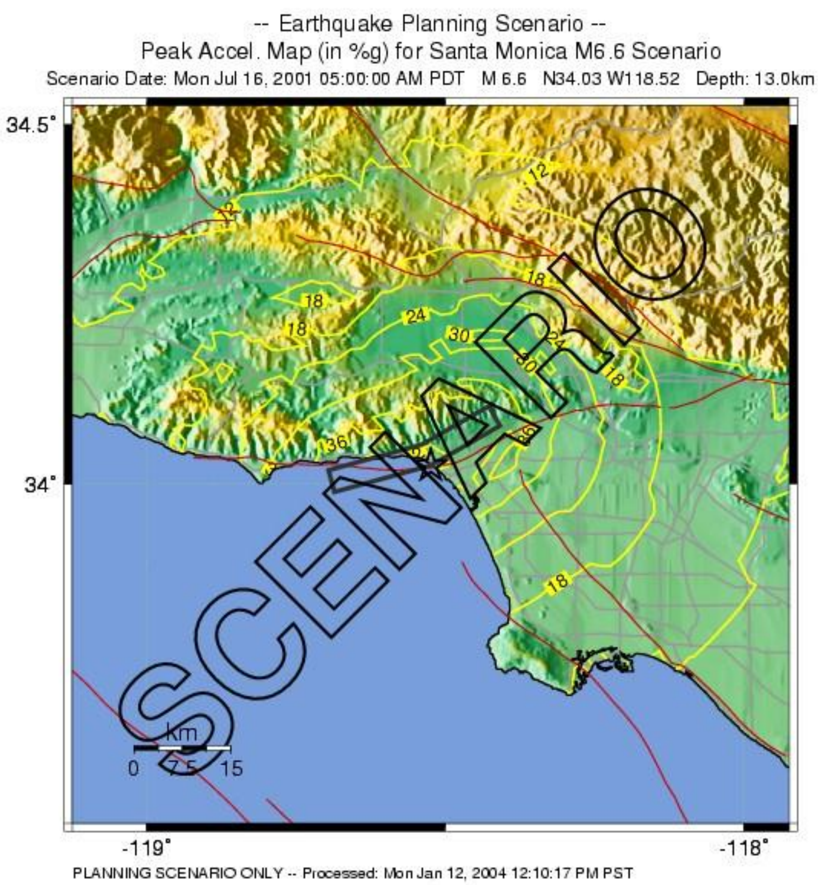
Map 2.3 Faults, Liquefaction Zones in Santa Monica

Santa Monica Fault

The Santa Monica fault is part of the Transverse Ranges Southern Boundary fault system, a west-trending system of reverse, oblique-slip, and strike-slip faults that extends for more than 200 km along the southern edge of the Transverse Ranges (Dolan et al., 1997, 2000a). Other faults in this system are the Hollywood and Raymond faults. The Anacapa-Dume, Malibu Coast, Santa Cruz Island, and Santa Rosa Island faults to the west are also part of this system.

The Santa Monica fault extends east from the coastline in Pacific Palisades through Santa Monica and West Los Angeles and merges with the Hollywood fault at the West Beverly Hills Lineament in Beverly Hills, west of the crossing of Santa Monica Boulevard and Wilshire Boulevard, where its strike is northeast. Onshore, the fault offsets the surface 2-3.5 km south of the Santa Monica Mountains range front.[iv]

Map 2.4 Santa Monica Fault



Santa Monica Fault

TYPE OF FAULTING: left-reverse
LENGTH: 24 km
NEARBY COMMUNITIES: Pacific Palisades, Westwood, Beverly Hills, Santa Monica
MOST RECENT SURFACE RUPTURE: Late Quaternary
SLIP RATE: between 0.27 and 0.39 mm/yr
INTERVAL BETWEEN MAJOR RUPTURES: unknown
PROBABLE MAGNITUDES: M_W6.0 - 7.0 (?)
OTHER NOTES: This is a north-dipping fault. Its slip rate may be greatest at its western end.[v]

In California, each earthquake is followed by revisions and improvements in the Building Codes. The 1933 Long Beach resulted in the Field Act, affecting school construction. The 1971 Sylmar earthquake brought another set of increased structural standards. Similar re-evaluations occurred after the 1989 Loma Prieta and 1994 Northridge earthquakes. These code changes have resulted in stronger and more earthquake resistant structures.

The Alquist-Priolo Earthquake Fault Zoning Act was passed in 1972 to mitigate the hazard of surface faulting to structures for human occupancy. This state law was a direct result of the 1971 San Fernando Earthquake, which was associated with extensive surface fault ruptures that damaged numerous homes, commercial buildings, and other structures. Surface rupture is the most easily avoided seismic hazard.[vi]

The Seismic Hazards Mapping Act, passed in 1990, addresses non-surface fault rupture earthquake hazards, including liquefaction and seismically induced landslides.[vii] 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

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. Map 2.3 identifies the local population centers in City of Santa Monica that have soils vulnerable to liquefaction.

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[viii] . 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.[ix] 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, ten’s 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.

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.

Damage to Vital Public Services, Systems and Facilities

Communications
Telephone systems will be affected by system failure, overloads, loss of electrical power and possible failure of some alternate power systems. Immediately after the event, numerous failures will occur coupled with saturation overloads. This will disable up to 80% of the telephone system for approximately one day. In light of the expected situation, emergency planners should not plan on the use of telephone systems for the first few days after the event.

During a major emergency, communication from the City’s Emergency Operations Center (EOC) to the outside world is a primary necessity. Twenty individual private lines are currently connected directly to the EOC from General Telephone. One line is connected through the City’s telephone switch through one Police Department extension. This allows the EOC to operate independently of the City Hall network should the system be damaged or fail to operate. The obvious disadvantage of this system is the potential for damage to occur to the hard wire connections between the EOC and General Telephone.

Four separate and independent radio systems are available for emergency use by EOC personnel. They are already in place and are operated by the

Environmental Public Works Management (EPWM), Fire Department, the Police Department and Transportation Department. Each system has its own unique characteristics. In a disaster, it is possible that all systems could be rendered partially or completely inoperative.

Additionally, the Disaster Communication Services (DCS) provides amateur radio communication. DCS Communication equipment is located at the EOC, Fire Station One, Fire Station Five, and the Alternate EOC at the Ken Edwards Center.

Environmental and Public Works Management (EPWM) Communications

The backbone of the EPWM radio system is a fully repeated receiver/transmitter located on the reservoir property in the 800-900 block of Franklin Street. There are five locations within the city that have remote control links connected to the system; City Hall; Police Headquarters; City Yards; Clover Park; and the Fire Department. The primary area of concern during a disaster would be whether or not the telephone lines would continue to function from the control points and receiver locations. If telephone lines were to fail and if the Franklin equipment were not damaged, the system would continue to operate by itself, for car to car operation, but with some range limitation. There is good possibility that the back-up system located at 2500 Michigan would enable one of these systems to work during and after a disaster.

Fire Department Communications

The Fire Department’s radio system functions through three remote receivers which are connected via telephone lines to the main receiver site located at 2500 Michigan Avenue. The major disadvantage with this type of system lies with the telephone connections. If the main lines between the dispatcher and transmitter should fail, the dispatcher would lose the ability to hear or transmit to field units. To mitigate this problem, the fire department has installed a back-up transmitter at their dispatch center. Although providing only reduced coverage, this back-up will provide emergency communication should the main transmitter site fail.

Police Department Communications

The Police Department’s radio system operates from their main transmitter site located on the roof of 100 Wilshire Boulevard, formally known as the GTE building. Receivers are placed in four strategic locations around the city and received signals are routed via telephone lines to Police Headquarters where the best signal is selected and routed back up to the 100 Wilshire site for transmission. As in other systems the telephone lines have been determined to be the weak link. Once this system is replaced by microwave, Police communication will be fault free as long as electrical power is not interrupted and the building structures are in place. Generator power is available at the Police Facility, 100 Wilshire and the City Yards. Some of these locations also have battery back-up as do all the sites without generator power. The City Hall telephone network, the 911 telephone network, and the Police dispatch equipment are all supported by back-up battery power which is in turn charged by the generator. Radio systems are expected to be 40 to 75% effective; microwave systems, 30% effective or less.

Dam/Flood Control Channels
No dam/flood control channels exist in Santa Monica. Portions of the City may be subject to flooding, due to flash flooding, urban flooding (storm drain failure/infrastructure breakdown), river channel overflow, downstream flooding, etc.) The City has not historically been vulnerable to storm surge inundation associated with hurricanes and tropical storms.

Stone Canyon Reservoir
The Stone Canyon Reservoir is located in the City of Los Angeles. There is a likelihood that the 10,370 acre feet capacity Stone Canyon Reservoir above the City of Brentwood would rupture in a major earthquake, inundating Brentwood and portions of West Los Angeles, and depositing no less than several inches of water on the northeast portion of Santa Monica.

Riviera Reservoir
The Riviera Reservoir, 1252 Capri, Los Angeles, is owned by the City of Santa Monica and located about two miles north of the City in Santa Monica Canyon. The California Department of Water Resources Bulletin No.17 lists the reservoir as having a height of 40 feet and a storage capacity of 76 acre-feet, which translates to approximately 25 million gallons.

The Riviera Reservoir is an off-stream, covered storage reservoir built with vertical concrete walls. These walls are keyed top and bottom to the roof and foundations. The north and west sidewalls on the south and east have compacted backfill in front of them. These are the sides through which water will pass should a failure occur.

If the failure were to occur on the east side, the structures, located at the Riviera Golf Course, immediately below the dam will definitely be in jeopardy. If the south side of the dam were to fail, no structures would be harmed. However, the golf course would be flooded.

Flood waters released during the reservoir failure would empty onto the Riviera Country Golf Course, eventually flowing into the Santa Monica Creek. The flood control channels will contain the flood waters directing them to the

Pacific Ocean. Santa Monica Creek located in the City of Los Angeles, is dry the majority of the time and is not likely to be carrying flow at a time when the reservoir might fail. Damage to any homes adjacent to the golf course is considered unlikely. The travel time of the flood flows to the flood control channel would be within 15 minutes.

Electrical Power

Major power plants are expected to sustain some damage due to liquefaction and the intensity of the earthquake. During the Northridge earthquake power was restored within 24 hours in most areas of Santa Monica. Up to 60% of the system load may be interrupted immediately following the initial shock. According to representatives of Southern California Edison Company, the electrical power will not be rerouted and will be lost for an undefined period of time. Much of the imported power is expected to be lost. In some areas of greatest shaking it should be anticipated that some of the distribution lines, both underground and surface, will be damaged. Much of the affected area may have service restored in days; damaged areas with underground distribution may require a longer time. Loss of Southern California Edison transmission lines is possible.

Fire Operations

Although total collapse of fire stations is not expected, possible disruption of utilities, inoperable apparatus doors and loss of power can create major problems. Numerous fires due to disruption of power and natural gas networks can be expected. Many connections to major water sources may be out and storage facilities would have to be relied on; water supply could vary from little or none to inadequate. First response from fire personnel is expected to be assessment of the area to establish what is needed to determine response and recovery needs. Operations may take days because of the disruption of transportation routes for fire department personnel and equipment.

Secondary responses by the Fire Service after assessment will be placed upon diversion of resources to accomplish search and rescue of trapped persons and extinguishment of fires with conflagration potential. Major problems the Fire Service should expect are loss of power and water, restricted mobility due to debris, and possible loss of primary dispatch capability.

Highways and Bridges

Damage to freeway systems is expected to be major as experienced in the partial collapse of the Santa Monica Freeway (U.S. Highway 10) during the Northridge earthquake. Any inner surface transportation routes could be subject to delays and detours. A major portion of surface streets in the vicinity of freeways could be blocked due to collapsed overpasses. Many surface streets in the older central business districts will be blocked by debris from buildings, falling electrical wires and pavement damage.

Natural Gas

Damage to natural gas facilities will consist primarily of (a) some isolated breaks in major transmission lines, and (b) innumerable breaks in mains and individual service connections within the distribution systems, particularly in the areas of intense ground shaking. These many leaks in the distribution system will affect a major portion of the urban areas, resulting in a loss of service for extended periods. Fires should be expected at the sites of a small percentage of ruptures both in the transmission lines and the distribution system. Transmission pipelines serving the general basin area are most vulnerable to damage.

Railroads

No operational railroads exist in the City of Santa Monica. However, it is expected that 21 of the 59 route segments serving the Southern California region could be unavailable for post-earthquake service; the 21 segments include all major connections with the north. The post earthquake capacity to serve both the Los Angeles and Orange County areas would be very small-probably no more than 5 trains a day. This is a dramatic loss from the 120 to 140 trains per day that can currently enter the area. Many railroad bridges are susceptible to damage because of age, design and construction. Some lines could be blocked because of damage to freeway overpass structures.

Sanitation Systems

The Sewer System is operated and maintained by the City of Santa Monica. Santa Monica sewage is treated by the City of Los Angeles at the Hyperion Treatment Plant in Playa Del Rey.

Many waste water treatment facilities could be out of service from 4 to 6 months depending on the damage caused by the severity of intensity and liquefaction. There is a limited volume of storage available in the waste water treatment plants; if the treatment infrastructure cannot be restored before storage is exceeded, the waste water will require discharge with emergency chlorination to reduce health hazards. Overflow of sewage through manholes and from ponds can be expected due to breakage in mains and loss of power. As a result, there will be a danger of excessive collection of explosive gas in sewer mains, and flow of untreated sewage in some street gutters. Many residential sewer connections will break and plug.

Water Supply

Most of the City's water is provided by the Metropolitan Water District. In a major earthquake, two of the three major aqueducts serving Southern

California are expected to be out of service from 3 to 6 months following the event; only the Colorado River Aqueduct is expected to remain in service. This indicates the imported water supply to Los Angeles County may be only partial for a 3 to 6 months period. Several ruptures are anticipated along the water pipelines in the County. Anticipated damage to reservoir outlet works could take weeks to repair. The majority of water wells are expected to be disabled by loss of electricity and the lack of backup power sources. In addition, shear forces could render about a third of the wells inoperative for an indefinite period. Water availability and distribution for needed life support, to treat the sick and injured and for fire suppression activities is of MAJOR concern to each community.

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

The following sections of the City's Building Code address the earthquake hazard:

- 8.16 Supplemental Earthquake Provisions
  - 8.16.020 Earthquake Design Provisions
  - 8.16.040 Concrete and Masonry Chimneys/Veneer
  - 8.16.050 Steel Construction
  - 8.16.060 Wood Construction
- 8.56 Northridge Earthquake Provisions
  - 8.56.010 Repair, Reconstruction and Reinforcement of Unreinforced Masonry Buildings Requirements
  - 8.56.020 Standards for Repair, Reconstruction and Reinforcement of Unreinforced Masonry Buildings Requirements
  - 8.56.030 Repair, Reconstruction and Reinforcement of Soft Story Buildings
- 8.60 Seismic Strengthening Provisions for Unreinforced Masonry Bearing Wall Buildings
- 8.64 Seismic Strengthening Provisions for Existing Concrete and Reinforced Masonry Wall Buildings with Flexible Diaphrams
- 8.68 Voluntary Seismic Strengthening Provisions for Cripple Walls and Sill Plate Anchorage in Single-Family Dwellings
- 8.72 Seismic Strengthening Provisions for Soft, Weak or Open Front

Walls in Light, Wood-Framed Buildings

8.76 Seismic Strengthening Provisions for Existing Welded Steel Moment Frame Structures

8.80 Seismic Strengthening Provisions for Existing Non-Ductile Concrete Buildings

The City of Santa Monica 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, 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.

Coordination Among Building Officials
The City of Santa Monica Building Code sets the minimum design and construction standards for new buildings. In 2002 the City of Santa Monica adopted the most recent seismic standards in its building code, which requires that new buildings be built at a higher seismic standard.

Businesses/Private Sector
Natural hazards have a devastating impact on businesses. In fact, of all businesses which close following a disaster, more than forty-three percent never reopen, and an additional twenty-nine percent close for good within the next two years.[x] The Institute of Business and Home Safety has developed "Open for Business", which is a disaster planning toolkit to help guide businesses in preparing for and dealing with the adverse affects natural hazards. The kit integrates protection from natural disasters into the company's risk reduction measures to safeguard employees, customers, and the investment itself. The guide helps businesses secure human and physical resources during disasters, and helps to develop strategies to maintain business continuity before, during, and after a disaster occurs.

Hospitals
"The Alfred E. Alquist Hospital Seismic Safety Act ("Hospital Act") was enacted in 1973 in response to the moderate Magnitude 6.6 Sylmar Earthquake in 1971 when four major hospital campuses were severely damaged and evacuated. Two hospital buildings collapsed killing forty seven people. Three others were killed in another hospital that nearly collapsed.

In approving the Act, the Legislature noted that:

Hospitals, that house patients who have less than the capacity of normally healthy persons to protect themselves, and that must be reasonably capable of providing services to the public after a disaster, shall be designed and constructed to resist, insofar as practical, the forces generated by earthquakes, gravity and winds. (Health and Safety Code Section 129680)

When the Hospital Act was passed in 1973, the State anticipated that, based on the regular and timely replacement of aging hospital facilities, the majority of hospital buildings would be in compliance with the Act's standards within 25 years. However, hospital buildings were not, and are not, being replaced at that anticipated rate. In fact, the great majority of the State's urgent care facilities are now more than 40 years old.

The moderate Magnitude 6.7 Northridge Earthquake in 1994 caused $3 billion in hospital-related damage and evacuations. Twelve hospital buildings constructed before the Act were cited (red tagged) as unsafe for occupancy after the earthquake. Those hospitals that had been built in accordance with the 1973 Hospital Act were very successful in resisting structural damage. However, nonstructural damage (for example, plumbing and ceiling systems) was still extensive in those post-1973 buildings

Senate Bill 1953 ("SB 1953"), enacted in 1994 after the Northridge Earthquake, expanded the scope of the 1973 Hospital Act. Under SB 1953, all hospitals are required, as of January 1, 2008, to survive earthquakes without collapsing or posing the threat of significant loss of life. The 1994 Act further mandates that all existing hospitals be seismically evaluated, and retrofitted, if needed, by 2030, so that they are in substantial compliance with the Act (which requires that the hospital buildings be reasonably capable of providing services to the public after disasters). SB 1953 applies to all urgent care facilities (including those built prior to the 1973 Hospital Act) and affects approximately 2,500 buildings on 475 campuses.

SB 1953 directed the Office of Statewide Health Planning and Development ("OSHPD"), in consultation with the Hospital Building Safety Board, to develop emergency regulations including "…earthquake performance categories with subgradations for risk to life, structural soundness, building contents, and nonstructural systems that are critical to providing basic services to hospital inpatients and the public after a disaster." (Health and Safety Code Section 130005)

<u>The Seismic Safety Commission Evaluation of the State's Hospital Seismic Safety Policies</u>

In 2001, recognizing the continuing need to assess the adequacy of policies, and the application of advances in technical knowledge and understanding, the California Seismic Safety Commission created an Ad Hoc Committee to re-examine the compliance with the Alquist Hospital Seismic Safety Act. The formation of the Committee was also prompted by the recent evaluations of hospital buildings reported to OSHPD that revealed that a large percentage (40%) of California's operating hospitals are in the highest category of collapse risk.".[xi]

California Earthquake Mitigation Legislation
California is painfully aware of the threats it faces from earthquakes. Dating back to the 19th century, Californians have been killed, injured, and lost property as a result of earthquakes. As the State's population continues to grow, and urban areas become even more densely built up, the risk will continue to increase. For decades the Legislature has passed laws to strengthen the built environment and protect the citizens. Table xx-xx provides a sampling of some of the 200 plus laws in the State's codes.

Table xx-xx: Partial List of the Over 200 California Laws on Earthquake Safety

Government Code Section 8870-8870.95	Creates Seismic Safety Commission.
Government Code Section 8876.1-8876.10	Established the California Center for Earthquake Engineering Research.
Public Resources Code Section 2800-2804.6	Authorized a prototype earthquake prediction system along the cental San Andreas fault near the City of Parkfield.
Public Resources Code Section 2810-2815	Continued the Southern California Earthquake Preparedness Project and the Bay Area Regional Earthquake Preparedness Project.
Health and Safety Code Section 16100-16110	The Seismic Safety Commission and State Architect, will develop a state policy on acceptable levels of earthquake risk for new and existing state-owned buildings.
Government Code Section 8871-8871.5	Established the California Earthquake Hazards Reduction Act of 1986.
Health and Safety Code Section 130000-130025	Defined earthquake performance standards for hospitals.
Public Resources Code Section 2805-2808	Established the California Earthquake Education Project.
Government Code Section 8899.10-8899.16	Established the Earthquake Research Evaluation Conference.
Public Resources Code Section 2621-2630 2621.	Established the Alquist-Priolo Earthquake Fault Zoning Act.

Government Code Section 8878.50-8878.52 8878.50.	Created the Earthquake Safety and Public Buildings Rehabilitation Bond Act of 1990.
Education Code Section 35295-35297 35295.	Established emergency procedure systems in kindergarten through grade 12 in all the public or private schools.
Health and Safety Code Section 19160-19169	Established standards for seismic retrofitting of unreinforced masonry buildings.
Health and Safety Code Section 1596.80-1596.879	Required all child day care facilities to include an Earthquake Preparedness Checklist as an attachment to their disaster plan.
Source: http://www.leginfo.ca.gov/calaw.html	

Earthquake Education

Earthquake research and education activities are conducted at several major universities in the Southern California region, including Cal Tech, USC, UCLA, UCSB, UCI, and UCSB. The local clearinghouse for earthquake information is the Southern California Earthquake Center located at the University of Southern California, Los Angeles, CA 90089, Telephone: (213) 740-5843, Fax: (213) 740-0011, Email: SCEinfo@usc.edu, Website: http://www.scec.org. The Southern California Earthquake Center (SCEC) is a community of scientists and specialists who actively coordinate research on earthquake hazards at nine core institutions, and communicate earthquake information to the public. SCEC is a National Science Foundation (NSF) Science and Technology Center and is co-funded by the United States Geological Survey (USGS).

In addition, Los Angeles County along with other Southern California counties, sponsors the Emergency Survival Program (ESP), an educational program for learning how to prepare for earthquakes and other disasters. Many school districts have very active emergency preparedness programs that include earthquake drills and periodic disaster response team exercises.

Earthquake Resource Directory

Local and Regional Resources

Los Angeles County Public Works Department

Level: County	Hazard: Multi	http://ladpw.org	
900 S. Fremont Ave.			
Alhambra, 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
		Ph: Fx:

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.

Governor's Office of Emergency Services (OES)

Level: State	Hazard: Multi	www.oes.ca.gov
P.O. Box 419047		
Rancho Cordova, CA 95741-9047		Ph: 916 845- 8911 Fx: 916 845- 8910

Notes: The Governor's Office of Emergency Services 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
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. aI., (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.

Website: http://www.fema.gov

End Notes

I. http://pubs.usgs.gov/gip/earthq3/when.html

II. http://www.gps.caltech.edu/~sieh/home.html

III. Planning for Natural Hazards: The California Technical Resource Guide, Department of Land Conservation and Development (July 2000)

IV. Dolan et. al., "Active Faults in the Los Angeles Metropolitan Region", Southern California Earthquake Center Group C

V. http://www.data.scec.org/fault_index/monica.html

VI. http://www.consrv.ca.gov/CGS/rghm/ap/

VII. Ibid

VIII. Burby, R. (Ed.) Cooperating with Nature: Confronting Natural Hazards with Land Use Planning for Sustainable Communities (1998), Washington D.C., Joseph Henry Press.

IX. FEMA HAZUS http://www.fema.gov/hazus/hazus2.htm (May 2001)

X. Institute for Business and Home Safety Resources (April 2001)

XI. http://www.seismic.ca.gov/pub/CSSC_2001-04_Hospital.pdf

2.2 Landslide

Table of Contents

Why are Landslides a Threat to City of Santa Monica

Landslides are a serious geologic hazard in almost every state in America. Nationally, landslides cause 25 to 50 deaths each year.[xii] The best estimate of direct and indirect costs of landslide damage in the United States range between $1 and $2 billion annually.[xiii] As a seismically active region, California has had significant number of locations impacted by landslides. Some landslides result in private property damage, 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 topography of the City of Santa Monica is essentially flat and there is little (or no) danger of landslide activity. However, the Palisades, located in the northwest portion of the City, is a sheer cliff of fragile sandstone that rises about 100 feet above the coast that separates the northern part of the City from the beach below. As this area is susceptible to landslides, mitigation projects have been enacted.

The City of Santa Monica does have liquefaction zones as indicated on Map 2.3. Since the settlement of the city in the 1800's, there have not (or have) been any instances of liquefaction associated with seismic activity.

Fortunately, there are no critical facilities that are at risk of being impacted by landslides in Santa Monica. The built environment that could be impacted by landslide activity at the Bluffs includes public walkways, lighting, irrigation systems, a senior center, and other structures in Palisades Park.

Historic Southern California Landslides

1928 St. Francis Dam failure

Los Angeles County, California. The dam gave way on March 12, and its waters swept through the Santa Clara Valley toward the Pacific Ocean, about 54 miles away. Sixty five miles of valley was devastated, and over 500 people were killed. Damages were estimated at $672.1 million (year 2000 dollars).[xiv]

1956 Portuguese Bend, California

Cost, $14.6 million (2000 dollars) California Highway 14, Palos Verdes Hills. Land use on the Palos Verdes Peninsula consists mostly of single-family homes built on large lots, many of which have panoramic ocean views. All of the houses were constructed with individual septic systems, generally consisting of septic tanks and seepage pits. Landslides have been active here for thousands of years, but recent landslide activity has been attributed in part to human activity. The Portuguese Bend landslide began its modern movement in August 1956, when displacement was noticed at its northeast margin. Movement gradually extended downslope so that the entire eastern edge of the slide mass was moving within 6 weeks. By the summer of 1957, the entire slide mass was sliding towards the sea.[xv]

1958-1971 Pacific Palisades, California
Cost, $29.1 million (2000 dollars) California Highway 1 and house damaged.[xvi]

1961 Mulholland Cut, California
Cost, $41.5 million (2000 dollars) On Interstate 405, 11 miles north of Santa Monica, Los Angeles County.[xvii]

1963 Baldwin Hills Dam Failure.
On December 14, the 650 foot long by 155 foot high earth fill dam gave way and sent 360 million gallons of water in a fifty foot high wall cascading onto the community below, killing five persons, and damaging $50 million (2000 dollars) of dollars in property.

1969 Glendora, California
Cost, $26.9 million (2000 dollars) Los Angeles County, 175 houses damaged, mainly by debris flows.[xviii]

1969 Seventh Ave., Los Angeles County, California
Cost, $14.6 million (2000 dollars) California Highway 60.[xix]

1970 Princess Park, California
Cost, $29.1 million (2000 dollars) California Highway 14, 10 miles north of Newhall, near Saugus, northern Los Angeles County.[xx]

1971 Upper and Lower Van Norman Dams, San Fernando, California
Earthquake-induced landslides Cost, $302.4 million (2000 dollars). Damage due to the February 9, 1971, magnitude 7.5 San Fernando, California, earthquake. The earthquake of February 9 severely damaged the Upper and Lower Van Norman Dams.[xxi]

1971 Juvenile Hall, San Fernando, California
Landslides caused by the February 9, 1971, San Fernando, California, earthquake Cost, $266.6 million (2000 dollars). In addition to damaging the San Fernando Juvenile Hall, this 1.2 km-long slide damaged trunk lines of the Southern Pacific Railroad, San Fernando Boulevard, Interstate Highway 5, the Sylmar, California, electrical converter station, and several pipelines and canals.[xxii]

1977-1980 Monterey Park, Repetto Hills, Los Angeles County, California
Cost, $14.6 million (2000 dollars) 100 houses damaged in 1980 due to debris flows.[xxiii]

1978 Bluebird Canyon Orange County
California October 2, cost, $52.7 million (2000 dollars) 60 houses destroyed or damaged. Unusually heavy rains in March of 1978 may have contributed to initiation of the landslide. Although the 1978 slide area was approximately 3.5 acres, it is suspected to be a portion of a larger, ancient landslide.[xxiv]

1979 Big Rock, California, Los Angeles County
Cost, approximately $1.08 billion (2000 dollars) California Highway 1 rockslide.[xxv]

1980 Southern California slides
$1.1 billion in damage (2000 dollars) Heavy winter rainfall in 1979-90 caused damage in six Southern California counties. In 1980, the rainstorm started on February 8. A sequence of 5 days of continuous rain and 7 inches of precipitation had occurred by February 14. Slope failures were beginning to develop by February 15 and then very high-intensity rainfall occurred on February 16. As much as 8 inches of rain fell in a 6 hour period in many locations. Records and personal observations in the field on February 16 and 17 showed that the mountains and slopes literally fell apart on those 2 days.[xxvi]

1983 San Clemente, California, Orange County
Cost, $65 million (2000 dollars), California Highway 1. Litigation at that time involved approximately $43.7 million (2000 dollars).[xxvii]

1983 Big Rock Mesa, California
Cost, $706 million (2000 dollars) in legal claims condemnation of 13 houses, and 300 more threatened rockslide caused by rainfall [xxviii]

1978-1979, 1980 San Diego County, California
Experienced major damage from storms in 1978, 1979, and 1979-80, as did neighboring areas of Los Angeles and Orange County, California. One hundred and twenty landslides were reported to have occurred in San Diego County during these 2 years. Rainfall for the rainy seasons of 78-79 and 79-80 was 14.82 and 15.61 inches (37.6 and 39.6 cm) respectively, compared to a 125-year average (1850-1975) of 9.71 inches (24.7 cm). Significant landslides occurred in the Friars Formation, a unit that was noted as slide-prone in the Seismic Safety Study for the City of San Diego. Of the nine landslides that caused damage in excess of $1 million, seven occurred in the Friars Formation, and two in the Santiago Formation in the northern part of San Diego County.[xxix]

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 km2. Most were in the Santa Susana Mountains and in mountains north of the Santa Clara River Valley. Destroyed dozens of homes, blocked roads, and damaged oil-field infrastructure. Caused deaths from Coccidioidomycosis (valley fever) the spore of which was released from the soil and blown toward the coastal populated areas. The spore was released from the soil by the landslide activity.[xxx]

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 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.[xxxi]

The City of Santa Monica's Roads Division has responded to debris clearance resulting from sloughing at the Bluffs often over the past several years, following significant rainfalls. In 1994, 1995, 1998, and most recently in 2005, the Pacific Coast Highway below the Bluffs has been closed for debris clearance. There have been no significant damages to property resulting from these landslides, however there are clear economic and other impacts due to the closure of the Pacific Coast Highway when debris clearance activities are undertaken. The California Incline, the roadway south of the

Bluffs, has also been closed due to sloughing from the Bluffs, intermittently over the years. When these roads are closed, there is a significant economic impact to the Santa Monica area and its neighbors. Traffic is either diverted to alternate routes, or is slowed to a point that reduces traffic flows a great deal. For example, whenever there is sloughing from the Bluffs that impacts the PCH or the California Incline, these routes are generally impacted for several days, until debris is safely removed.

Other Relevant Santa Monica landslide information:

Much of the following information was collected in a meeting with the City of Santa Monica's Principal Civil Engineer, David Britton. Mr. Britton has been with the City of Santa Monica's Engineering Department for more than twenty five years and is well-versed in the landslide issues and mitigative steps that have been undertaken by the City Of Santa Monica. Many of the issues addressed in this meeting were raised in FEMA's initial review of the City of Santa Monica's Local Hazard Mitigation Plan.

Background

The Palisades Bluffs rise 30 to 150 feet above Pacific Coast Highway from the McClure tunnel to the northerly city limits. The slope of the bluff is steep to near vertical at various locations with deeply eroded gullies and areas of landslide debris. After the January 17, 1994 Northridge earthquake, various sections were impacted by earth falls, debris and mudflows, fractures and slides. Further sloughing after the disaster level storms of 1995 and 1998 exacerbated the damage.

At that time the City retained the services of Dames and Moore, geotechnical engineers, to conduct an evaluation of the earthquake and storm damaged areas of Palisades Park and the bluffs. Several remedial measures were taken as a result of the recommendations from the studies including relocating portions of the fence in Palisades Park; installing subsurface drains in the face of the bluff; landscaping restoration; and grading Palisades Park to direct the existing surface drainage into underground storm drain devices in Ocean Avenue to reduce the amount of surface runoff.

In 1998, Congress passed the Transportation Equity Act for the 21st Century. One of the high priority projects approved under that Act was the Santa Monica Palisades Bluff Improvement Project. The federal funding authorized for the construction of the project amounts to $6,000,000.

On February 12, 2002, the City Council approved a professional services contract with URS Corporation to provide a geotechnical study for the Santa

Monica Palisades Bluff Improvement project. The intent of the geotechnical study was to evaluate the current conditions of the soils within the existing bluff area and to provide recommendations to mitigate existing damage and potential future deterioration of the bluffs.

Discussion

The geotechnical study conducted by URS Corporation, included a comprehensive review of the following:

- Existing geotechnical data;
- Geologic mapping;
- Field reconnaissance;
- Drilling of vertical and horizontal exploratory borings along the Santa Monica Palisades Park and the easterly side of the Pacific Coast Highway from the McClure tunnel to the northerly City Limits respectively;
- Installation of observation wells and horizontal drains; and
- Laboratory and field testing of soils

Based on the URS Corporation findings, staff proposes non-intrusive improvement elements that can be applied individually or in combination for different areas of the Bluffs as needed. The proposed mitigation strategies include: subsurface drainage to improve the overall stability of the Bluffs through the application of dewatering systems; surface improvement such as surface grouting, filling of erosion pockets, ground cracks and deep gullies; and micro piles to support areas of marginal stability.

Implementation of these strategies would result in the following temporary impacts to the public:

- Dewatering systems such as hydraugers along PCH will result in lane closures during the construction period;
- Construction of a dewatering tunnel below Palisades Park will require installation of two temporary access shafts in the Palisades Park that will produce noise at the shaft locations and traffic impact on Ocean Avenue during construction;
- Vertical Interceptor drains along Ocean Avenue will impact traffic by lane closures on Ocean Avenue during construction.

Budget / Financial Impact

Currently there is $1.3 million in Redevelopment Funds and an additional $6 million Federal grant budgeted for this project. Staff will report to Council with additional budget/financial impact information when recommending award of the design and construction contracts.

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."[xxxii]

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.[xxxiii]

"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 of speeds up to 200 miles per hour (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."[xxxiv]

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 with speeds greater than 20 mile per hour, and can often move much faster.[xxxv] 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 produces 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. Even with proper planning, landslides will continue to threaten the safety of people, property, and infrastructure, but 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.[xxxvi] 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 are typically rapidly moving and also tend to increase in volume as they scour out the channel.[xxxvii] Flows often occur during heavy rainfall, 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 locating 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 effecting landslides include: excavation, drainage and groundwater alterations, and changes in vegetation.[xxxviii]

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; and
- Fan-shaped areas of sediment and boulder accumulation at the outlets of canyons.
- 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 the City of Santa Monica. 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.[xxxix]

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. **Insert here any efforts being made to map slide or potential slide areas. Briefly describe those projects and the effects/impacts that they may have on mitigating landslide hazards.**

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.[xl] 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.

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 the City of Santa Monica 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

Losses incurred from landslide hazards in the City of Santa Monica have been associated with roads, specifically the Pacific Coast Highway. The City of Santa Monica Roads Division is responsible for responding to slides that inhibit the flow of traffic or are damaging a road or a bridge. The roads department does its best to communicate with residents impacted by landslides, but can usually only repair the road itself, as well as the areas adjacent to the slide where the city has the right of way.

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.

Map 2.5 Landslide Susceptibility in Santa Monica

Landslide Resource Directory (See details in Appendix A)

County Resources

- Los Angeles County Department of Public Works

State Resources

- Department of Conservation Headquarters
- California Geological Survey Headquarters/Office of the State Geologist
- California Division of Forestry
- Department of Water Resources
- Governor's Office of Emergency Services
- California Department of Transportation (Cal Trans)

Federal Resources and Programs

- Federal Emergency Management Agency (FEMA)
- Natural Resource Conservation Service (NRCS)
- US Geological Survey, National Landslide Information Center

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.

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XXVIII. . *Homeowners Guide for Landslide Control, Hillside Flooding, Debris Flows, Soil Erosion*, (March 1997)

XXIX. . Burby, R. (Ed.) *Cooperating With Nature* (1998) Washington, D.C.: Joseph Henry Press.

2.3 Flood

Table of Contents

Why are Floods a Threat to the City of Santa Monica

Santa Monica is designated by the National Flood Insurance Program as a Zone "C", or City of minimal flood hazard. The hazardous situations caused by storms are generally dependent on the amount of warning time that the City receives prior to an actual disaster. Monitoring of storms by weather services have historically provided warning times that can vary from weeks to hours prior to the event. The ability of City personnel to conduct an evacuation, provide sandbagging, and perform other mitigative measures is dependent on the amount of warning time that the City receives from weather services.

The City of Santa Monica is familiar with the flooding and destruction caused by astronomical tides and heavy storm conditions. During the winter of 1983, the City suffered a major loss to the Pier facility. Most of the west end of the Pier and the section under Pacific Park was rebuilt with concrete pilings and caps following the 1983 storm. Again, in 1988, additional storm damage was sustained. In 1998, the El Nino Storms created approximated $400,000 in flood damage and recurring landslides along Palisades Park blocking Pacific Coast Highway. The landslide was approximately 115 feet high and 150 feet wide. Sloughing affected the stability of the near vertical bluff. Mitigation measures of drilling vertically and horizontally into the hillside assisted in removing water from bluff and grading the top and bottom of the bluff reduced the threat to life and property.

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.

The Los Angeles County Drainage Area comprises a 1,459 square mile watershed which flows to the Pacific Ocean mainly through the Los Angeles River and the San Gabriel River. The Los Angeles River is approximately 55 miles long and has an aggregate tributary system which is 225 miles in length. Stream slopes range from extremely steep, 200 feet per mile or more in the mountains, to about three feet per mile over the coastal plain.

Due to steep terrain, runoff from the mountains concentrates quickly. Runoff from urban watersheds is generally uncontrolled and is characterized by high flood peaks of short durations, because a high percentage of the rain falls on impervious cover. Los Angeles area flood events are typically of less than twelve hour durations. The lower Los Angeles River will respond to heavy rain by rising from 2/3 channel capacity to full in less than an hour, and reversing to 2/3 channel capacity within two hours. Such events have been noted recently, in 1980, 1993 and 1995.

Through historic times, and as evidenced in a variety of pre-historic sources, the Los Angeles area has been periodically pounded by heavy rains and inundated by floods. Some of the heaviest rains ever recorded on the west coast of North America occurred near Los Angeles as a result of the high transverse orographic barrier catching a moist subtropical airflow. Historical references highlight eight major floods across the coastal plain in the Los Angeles area between 1815 and 1876. From 1884 to 1938, nine more floods wreaked havoc. In the latter half of the twentieth century, enormous public work projects were completed which served to mitigate flood damage in the Los Angeles area.

Prior to 1915, little was done to control flooding within the county. To the contrary, uncontrolled growth and economic development did much to exacerbate a growing urban flood problem, which in fact had become one of the worst in the United States.

Through the early twentieth century, the Los Angeles River, at 55 miles long, was the county’s major (and most capricious) drainage. The Los Angeles River had a long history of meandering almost at random across the coastal plain, emptying into the Pacific Ocean at various places from Santa Monica to Long Beach.

Flood destruction and loss of life awakened the growing population of the Los Angeles Basin to the need for flood control. The Los Angeles County Flood Control District was established in 1915, and Congress authorized the U.S. Army Corps of Engineers to work on the Los Angeles River problem at about the same time.

The river posed major difficulties: An intermittent and swampy slough in the late summer, it became an unpredictable and raging torrent during periods of heavy rain. In flood stage, the river was gorged with huge volumes of water, strong current velocities, large debris loads, and unstable channels. As the population of the Los Angeles area grew rapidly in the early twentieth century, each flood produced increasing damage to the district, and scores of lives were lost. Flood control had become absolutely essential.

Between 1917 and 1965, the huge public works projects undertaken by the Corps of Engineers and its partners bore fruit. With great leaps forward in technology and in ecological sensitivity, a series of catchment basins and concrete or stone-lined channels controlled the Los Angeles River, its tributaries, and other streams within the district. The cost was high — over two billion dollars in federal and local funds for the entire project — but great benefits were realized. There were no more catastrophic floods after the 1950s, in spite of the sharp upward trend in urbanization and an increase in the number of heavy rainfall events late in the century. In addition, valuable recreation land was set aside for the public trust as a result of construction of catchment basins along channels.

The last major flood destruction in Los Angeles occurred on March 2, 1938. Forty-nine lives were lost. A major rainfall event occurred in 1969, in which an estimated $1.5 billion in damage was saved by flood control projects. Other heavy rains in 1983, 1992 and 1998 were well-handled by the complex system of drainages, catchments and bridges built by the Corps of Engineers within the Los Angeles area.

The current Los Angeles County Drainage Area flood control system is one of the world's largest and most extensive flood protection infrastructures. This flood protection includes:

15 flood control reservoirs
5 flood control basins
143 debris control basins
225 stabilization dams
33 storm water pumping plants
470 miles of open, improved channel
2,400 miles of underground drains
75,000 catch basins

The Corps of Engineers estimates that the value of damages prevented by the system in storms during its lifetime has already reached $3.6 billion.

Projects now underway in the lower Los Angeles River will expand the channel capacity from 133,000 cubic feet per second (cfs) to 182,000 cfs, which would approximate a 133-year flood (Plates 1-5). (*Attached to text).*

Heavy rain still poses a flooding threat in the Los Angeles Basin, but the greatest problems are now associated with urban flooding, ponding of water in poorly drained areas, and high outflow of water, mud and debris below canyons draining higher terrain.

Historic Flooding in Los Angeles County

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.1

Table 2.2 Major Floods of the Los Angeles River

1811	Flooding
1815	Flooding
1825	River changed its course back from the Ballona wetlands to San Pedro
1832	Heavy flooding
1861-62	Heavy flooding. Fifty inches of rain falls during December and January.
1867	Floods create a large, temporary lake out to Ballona Creek.
1876	The Novician Deluge
1884	Heavy flooding causes the river to change course again, turning east to Vernon and then southward to San Pedro.
1888-1891	Annual floods
1914	Heavy flooding. Great damage to the harbor.
1921	Flooding
1927	Moderate flood
1934	Moderate flood starting January 1. Forty dead in La Canada.
1938	Great County-wide flood with 4 days of rain. Most rain on day 4.
1941-44	L.A. River floods five times.
1952	Moderate flooding
1969	One heavy flood after 9 day storm. One moderate flood.
1978	Two moderate floods
1979	Los Angeles experiences severe flooding and mudslides.
1980	Flood tops banks of river in Long Beach. Sepulveda Basin spillway almost opened.
1983	Flooding kills six people.
1992	15 year flood. Motorists trapped in Sepulveda basin. Six people dead.
1994	Heavy flooding
Sources: http://www.lalc.k12.ca.us/target/units/river/tour/hist.html and (http://www.losangelesalmanac.com/topics/History/hi01i.htm)	

Flooding in the Los Angeles Basin was mentioned by Spanish missionaries as early as the eighteenth century. But from the time of the establishment of the civil settlement at Los Angeles in 1781 until the second decade of the nineteenth century, rainfall rates were remarkably low in the area. Then in 1815, a massive flood cut a channel across what is now the downtown district, re-routing the Los Angeles River westward, where it emptied into the Pacific Ocean south of Santa Monica, at Ballona Lagoon. A decade later, an

1825 storm returned the Los Angeles River to its present channel, which now flows southward into the Pacific Ocean at San Pedro Bay.

From December 24, 1861 to January 31, 1862 almost continuous heavy rainfall deluged all of California. Heaviest rains were recorded at San Francisco — which averaged almost an inch of rain per day for 30 days, in what was computed to be a 37,000 year event (Goodridge, 1997). In Los Angeles, measurable rain occurred on thirty consecutive days. Flooding and massive mudslides occurred throughout Los Angeles County, destroying property and roadways.

Immediately following the flooding, in the fall of 1862, a severe drought settled into Los Angeles County. No significant rains fell again in Los Angeles until the fall of 1864. This drought doomed the embryonic cattle and livestock industry within the basin.

Almost 26 inches of rain fell at Los Angeles in February and March 1884. The 1883-84 rainfall season was the wettest in recorded history, with 38.18 inches recorded downtown. There was some loss of life in the February and March floods, and a great deal of property damage. Fifty houses were washed away in floods.

The heavy rains of January 25-26, 1914 were followed by a second and larger storm three weeks later. Large areas of the basin were flooded by the Los Angeles River,. This flooding led directly to the establishment of the Los Angeles County Flood Control District in 1915.

In January 1916 Los Angeles was on the northern fringe of the storm that drenched San Diego County with its all-time record rainfalls. Los Angeles was spared the worst of the disaster, but still received nearly eleven inches of rain between January 14th and 28th, and widespread flooding occurred within the district.

Beginning December 31, 1933 and continuing into New Year's Day 1934, very heavy rains caused destructive flooding and mudslides across Los Angeles County from Malibu to Covina. Fourteen weather stations in the Los Angeles area reported record maximum two-day rainfalls, with two locations recording 1,000-year events. A rain gauge located on the slopes below Mount Wilson recorded almost fifteen inches of rain on New Year's Day. Glendale and Montrose — along the La Crescenta delta cone northwest of Pasadena — were severely affected by a huge debris flow. The effect of the heavy canyon outflows of mud, debris and boulders was exacerbated by a fire which had burned over the district during the previous summer. In all, the flooding left more than forty persons dead and destroyed or damaged

500 homes. The City of Pasadena measured 6.21 inches of rain on that New Year's Day in 1934, but the Tournament of Roses Parade went ahead as scheduled.

The storm of March 2, 1938 produced another astounding precipitation and flooding event in Los Angeles County. This flood was the most destructive and violent of the twentieth century. Leading up to the March rains, Los Angeles had received about ten inches of rain in February. On March 2nd, with the ground already saturated, five to seven inches of rain fell across the basin. Rainfall in the surrounding mountains was much heavier. Seventeen mountain gauges recorded ten inches or more of rain, with a few receiving up to 18 inches. Stream flows recorded by gauging stations within the San Gabriel Mountain watershed were phenomenal. Forty-nine persons were killed and millions of dollars of destruction was reported.

Less than five years later, in 1943, it rained extremely hard on January 22nd and 23rd. The greatest 24-hour rainfall in California history occurred in this storm when 26.12 inches fell at Hoegees, below Mount Wilson. Fifteen weather stations in the transverse ranges received storm totals exceeding twenty inches — Hoegees had a storm total of 36.34 inches — while many more stations in the foothills and valleys of Los Angeles County reported a one hundred-year event. Goodridge (1998) stated that the area encompassing a 100-year or more return period covered 11,000 square miles, and extended from Santa Barbara County to Riverside County.

Southern California received heavy precipitation through the 1968-69 season, particularly during January and February, when almost 23 inches of rain fell at downtown Los Angeles. A low pressure trough had anchored off the southern California coast, setting up a steady-state subtropical moisture flow across the district. During this event, almost three hundred rain gauges recorded the highest-ever 60-day rainfall totals.

Flood control projects completed before 1968 mitigated property damage in Los Angeles. When the 1969 *El Nino* rains finally ended, Frank G. Bonelli of the Los Angeles County Board of Supervisors stated that "the overall flood control system prevented one of the worst catastrophes in the history of Los Angeles." To the north, across Santa Barbara County and San Luis Obispo County, losses and damage from these heavy rains had been much more severe.

In the month of February 1980, thirteen inches of rain fell after an abnormally wet January. The Los Angeles River slightly overflowed the levees at the lower end of the river at Wardlow Road. The 129,000 cfs river gauge measurement at that location was the highest recorded since records began in 1928. This 40-year flood event broke through a barrier that was supposed to withstand a 100-year flood, which caused the Corps of Engineers to re-evaluate flood protection for the lower Los Angeles River.

The January 4, 1995 storm caused about six million dollars damage, mostly as a result of urban flooding from record rainfalls in the south portion of the Los Angeles Basin. Between 3:00 and 4:30 p.m. on January 4th, the area in south Los Angeles County between Long Beach and Carson was deluged with up to 3.40 inches of rain, while a gauge near LAX received only 0.12 inches and the Pomona area reported 0.55 inches. Two hundred structures were flooded and one hundred vehicles abandoned. Flood control facilities operated at peak capacity at many locations for short periods of time during the event, but the Los Angeles River did not approach capacity because intense rainfall occurred over only a relatively small portion of the lower drainage basin.

In 1998, another strong El Nino episode produced the wettest February of all time at downtown Los Angeles, with 13.68 inches recorded during the month. Over nineteen inches fell at Montebello Fire Station, just east of the downtown weather station. In the Los Angeles metropolitan area, seasonal rainfall records were established at six key area stations, including Chatsworth with an incredible 44.19 inches. For the entire 1997-98 rainfall season, precipitation over the whole district averaged a whopping 230% of normal. With such huge numbers, it was somewhat surprising to note that the only flooding reported was of the urban and small stream variety—more nuisance than disaster. Several reasons are offered to explain the lack of problems associated with this very heavy rainfall season:

- Ample warning, well in advance, of the strong probability of heavy winter rains was provided by the National Weather Service and the media. This prompted extra vigilance in the removal of debris from storm basins and flood channels. When rains did occur, the National Weather Service, using latest technologies, communicated warnings to emergency officials. This, in turn, led to appropriate action-response.
- The rains were spread fairly evenly over the course of the 1997-1998 season.

Adequate long-term flood control measures by the U.S. Army Corps of Engineers and their partners were largely completed and in place.

The towering mountains that give the Los Angeles region its spectacular views also wring 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"2

Naturally, this rainfall moves rapidly down stream, 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 regions rivers and streams.

What Factors Create Flood Risk?

Flooding occurs when climate, geology, and hydrology combine to create conditions where water flows outside of its usual course.

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.

Monsoons

Another relatively regular source for heavy rainfall, particularly in the mountains and adjoining cities is from summer tropical storms. Table xxx lists tropical storms that have had significant rainfall in the past century, and the general areas affected by these storms. These tropical storms usually coincide with El Niño years.

Table 2.3 Tropical cyclones that have affected Southern California during the 20th Century

Month-Year	Date(s)	Area(s) Affected	Rainfall
July 1902	20-21	Deserts & Southern	up to 2"

		Mountains	
Aug. 1906	18-19	Deserts & Southern Mountains	up to 5"
Sept. 1910	15	Mountains of Santa Barbara County	2"
Aug. 1921	20-21	Deserts & Southern Mountains	up to 2"
Sept. 1921	30	Deserts	up to 4"
Sept. 1929	18	Southern Mountains & Deserts	up to 4"
Sept. 1932	28-Oct 1	Mountains & Deserts, 15 Fatalities	up to 7
Aug. 1935	25	Southern Valleys, Mountains & Deserts	up to 2"
Sept. 1939	4-7	Southern Mountains, Southern & Eastern Deserts	up to 7
	11-12	Deserts, Central & Southern Mountains	up to 4"
	19-21	Deserts, Central & Southern Mountains	up to 3"
	25	Long Beach, W/ Sustained Winds of 50 Mph	5"
		Surrounding Mountains	6 to 12"
Sept. 1945	9-10	Central & Southern Mountains	up to 2"
Sept. 1946	30-Oct 1	Southern Mountains	up to 4"
Aug. 1951	27-29	Southern Mountains & Deserts	2 to 5"
Sept. 1952	19-21	Central & Southern Mountains	up to 2"
July 1954	17-19	Deserts & Southern Mountains	up to 2"
July 1958	28-29	Deserts & Southern Mountains	up to 2"
Sept. 1960	9-10	Julian	3.40"
Sept. 1963	17-19	Central & Southern Mountains	up to 7"
Sept. 1967	1-3	Southern Mountains & Deserts	2"
Oct. 1972	6	Southeast Deserts	up to 2"

Sept. 1976	10-11	Central & Southern Mountains.	6 to 12"
Aug. 1977	n/a	Los Angeles	2"
		Mountains	up to 8"
Oct. 1977	6-7	Southern Mountains & Deserts	up to 2"
Sept. 1978	5-6	Mountains	3"
Sept. 1982	24-26	Mountains	up to 4"
Sept. 1983	20-21	Southern Mountains & Deserts	up to 3"

http://www.fema.gov/nwz97/eln_scal.shtm

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"3

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 replacing 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 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.

Flood Fringe
The flood fringe refers to the outer portions of the floodplain, beginning at the edge of the floodway and continuing outward.

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

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 faster 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. Adding these elements to the hydrological systems can result in flood waters that rise very rapidly and peak with violent force.

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 Santa Monica. 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. For more detailed information regarding dam failure flooding, and potential flood inundation zones for a particular dam in the county, refer to the the City of Santa Monica Emergency Action Plan.

There have been a total of 45 dam failures in California, since the 19th century. The significant dam failures in Southern California are listed in Table xxx.

Table 2.4   Dam Failures in Southern California

Sheffield	Santa Barbara	1925	Earthquake slide
Puddingstone	Pomona	1926	Overtopping during construction
Lake Hemet	Palm Springs	1927	Overtopping

Saint Francis	San Francisquito Canyon	1928	Sudden failure at full capacity through foundation, 426 deaths
Cogswell	Monrovia	1934	Breaching of concrete cover
Baldwin Hills	Los Angeles	1963	Leak through embankment turned into washout, 3 deaths

http://cee.engr.ucdavis.edu/faculty/lund/dams/Dam_History_Page/Failures.htm

The two most significant dam failures are the St. Francis Dam in 1928 and the Baldwin Hills Dam in 1963. "The failure of the St. Francis Dam, and the resulting loss of over 500 lives in the path of a roaring wall of water, was a scandal that resulted in the almost complete destruction of the reputation of its builder, William Mulholland. Mulholland was an immigrant from Ireland who rose up through the ranks of the city's water department to the position of chief engineer. It was he who proposed, designed, and supervised the construction of the Los Angeles Aqueduct, which brought water from the Owens Valley to the city. The St. Francis Dam, built in 1926, was 180 feet high and 600 feet long; it was located near Saugus in the San Francisquito Canyon. The dam gave way on March 12, 1928, three minutes before midnight. Its waters swept through the Santa Clara Valley toward the Pacific Ocean, about 54 miles away. 65 miles of valley was devastated before the water finally made its way into the ocean between Oxnard and Ventura. At its peak the wall of water was said to be 78 feet high; by the time it hit Santa Paula, 42 miles south of the dam, the water was estimated to be 25 feet deep. Almost everything in its path was destroyed: livestock, structures, railways, bridges, and orchards. By the time it was over, parts of Ventura County lay under 70 feet of mud and debris. Over 500 people were killed and damage estimates topped $20 million."4

The Baldwin Hills dam failed during the daylight hours, and was one of the first disaster events documented a live helicopter broadcast. "The Baldwin Hills Dam collapsed with the fury of a thousand cloudbursts, sending a 50-foot wall of water down Cloverdale Avenue and slamming into homes and cars on Dec. 14, 1963. Five people were killed. Sixty-five hillside houses were ripped apart, and 210 homes and apartments were damaged. The flood swept northward in a V-shaped path roughly bounded by La Brea Avenue and Jefferson and La Cienega boulevards.

The earthen dam that created a 19-acre reservoir to supply drinking water for West Los Angeles residents ruptured at 3:38 p.m. As a pencil-thin crack widened to a 75-foot gash, 292 million gallons surged out. It took 77 minutes for the lake to empty. But it took a generation for the neighborhood below to recover. And two decades passed before the Baldwin Hills ridge top was reborn.

The cascade caused an unexpected ripple effect that is still being felt in Los Angeles and beyond. It foreshadowed the end of urban-area earthen dams as a major element of the Department of Water and Power's water storage system. It prompted a tightening of Division of Safety of Dams control over reservoirs throughout the state. The live telecast of the collapse from a KTLA-TV helicopter is considered the precursor to airborne news coverage that is now routine everywhere."5

Debris Flows
Another flood related hazard that can affect certain parts of the Southern California region are debris flows. Most typically debris flows occur in mountain canyons and the foothills against the San Gabriel Mountains. However, any hilly or mountainous area with intense rainfall and the proper geologic conditions may experience one of these very sudden and devastating events. "Debris flows, sometimes referred to as mudslides, mudflows, lahars, or debris avalanches, are common types of fast-moving landslides.

These flows generally occur during periods of intense rainfall or rapid snow melt. They usually start on steep hillsides as shallow landslides that liquefy and accelerate to speeds that are typically about 10 miles per hour, but can exceed 35 miles per hour. The consistency of debris flows ranges from watery mud to thick, rocky mud that can carry large items such as boulders, trees, and cars. Debris flows from many different sources can combine in channels, and their destructive power may be greatly increased. They continue flowing down hills and through channels, growing in volume with the addition of water, sand, mud, boulders, trees, and other materials. When the flows reach flatter ground, the debris spreads over a broad area, sometimes accumulating in thick deposits that can wreak havoc in developed areas."6

Coastal Flooding
Low lying coastal communities of Southern California have one other source of flooding, coastal flooding. This occurs most often during storms which bring higher than normal tides. Storms, the time of year and the tidal cycle can sometimes work to bring much higher than normal tides which cause flooding in low lying coastal areas. This hazard however is limited to those areas.

What is 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. Local governments must require engineer certification to ensure that proposed developments will not adversely affect the flood carrying capacity of the Special Flood Hazard Area (SFHA). 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.

How are Flood-Prone Areas Identified?
Flood maps and Flood Insurance Studies (FIS) are often used to identify flood-prone areas. 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. 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. There are no flood prone zones in Santa Monica.

Flood Insurance Rate Maps (FIRM) and Flood Insurance Studies (FIS)
Floodplain maps are the basis for implementing floodplain regulations and for delineating flood insurance purchase requirements. A Flood Insurance Rate Map (FIRM) is the official map produced by FEMA which delineates SFHA in communities where NFIP regulations apply. FIRMs are also used by insurance agents and mortgage lenders to determine if flood insurance is required and what insurance rates should apply.

Water surface elevations are combined with topographic data to develop FIRMs. FIRMs illustrate areas that would be inundated during a 100-year flood, floodway areas, and elevations marking the 100-year-flood level. In some cases they also include base flood elevations (BFEs) and areas located within the 500-year floodplain. Flood Insurance Studies and FIRMs produced for the NFIP provide assessments of the probability of flooding at a given location. FEMA conducted many Flood Insurance Studies in the late 1970s and early 1980s. These studies and maps represent flood risk at the point in time when FEMA completed the studies. However, it is important to note that not all 100-year or 500-year floodplains have been mapped by FEMA.

FEMA flood maps are not entirely accurate. These studies and maps represent flood risk at the point in time when FEMA completed the studies, and does not incorporate planning for floodplain changes in the future due to new development. Although FEMA is considering changing that policy, it is optional for local communities. Man-made and natural changes to the environment have changed the dynamics of storm water run-off since then.

Flood Mapping Methods and Techniques
Although many communities rely exclusively on FIRMs to characterize the risk of flooding in their area, there are some flood-prone areas that are not mapped but remain susceptible to flooding. These areas include locations next to small creeks, local drainage areas, and areas susceptible to manmade flooding.

Communities find it particularly useful to overlay flood hazard areas on tax assessment parcel maps. This allows a community to evaluate the flood hazard risk for a specific parcel during review of a development request. Coordination between FEMA and local planning jurisdictions is the key to making a strong connection with GIS technology for the purpose of flood hazard mapping.

FEMA and the Environmental Systems Research Institute (ESRI), a private company, have formed a partnership to provide multi-hazard maps and information to the public via the Internet. ESRI produces GIS software, including ArcViewC9 and ArcInfoC9 . The ESRI web site has information on GIS technology and downloadable maps. The hazards maps provided on the ESRI site are intended to assist communities in evaluating geographic information about natural hazards. Flood information for most communities is available on the ESRI web site. Visit www.esri.com for more information.

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 (i.e., 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.

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 Santa Monica 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 Santa Monica. 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 Santa Monica.

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 Santa Monica 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. Losses in the City of Santa Monica over the past 25 years have totaled approximately $23,102.

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.

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/Highways
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 Santa Monica 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 Santa Monica are state, county, city, or privately 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.

Dam/Flood Control Channels

No dam/flood control channels exist in Santa Monica. Portions of the City may be subject to flooding, due to flash flooding, urban flooding (storm drain failure/infrastructure breakdown), river channel overflow, downstream flooding, etc.) The City has not historically been vulnerable to storm surge inundation associated with hurricanes and tropical storms.

Stone Canyon Reservoir

The Stone Canyon Reservoir is located in the City of Los Angeles. There is a likelihood that the 10,370 acre feet capacity Stone Canyon Reservoir above the City of Brentwood would rupture in a major earthquake, inundating Brentwood and portions of West Los Angeles, and depositing no less than several inches of water on the northeast portion of Santa Monica.

Riviera Reservoir

The Riviera Reservoir, 1252 Capri, Los Angeles, is owned by the City of Santa Monica and located about two miles north of the City in Santa Monica Canyon. The California Department of Water Resources Bulletin No.17 lists the reservoir as having a height of 40 feet and a storage capacity of 76 acre-feet, which translates to approximately 25 million gallons.

The Riviera Reservoir is an off-stream, covered storage reservoir built with vertical concrete walls. These walls are keyed top and bottom to the roof and foundations. The north and west sidewalls on the south and east have compacted backfill in front of them. These are the sides through which water will pass should a failure occur.

If the failure were to occur on the east side, the structures, located at the Riviera Golf Course, immediately below the dam will definitely be in jeopardy. If the south side of the dam were to fail, no structures would be harmed. However, the golf course would be flooded.
Flood waters released during the reservoir failure would empty onto the Riviera Country Golf Course, eventually flowing into the Santa Monica Creek.

The flood control channels will contain the flood waters directing them to the Pacific Ocean. Santa Monica Creek located in the City of Los Angeles, is dry the majority of the time and is not likely to be carrying flow at a time when the reservoir might fail. Damage to any homes adjacent to the golf course is considered unlikely. The travel time of the flood flows to the flood control channel would be within 15 minutes.

Stormwater

Stormwater, which is more accurately called urban runoff, consists of rainwater as well as runoff draining to city streets generated by irrigation, car washing or the hosing down of streets and sidewalks. The majority of this urban runoff in Santa Monica drains untreated into Santa Monica Bay via an underground storm drain system. This system consists of 2,308 catch basins and 64 storm drain lines which discharge at five outfalls within the city limits. The largest of these is located on the beach at Pico Boulevard and is known as the Pico-Kenter outfall. In addition to runoff from Santa Monica, this outfall also discharges runoff from parts of Brentwood and West Los Angeles. The other four outfalls are located on the beach at Montana Avenue, Wilshire Boulevard, the Santa Monica Pier, and Ashland Avenue. The Montana and Wilshire outfalls typically only discharge runoff to the ocean during heavy rains. The remaining three outfalls discharge year-round, during wet and dry periods. Under the federal Clean Water Act (CWA) the City is responsible for the quality of the urban runoff entering the storm drain system and for the enforcement and implementation of Local, State and Federal stormwater regulations. City oversight of stormwater programs and operation and maintenance of the stormwater system is coordinated by the Department of Environmental and Public Works Management. The City is responsible for the operation and maintenance of 824 catch basins and approximately 20 miles of storm drain lines. The remainder of the catch basins and storm drains within the city are owned and maintained by Los Angeles County.

The CWA and the California Ocean Plan are the primary mechanisms through which pollutant discharges to water bodies are regulated in California. The CWA established minimum national water quality goals and created the National Pollutant Discharge Elimination System (NPDES) to regulate the quality of discharged water. As of 1990 all municipal stormwater runoff became regulated under the NPDES system. The City of Santa Monica is currently a co-permittee with all other cities in Los Angeles County on the County's NPDES permit which was issued in 1990. Under this permit all co-permittees were required to develop a stormwater management plan which includes implementation of 13 baseline best management practices (BMPs) related to stormwater. These BMPs include: (1) catch basin labeling, (2) institution of a public reporting program, (3) implementation of a municipal runoff control ordinance, (4) development of public education material, (5) catch basin cleaning, (6) encourage increased trash receptacle usage, (7) increased street sweeping, (8) discourage improper litter disposal, (9) inspection of restaurants and automobile facilities, (10) encourage residents to remove dirt, rubbish and debris from sidewalks, (11) establish a recycling program, (12) motivate residents to properly dispose of hazardous waste, and (13) encourage water conservation. To date Santa Monica has met all of its compliance deadlines for implementation of these BMPs.

The Los Angeles Regional Water Quality Control Board (RWQCB) recently completed a comprehensive revision of the NPDES permit for the Los Angeles region. This revised permit was approved in July 1996. The permit revision was undertaken due to a perceived need to toughen existing standards because compliance with the existing permit had been inconsistent throughout the region. The revised permit is more comprehensive and specific than the previous permit and requires the City to conduct additional employee education and institute a construction-site inspection program to help mitigate construction-related stormwater impacts.

Wastewater
Wastewater (or "sewage") generated by Santa Monica's residential, commercial and industrial water users flows through underground sewer lines to the City of Los Angeles' Hyperion Treatment Plant, located approximately 7 miles southeast of Santa Monica in Playa del Rey. There the wastewater is screened, settled, and biologically treated before being discharged into Santa Monica Bay. Santa Monica pays a fee to Los Angeles for disposal of its wastewater based on the monthly effluent flows to the treatment plant. There are approximately 125 miles of sewer lines within the city limits. They are owned by Santa Monica and are inspected and maintained by the City's Environmental and Public Works Management Department. Permitting and inspection of commercial and industrial wastewater generators is overseen by the department's Industrial Waste Division. Santa Monica's sewer system is completely separate from the stormwater system with only the wastewater being treated before it enters the Bay.

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
Governor's Office of Emergency Services (OES)
P.O. Box 419047
Rancho Cordova, CA 95741-9047
Ph: 916 845- 8911
Fx: 916 845- 8910

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 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

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 in the City of Santa Monica.

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

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 that 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

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

Publications

NFIP 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 NFIP

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, nonregulatory). 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

Flood Endnotes

1. http://www.lalc.k12.ca.us/target/units/river/tour/hist.html
2. Gumprecht, Blake, 1999, Johns Hopkins University Press, Baltimore, MD.
3. Ibid
4. http://www.usc.edu/isd/archives/la/scandals/st_francis_dam.html
5. http://www.latimes.com/news/local/surroundings/la-mesurround11dec11,0,1754871.story?coll=la-adelphia-right-rail
6. http://www.fema.gov/rrr/talkdiz/landslide.shtm#

Table of Contents

Why Are Tsunamis a Threat to Southern California?
History has shown that the probability of a tsunami in the City of Santa Monica is an extremely low threat. However, if a tsunami should occur, the consequences would be great. As shown on the tsunami run-up map (Map 2.6 on page 122), the entire City of Santa Monica coastline could be impacted. Thirty percent of the City's residents would have to be evacuated. The impact could cause loss of life, destroy thousands of high priced homes and greatly affect the City's downtown and coastal businesses, and impact tourism. Even if all residents and visitors were safely evacuated, the damage to property in this densely populated, high property value area would still be tremendous.

California's Tsunamis
"Since 1812, the California coast has had 14 tsunamis with wave heights higher than three feet; six of these were destructive. The Channel Islands were hit by a big tsunami in the early 1800s. The worst tsunami resulted from the 1964 Alaskan earthquake and caused 12 deaths and at least $17 million in damages in northern California."[xli]

What are Tsunamis?
The phenomenon we call "tsunami" (soo-NAH-mee) is a series of traveling ocean waves of extremely long length generated primarily by earthquakes occurring below or near the ocean floor. Underwater volcanic eruptions and landslides can also generate tsunamis. In the deep ocean, the tsunami waves move across the deep ocean with a speed exceeding 500 miles per hour, and a wave height of only a few inches. Tsunami waves are distinguished from ordinary ocean waves by their great length between wave crests, often exceeding 60 miles or more in the deep ocean, and by the time between these crests, ranging from 10 minutes to an hour.

As they reach the shallow waters of the coast, the waves slow down and the water can pile up into a wall of destruction up to 30 feet or more in height. The effect can be amplified where a bay, harbor or lagoon funnels the wave as it moves inland. Large tsunamis have been known to rise over 100 feet. Even a tsunami 1-3 feet high can be very destructive and cause many deaths and injuries.

What causes Tsunami?
There are many causes of tsunamis but the most prevalent is earthquakes. In addition, landslides, volcanic eruptions, explosions, and even the impact of cosmic bodies, such as meteorites, can generate tsunamis.

Plate Tectonics
Plate Tectonic theory is based on an earth model characterized by a small

number of lithospheric plates, 40 to 150 miles thick, that float on a viscous under-layer called the asthenosphere. These plates, which cover the entire surface of the earth and contain both the continents and sea floor, move relative to each other at rates of up to several inches per year. The region where two plates come in contact is called a plate boundary, and the way in which one plate moves relative to another determines the type of boundary: spreading, where the two plates move away from each other; subduction, where the two plates move toward each other and one slides beneath the other; and transform, where the two plates slide horizontally past each other. Subduction zones are characterized by deep ocean trenches, and the volcanic islands or volcanic mountain chains associated with the many subduction zones around the Pacific rim are sometimes called the Ring of Fire.

Earthquakes and Tsunamis
An earthquake can be caused by volcanic activity, but most are generated by movements along fault zones associated with the plate boundaries. Most strong earthquakes, representing 80% of the total energy released worldwide by earthquakes, occur in subduction zones where an oceanic plate slides under a continental plate or another younger oceanic plate.

Not all earthquakes generate tsunamis. To generate a tsunami, the fault where the earthquake occurs must be underneath or near the ocean, and cause vertical movement of the sea floor over a large area, hundreds or thousands of square miles. "By far, the most destructive tsunamis are generated from large, shallow earthquakes with an epicenter or fault line near or on the ocean floor."[xlii] The amount of vertical and horizontal motion of the sea floor, the area over which it occurs, the simultaneous occurrence of slumping of underwater sediments due to the shaking, and the efficiency with which energy is transferred from the earth's crust to the ocean water are all part of the tsunami generation mechanism. The sudden vertical displacements over such large areas, disturb the ocean's surface, displace water, and generate destructive tsunami waves.[xliii]
Although all oceanic regions of the world can experience tsunamis, the most destructive and repeated occurrences of tsunamis are in the Pacific Rim region.

Tsunami Earthquakes
The September 2, 1992 earthquake (magnitude 7.2) was barely felt by residents along the coast of Nicaragua. Located well off-shore, the severity of shaking on a scale of I to XII, was mostly II along the coast, and reached III at only a few places. Twenty to 70 minutes after the earthquake occurred, a tsunami struck the coast of Nicaragua with wave amplitudes up to 13 feet above normal sea level in most places and a maximum run-up

height of 35 ft. The waves caught coastal residents by complete surprise and caused many casualties and considerable property damage.

This tsunami was caused by a tsunami earthquake, an earthquake that produces an unusually large tsunami relative to the earthquake magnitude. Tsunami earthquakes are characterized by a very shallow focus, fault dislocations greater than several meters, and fault surfaces that are smaller than for a normal earthquake.

Tsunami earthquakes are also slow earthquakes, with slippage along the fault beneath the sea floor occurring more slowly than it would in a normal earthquake. The only known method to quickly recognize a tsunami earthquake is to estimate a parameter called the seismic moment using very long period seismic waves (more than 50 seconds/cycle). Two other destructive and deadly tsunamis from tsunami earthquakes have occurred in recent years in Java, Indonesia (June 2, 1994) and Peru (February 21, 1996).

> "Less frequently, tsunami waves can be generated from displacements of water resulting from rock falls, icefalls and sudden submarine landslides or slumps. Such events may be caused impulsively from the instability and sudden failure of submarine slopes, which are sometimes triggered by the ground motions of a strong earthquake. For example in the 1980's, earth moving and construction work of an airport runway along the coast of Southern France, triggered an underwater landslide, which generated destructive tsunami waves in the harbor of Thebes."[xliv]

TSUNAMI CHARACTERISTICS

How Fast?

Unnoticed tsunami waves can travel at the speed of a commercial jet plane, over 500 miles per hour. They can move from one side of the Pacific Ocean to the other in less than a day. This great speed makes it important to be aware of the tsunami as soon as it is generated. Scientists can predict when a tsunami will arrive at various places by knowing the source characteristics of the earthquake that generated the tsunami and the characteristics of the sea floor along the paths to those places. Tsunamis travel much slower in more shallow coastal waters where their wave heights begin to increase dramatically.

How Big?

Offshore and coastal features can determine the size and impact of tsunami waves. Reefs, bays, entrances to rivers, undersea features and the slope of the beach all help to modify the tsunami as it attacks the coastline. When the tsunami reaches the coast and moves inland, the water level can rise many feet. In extreme cases, water level has risen to more than 50 feet for tsunamis of distant origin and over 100 feet for tsunami waves generated near the earthquake's epicenter. The first wave may not be the largest in the series of waves. One coastal community may see no damaging wave activity while in another nearby community destructive waves can be large and violent. The flooding can extend inland by 1000 feet or more, covering large expanses of land with water and debris.

How Frequent?
Since scientists cannot predict when earthquakes will occur, they cannot determine exactly when a tsunami will be generated. However, by looking at past historical tsunamis and run-up maps, scientists know where tsunamis are most likely to be generated. Past tsunami height measurements are useful in predicting future tsunami impact and flooding limits at specific coastal locations and communities.

TYPES OF TSUNAMIS

Pacific-wide and Regional Tsunamis
Tsunamis can be categorized as "local" and Pacific-wide. Typically, a Pacific-wide tsunami is generated by major vertical ocean bottom movement in offshore deep trenches. A "local" tsunami can be a component of the Pacific-wide tsunami in the area of the earthquake or a wave that is confined to the area of generation within a bay or harbor and caused by movement of the bay itself or landslides.

The last large tsunami that caused widespread death and destruction throughout the Pacific was generated by an earthquake located off the coast of Chile in 1960. It caused loss of life and property damage not only along the Chile coast but also in Hawaii and as far away as Japan. The Great Alaskan Earthquake of 1964 killed 106 people and produced deadly tsunami waves in Alaska, Oregon and California.

In July 1993, a tsunami generated in the Sea of Japan killed over 120 people in Japan. Damage also occurred in Korea and Russia but spared other countries since the tsunami wave energy was confined within the Sea of Japan. The 1993 Japan Sea tsunami is known as a "regional event" since its impact was confined to a relatively small area. For people living along the northwestern coast of Japan, the tsunami waves followed the earthquake within a few minutes.

During the 1990's, destructive regional tsunamis also occurred in Nicaragua, Indonesia, the Philippines, Papua New Guinea, and Peru, killing thousands of people. Others caused property damage in Chile and Mexico. Some damage also occurred in the far field in the Marquesas Islands (French Polynesia) from the July 30, 1995, Chilean and February 21, 1996, Peruvian tsunamis.

In less than a day, tsunamis can travel from one side of the Pacific to the other. However, people living near areas where large earthquakes occur may find that the tsunami waves will reach their shores within minutes of the earthquake. For these reasons, the tsunami threat to many areas such as Alaska, the Philippines, Japan and the United States West Coast can be immediate (for tsunamis from nearby earthquakes which take only a few minutes to reach coastal areas) or less urgent (for tsunamis from distant earthquakes which take from three to 22 hours to reach coastal areas).

HISTORY OF REGIONAL TSUNAMIS

Local
The local tsunami may be the most serious threat as it strikes suddenly, sometimes before the earthquake shaking stops. Alaska has had six serious local tsunamis in the last 80 years and Japan has had many more.

Local History of Tsunamis
Tsunamis have been reported since ancient times. They have been documented extensively in California since 1806. Although the majority of tsunamis have occurred in Northern California, Southern California has been impacted as well. In the 1930's, four tsunamis struck the LA, Orange County, and San Diego coastal areas. In Orange County the tsunami wave reached heights of 20 feet or more above sea level. In 1964, following the Alaska 8.2 earthquake, tidal surges of approximately 4 feet to 5 feet hit the Huntington Harbour area causing moderate damage.

Table 2.5 Tsunami Events In California 1930-2004

Date	Location	Maximum Run up*(m)	Earthquake Magnitude
08/31/1930	Redondo Beach	6.10	5.2
08/31/1930	Santa Monica	6.10	5.2
08/31/1930	Venice	6.10	5.2
03/11/1933	La Jolla	0.10	6.3
03/11/1933	Long Beach	0.10	6.3
08/21/1934	Newport Beach	12.00	Unknown

02/09/1941	San Diego	Unknown	6.6
10/18/1989	Monterey	0.40	7.1
10/18/1989	Moss Landing	1.00	7.1
10/18/1989	Santa Cruz	0.10	7.1
04/25/1992	Arena Cove	0.10	7.1
04/25/1992	Monterey	0.10	7.1
09/01/1994	Crescent City	0.14	7.1
11/04/2000	Point Arguello	5.00	

Source: Worldwide Tsunami Database www.ngdc.noaa.gov

* Maximum Run up (M)-The maximum water height above sea level in meters. The run-up is the height the tsunami reached above a reference level such as mean sea level. It is not always clear which reference level was used.

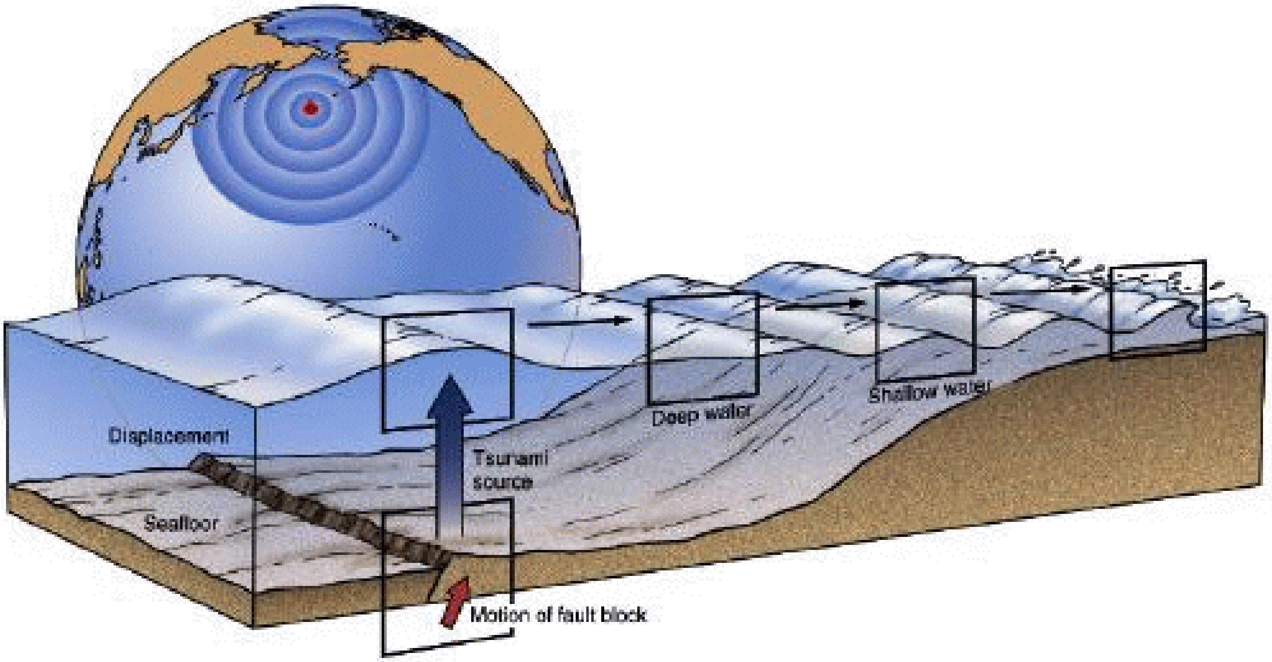
TSUNAMI HAZARD ASSESSMENT

Hazard Identification

A tsunami threat to the City of Santa Monica is considered low to moderate. Santa Monica occupies a central position along the arching shoreline of Santa Monica Bay. The beach, which has grown through accretion, is several hundred feet wide—one of the widest stretches of beach in this part of southern California.

Santa Monica sits atop a coastal plain that is defined on its northern boundary by Santa Monica Canyon. This deep arroyo attracted native American settlements and then the area’s first European settlement in the 1860s—a summer colony for residents of the new City of Los Angeles some twelve miles inland along the foot of the mountains. South of the canyon, the rugged terrain gives way to the gently south sloping upland of the City’s north side. The land descends to a historic drainage channel that ran west to the sea along the general line of the present-day Santa Monica freeway. This drainage formed a distinctive draw that originally marked the edge of the Palisades and defined the City’s southerly border. It is this collision of this south sloping upland with the southwesterly trending coastline that creates the City’s most memorable topographic feature—the Palisades—a sheer cliff of fragile sandstone that rises about 100 feet above the coast that separates the northern portion of the City from the beach below.

Damage factors of tsunamis



Tsunamis cause damage in three ways: inundation, wave impact on structures, and erosion.

> "Strong, tsunami-induced currents lead to the erosion of foundations and the collapse of bridges and sea walls. Flotation and drag forces move houses and overturn railroad cars. Considerable damage is caused by the resultant floating debris, including boats and cars that become dangerous projectiles that may crash into buildings, break power lines, and may start fires. Fires from damaged ships in ports or from ruptured coastal oil storage tanks and refinery facilities, can cause damage greater than that inflicted directly by the tsunami. Of increasing concern is the potential effect of tsunami draw down, when receding waters uncover cooling water intakes of nuclear power plants."[xlv]

A United States Government study reports that, "Local earthquakes will not generate a tsunami, in this area". Tsunamis are due to large off-shore earthquakes and ocean landslides. Dangerous tsunamis would most likely originate in the Aleutian and Chilean offshore submarine trenches. The City of Santa Monica has western facing beaches that are vulnerable to tsunamis or tidal surges from the from the west.

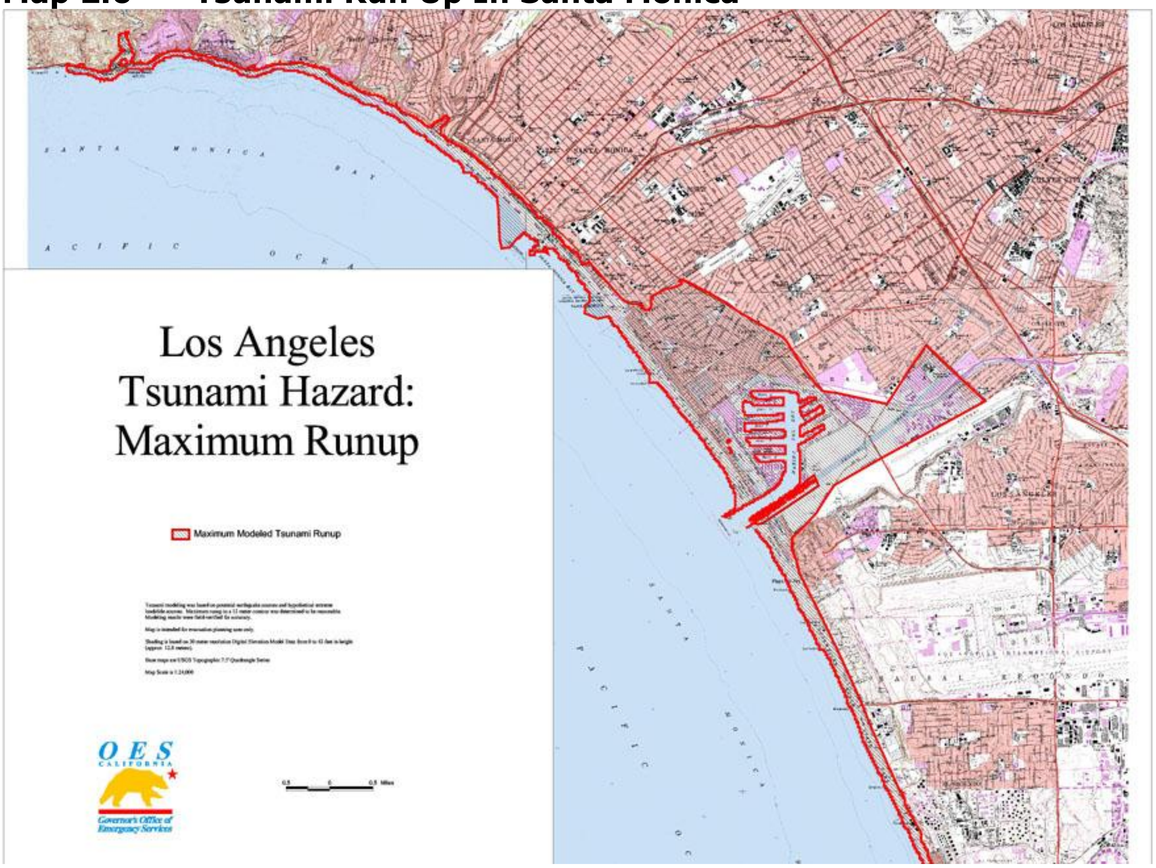
Predicted wave heights, exclusive of tide and storm generated wave heights are:

For a 100 year occurrence	For a 500 year occurrence
4.0 feet minimum	6.8 feet minimum

6.6 feet average | 11.4 feet average
9.2 feet maximum | 16.0 feet maximum

According to the Modern Tsunami Run-up Map (see next page) the entire coastline of Santa Monica would be severely impacted. During the summer months City of Santa Monica can attract over 200,000 people a day to its beaches. If a tsunami were to occur it could devastate the entire coastal area.

Map 2.6 Tsunami Run Up In Santa Monica



TSUNAMI WATCHES AND WARNINGS

Warning System

The tsunami warning system in the United States is a function of the National Oceanic and Atmospheric Administration’s (NOAA) National Weather Service. Development of the tsunami warning system was impelled by the disastrous waves generated in Alaska in April 1946, which surprised Hawaii and the U.S. West Coast, taking a heavy toll in life and property.

The disastrous 1964 tsunami resulted in the development of a regional warning system in Alaska. The Alaska Tsunami Warning Center is in Palmer, Alaska. This facility is the nerve center for an elaborate telemetry network of remote seismic stations in Alaska, Washington, California, Colorado, and other locations. Tidal data is also telemetered directly to the ATWC from eight Alaskan locations. Tidal data from Canada, Washington, Oregon, and California are available via telephone, teletype, and computer readout.

Watch vs. Warning
The National Warning System (NAWAS) is an integral part of the Alaska Tsunami Warning Center. Reports of major earthquakes occurring anywhere in the Pacific Basin that may generate seismic sea waves are transmitted to the Honolulu Observatory for evaluation. An Alaska Tsunami Warning Center is also in place for public notification of earthquakes in the Pacific Basin near Alaska, Canada, and Northern California. The Observatory Staff determines action to be taken and relays warnings over the NAWAS circuits to inform and warn West Coast states. The State NAWAS circuit is used to relay the information to the Orange County Operational Area warning center which will in turn relay the information to local warning points in coastal areas. The same information is also transmitted to local jurisdictions over appropriate radio systems, teletype, and telephone circuits to ensure maximum dissemination.

A Tsunami Watch Bulletin is issued if an earthquake has occurred in the Pacific Basin and could cause a tsunami. A Tsunami Warning Bulletin is issued when an earthquake has occurred and a tsunami is spreading across the Pacific Ocean. When a threat no longer exists, a Cancellation Bulletin is issued.

When there is a high probability that a tsunami will reach City of Santa Monica, the City will activate its Warning Siren System. When activated, the sirens alert the public to turn on their AM/FM radio and listen to the Emergency Alerting System (EAS). The City Public Information Officer will activate EAS and provide them with a prepared statement of who should evacuate, where to evacuate to and what routes to take.

Evacuation
Upon receipt of a Tsunami Watch/Warning Bulletin, an immediate evaluation will be made of the potential

threat to the coastal areas of the City of Santa Monica. After a thorough evaluation, a determination will be made as to the degree of evacuation necessary to eliminate any threats to the resident and visiting populations.

Once the degree of evacuation has been determined, the Police Department will begin an immediate evacuation of the low-lying areas that have been determined to be at risk. Officers will block all movements on Pacific Coast Highway except those necessary to gain access to the nearest arterial highway leading away from the ocean. The population will be directed inland using the closest available northbound or eastbound arterial highway. It is imperative that the evacuation routes be kept open and clear at all times.

Neighboring jurisdictions along with the American Red Cross would be called upon for care and shelter duties. Displacing residents, utilization of Cities resources, and disaster cleanup can cause an economic hardship on all impacted communities.

Vulnerability and Risk
With an analysis of tsunami events depicted in the "Local History" section, we can deduce the common tsunami impact areas will include impacts on life, property, infrastructure and transportation.

COMMUNITY TSUNAMI ISSUES

What is Susceptible to Tsunami?

Life and Property
The largest impact on the community from a tsunami event is the loss of life and property. Known risk areas include, but are not limited to:

- Beaches
- Santa Monica Pier
- All buildings and apartments on west of Pacific Coast Highway (PCH)
- Vehicles and pedestrians on PCH in low lying areas

Using the Tsunami Warning and Watch Bulletin would provide time to allow coastal residents to evacuate and seek higher ground for shelter. This would greatly reduce injuries and loss of life.

Commercial
City of Santa Monica's pier and beaches are world famous. During summer months up to 200,000 people a day come into the community to stay in the beautiful hotels and shop at the unique boutiques. The local government relies heavily on tourism and sales tax. A tsunami event would impact businesses by damaging property and by interrupting business and services.

Any residential or commercial structure with weak reinforcement would be susceptible to damage.

Infrastructure
Tsunamis (and earthquakes) can damage buildings, power lines, and other property and infrastructure due to flooding. Tsunamis can result in collapsed or damaged buildings or blocked roads and bridges, damaged traffic signals, streetlights, and parks, among others. Damage to public water and sewer systems, transportation networks, and flood channels would greatly impact daily life for residents.

Roads blocked by objects during a tsunami may have severe consequences to people who are attempting to evacuate or who need 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 tsunamis related to both physical damages and interrupted services.

Existing Mitigation Activities
City of Santa Monica has implemented a number of tsunami mitigation activities over the years. Some of the current mitigation programs include:

- The City's Warning Siren System
- Public Information Plan for Emergency Alerting System (EAS)
- Disaster Preparedness Public Education

TSUNAMI RESOURCE DIRECTORY

County Resources
Los Angeles County Office of Emergency Management
Jeff Terry, Tsunami Coordinator
1375 N. Eastern Ave.
Los Angeles, CA., 90063
Telephone: 323-980-2260
www.lacoeoc.org

Federal Resources and Programs
West Coast & Alaska Tsunami Warning Center

The West Coast/Alaska Tsunami Warning Center's objectives are to rapidly locate and size major earthquakes in the Pacific basin, determine their tsunami potential, predict tsunami arrival times and, when possible, runup on the coast, and provide timely and effective tsunami information and warning bulletins for the Pacific coastal populations of California, Oregon, Washington, British Columbia, and Alaska.

910 S. Felton St.
Palmer, AK 99645
Ph: 907-745-4212
Fx: 907-745-6071

Additional Resources
University of Southern California
Department of Civil and Environmental Engineering
Tsunami Research Group
Dr. Costas E. Synolakis, Director
3620 S. Vermont Avenue
Kaprielian Hall 210
Los Angeles, CA 90089-2531
Ph: 213-740-0603
Fx: 213-744-1426
civileng@usc.edu

Tsunami Endnotes

. http://education.sdsc.edu/optiputer/htmlLinks/california_tsunami.html

2. http://www.prh.noaa.gov/itic/library/about_tsu/faqs.html#1

3. Ibid

4. Ibid

5. Ibid

2.5 Wildfires

Table of Contents

Why are Wildfires a Threat to Southern California?

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. According to the California Division of Forestry (CDF), there were over seven thousand reportable fires in California in 2003, with over one million acres burned.[xlvi] According to CDF statistics, in the October, 2003 Firestorms, over 4,800 homes were destroyed and 22 lives were lost.[xlvii]

The 2003 Southern California Fires

The fall of 2003 marked the most destructive wildfire season in California history. In a ten day period, 12 separate fires raged across Southern California in Los Angeles, Riverside, San Bernardino, San Diego and Ventura counties. The massive "Cedar" fire in San Diego County alone consumed of 2,800 homes and burned over a quarter of a million acres.

Table 2.6 October 2003 Firestorm Statistics

County	Fire Name	Date Began	Acres Burned	Homes Lost	Homes Damaged	Lives Lost
Riverside	Pass	10/21/03	2,397	3	7	0
Los Angeles	Padua	10/21/03	10,446	59	0	0
San Bernardino	Grand Prix	10/21/03	69,894	136	71	0
San Diego	Roblar 2	10/21/03	8,592	0	0	0
Ventura	Piru	10/23/03	63,991	8	0	0
Los Angeles	Verdale	10/24/03	8,650	1	0	0
Ventura	Simi	10/25/03	108,204	300	11	0
San Diego	Cedar	10/25/03	273,246	2,820	63	14
San Bernardino	Old	10/25/03	91,281	1,003	7	6
San Diego	Otay / Mine	10/26/03	46,000	6	11	0
Riverside	Mountain	10/26/03	10,000	61	0	0
San Diego	Paradise	10/26/03	56,700	415	15	2
Total Losses			749,401	4,812	185	22

Source: http://www.fire.ca.gov/php/fire_er_content/downloads/2003LargeFires.pdf

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."[xlviii]

Table 2.7 Large Historic Fires in California 1961-2003
20 Largest California Wildland Fires (Structures Destroyed)
(Southern California fires are shown in bold)

	Fire Name	Date	County	Acres	Structures	Deaths
1	Tunnel	October 1991	Alameda	1,600	2,900	25
2	**Cedar**	**October 2003**	**San Diego**	**273,246**	**2,820**	**14**
3	**Old**	**October 2003**	**San Bernardino**	**91,281**	**1,003**	**6**
4	Jones	October 1999	Shasta	26,200	954	1
5	Paint	June 1990	Santa Barbara	4,900	641	1
6	Fountain	August 1992	Shasta	63,960	636	0
7	City of Berkeley	September 1923	Alameda	130	584	0
8	**Bel Air**	**November 1961**	**Los Angeles**	**6,090**	**484**	**0**
9	**Laguna Fire**	**October 1993**	**Orange**	**14,437**	**441**	**0**
10	**Paradise**	**October 2003**	**San Diego**	**56,700**	**415**	**2**
11	**Laguna**	**September 1970**	**San Diego**	**175,425**	**382**	**5**
12	**Panorama**	**November 1980**	**San Bernardino**	**23,600**	**325**	**4**
13	**Topanga**	**November 1993**	**Los Angeles**	**18,000**	**323**	**3**
14	49er	September 1988	Nevada	33,700	312	0
15	**Simi**	**October 2003**	**Ventura**	**108,204**	**300**	**0**
16	**Sycamore**	**July 1977**	**Santa Barbara**	**805**	**234**	**0**
17	Canyon	September 1999	Shasta	2,580	230	0
18	**Kannan**	**October 1978**	**Los Angeles**	**25,385**	**224**	**0**
19	**Kinneloa**	**October 1993**	**Los Angeles**	**5,485**	**196**	**1**
19	**Grand Prix**	**October 2003**	**San Bernardino**	**59,448**	**196**	**0**

20	Old Gulch	August 1992	Calaveras	17,386	170	0

http://www.fire.ca.gov/FireEmergencyResponse/HistoricalStatistics/PDF/20LSTRUCTURES.pdf

"Structures" is meant to include all loss - homes and outbuildings, etc.

During the 2002 fire season, more than 6.9 million acres of public and private lands burned in the US, resulting in loss of property, damage to resources and disruption of community services.[xlix] Taxpayers spent more than $1.6 billion[l] to combat more than 88,400 fires nationwide. Many of these fires burned in wildland/urban interface areas and exceeded the fire suppression capabilities of those areas. Table 8-3 illustrates fire suppression costs for state, private and federal lands.

Wildfire Characteristics

There are three categories of interface fire:[li] 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; and 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: 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. The higher elevations of mountains also have heavily forested terrain. The lower elevations covered with chaparral create one type of exposure.

> ""Past fire suppression is not to blame for causing large shrubland wildfires, nor has it proven effective in halting them."" said Dr. Jon Keeley, a USGS fire researcher who studies both southern California shrublands and Sierra Nevada forests. ""Under Santa Ana conditions, fires carry through all chaparral regardless of age class. Therefore, prescribed burning programs over large areas to remove old stands and maintain young growth as bands of firebreaks resistant to ignition are futile at stopping these wildfires.""[lii]

The higher elevations of Southern California's mountains are typically heavily forested. The magnitude of the 2003 fires is the result of three primary factors: (1) severe drought, accompanied by a series of storms that produce thousands of lightning strikes and windy conditions; (2) an infestation of bark beetles that has killed thousands of mature trees; and (3) the effects of wildfire suppression over the past century that has led to buildup of brush and small diameter trees in the forests.

> "When Lewis and Clark explored the Northwest, the forests were relatively open, with 20 to 25 mature trees per acre. Periodically, lightning would start fires that would clear out underbrush and small trees, renewing the forests. Today's forests are completely different, with as many as 400 trees crowded onto each acre, along with thick undergrowth. This density of growth makes forests susceptible to disease, drought and severe wildfires. Instead of restoring forests, these wildfires destroy them and it can take decades to recover. This radical change in our forests is the result of nearly a century of well-intentioned but misguided management."[liii]

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 are not aware of 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."[liv]

> "The vegetation of chaparral communities has evolved to a point it requires fire to spawn regeneration. Many species invite fire through the production of plant materials with large surface-to-volume ratios, volatile oils and 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."[lv]

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.

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.[lvi] 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 so-called "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.

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 fire fighting 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

Wildfire 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.

Table 2.? illustrates a rating system to identify wildfire hazard risk (with a score of 3 equaling the most danger and a score of 1 equaling the least danger.)

Table 2.8 Sample Hazard Identification Rating System

Category	Indicator	Rating
Roads and Signage	Steep; narrow; poorly signed	3
	One or two of the above	2
	Meets all requirements	1
Water Supply	None, except domestic	3
	Hydrant, tank, or pool over 500 feet away	2
	Hydrant, tank, or pool within 500 feet	1
Location of the Structure	Top of steep slope with brush/grass below	3
	Mid-slope with clearance	2

	Level with lawn, or watered groundcover	1
Exterior Construction	Combustible roofing, open eaves, Combustible siding	3
	One or two of the above	2
	Non-combustible roof, boxed eaves, non-combustible siding	1

In order to determine the "base hazard factor" of specific wildfire hazard sites and interface regions, several factors must be taken into account. Categories used to assess the base hazard factor include:

Topographic location, characteristics and fuels;
Site/building construction and design;
Site/region fuel profile (landscaping);
Defensible space;
Accessibility;
Fire protection response; and
Water availability.

The use of Geographic Information System (GIS) technology in recent years has been a great asset to fire hazard assessment, allowing further integration of fuels, weather and topography data for such ends as fire behavior prediction, watershed evaluation, mitigation strategies and hazard mapping.

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. Santa Monica does not have an urban interface with the surrounding mountains, lessing the risk of wildfire.

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 turnarounds 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

Fire fighters 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 fire fighting 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 are 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 somwhat 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;
Citizen Emergency Response Team (CERT) training;
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 recent Hokkaido Nansei-oki Earthquake all demonstrate the current, real 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."[lvii]

This in Southern California, this scenario highlights the need for fire mitigation activity in all sectors of the region, urban/wildland interface or not.

Federal Programs
The role of the federal land managing agencies in the wildland /urban interface is reducing fuel hazards on the lands they administer; cooperating in prevention and education programs; providing technical and financial assistance; and developing agreements, partnerships and relationships with property owners, local protection agencies, states and other stakeholders in wildland/urban interface areas. These relationships focus on activities before a fire occurs, which render structures and communities safer and better able to survive a fire occurrence.

Federal Emergency Management Agency (FEMA) Programs FEMA is directly responsible for providing fire suppression assistance grants and, in certain cases, major disaster assistance and hazard mitigation grants in response to fires. The role of FEMA in the wildland /urban interface is to encourage comprehensive disaster preparedness plans and programs, increase the capability of state and local governments and provide for a greater understanding of FEMA programs at the federal, state and local levels.[lviii]

Fire Suppression Assistance Grants
Fire Suppression Assistance Grants may be provided to a state with an approved hazard mitigation plan for the suppression of a forest or grassland fire that

threatens to become a major disaster on public or private lands. These grants are provided to protect life and improved property and encourage the development and implementation of viable multi-hazard mitigation measures and provide training to clarify FEMA's programs. The grant may include funds for equipment, supplies and personnel. A Fire Suppression Assistance Grant is the form of assistance most often provided by FEMA to a state for a fire. The grants are cost-shared with states. FEMA's US Fire Administration (USFA) provides public education materials addressing wildland/urban interface issues and the USFA's National Fire Academy provides training programs.

National Wildland/Urban Interface Fire Protection Program
Federal agencies can use the National Wildland/Urban Interface Fire Protection Program to focus on wildland/urban interface fire protection issues and actions. The Western Governors' Association (WGA) can act as a catalyst to involve state agencies, as well as local and private stakeholders, with the objective of developing an implementation plan to achieve a uniform, integrated national approach to hazard and risk assessment and fire prevention and protection in the wildland/urban interface. The program helps states develop viable and comprehensive wildland fire mitigation plans and performance-based partnerships.

U.S. Forest Service
The U. S. Forest Service (USFS) is involved in a fuel-loading program implemented to assess fuels and reduce hazardous buildup on forest lands. The USFS is a cooperating agency and, while it has little to no jurisdiction in the lower valleys, it has an interest in preventing fires in the interface, as fires often burn up the hills and into the higher elevation US forest lands.

Other Mitigation Programs and Activities
Some areas of the country are facing wildland/urban issues collaboratively. These are model programs that include local solutions. Summit County, Colorado, has developed a hazard and risk assessment process that mitigates hazards through zoning requirements. In California, the Los Angeles County Fire Department has retrofitted more than 100 fire engines with fire retardant foam capability and Orange County is evaluating a pilot insurance grading and rating schedule specific to the wildland/urban interface. All are examples successful programs that demonstrate the value of pre-suppression and prevention efforts when combined with property owner support to mitigate hazards within the wildland/urban interface.

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. The interactive home page allows users to ask fire protection experts questions and to register for new information as it becomes available.

FireFree Program

FireFree is a unique private/public program for interface wildfire mitigation involving partnerships between an insurance company and local government agencies. It is an example of an effective non-regulatory approach to hazard mitigation. Originating in Bend, Oregon, the program was developed in response to the city's "Skeleton Fire" of 1996, which burned over 17,000 acres and damaged or destroyed 30 homes and structures. Bend sought to create a new kind of public education initiative that emphasized local involvement. SAFECO Insurance Corporation was a willing collaborator in this effort. Bend's pilot program included:

1. A short video production featuring local citizens as actors, made available at local video stores, libraries and fire stations;
2. Two city-wide yard debris removal events;
3. A 3D-minute program on a model FireFree home, aired on a local cable television station; and
4. Distribution of brochures, featuring a property owner evaluation checklist and a listing of fire-resistant indigenous plants.

WILDFIRE RESOURCE DIRECTORY

Local Resources

Santa Monica Fire Department
333 Olympic Drive, 2nd Floor
Santa Monica, CA 90401
Telephone: 310.458-8651
http://santamonicafire.org/index.htm

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

Wildfire Endnotes

http://www.fire.ca.gov/php/2003fireseasonstats_v2.asp

[2] http://www.fire.ca.gov/php/fire_er_content/downloads/2003LargeFires.pdf

[3] http://www.usgs.gov/public/press/public_affairs/press_releases/pr1805m.html

[4] http://www.nifc.gov/stats/wildlandfirestats.html

[5] http://research.yale.edu/gisf/assets/pdf/ppf/wildfire_report.pdf

[6] Planning for Natural Hazards: The Oregon Technical Resource Guide, (July 2000) Department of Land Conservation and Development

[7] http://www.usgs.gov/public/press/public_affairs/press_releases/pr1805m.html

[8] Overgrown Forests Require Preventive Measures, By Gale A. Norton (Secretary of the Interior), USA Today Editorial, August 21, 2002

[9] http://www.coastal.ca.gov/fire/ucsbfire.html

[10] Ibid

[11] Planning for Natural Hazards: The Oregon Technical Resource Guide, (July 2000), Department of Land Conservation and Development

[12] http://www.eqe.com/publications/revf93/firefoll.htm

[12] Source: National Interagency Fire Center, Boise ID and California Division of Forestry, Riverside Fire Lab.

Table of Contents

Why are Severe Windstorms a Threat to the City of Santa Monica?

Severe wind storms 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 utility services.

Map 2.7 Wind patterns in Southern California (NASA's "Observatorium")

WINDSTORM CHARACTERISTICS IN SOUTHERN CALIFORNIA

Santa Ana Winds and Tornado-Like Wind Activity
Based on local history, most incidents of high wind in the City of Santa Monica are the result of the Santa Ana wind conditions. While high impact wind 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."[lix] 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 create 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 downslope from the high plateau. The air warms as it descends toward the California coast at the rate of 5 degrees F 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."[lx]

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 Los Angeles, where they pick up speed.

What are Tornados?

Tornadoes 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.

In order to measure the intensity and wind strength of a tornado, Dr. T. Theodore Fujita developed the Fujita Tornado Damage Scale. This scale compares the estimated wind velocity with the corresponding amount of suspected damage. The scale measures six classifications of tornadoes with increasing magnitude from an "F0" tornado to a "F6+" tornado.

Table 2.9 Fujita Tornado Damage Scale

Scale	Wind Estimate (mph)	Typical Damage
F0	< 73	**Light damage.** Some damage to chimneys and TV antennas; breaks twigs off trees; pushes over shallow-rooted trees.
F1	73-112	**Moderate damage.** Peels surface off roofs; windows broken; light trailer houses pushed or overturned; some trees uprooted or snapped; moving automobiles pushed off the road. 74 mph is the beginning of hurricane wind speed.
F2	113-157	**Considerable damage.** Roofs torn off frame houses leaving strong upright walls; weak buildings in rural areas demolished; trailer houses destroyed; large trees snapped or uprooted; railroad boxcars pushed over; light object missiles generated; cars blown off highway.
F3	158-206	**Severe damage.** Roofs and some walls torn off frame houses; some rural buildings completely demolished; trains overturned; steel-framed hangar-warehouse-type structures torn; cars lifted off the ground; most trees in a forest uprooted snapped, or leveled.
F4	207-260	**Devastating damage.** Whole frame houses leveled, leaving piles of debris; steel structures badly damaged; trees

		debarked by small flying debris; cars and trains thrown some distances or rolled considerable distances; large missiles generated.
F5	261-318	**Incredible damage.** Whole frame houses tossed off foundations; steel-reinforced concrete structures badly damaged; automobile-sized missiles generated; trees debarked; incredible phenomena can occur.
F6-F12	319 to sonic	**Inconceivable damage.** Should a tornado with the maximum wind speed in excess of F5 occur, the extent and types of damage may not be conceived. A number of missiles such as iceboxes, water heaters, storage tanks, automobiles, etc. will create serious secondary damage on structures.

Source: http://weather.latimes.com/tornadoFAQ.asp

Microbursts

Unlike tornados, 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.[lxi]

A downburst is a straight-direction surface wind in excess of 39 mph caused by a small-scale, strong downdraft from the base of convective thundershowers and thunderstorms. In later investigations into the phenomena he defined two sub-categories of downbursts: the larger macrobursts and small microbursts.[lxii]

Macrobursts are downbursts with winds up to 117 mph 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 270 km/hr (170 mph) and often last for less than five minutes.[lxiii]

> “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 sink bottom.
>
> 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."[lxiv]

Tornados, like those that occur every year in the Midwest and Southeast parts of the United States, are a rare phenomenon in most of California, with most tornado-like activity coming from micro-bursts.

LOCAL HISTORY OF WINDSTORM EVENTS

Tornados

The south coastal region of California, including the Los Angeles Basin, has the greatest incidence of tornadoes in the state. In the period from 1950 to 1992, the basin had 99 confirmed tornadoes. According to Blier and Battan (1994), this area has a tornadic incidence similar to that of the State of Oklahoma. However, these researchers go on to point out that the size, severity and duration of California tornadoes is less than those common to the plains states, and the tornado count in the Golden State may be inflated due to inaccuracies within the database. Nevertheless, the fact that tornadoes occur with great frequency in a very densely populated urban area makes the occurrence of tornadoes in the Los Angeles Basin particularly relevant.

Unlike their Plains counterparts, southern California tornadoes occur mainly in the winter. Of the 99 tornadoes that were reported in the Los Angeles Basin between 1950 and 1992, the vast majority (83) occurred in the months November through March. March had the highest number of incidents (22). The fact that few tornadoes occur in the Los Angeles Basin during the warm season is primarily due to the stabilizing effect of the marine layer, and the lack of dynamic forcing during the warmer months.

Roughly a quarter of the tornadoes listed by Blier and Battan originated as waterspouts over either Santa Monica Bay or San Pedro Channel. There were many more waterspouts that never made landfall; these were not included in the tornado count.

The cause of many, if not most, of the Los Angeles Basin tornadoes seems to be linked to the terrain layout of the basin. Hales specifically mentioned the natural curvature of the shoreline and the location of the coastal mountains. Due to frictional and barrier flow effects, a convergent cyclonic wind pattern is established in the vicinity where most L.A. tornadoes occur. Blier and Battan discussed several features that require further investigation, including convergence to the lee of the Palos Verdes Peninsula and Santa Catalina Island.

In the 1997-98 *El Nino* episode, the Pacific storm track was located over southern California for much of the winter season. This produced a number of days in which Hale's criteria were approximated over the Los Angeles Basin and adjacent waters. In that season, there were over twenty days in which either waterspouts, funnel clouds or tornadoes were reported—including 30 separate sightings. Two tornadoes touched down within the City of Long Beach.

Thunderstorms

A mass of warm, moist subtropical air occasionally overlies the Los Angeles Basin during the mid to late summer. The subtropical airmass originates in Mexico, then moves northwest into Arizona usually around the first week in July. The humid, sultry air, with its characteristic high dewpoints, frequently pulses into southern California deserts and occasionally extends into the coastal plain. During these periods, thunderstorms form mostly over the mountains of southern California in the afternoons, then occasionally meander over the coastal lowlands during evening and nighttime hours.

The mean number of days per year on which thunderstorms occur (i.e. days on which thunder is heard, regardless of precipitation) is 4.1 in the downtown Los Angeles area.

Because they are an infrequent visitor to the heavily populated southern California coast, thunderstorms are very notable when they do occur. Even when they produce only light precipitation, they can be a source of serious inconvenience by wetting an area that had been dry for weeks, or even months. Also, they may cause shifting surface winds with local gusts to 50 miles per hour or more. This combination, more or less innocuous in other parts of the United States, is actually dangerous in Los Angeles. The inevitable result of even small summer thunderstorms is a rash of highway accidents, freeway traffic jams and local power outages.

During one afternoon in the spring of 1999 when scattered thunderstorms occurred across the Los Angeles Basin, a cluster of traffic accidents was reported, including one 70-car pileup on Interstate 10.

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 that can last for several days as in the case of the January 2003 Santa Ana wind event. Windstorms in the City of Santa Monica area can cause extensive damage including heavy tree stands, exposed coastal properties, road and highway infrastructure, and critical utility facilities. Heavy tourist traffic on the State and Local beach property is at great risk during windstorm activity.

The map shows clearly the direction of the Santa Ana winds as they travel from the stable, high-pressure weather system called the Great Basin High through the canyons and towards the low-pressure system off the Pacific. Clearly the area of the City of Santa Monica is in the direct path of the ocean-bound Santa Ana winds.

We can deduce the common windstorm impact areas including impacts 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.

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 which can be adversely impacted during a windstorm event. This can result in the involvement of City of Santa Monica 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 below, coined and developed by Sir Francis Beaufort in 1805, illustrates the effect that varying wind speed can have on sea swells and structures:

Table 2.10 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 in Southern California.

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.

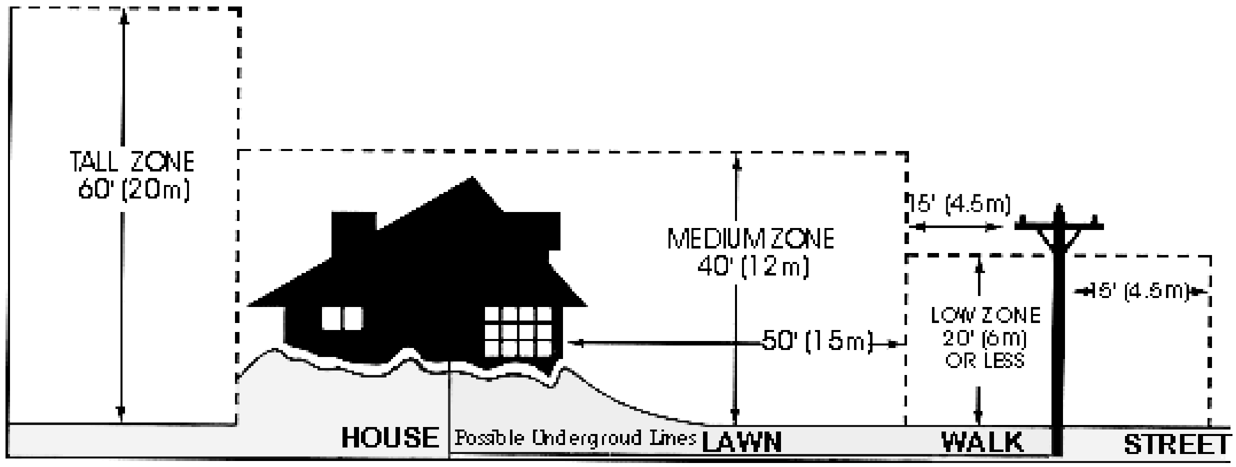
Increased Fire Threat
Perhaps the greatest danger from windstorm activity in Southern California comes from the combination of the Santa Ana winds with the major fires that occur every few years in the urban/wildland interface. With the Santa Ana winds driving the flames, the speed and reach of the flames 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:[lxv]

4293: Power Line Clearance Required
4292: Power Line Hazard Reduction
4291: Reduction of Fire Hazards Around Buildings
4171: Public Nuisances

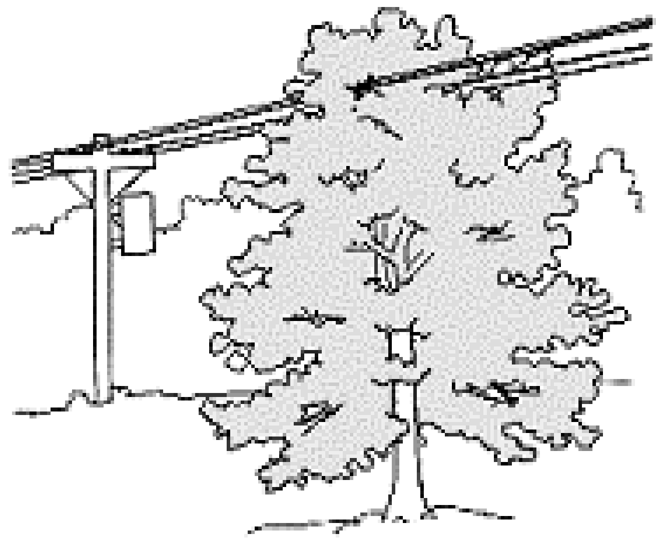
The following pertain to tree pruning regulations and are taken from the California Code of Regulations:

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 failure. From the collection of this data, the power company can advise residents as to the most appropriate vegetative planting and pruning procedures. The following chart depicts some of the tree failure data collected by Southern California Edison in this comprehensive mitigation strategy:

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

End Notes

1. http://nimbo.wrh.noaa.gov/Sandiego/snawind.html
2. Ibid
3. Keith C. Heidorn at http://www.suite101.com/article.cfm/13646/100918, June 1, 2003
4. Ibid
5. Ibid
6. Ibid

www.cpuc.ca.gov/js.asp

1