City of Sierra Madre

Natural Hazard Mitigation Plan

232 W. Sierra Madre Blvd.
Sierra Madre, CA 91024

Developed under the guidance of the

Sierra Madre Disaster Mitigation Committee

JULY 2008

ADOPTED BY CITY COUNCIL RESOULTION AUGUST 19, 2008

Special Recognition and Profound Appreciation:

The City of Sierra Madre and Disaster Management Area Coordinators of Los Angeles County owe no small debt of gratitude to Clackamas County Oregon and its Natural Hazards Mitigation Committee.

Vicki Harguth, the County's Emergency Management Coordinator and Cindy Kolomechuck, their Hazard Mitigation Specialist graciously shared their plan with us and allowed us to use it as a basis for our working plan.

While there are sometimes interesting differences between the climate and topography of Clackamas County, Oregon and the greater Los Angeles basin, the plan was so well organized and it was easily adapted to suit the needs of the City of Sierra Madre.

The generosity of Clackamas County and its emergency management personnel is typical of the spirit of cooperation that pervades the emergency management profession.

We also availed ourselves of data, reports and plans from a variety of cities, counties and states from across the country as part of the research in preparing this plan. Thank you to all those agencies that were so generous to their colleagues in the emergency management profession. The work of many of these agencies is cited in Section 1.

Special Thanks & Acknowledgments

Sierra Madre Disaster Mitigation Committee
Sierra Madre Public Works Department
Sierra Madre Development Services Department
Sierra Madre Police Department
Sierra Madre Volunteer Fire Department
Disaster Management Coordinators, Mike Martinet, Brenda Hunemiller and Fan Abel
California Division of Mines and Geology
Federal Emergency Management Agency, Region IX
Governor's Office of Emergency Services
Dimensions Unlimited and several Area D cities

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PART I: MITIGATION ACTION PLAN

Executive Summary

The City of Sierra Madre Natural Hazards Mitigation 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 action items that may assist the City of Sierra Madre in reducing risk and preventing loss from future natural hazard events. The action items address multi-hazard issues, as well as activities for earthquakes, wildfires, landslides, flooding, and wind storms.

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 Sierra Madre, sections on five natural hazards that occur within the City, and a number of appendices. All of the sections are described in detail in Section 1, the plan introduction.

Who Participated in Developing the Plan?

The City of Sierra Madre Natural Hazards Mitigation Plan is the result of a collaborative effort between City of Sierra Madre 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. Questionnaires were sent out to stakeholders across the City, and one public hearing was held to include Sierra Madre residents in plan development. A Disaster Mitigation Committee guided the process of developing the plan.

The Disaster Mitigation Committee was comprised of representatives from:

City of Sierra Madre Public Works Department
City of Sierra Madre Development Services Department
City of Sierra Madre Emergency Services Coordinator
City of Sierra Madre Police Department
City of Sierra Madre Volunteer Fire Department
City of Sierra Madre resident

What is the Plan Mission?

The mission of the City of Sierra Madre 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 Sierra Madre 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.

1. ***Protect Life and Property***

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

2. ***Public Awareness***

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

3. ***Natural Systems***

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

4. ***Partnerships and Implementation***

    - Strengthen communication and coordinate participation among and within public agencies, citizens, non-profit organizations, business, and industry to gain a vested interest in implementation.
    - Encourage leadership within public and private sector organizations to prioritize and implement local and regional hazard mitigation activities.

5. ***Emergency Services***

    - Establish policy to ensure mitigation projects for critical facilities, services, and infrastructure.
    - Strengthen emergency operations by increasing collaboration and

coordination among public agencies, non-profit organizations, business, and industry.

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

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 each hazard section, 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.

Time line. 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. The matrix includes the page number within the mitigation plan where this information can be found.

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. Protect Life and Property
2. Public Awareness

3. Natural Systems
4. Partnerships and Implementation
5. Emergency Services

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 Sierra Madre Natural Hazards Mitigation Plan are potential partners recommended by the Disaster Mitigation 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 Sierra Madre 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 Sierra Madre intends to incorporate the mitigation strategies outlined in this Plan into existing planning mechanisms such as the City's General Plan, Capital Improvement Plans, and Building & Safety Codes.

Plan Adoption

Once the plan is completed, the Sierra Madre City Council will be responsible for adopting the "City of Sierra Madre Natural Hazards Mitigation 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.

Coordinating Body

A City of Sierra Madre Disaster Mitigation Committee will be responsible for coordinating implementation of Plan action items and undertaking the formal review

process. The City Manager will assign representatives from City departments, including, but not limited to, the current Disaster Mitigation Committee members.

Convener

The City Council will adopt the City of Sierra Madre Natural Hazard Mitigation Plan, and the Disaster Mitigation Committee will take responsibility for plan implementation. The emergency services coordinator will serve as a convener to facilitate the Disaster Mitigation 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 Disaster Mitigation Committee Members.

Implementation through Existing Programs

City of Sierra Madre 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. City of Sierra Madre 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 Sierra Madre 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 departments and organizations participating in plan evaluation. The convener will be responsible for contacting the Disaster Mitigation 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

City of Sierra Madre 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 the library. The existence and location of these copies will be publicized in City newsletters. The plan also includes the address and the phone number of the Emergency Services Coordinator, responsible for keeping track of public comments on the Plan. In addition, copies of the Plan and any proposed changes will be posted on the City website. This site will also contain an email address and phone number to which people can direct their comments and concerns.

SECTION 1: INTRODUCTION

Throughout history, the residents of City of Sierra Madre have dealt with the various natural hazards affecting the area. Photos, journal entries, and newspapers from the 1800's show that the residents of the area dealt with earthquakes, wildfires, landslides, flooding and wind storms.

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

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

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

City of Sierra Madre most recently experienced large-scale destruction during the Sierra Madre Earthquake. The damage to City of Sierra Madre businesses, residences, and infrastructure was estimated at about $12.5 million, which is approximately 300% of the City's $4 million annual operating budget. The City of Sierra Madre Volunteer Fire Department estimated that the earthquake event directly or indirectly affected 80% of the City's 10,650 residents.

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.

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 Sierra Madre;

(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 Sierra Madre Natural Hazards Mitigation Plan affects entire city. Map 3 (Appendix E) shows major roads in the City of Sierra Madre. This plan provides a framework for planning for natural hazards. The resources and background information in the plan is applicable City-wide, and the goals and recommendations can lay groundwork for local mitigation plans and partnerships.

Natural Hazard Land Use Policy in California

Planning for natural hazards should be an integral element of any city's land use planning program. All California cities and counties have General Plans and 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 and Fire (CalFire) is responsible for all aspects of wildland fire protection on state lands and contracted counties, and administers forest practices regulations, including landslide mitigation, on non-federal lands.

- The California Division of Mines and Geology (DMG) is responsible for geologic hazard characterization, public education, the development of partnerships aimed at reducing risk, and exceptions (based on science-based refinement of tsunami inundation zone delineation) to state mandated tsunami zone restrictions; 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 Sierra Madre conducted data research and analysis, facilitated committee meetings and public questionnaires, and developed the final mitigation plan. The research methods and various contributions to the plan include:

Input from the Disaster Mitigation Committee:

The Disaster Mitigation Committee convened about every 2 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 the City of Sierra Madre, including:

City of Sierra Madre Public Works Department
City of Sierra Madre Development Services Department
City of Sierra Madre Emergency Services Coordinator
City of Sierra Madre Police Department
City of Sierra Madre Volunteer Fire Department
City of Sierra Madre resident

Stakeholder Interviews:

Committee members conducted 15 interviews with individuals and specialists from organizations interested in natural hazards planning. The interviews identified common concerns related to natural hazards and identified key long and short-term activities to reduce risk from natural hazards. A complete listing of all stakeholders is located in Appendix B. Stakeholders interviewed for the plan included representatives from:

San Gabriel Valley Municipal Water District
San Gabriel Valley Mosquito Vector Control District
Los Angeles Unified School District
Arcadia Fire Department
Monrovia Fire Department
Los Angeles County Public Works
Los Angeles County Office of Emergency Management
Sierra Madre residents
Southern California Edison
Southern California Gas Company

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.

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

City of Sierra Madre 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) Associations 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
Local Hazard Mitigation Plan, El Monte Unified School District

Hazard specific research: City of Sierra Madre staff collected data and compiled research on five hazards: earthquakes, earth movements, flooding, wildfires and wind storms. Research materials came from state agencies including OES, and CDF. The City of Sierra Madre staff conducted research by referencing historical local newspapers, interviewing long time residents, long time City of Sierra Madre employees and locating City of Sierra Madre information in historical documents.
The City of Sierra Madre staff identified current mitigation activities, resources and programs, and potential action items from research materials and stakeholder interviews.

Public Participation

The City of Sierra Madre staff facilitated one public hearing and sent out questionnaires to all of the City's residents to gather comments and ideas from its citizens about mitigation planning and priorities for mitigation plan goals. The public hearing, held October 25, 2004, attracted 5 citizens, and the questionnaire garnered 16 returns.

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

Review of Existing Plans & Documents

The Sierra Madre Disaster Mitigation Committee reviewed several other City plans and documents during its meetings. These plans include the City General Plan, Municipal Codebook, Water Infrastructure Vulnerability Assessment Plan, 5-year Capital Improvement Plan (CIP), Parks Master Plan, Southern California Edison (SCE) Hazard Mitigation Plan, Water Department Disaster Management Plan, and the City's Standardized Emergency Management System Plan (SEMS).

Each of these plans was scrutinized to determine if they had relevant information to be incorporated into the Natural Hazard Plan. With the exception of the General Plan, Municipal Codebook, SCE Plan and the City's SEMS plan, all plans were deemed as supplementary information that didn't lend to this document.

Upon review, the City's General Plan provided some relevant information. Specifically, the committee was able to review sections 1, 2 and 3. Each of these sections outlined the existing conditions, goals, objectives and policies of each of their respective areas- fire safety, flooding/landslides, and seismic safety. Information from each of these areas was extracted and incorporated into the mitigation section of several of the hazards this plan addresses.

There are several sections within this plan which document to some extent the municipal codes the City has in place to mitigate hazards. These codes can be found in each of the five disaster areas.

The SCE Plan, while it was not physically incorporated into this plan, is kept in the same binder as our plan and is therefore, a valuable reference tool. Within this plan SCE outlines their goals and objectives as they relate to disaster response and mitigation. The plan provides contact information and specific mitigation activities SCE has done or will do to mitigate potential hazards.

The City SEMS plan is not necessarily a mitigation plan as much as it is a real-time response tool for our Emergency Operations Center (EOC). The SEMS plan isn't referenced necessarily in this plan; however there are sections within the plan that parallel those of this plan, and the Committee therefore thought it was worthwhile mentioning.

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 Sierra Madre.

The mitigation plan is organized in three parts. Part I (Mitigation Action Plan) contains an executive summary, introduction, community profile, risk assessment, multi-hazard action items, and plan maintenance. Part II (Specific Natural Hazards) contains the five natural hazard sections, and Part III includes the appendices. Each section of the plan is described below.

Part I: 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 hazard-specific activities that can be implemented to reduce risk and prevent loss from future natural hazard events.

Section 1: Introduction

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

Section 2: Community Profile

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

Section 3: Risk Assessment

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

Section 4: Multi-Hazard Goals and Action Items

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

Section 5: Plan Maintenance

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

Part II: 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:

Section 6: Earthquake
Section 7: Wildfire
Section 8: Earth Movement (Landslide / Debris Flow)
Section 9: Flooding
Section 10: Windstorm

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, earth movement, flooding and wildfire 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.

Part III: Appendices

The plan appendices are designed to provide users of the City of Sierra Madre 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 Sierra Madre 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: 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 Sierra

Madre Natural Hazards Mitigation Plan.

Appendix D: Glossary

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

Appendix E: List of Maps

This section provides all of the maps referenced throughout the plan.

Appendix F: FEMA National Flood Insurance Program (NFIP)/Hazard Area Letters

This section contains two FEMA letters, which determine, among other things, Sierra Madre to be in FEMA Flood Zone D. This determination indicates that Sierra Madre doesn't need to procure flood insurance.

Appendix G: Economic Analysis Guidelines for Natural Hazard Mitigation Projects

This section discusses the methodology to determine cost vs. benefits of projects.

Appendix H: FEMA Crosswalk

This is the document used by FEMA to ensure that the plan addresses all of the Disaster Mitigation Act of 2000 requirements.

SECTION 2: COMMUNITY PROFILE

Why Plan for Natural Hazards in City of Sierra Madre?

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

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

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

Geography and the Environment

City of Sierra Madre has an area of 3.1 square miles and is located at the base of the San Gabriel Valley Foothills within Los Angeles County.

Elevations in the City range from a high of 1500 feet to a low of 600 feet. The terrain of the city is primarily flat with a consistent downgrade slope of 7.5%.

Community Profile

The City of Sierra Madre is rich in history. The area comprising the City of Sierra Madre was first settled in 1881 and the city itself was incorporated in 1907.

The City is served by the 210 freeway, and the major arterial to the highways are Baldwin Ave, which runs north to south and Sierra Madre Blvd., which runs east to west.

Public transportation is provided by the Metropolitan Transportation Authority (MTA) and the City's transit buses.

Major Rivers

The nearest major river is the San Gabriel River. This River does not have any potential impact on the. Normally this river channel is dry and only carries a significant water flow during a major rain storm. The City is designed to handle a 100-year flood.

Climate

Temperatures in the City of Sierra Madre range from 40 degrees in the winter months to 100+ degrees in the summer months. However the temperatures can vary over a wide range, particularly when the Santa Ana winds blow, bringing higher temperatures and very low humidity. Temperatures rarely exceed 100F in the summer months (June - September), and rarely drop below 45F in the winter months (November-March).

Rain fall in the city averages 18 inches of rain per year. However the term "average rainfall" is misleading because over the recorded history of rain fall in the City of Sierra Madre rain fall amounts have ranged from no rain at all in some years to 49 inches of rain in very wet years.

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

Minerals and Soils

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

The surface material includes unconsolidated, fine-grained deposits of silt, sand, gravel, and alluvial plain deposits. Torrential flood events can introduce large deposits of sand and gravel. Sandy silt and silt containing clay are moderately dense and firm, and are primarily considered to be prone to liquefaction, an earthquake related hazard. Basaltic lava consists mainly of weathered and non-weathered, dense, fine-grained basalt. Though the characteristics of this lava may offer solid foundation support, landslides are common in many of these areas where weathered residual soil overlies the basalt. Understanding the geologic characteristics of City of Sierra Madre is an important step in hazard mitigation and avoiding at-risk development.

Other Significant Geologic Features

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

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

- San Andreas
- Newport Inglewood
- Palos Verdes
- Whittier
- Santa Monica
- Sierra Madre

The Los Angeles Basin has a history of powerful and relatively frequent earthquakes, dating back to the powerful 8.0+ San Andreas earthquake of 1857 which did substantial damage to the relatively few buildings that existed at the time. Paleoseismological research indicates that large (8.0+) earthquakes occur on the San Andreas fault at intervals between 45 and 332 years with an average interval of 140 years[i]. Other lesser faults have also caused very damaging earthquakes since 1857. Notable earthquakes include the Long Beach earthquake of 1933, the San Fernando Earthquake of 1971, the 1987 Whittier Earthquake, the 1991 Sierra Madre Earthquake and the 1994 Northridge Earthquake.

In addition, many areas in the Los Angeles Basin have sandy soils that are subject to liquefaction. The City of Sierra Madre has one liquefaction zone as shown on map 10 (Appendix E). The liquefaction area spans the entire distance of hillside between Brookside Lane and Woodland Drive. See map 3.

The City of Sierra Madre also has areas with land movement potential. These areas always contain hillside development and are typically part of the wildland urban interface. See map 10 for specific areas of land movement potential.

Population and Demographics

City of Sierra Madre has a population of about 10,650 in an area of 3.1 square miles. The population has steadily increased from the mid 1800's through 1990, and decreased 2% from 1990 to 2000 according to the 2000 Census.

The density of the people living in City of Sierra Madre creates more community exposure, and changes how agencies prepare for and respond to natural hazards. For example, more people living on the urban fringe can increase risk of fire. Wildfire has an increased chance of starting due to human activities in the urban/rural interface, and has the potential to injure more people and cause more property damage. But an Urban/wildland fire is not the only exposure to the city of Sierra Madre. In the 1987 publication, Fire Following Earthquake issued by the All Industry Research Advisory Council, Charles Scawthorn explains how a post-earthquake urban conflagration would develop. The conflagration would be started by fires resulting from earthquake damage, but made much worse by the loss of pressure in the fire mains, caused by either lack of

[i] Peacock, Simon M., http://aamc.geo.lsa.umich.edu/eduQuakes/EQpredLab/EQprediction.peacock.html

electricity to power water pumps, and /or loss of water pressure resulting from broken fire mains.

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

The most dense and consequently, at risk area of conflagration is located within the eastern and western canyon portions of the City. Within this area there is a great deal of in-fill building, which increases the population density creating greater service loads on the built infrastructure, including roads, water supply, sewer services and storm drains.

Natural hazards do not discriminate, but the impacts in terms of vulnerability and the ability to recover vary greatly among the population. According to Peggy Stahl of the Federal Emergency Management Agency (FEMA) Preparedness, Training, and Exercise Directorate, 80% of the disaster burden falls on the public, and within that number, a disproportionate burden is placed upon special needs groups: women, children, minorities, and the poor.[ii]

The number of people that live at or below the poverty level in the City is approximately 4% of the population.

According to 2000 census figures, the demographic make up of the city is as follows:

Caucasian - 85.81%
Hispanic – 9.96%
African American – 1.14%
Asian – 5.60%
Native American - .1%
Other – 3.02%

Vulnerable populations, including seniors, disabled citizens, women, and children, as well as those people living in poverty, may disproportionately be impacted by natural hazards.

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

The cost of natural hazards recovery can place an unequal financial responsibility on

[ii] www.fema.gov

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

Land and Development

Development in Southern California from the earliest days was a cycle of boom and bust. The Second World War however dramatically changed that cycle. Military personnel and defense workers came to Southern California to fill the logistical needs created by the war effort. The available housing was rapidly exhausted and existing commercial centers proved inadequate for the influx of people. Immediately after the war, construction began on the freeway system, and the face of Southern California was forever changed. Home developments and shopping centers sprung up everywhere and within a few decades the central basin of Los Angeles County was virtually built out. This pushed new development further and further away from the urban center.

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

The City of Sierra Madre is 90% residential and 10% commercial. The only area available for development is in the Hillside area on the Northern borders of the City and a recently enacted Hillside Management Zone Ordinance covers all of the potential hazards that will need to be mitigated. A recent change to the building code has limited multi-use in the commercially zoned areas.

Housing and Community Development

In the City of Sierra Madre the demand for housing outstrips the available supply, and the recent low interest rates have further fueled a pent up demand. The City is primarily a built-out bedroom community made up of approximately 63% single-family and 37% multi-family dwellings. In the last five years, Sierra Madre like many other Southern California Cities has experienced a substantial average home value increase. Demand for low to medium priced homes continues to be strong. The average value for homes in the City of Sierra Madre is estimated at $650,000. The recent economic problems with sub-prime loans ahs slowed home sales, but not impacted the price for homes.

To address development issues, the Sierra Madre Community Redevelopment Agency has engaged in activities that promote the quality of life for the citizens of City of Sierra Madre. The large-scale effort is termed the Strategic Plan, and includes neighborhood and other public facility improvements, rehabilitation of existing housing, and new housing development. The agency is also a body that helps to promote economic

prosperity throughout the City. Their mission is to promote development while maintaining quality of life and integrity of the environment.

The City participates in the Community Development Block Grant (CDBG) program. The primary resource available to address non-housing community development needs is the CDBG. City of Sierra Madre's CDBG allocation for FY 2004-05 is $7,000.

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

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

Subtle, but very measurable, changes occur constantly in communities that increase the potential loss that will occur in a major disaster. There are number of factors that contribute to this increasing loss potential. First, populations continue to increase, putting more people at risk within a defined geographic space. Second, inflation constantly increases the worth of real property and permanent improvements. Third, the amount of property owned per capita increases over time. Information from the U.S. Census Bureau shows gains in average housing standards.

Amount of Property per person	1975	1998
Increased Size of new homes	1645 sq. ft.	2190 sq. ft.
% of homes with 4 + bedrooms	21%	33%
% of homes with 2 ½ or more baths	20%	52%
Source: U.S. Department of Census		

If we look at the greatest recorded earthquakes in American history, and compare the level of population and development today with that which existed at the time of the event, the scale of potential damage is staggering.

1886 Charleston EQ M7.3 in Charleston, SC
Estimated insured damage if happened today $10 Billion
1906 San Francisco EQ M8.3 Significant fire following damage
Estimated insured damage if happened today $36 Billion
1811-12 New Madrid EQ 1811-12, series of 4 EQs over 7 weeks
Estimated insured damage if happened today $88 Billion

Source: Risk Management Solutions

Employment and Industry

Tourism, service industries, and commerce are City of Sierra Madre's principal employment and industrial activities. The City also has significant employment in finance, insurance, and real estate.

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

Transportation and Commuting Patterns

City of Sierra Madre is the 77th largest City in the Los Angeles Metropolitan Statistical Area (LAMSA). Over the past decade, the LAMSA experienced rapid growth in employment and population. There has been a substantial increase in vehicle licensing transactions and vehicle miles traveled within the City of Sierra Madre alone.

Private automobiles are the dominant means of transportation in Southern California and in the City of Sierra Madre*;* however, the City of Sierra Madre meets its public transportation needs through a mixture of a regional transit system (MTA), and various city contracted bus systems. MTA provides bus service to the City of Sierra Madre and to the Los Angeles County metropolitan area. In addition to this service, the City promotes alternative transportation activities.

Regional light rail transportation for Sierra Madre residents and businesses is accessed at the Gold Line terminus at the Sierra Madre Villa Station in Pasadena, approximately two miles southwest of the Sierra Madre city boundary. Rail transportation is subject to disruption due to power outages, downed trees, flooding, damaged roadbed or rail infrastructure, or damaged passenger terminals.

The City of Sierra Madre is indirectly served by the 210 freeway, connecting the city to adjoining parts of Los Angeles County. The freeway does not pass through Sierra Madre, but rather, is accessed by Sierra Madre residents primarily via on and off ramps at Santa Anita Avenue and Baldwin Avenue which are within the boundaries of the City of Arcadia and via off ramps at Michillinda Avenue, within the City of Pasadena.

The City's 35 mile road system is comprised primarily of local roads, with a few streets considered as urban collector, principal arterial, or minor arterial streets under the 1999 Federal/State Functional Classification System.

Principle Arterials:

- Sierra Madre Boulevard
- Baldwin Avenue

Minor Arterials:

- Michillinda Avenue
- Grandview Avenue
- Santa Anita Avenue
- Orange Grove Avenue

Collector Streets:

- Carter Avenue
- East Miramonte Avenue
- Sunnyside Avenue
- Lima Street
- Auburn Avenue
- Churchill Road
- Sturtevant Drive
- Woodland Drive
- Canyon Crest Drive
- Skyland Drive
- Highland Avenue

All public roadways within the City of Sierra Madre are paved with asphalt to form an all-weather driving surface. Most streets have concrete curb and gutter to channel stormwater runoff. Many streets serve a dual function as a surface component of the City's drainage system.

On-street transit is subject to disruption through natural hazard due to fallen trees, downed power lines, flooding, damaged pavement, or ruptured underground utilities (natural gas, water, and sewer). The City of Sierra Madre has no traffic signals, thus power outages do not affect traffic flow within the City.

SECTION 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 Sierra Madre identified five major hazards that affect this geographic area. These hazards - earthquakes, earth movements, flooding, wildfires and wind storms were identified through an extensive process that utilized input from the Disaster Mitigation Committee. The geographic extent of each of the identified hazards has been identified by the City of Sierra Madre Disaster Mitigation Committee using the best available data, and is illustrated by the charts/maps listed in Table 3-1.

2) Profiling Hazard Events

This process describes the causes and characteristics of each hazard, how it has affected City of Sierra Madre in the past, and what part of the City of Sierra Madre'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, charted / mapped, and are illustrated in Chart/map 3 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

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 Sierra Madre 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 Sierra Madre 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.

Table 3-1*:* List of Hazard Mitigation Plan Charts/maps

Map #	Type of Map	Section of the Plan
1	City of Sierra Madre Location – Los Angeles County	Appendix E: Map 1
2	City of Sierra Madre Location – Disaster Management Area D	Appendix E: Map 2
3	City of Sierra Madre Base Map with Essential Facilities - City facilities, schools and major roads	Appendix E: Map 3
4	City of Sierra Madre Land Use Map with Essential Facilities - all commercial and major retail areas	Appendix E: Map 4
5	Critical Facilities (Emergency Services) - Disaster Management Area D	Appendix E: Map 5
6	Hazardous Materials Sites - Disaster Management Area D	Appendix E: Map 6
7	Sierra Madre Infrastructure - water pump stations, water reservoirs, water lines and sewer lines	Appendix E: Map 7
8	Earthquake Fault map - Southern California	Appendix E: Map 8
9	Earthquake Fault/Hazards Map - Disaster Management Area D	Appendix E: Map 9
10	Mt. Wilson Quadrangle Seismic Hazard Zones – Sierra Madre	Appendix E: Map 10
11	Wildland Urban Interface - Sierra Madre	Appendix E: Map 11
12	Fire Hazards - Disaster Management Area D	Appendix E: Map 12
13	Historic Fire Areas - Disaster Management Area D	Appendix E: Map 13

14	FEMA Flood Plains Map - Disaster Management Area D	Appendix E: Map 14
15	FEMA Flood Plains Map - Sierra Madre	Appendix E: Map 15
16	Dam Failure Inundation Areas - Disaster Management Area D	Appendix E: Map 16
17	Dam Failure Inundation Areas - Sierra Madre	Appendix E: Map 17
18	City of Sierra Madre Potential Losses Table	Appendix E:Chart 1

Note: The information on the maps in this plan was derived from a variety of resources found in Appendix A. Care was taken in the creation of these maps, but is provided "as is". City of Sierra Madre cannot accept any responsibility for any errors, omissions or positional accuracy, and therefore, there are no warranties that accompany these products (the maps). Although information from land surveys may have been used in the creation of these products, in no way does this product represent or constitute a land survey. Users are cautioned to field verify information on this product before making any decisions.

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.

Risk Identification and Vulnerabilities Summary

Identified risks and vulnerabilities associated with natural hazards in the City of Sierra Madre are summarized below. Sections 6-10 document the analysis yielding these conclusions.

EARTHQUAKE

The following vulnerabilities and risks associated with ground shaking, liquefaction, and earthquake induced landslides have been prioritized for mitigation actions:

- Most building in the city of Sierra Madre were built before the implementation of the seismic safety standards of 1976. All facilities housing city emergency operations were built after this date.

- There are 42 unreinforced masonry buildings in the business district. These

buildings are known for their inability to withstand earthquakes of a long duration.

- Over 100 homes (built pre-1920) are been designated as historical structures have not been retrofitted, and as such, are not secured to any foundations or have shear panels installed.

- Much of the water and telephone infrastructure is aged and will need to be replaced if the shaking is of any duration. There are approximately 40 miles of water transmission lines and 30 miles of sewer lines. Water reservoirs have been upgraded in the last five years, but no the feeder lines to residents and businesses.

Landslides

The following vulnerabilities and risks associated with landslides have been prioritized for mitigation actions.

- Residential developments in the hillsides and the upper and lower Canyon areas are at risk landslides. This also includes the roads the run though and adjacent to these areas.

Wildfire

The following vulnerabilities and risks associated with wildfires have been prioritized for mitigation actions.

- As the entire northern borders of the city are adjacent to the Angeles National Forest, a significant residential population is impacted when these types of incident occur. And if they occur during an earthquake, the delivery of water could be a problem.

Windstorm

The following vulnerabilities and risks associated with windstorms have been prioritized for mitigation actions.

- Santa Ana Winds, which occur normally between October and March, can damage electrical transmission systems, damage roofs and fall trees onto roads. These would affect the entire city. All emergency city facilities have generator backup capability. There is no high risk to city assets.

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, wildfires and wind storms. The Federal criteria for risk assessment and information on how the City of Sierra Madre Natural Hazard Mitigation Plan meets those criteria are outlined in Table 3-2 below.

Table 3-2*:* 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 Sierra Madre 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/Essential 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 a jail, law enforcement center, public services building, and other public facilities such as schools. Maps 3, 4 and 5 illustrate the known critical facilities, essential facilities, and public infrastructure within the City of Sierra Madre

Summary

Natural hazard mitigation strategies can reduce the impacts concentrated at large employment and industrial centers, public infrastructure, and critical facilities. Natural hazard mitigation for industries and employers may include developing relationships with emergency management services and their employees before disaster strikes, and establishing mitigation strategies together. Collaboration among the public and private sector to create mitigation plans and actions can reduce the impacts of natural hazards.

SECTION 4: MULTI-HAZARD GOALS AND ACTION ITEMS

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

Mission

The mission of the City of Sierra Madre 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.

Goals

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

Action Items

The action items are a listing of activities in which City departments 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.

Mitigation Plan Goals and Public Participation

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

Protect Life and Property

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

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

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

Public Awareness

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

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

Natural Systems

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

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

Partnerships and Implementation

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

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

Emergency Services

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

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

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

Public Participation

- Public input during development of the mitigation plan assisted in creating plan goals. Meetings with the Disaster Mitigation Committee, stakeholder interviews, and a public hearing served as methods to obtain input and identify priorities in developing goals for reducing risk and preventing loss from natural hazards in the City of Sierra Madre.

To achieve comprehensive stakeholder interviews, the Sierra Madre Disaster Mitigation Committee sent out Community Hazards Questionnaires to all residential, commercial, and industrial properties in Sierra Madre. The solicitations were sent out in June and July of 2004, and were designed to gather ideas from City of Sierra Madre residents regarding the goals for the City of Sierra Madre Natural Hazards Mitigation Plan. In addition to mailers the committee members advertised the questionnaire using the City's closed-circuit cable channel and website. The committee received approximately sixteen completed questionnaires. The returned questionnaires included representatives from public agencies, private organizations, Community Planning Organizations, and private residents. The representatives identified goals for the plan by examining the issues and concerns that they have had regarding natural hazards, and further discussed potential action items for the Plan.

Prior to adoption of the plan the Committee plans to hold a public hearing. This hearing was held October 25, 2004 to review mitigation plan action items and provide the participants with a chance to comment on the final plan recommendations.

Natural Hazard Mitigation Plan Action Items

The mitigation plan identifies short and long-term action items developed through data collection and research, and the public participation process. Mitigation plan activities may be considered for funding through Federal and State grant programs, and when other funds are made available through the city. Action items address multi-hazard (MH) and hazard specific issues. To help ensure activity implementation, each action item includes information on the time line and coordinating organizations. To address deficiencies, each action item is also prioritized. Prioritization of all action items within this plan were based on 1) staff 2) resources 3) feasibility 4) threat analysis 5) existing deficiencies. Upon implementation, the coordinating organizations may look to partner organizations for resources and technical assistance.

Coordinating Organization

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

Time line

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 that city agencies may' implement with existing resources and authorities within one to two years. Long-term action items may require new or additional resources or authorities, and may take between one and five years (or more) to implement.

Ideas for Implementation

Each action item includes ideas for 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.

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.

Project Evaluation Worksheets

The Disaster Mitigation Committee has reviewed two documents that will help the committee determine the most cost effective mitigation solutions for the community. The first document is the City's operating and capital expenditures budget. The second document is the City's Five-Year Capital Improvement Plan. The process of prioritizing was based on need and available funding. After review the Disaster Mitigation Committee supported the Capital Improvement Plan that also addresses mitigation needs.

Multi-Hazard Action Items

Multi-hazard action items are those activities that pertain to two or more of the five hazards in the mitigation plan: floods, landslides, wildfires, windstorms and earthquakes. There are six short-term and two long-term multi-hazard action items described below.

SHORT TERM ACTIVITY - MULTI HAZARD #I: Integrate the goals and action items from the City of Sierra Madre Natural Hazard Mitigation Plan into existing regulatory documents and programs, where appropriate.

Ideas for Implementation:

- Use the mitigation plan to help the city's General Plan institutionalize guidelines for sustainable development in all new construction and development projects according to the hazards that impact the City of Sierra Madre

- Integrate the city's mitigation plan into current capital improvement plans to ensure that development does not encroach on known hazard areas: and

- Partner with other organizations and agencies with similar goals to promote Building & Safety Codes that are more disaster resistant at the state level.

Coordinating Organization:	Sierra Madre Disaster Mitigation Committee
Time line:	Ongoing
Plan Goals Addressed:	Partnerships and Implementation
Constraints:	Limited to time available from City staff

SHORT TERM ACTIVITY - MULTI HAZARD #2: Identify and pursue funding opportunities to develop and implement local and city mitigation activities.

Ideas for Implementation:

- Develop incentives for citizens, and businesses to pursue hazard mitigation projects:

- Allocate city resources and assistance to mitigation projects when possible: and

- Partner with other organizations and agencies in City of Sierra Madre to identify grant programs and foundations that may support mitigation activities.

Coordinating Organization:	Development Services Department
Time line:	Ongoing
Plan Goals Addressed:	Partnerships and Implementation
Constraints:	Limited dollars available

SHORT TERM ACTIVITY - MULTI HAZARD #3: Establish a formal role for the City of Sierra Madre Disaster Mitigation Committee to develop a sustainable process for implementing, monitoring, and evaluating citywide mitigation activities.

Ideas for Implementation:

- Establish clear roles for participants, meeting regularly to pursue and evaluate implementation of mitigation strategies.
- Oversee implementation of the mitigation plan.
- Establish measurable standards to evaluate mitigation policies and programs and provide a mechanism to update and revise the mitigation plan.
- Monitor hazard mitigation implementation by jurisdictions and participating organizations through surveys and other reporting methods.
- Develop updates for the Natural Hazards Mitigation Action Plan based on new information.
- Conduct a full review of the Natural Hazards Mitigation Action Plan every 5 years by evaluating mitigation successes, failures, and areas that were not addressed.
- Provide training for Committee members to remain current on developing issues in the natural hazard loss reduction field.

Coordinating Organization:	Sierra Madre Disaster Mitigation Committee
Time line:	Ongoing
Plan Goals Addressed:	Partnerships and Implementation
Constraints:	Limited staff time available to maintain bi-weekly meetings

SHORT TERM ACTIVITY - MULTI HAZARD #4: Identify, improve, and sustain collaborative programs focusing on the real estate and insurance industries, public and private sector organizations, and individuals to avoid activity that increases risk to natural hazards.

Ideas for Implementation:

- Distribute information about flood, fire, earthquake, and other forms of natural hazards insurance to property owners in areas identified to be at risk through hazard mapping.

- Develop a one-page handout on types of insurance and deliver through city utility or service agencies.

- Educate individuals and businesses on the benefit of engaging in mitigation activities such as developing impact analyses.

- Pinpoint areas of high risk and transfer the cost of risk to property owners through insurance (rather than to the public).

- Encourage the development of unifying organizations to ensure communication and dissemination of natural hazard mitigation information.

Coordinating Organization:	Development Services Department
Time line:	Ongoing
Plan Goals Addressed:	Protect Life and Property, Public Awareness, Partnerships and Implementation
Constraints:	Lack of staff in the Department

SHORT TERM ACTIVITY - MULTI HAZARD #5: Develop public and private partnerships to foster natural hazard mitigation program coordination and collaboration in City of Sierra Madre.

Ideas for Implementation:

- Work with other city governments to develop local Natural Hazards Mitigation Plans that are consistent with the goals and framework of the city plan.

- Identify all organizations within City of Sierra Madre that have programs or interests in natural hazards mitigation.

- Involve private businesses throughout the city in mitigation planning.

- Improve communication between Cal Trans and city road departments, and work together to prioritize and identify strategies to deal with road problems.

- Establish protocol for communication electric providers and the Department of Transportation and Development to assure rapid restoration of transportation capabilities.

Coordinating Organization: Sierra Madre Disaster Mitigation Committee
Time line: Ongoing
Plan Goals Addressed: Partnerships and Implementation
Constraints: Lack of staff resources

SHORT TERM ACTIVITY - MULTI HAZARD #6: Develop inventories of at-risk buildings and infrastructure and prioritize mitigation projects.

Ideas for Implementation:

- Identify critical facilities at risk from natural hazards events.

- Develop strategies to mitigate risk to these facilities, or to utilize alternative facilities should natural hazard events cause damages to the facilities in question.

- Incorporate the building inventory developed by the Department of Geology and Mineral Industries (Dec. 2002) into the hazard assessment.

Coordinating Organization: Development Services Department
Time line: 1-2 Years
Plan Goals Addressed: Protect Life and Property, Partnerships and Implementation
Constraints: Limited staff available

LONG TERM ACTIVITY - MULTI HAZARD #I: Strengthen emergency services preparedness and response by linking emergency services with natural hazard mitigation programs, and enhancing public education on a regional scale.

Ideas for Implementation:

- Encourage individual and family preparedness through public education projects such as safety fairs.

- Coordinate the maintenance of emergency transportation routes though communication among the Public Works Department, neighboring jurisdictions, and the California Department of Transportation.

- Identify opportunities for partnering with citizens, private contractors, and other jurisdictions to increase availability of equipment and manpower for efficiency of response efforts.

- Work with Community Planning Organizations (CPO's) and other neighborhood groups to establish community response teams.

- Familiarize public officials of requirements regarding public assistance for disaster response.

Coordinating Organization: Development Services Department
Time line: Ongoing
Plan Goals Addressed: Emergency Services
Constraints: Funding to allocate towards this action item.

LONG TERM ACTIVITY - MULTI HAZARD #2: Develop, enhance, and implement education programs aimed at mitigating natural hazards, and reducing the risk to citizens, public agencies, private property owners, businesses, and schools.

Ideas for Implementation:

- Make the City of Sierra Madre Natural Hazards Mitigation Plan available to the public by publishing the plan electronically on the city's website.

- Develop and complete a baseline survey to gather perceptions of private citizens and the business community regarding natural hazard risks and identify mitigation needs. Repeat the survey in five years to monitor successes and failures of natural hazard mitigation programs.

- Develop outreach programs to business organizations that must prepare for flooding events.

- Use local cable stations as a conduit for advertising public forums.

- Conduct workshops for public and private sector organizations to raise awareness of mitigation activities and programs.

- Develop outreach materials for mitigation, preparedness, response and recovery.

Coordinating Organization:	Sierra Madre Disaster Mitigation Committee
Time line:	Ongoing
Plan Goals Addressed:	Public Awareness, Protect Life and Property
Constraints:	Funding to allocated toward this item

SECTION 5: PLAN MAINTENANCE

The plan maintenance section of this document details the formal process that will ensure that the City of Sierra Madre 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 Sierra Madre intends to incorporate the mitigation strategies outlined in this Plan into existing planning mechanisms such as the City General Plan, Capital Improvement Plans, and Building and Safety Codes.

Monitoring and Implementing the Plan

Plan Adoption

The City Council will be responsible for adopting the City of Sierra Madre Natural Hazards Mitigation Plan. This governing body has the authority to promote sound public policy regarding natural hazards. Once the plan has been adopted, the City Emergency Manager will be responsible for submitting it to the State Hazard Mitigation Officer at 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, City of Sierra Madre will gain eligibility for Hazard Mitigation Grant Program funds.

Coordinating Body

A City of Sierra Madre Disaster Mitigation Committee will be responsible for coordinating implementation of plan action items and undertaking the formal review process. The City Council (or other authority) will assign representatives from city agencies, including, but not limited to, the current Disaster Mitigation Committee members. The city has formed a Disaster Mitigation Committee that consists of members from local agencies, organizations, and citizens, and includes the following:

- City of Sierra Madre Police Department
- City of Sierra Madre Volunteer Fire Department
- City of Sierra Madre Development Services Department
- City of Sierra Madre Public Works Department

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

- An elected official
- A representative from the Chamber of Commerce
- An insurance company representative
- Community Planning Organization representatives

The Disaster Mitigation Committee will meet no less than quarterly. Meeting dates will be scheduled once the final Disaster Mitigation 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 Sierra Madre Natural Hazard Mitigation Plan, and the Disaster Mitigation Committee will take responsibility for plan implementation. The Emergency Management Coordinator will serve as a convener to facilitate the Disaster Mitigation 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 Disaster Mitigation Committee Members.

Implementation through Existing Programs

City of Sierra Madre 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 Sierra Madre will have the opportunity to implement recommended mitigation action items through existing programs and procedures.

The City of Sierra Madre Development Services Department is responsible for administering the Building & Safety Codes. In addition, the Disaster Mitigation 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 CIP's, the Disaster Mitigation 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 Disaster Mitigation Committee will provide an opportunity for Committee members to report back on the progress made on the integration of mitigation planning elements into city planning documents and procedures.

Economic Analysis of Mitigation Projects

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

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

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

Given federal funding, the Disaster Mitigation Committee will use a FEMA-approved benefit/cost analysis approach to identify and prioritize mitigation action items. For other projects and funding sources, the Disaster Mitigation 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.

Local Mitigation Funding Sources

Currently, the Disaster Mitigation Committee does not have local mitigation funding to implement many of the action items. This can be attributed to a lack of taxes/assessments which promote mitigation.

To address this issue, the Disaster Mitigation Committee voted to recommend to City Council, that upon adoption of this plan, a Disaster Mitigation Fund be established within the City's budget to assist with implementation and development of mitigation action items.

Evaluating and Updating the Plan

Formal Review Process

The City of Sierra Madre 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 Disaster Mitigation 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, which may include reviewing periodic reports by agencies involved in implementing actions abstracted from their monthly reports.

The committee's evaluation will access whether goals and objectives (action items) address current and expected conditions., nature or magnitude of risks has changed 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.

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. The Disaster Mitigation 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 Sierra Madre is dedicated to involving the public directly in review and updates of the Hazard Mitigation Plan. The Disaster 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 existence and location of these copies will be publicized annually through the local newspapers and bi-annually in the billing inserts, which reach every household in the city. The plan also includes the address and the phone number of the city Disaster Mitigation Committee, responsible for keeping track of public comments on the Plan.

In addition, copies of the plan and any proposed changes will be posted on the city website. This site will also contain an email address and phone number to which people can direct their comments and concerns.

A public meeting will also be held after each annual evaluation or when deemed necessary by the Sierra Madre Disaster Mitigation Committee. The meetings will provide the public a forum for which they can express its concerns, opinions, or ideas about the Plan. The Emergency Management Coordinator will be responsible for using city resources to publicize the annual public meetings and maintain public involvement through the public access channel, web page, and newspapers.

PART II: SPECIFIC NATURAL HAZARDS

Identification and Prioritizing Natural Hazards

The process used to identify and prioritize threats to the City was to have the archives division in the Library Dept. research the history of events, their potential threat, and overall impact to the to community. The information gathered was presented to the Disaster Mitigation Committee for review, input, and recommendations.

The Committee reviewed a general list of natural threats and agreed on five potential natural hazard threats to the City. These hazards are earthquakes, wildland/urban interface fire hazards, earth movement (landslide/debris flows), flooding, and windstorms.

The Committee used the criteria of frequency, intensity, and resulting injury and damage generated by a single event. The following list of hazards is in order of threat priority:

1. Earthquake

Earthquakes do not have the frequency rate of other natural events. However, history shows the results of an event of significant magnitude is responsible for the loss of life, injuries, destruction of property, and a threat to the environment. Earthquakes can trigger other events; such as the loss of containment for hazardous material, debris flows, and igniting fires. Geological studies place the City in a liquefaction zone. The faults and fault zones near and around the City have the potential to generate an earthquake event of significant magnitude. Earthquakes can cause not only injury and property destruction but can financially impact the school district by loss of Average Daily Attendance (ADA) funding. Recovery and resumption from a major event can be lengthy and costly.

2. Wildland/Urban Interface Fire

The Committee considered wildfires as the second most significant natural hazard. The history of Sierra Madre's wildfires indicates that the following trends will continue as risk from wildfire to life, property, natural resources, and firefighter safety increases.

- Population will grow and more people will live and use wildland areas, especially in the lower and upper Canyon portions of Sierra Madre.
- Topography and climate support ecosystems where large wildfires can be expected.
- Lack of hillside weed abatement combined with drought-like conditions will continue to pose unpredictable but almost always dangerous risks in fire season.

- More structures will be constructed in areas that are very susceptible to wildfire.
- Historical legacy of narrow roads, difficult entrance, insufficient water supplies, flammable building construction and location that make many communities and homes wildfire-prone still exist.
- Public demand for wildland fire protection and other services will increase.
- Deteriorating forest health, increasing fuel loads and other manmade factors will continue to lead toward more intense and destructive wildfires;

Unabated, these patterns will continue. Assets at risk will increase, especially watershed assets, because of the rapid rise in the demand for water to supply more people. Based on population projections, the potential for accelerating loss of protected assets, especially life and property, will be greater from disastrous wildfires.

3. Earth Movement (Landslide/Debris Flows)

The Committee considered earth movements as being the next largest threat to the City. Triggered by the combination of heavy rainfall, steep slopes, and loose soil, earth movements in Sierra Madre have been historically preceded by major wildfires. Ashy slopes left denuded by wildfires have been especially susceptible to "mudslides" during and immediately after rainstorms. Since many Sierra Madre residents live down slope of wildfire areas, the community is at risk of mudslides and other earth movements.

4. Floods

The Committee considered flooding as the next significant natural hazard. Flooding has a history dating back to the 1850's however, a wide range of county projects were completed dating from the 1930's to the mid 1990's. These projects including several dams, a flood control channel system, and extensive spreading grounds. Dam failure is considered remote, and the only significant threat would be urban flooding. There is a future potential for flooding due to higher density development, which increases rapid water run off during heavy rains. The City has to continually prepare and mitigate by upgrading its storm drain infrastructure as population increases.

5. Windstorms

The Committee determined that windstorms are the least significant natural hazard threat to the City. Throughout most of the year, the Southern California, and City climate is generally mild and does not produce enough airflow to generate a windstorm. However during the fall season shifts in weather patterns begin to arise and produce very high and unpredictable winds. These windstorm conditions are

known as the Santa Ana winds and often produce events such as trees and power lines falling down.

Non – Threatening Hazards

The Disaster Committee reviewed the following natural hazards and found that they do not represent a threat to the City.

Coastal Erosion	No Impact – the City is not located near a coastal region
Coastal Storms	No Impact – the City is not located near a coastal region
Dam Failure	No Impact – Although the Santa Anita Dam is close to the City the probability of failure and overflow into City boundaries is remote.
Expansive Soils	No Impact – This is not a threat to the City with the exception of a seismic that causes liquefaction – covered in earthquake hazard.
Tsunami	No Impact – The City is not located in or near a costal region.
Volcano	No Impact – The general area in and around the City has no history of, or future potential for, volcanic activity.

SECTION 6: EARTHQUAKES

Why Are Earthquakes a Threat to the City of Sierra Madre

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

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

However, the earthquake occurred early in the morning on a holiday. This circumstance considerably reduced the potential effects. Many collapsed buildings were unoccupied, and most businesses were not yet open. The direct and indirect economic losses ran into the 10's of billions of dollars.

Historical and geological records show that California has a long history of seismic events. Southern California is probably best known for the San Andreas Fault, a 400 mile long fault running from the Mexican border to 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."[1]

But San Andreas is only one of dozens of known earthquake faults that zigzag 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.

History of Earthquake Events in Southern California/Sierra Madre

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 6-1 lists the historical earthquake events that have affected Southern California.

Table 6-1 - 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	1991 Sierra Madre Earthquake
1899 Lytle Creek Region	1992 Landers
1899 San Jacinto and Hemet	1992 Big Bear

1907 San Bernardino Region	1994 Northridge
1910 Glen Ivy Hot Springs	1999 Hector Mine
	2003 Paso Robles

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

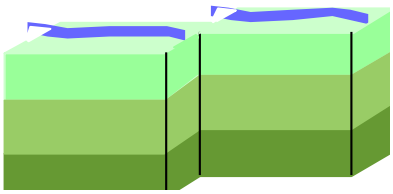
To better understand the earthquake hazard, the scientific community has looked at historical records and accelerated research on those faults that are the sources of the earthquakes occurring in the Southern California region. Historical earthquake records can generally be divided into records of the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

Since California was sparsely populated in the 1800s, the detection of pre-instrumental earthquakes is relatively difficult. However, two very large earthquakes, the Fort Tejon in 1857 (7.9) and the Owens Valley in 1872 (7.6) are evidence of the tremendously damaging potential of earthquakes in Southern California. In more recent times two 7.3 earthquakes struck Southern California, in Kern County (1952) and Landers (1992). The damage from these four large earthquakes was limited because they occurred in areas which were sparsely populated at the time they happened. The seismic risk is much more severe today than in the past because the population at risk is in the millions, rather than a few hundred or a few thousand persons.

Causes and Characteristics of Earthquakes in Southern California

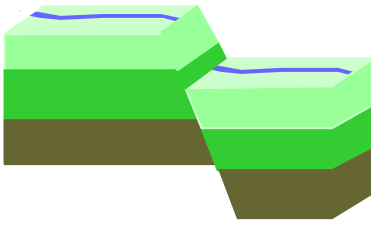
Earthquake Faults

A fault is a fracture along between blocks of the earth's crust where either side moves relative to the other along a parallel plane to the fracture. Map 8 (Appendix E) illustrates all of the known faults in Southern California.



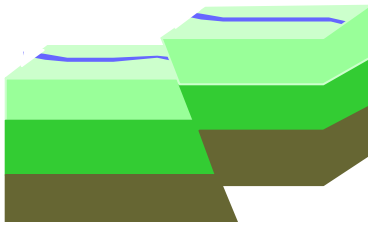
Strike-slip

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



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.



Oblique-Slip Fault

Oblique-slip faulting suggests both dip-slip faulting and strike-slip faulting. It is caused by a combination of shearing and tension of compress ional forces.

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." [2] 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

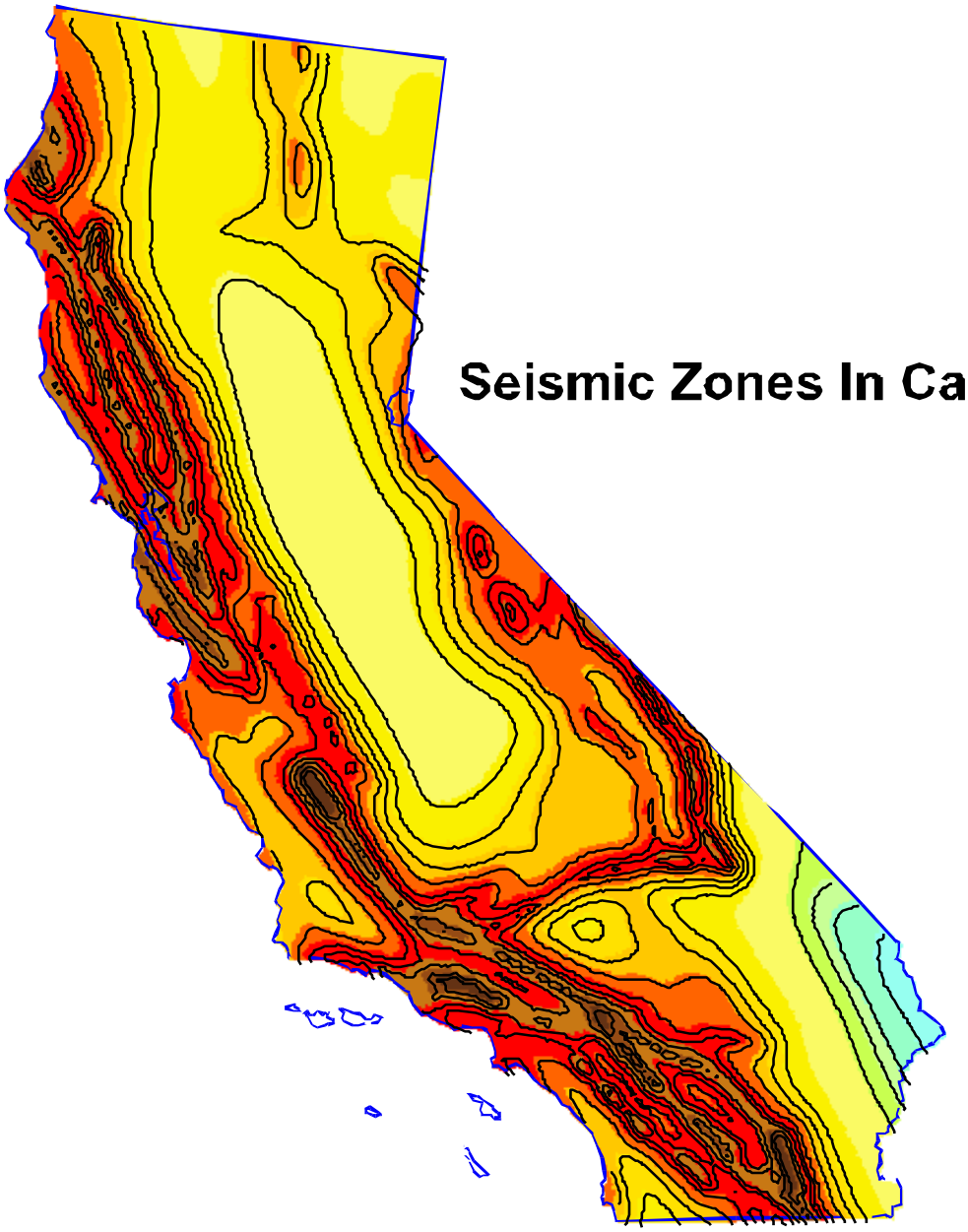
Soils and soft sedimentary rocks near the earth's surface can modify ground shaking caused by earthquakes. One of these modifications is amplification. Amplification increases the magnitude of the seismic waves generated by the earthquake. The amount of amplification is influenced by the thickness of geologic materials and their physical properties. Buildings and structures built on soft and unconsolidated soils can face greater risk.[3] Amplification can also occur in areas with deep sediment filled basins and on ridge tops.

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 8 (Appendix E) illustrates the known earthquake faults in Southern California. Map 9 illustrates the earthquake hazards in Area D.



Seismic Zones In California

Darker Shaded Areas indicate Greater Potential Shaking

Source: USGS Website

Earthquakes affecting Sierra Madre, CA

The most significant earthquake in the City of Sierra Madre was the Sierra Madre Earthquake. At 7:43 a.m. on June 28, 1991 this 5.8 earthquake struck. The epicenter (Sierra Madre fault, see map 8 was 7.5 miles northeast of Sierra Madre and damage

totaled $12.5 million. There were 18 personal injuries, but no injuries to hikers; 403 structures damaged; 2 businesses uninhabitable; 22 homes condemned (many in west Sierra Madre Sunnyside and Lima Streets) , and 3 religious institutions remained unoccupied; other problems included 36 toppled chimneys; 2 damaged church bell towers, 17 natural gas leaks, 6 water leaks, 4 hazardous materials leaks. The fire department received 150 calls. Sierra Madre School served as an emergency shelter.

Other nearby communities that were affected were the cities of Arcadia, Azusa, Irwindale, Monrovia, Pasadena and Rosemead. This was the most recent major rupture of the Sierra Madre fault.

History of Earthquakes affecting Sierra Madre, California

March 10, 1933 — Long Beach 6.3 Earthquake
No damage. No injuries. Fire Department first aid crew sent to Long Beach to assist. Sierra Madre Hospital took in many Long Beach patients. Gatherings of Sierra Madre residents at City Hall, the Woman's Club, and Legion headquarters plan relief efforts.

July 20, 1952 — Kern County 7.7 Earthquake
Minor property damage; canned goods dumped onto floor in Roess Market on Sierra Madre Blvd.; ruptured water pipe caused moderate damage at the 5 & 10 cent store; canyon home at 549 ½ Brookside damaged; some light flashes caused by the slapping of high tension wires.

February 9, 1971 — Sylmar 6.5 Earthquake
No local information regarding damage reported. Los Angeles County was declared a disaster area. Sierra Madre residents were encouraged to report the extent of damage and damages in excess of $1000 would warrant reassessment by the County.

October 1, 1987 — Whittier Narrows 5.8 Earthquake; 5.5 aftershock 3 days later
Chimneys toppled; store windows shattered; arch of old Post Office building demolished; grocery and liquor stores suffered damages to their goods, cracked windows at Old City Hall building at 55 W. Sierra Madre Blvd.; Sierra Madre Volunteer Fire Department estimated $400,000 in damages.

June 28, 1991 — Sierra Madre Earthquake at 7:43 a.m. – epicenter 7.5 miles northeast of Sierra Madre; a 5.8 earthquake damage totaled $12.5 million in Sierra Madre; 18 personal injuries but no injuries to hikers; 403 structures damaged; 2 businesses uninhabitable; 22 homes condemned (many in west Sierra Madre Sunnyside and Lima Streets) ; 3 religious institutions are not occupied; other problems included 36 toppled chimneys; 2 damaged church bell towers, 17 natural gas leaks, 6 water leaks, 4 hazardous materials

leaks. The fire department received 150 calls. Sierra Madre School served as an emergency shelter.

January 17, 1994 Northridge earthquake 6.7 magnitude hits at 4:31 a.m. Slight damage reported by Sierra Madre businesses. Residents complain of being rousted out of bed at an early hour. No overall estimate in damages. Photos in the newspaper show supplies spilled on the floor at Best Buy Drugs; shattered glass at Miner Harkness Insurance (damage estimate $700); cracked window at Household Bank; 3 broken windows at Howie's Ranch Market (damage estimate $2500); Bottle Shop losses at $500; Happy's Liquor losses total $250; cracked glass at Wistaria Salon (damage estimate $300); broken window at Harlequin Galleries.

Construction Mitigation

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.[4]

The Seismic Hazards Mapping Act, passed in 1990, addresses non-surface fault rupture earthquake hazards, including liquefaction and seismically induced landslides.[5] 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.

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. Map 10 identifies the area of Sierra Madre that has soils vulnerable to liquefaction.

The City of Sierra Madre has **0** unreinforced commercial buildings as they've all been retrofitted to current standards. Many pre-1933 residential buildings exist, but most owners have not come forward with the information as to whether they have been retrofitted. The most vulnerable asset owned by the city is its water delivery system. Most pipes are over 60 years old. Due to the city's slow growth initiative, no new structures or facilities are planned.

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[6] . 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.[7]

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.

Dams

There are a total of 103 dams in Los Angeles County, owned by 23 agencies or organizations, ranging from the Federal government to Home Owner Associations.[8] These dams hold billions of gallons of water in reservoirs. Releases of water from the major reservoirs are designed to protect Southern California from flood waters and to store domestic water. Seismic activity can compromise the dam structures, and the resultant flooding could cause catastrophic flooding. Following the 1971 Sylmar earthquake the Lower Van Norman Dam showed signs of structural compromise, and tens of thousands of persons had to be evacuated until the dam could be drained. The dam has never been refilled. The City of Sierra Madre does not have any water inundation dams.

Buildings

The built environment is susceptible to damage from earthquakes. Buildings that collapse can trap and bury people. Lives are at risk and the cost to clean up the damages is great. In most California communities, including the City of Sierra Madre, many buildings were built before 1993 when building codes were not as strict. In addition, retrofitting is not required except under certain conditions and can be expensive. Therefore, the number of buildings at risk remains high. The California Seismic Safety Commission makes annual reports on the progress of the retrofitting of unreinforced masonry buildings.

Infrastructure and Communication

Residents in the City of Sierra Madre commute frequently through personal automobiles and public transit such as buses and light rail. An earthquake can greatly damage bridges and roads, hampering emergency response efforts and the normal movement of people and goods. Damaged infrastructure strongly affects the economy of the community because it disconnects people from work, school, food, and leisure, and separates businesses from their customers and suppliers.

Bridge Damage

Damage to surrounding communities' bridges may result in a delay of mutual aid service response. Even modern bridges can sustain damage during earthquakes, leaving them unsafe for use. Some bridges have failed completely due to strong ground motion. Bridges are a vital transportation link - with even minor damages making some areas inaccessible. Because bridges vary in size, materials, location and design, any given earthquake will affect them differently. Bridges built before the mid-1970' s have a significantly higher risk of suffering structural damage during a moderate to large earthquake compared with those built after 1980 when design improvements were made. Sierra Madre has approximately eight small bridges that traverse the Los Angeles County flood control channel. These bridges are located in the Canyon area of the City and are relatively small in nature, ranging from 15'-20 wide to 20' long.

Much of the interstate highway system was built in the mid to late 1960's. Cal Trans has retrofitted most bridges on the freeway systems; however there are still some county maintained bridges that are not retrofitted. The FHWA requires that bridges on the National Bridge Inventory be inspected every 2 years. CalTrans checks when the bridges are inspected because they administer Federal funds for bridge projects.

Damage to Lifelines

Lifelines are the connections between communities and outside services. They include water and gas lines, transportation systems, electricity, and communication networks. Ground shaking and amplification can cause pipes to break open, power lines to fall, roads and railways to crack or move, and radio and telephone communication to cease. Disruption to transportation makes it especially difficult to bring in supplies or services. Lifelines need to be usable after earthquake to allow for rescue, recovery, and rebuilding efforts and to relay important information to the public.

Disruption of Critical Services

Critical facilities include police stations, fire stations, and other facilities that provide important services to the community. These facilities and their services need to be functional after an earthquake event. All city critical facilities are have been built since 1976 and are up to current seismic codes.

Businesses

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

Forty percent of businesses do not reopen after a disaster and another twenty-five percent fail within one year according to the Federal Emergency Management Agency (FEMA). Similar statistics from the United States Small Business Administration indicate that over ninety percent of businesses fail within two years after being struck by a disaster.[9]

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

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

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

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

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 Sierra Madre Codes
Implementation of earthquake mitigation policy most often takes place at the local government level. The City of Sierra Madre Department of Development Services enforces building codes pertaining to earthquake hazards. They also enforce the zoning and land use regulations relating to earthquake hazards.

The following sections of the Uniform Building Code (UBC) address earthquake hazard reduction:

1605, 1 (Distribution of Horizontal Sheer);
1605. 2 (Stability against Overturning);
1626 (Seismic);
1605. 3 (Anchorage); and
1632, 1633, 1633. 9 deal with specific earthquake hazards.

The following sections of the Sierra Madre Municipal Code (SMMC) address earthquake hazard reduction:

15.44.010 (Adoption of stringent standards associated with the Los Angeles Municipal Code);
15.44.010 (Glass and glazing);
15.44.030 (Parapets of unreinforced masonry or concrete)

Generally, these codes seek to discourage development in areas that could be prone to flooding, landslide, wildfire and/or seismic hazards; and that 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 Sierra Madre Building Code sets the minimum design and construction standards for new buildings. In 1990 the City of Sierra Madre adopted the most recent seismic standards in its building code, which requires that new buildings be built at a higher seismic standard.

Since 1990 the City of Sierra Madre also requires that site-specific seismic hazard investigations be performed for new essential facilities, major structures, hazardous facilities, and special occupancy structures such as schools, hospitals, and emergency response facilities.

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.[10] 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 sub gradations 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.".[11]

The city has no medical facilities located in the town other than doctors' offices.

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 6-2 provides a sampling of some of the 200 plus laws in the State's codes.

Table 6-2: 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 central 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, sponsor 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 Mitigation Action Items

Below are several earthquake mitigation action items. Each action item provides guidance on suggesting specific activities that agencies, organizations, and residents in the City of Sierra Madre can undertake to reduce risk and prevent loss from earthquake events. Each action item is followed by ideas for implementation, which can be used by the committee and local decision makers in pursuing strategies for implementation;

Action Item # 1*:* Integrate new earthquake hazard mapping data for the City of Sierra Madre and improve technical analysis of earthquake hazards.

Ideas for Implementation:

- Update the City of Sierra Madre earthquake HAZUS data using more localized data including the building inventory to improve accuracy of the vulnerability assessment for the City of Sierra Madre.

- Conduct risk analysis incorporating HAZUS data and hazard maps using GIS technology to identify risk sites and further assist in prioritizing mitigation activities and assessing the adequacy of current land use requirements.

Coordinating Organization:	City of Sierra Madre Geographic Information Systems
Timeline:	2 years
Plan Goals Addressed:	Partnerships and Implementation , Protect Life and Property
Constraints:	Limited staff to incorporate changes and monitor existing GIS infrastructure.

Action Item # 2*:* Incorporate the Regional Earthquake Transportation Evacuation Routes developed by the Area D Disaster Management Area Coordinators into appropriate planning documents.

Ideas for Implementation:

- Update the transportation routes map in the City of Sierra Madre Natural hazard Mitigation Plan with the evacuation routes data
- Integrate the evacuation routes data into the City of Sierra Madre Emergency Operations Plan

Coordinating Organization: City of Sierra Madre Emergency Management
Timeline: Ongoing
Plan Goals Addressed: Emergency Services
Constraints: None. This has already been implemented.

Action Item # 3*:* Identify funding sources for structural and nonstructural retrofitting of structures that are identified as seismically vulnerable.

Ideas for Implementation:

- Provide information for property owners, small businesses, and organizations on sources of funds (loans, grants, etc.)
- Explore options for including seismic retrofitting in existing programs such as low-income housing, insurance reimbursements, and pre and post disaster repairs

Coordinating Organization: Sierra Madre Disaster Mitigation Committee
Timeline: 2 years
Plan Goals Addressed: Partnerships and Implementation , Public Awareness
Constraints: Staff to maintain and provide research for this action item.

Action Item # 4*:* Encourage purchase of earthquake hazard insurance.

Ideas for Implementation:

- Provide earthquake insurance information to the City of Sierra Madre residents
- Coordinate with insurance companies to produce and distribute earthquake insurance information

Coordinating Organization: Sierra Madre Disaster Mitigation Committee
Timeline: 2 years
Plan Goals Addressed: Protect Life and Property, Public Awareness
Constraints: Staff to maintain and provide research for this action item.

Action Item # 5*:* Encourage seismic strength evaluations of critical facilities in the City of Sierra Madre to identify vulnerabilities for mitigation of schools and universities, public infrastructure, and critical facilities to meet current seismic standards.

Ideas for Implementation:

- Develop an inventory of schools, universities, and critical facilities that do not meet current seismic standards
- Encourage owners of non-retrofitted structures to upgrade them to meet seismic standards
- Encourage water providers to replace old cast iron pipes with more ductile iron, and identify partnership opportunities with other agencies for pipe replacement,

Coordinating Organization: Sierra Madre Disaster Mitigation Committee
Timeline: 5 years
Plan Goals Addressed: Protect Life and Property, Public Awareness
Constraints: Staff to maintain and provide research for this action item.

Action Item # 6*:* Encourage reduction of nonstructural and structural earthquake hazards in homes, schools, businesses, and government offices.

Ideas for Implementation:

- Provide information to government building and school facility managers and teachers on securing bookcases, filing cabinets, light fixtures, and other objects that can cause injuries and block exits

- Encourage facility managers, business owners, and teachers to refer to FEMA's practical guidebook: “Reducing the Risks Nonstructural Earthquake Damage”

- Encourage homeowners and renters to use “Is Your Home Protected from Earthquake Disaster? A Homeowner’s Guide to Earthquake Retrofit” (IBHS) for economic and efficient mitigation techniques

- Explore partnerships to provide retrofitting classes for homeowners, renters, building professionals, and contractors

- Target development located in potential fault zones or in unstable soils for intensive education and retrofitting resources

Coordinating Organization:	Sierra Madre Disaster Mitigation Committee
Timeline:	Ongoing
Plan Goals Addressed:	Protect Life and Property, Public Awareness
Constraints:	Staff to maintain and provide research for this action item.

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[1] http://pubs.usgs.gov/gip/earthq3/when.html

[2] http://www.gps.caltech.edu/~sieh/home.html

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

[4] http://www.consrv.ca.gov/CGS/rghm/ap/

[5] Ibid

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

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

[8] Source: Los Angeles County Public Works Department, March 2004

[9] http://www.chamber101.com/programs_committee/natural_disasters/DisasterPreparedness/Forty.htm

[10] Institute for Business and Home Safety Resources (April 2001),

[11] http://www.seismic.ca.gov/pub/CSSC_2001-04_Hospital.pdf

SECTION 7: WILDLAND/URBAN INTERFACE FIRE HAZARDS

Why are Wildfires a Threat to the City of Sierra Madre?

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 CalFire, there were over seven thousand reportable fires in California in 2003, with over one million acres burned.[12] According to CalFire statistics, in the October, 2003 Firestorms, over 4,800 homes were destroyed and 22 lives were lost.[13]

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 2,800 homes and burned over a quarter of a million acres.

Table 7-1: 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."[14]

Table 7-2: Large Historic Fires in California 1923-2003 (Structures Destroyed)

	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	Kanan	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

Table 7-3: Fires affecting Sierra Madre, California 1900-Present (Structures Destroyed)

	Fire Name	Date	County	Acres	Structures	Deaths
1	?	July 1900	Los Angeles	?	?	0
2	?	March 1953	Los Angeles	?	?	0
3	?	December 1953	Los Angeles	?	?	0
4	Monrovia Peak	April 1957	Los Angeles	0	?	0
5	Mt. Wilson	October 1961	Los Angeles	1,250	0	0
6	Mountain Trail	October 1978	Los Angeles	1,400	0	0
7	Kinneloa	October 1993	Los Angeles	5,485	0	0
8	Santa Anita 2	December 1999	Los Angeles	738	0	0
9	Santa Anita Fire	April 2008	Los Angeles	850	1	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.[15] Taxpayers spent more than $1.6 billion[16] 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 7-4 illustrates fire suppression costs for state, private and federal lands.

Table 7-4: National Fire Suppression Costs

Year	Suppression Costs	Acres Burned	Structures Burned
2000	$1.3 billion	8,422,237	861
2001	$0.5 billion	3,570,911	731
2002	$1.6 billion	6,937,584	815

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

Wildfire Characteristics

There are three categories of interface fire:[17] 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. Sierra Madre can be categorized as being an area where well-defined urban and suburban development presses up against open expanses of wildland areas; specifically the Angeles National Forest. 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 higher and lower mountain areas. The lower mountain areas, also known as the foothills, are most often covered with scrub brush or chaparral; this area characterizes Sierra Madre's area of risk as we are at the base of the foothills. The higher mountains areas also create a risk by having heavily forested terrain.

"Past fire suppression is not to blame for causing large shrub land wildfires, nor has it proven effective in halting them."" said Dr. Jon Keeley, a USGS fire researcher who studies both southern California scrublands 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."[18]

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."[19]

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.”[20]

“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.”[21]

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.[22] 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 7-5 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 7-5: 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
- 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. Map 11 (Appendix E) depicts wildland urban interface in the City of Sierra Madre. Map 12 illustrates fire hazards in Disaster Management Area D and Map 13 illustrates historic fire areas in Disaster Management Area D.

Vulnerability and Risk

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

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

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

Community Wildfire Issues

What is Susceptible to Wildfire?

Growth and Development in the Interface

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

In the event of a wildfire, vegetation, structures and other flammables can merge into unwieldy and unpredictable events. Factors important to the fighting of such fires include access, firebreaks, proximity of water sources, distance from a fire station and

available firefighting personnel and equipment. Reviewing past wildland/urban interface fires shows that many structures are destroyed or damaged for one or more of the following reasons:

- Combustible roofing material
- Wood construction
- Structures with no defensible space
- Fire department with poor access to structures
- Subdivisions located in heavy natural fuel types
- Structures located on steep slopes covered with flammable vegetation
- Limited water supply
- 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.

Road access is a problem in the canyon area of Sierra Madre. Typically, fire personnel have to back up fire apparatus up canyon roadways in case they need to evacuate, should the fire overwhelm them.

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.

Historically, Sierra Madre has never had a water supply problem when it comes to firefighting activities. We supply our own water through a total of four wells and two tunnels. In tandem with these water sources Sierra Madre also has two large reservoirs and one smaller one.

Interface Fire Education Programs and Enforcement

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

The Need for Mitigation Programs

Continued development into the interface areas will have growing impacts on the wildland/urban interface. Periodically, the historical losses from wildfires in Southern

California have been catastrophic, with deadly and expensive fires going back decades. The continued growth and development increases the public need for natural hazards mitigation planning in Southern California.

Wildfire Mitigation Activities

Existing mitigation activities include current mitigation programs and activities that are being implemented by county, regional, state, or federal agencies or organizations. Sierra Madre has a weed abatement program that has proven to be successful in resident's taking the initiative towards proper brush clearance.

The City of Sierra Madre also has an extensive public outreach program designed to inform the average resident of the threat of wildfires. Periodically and time permitting, fire personnel will do comprehensive site visits designed to educate property owners. In tandem with these efforts and depending on the budget, the Sierra Madre Volunteer Fire Dept. hosts an annual safety and awareness fair.

Local Programs

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

These 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, which are designed to treat 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
- 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 earthquakes, has only been briefly 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."[23]

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

Fire Codes

Local Fire Codes

SMMC8.24.010 Fireworks prohibited--Exception.

The sale, possession or discharge of all fireworks is prohibited within the city of Sierra Madre. The provisions of this section shall not apply to public displays of fireworks conducted by licensed pyrotechnic engineers. (Ord. 1002 § 1, 1982: prior code § 4108 (part))

SMMC§8.28.00 Protected Fire Areas

The unrestricted use of grass, grain, brush or forest covered land, and the failure to control fire hazards is a potential menace to life and property from fire and resulting erosion. It is therefore the intent of this chapter to provide and encourage adequate fire protection facilities to control the spread of fire which might be caused by recreational, residential, commercial, industrial, or other activities through established protected fire

areas. In general, such protected fire areas will be located north of a southern boundary to be established by the city council, as set forth in this chapter. (Prior code § 4201)

SMMC§8.36.030 Hazardous Brush Clearance

Each person who has any ownership or possessory interest in, or control of, a parcel of land shall:

A. Remove form the property all dead tress, and maintain all weeds and other vegetation…if such weeds are within one hundred feet of a building.
B. Maintain trees within one hundred feet of any building or structure or within ten feet of that portion of highway.
C. Remove any portion of a tree which extends within ten feet of an outlet of a chimney or stovepipe;
D. Keep all trees, shrubs and, other growing vegetation or portions thereof adjacent to or overhanging any building or structure free of dead limbs, branches and other combustible matter;
E. Maintain five feet of vertical clearance between roof surfaces and portions of trees overhanging any building or structure;
F. Maintain the roofs of all buildings or structures free of leaves, needles, twigs and other combustible matter;
G. Maintain all weeds and other vegetation located within ten feet of any combustible fence or an edge of that portion of any highway, street, alley or driveway …;
H. Nothing contained in this section shall be deemed to preclude the fire chief from requiring more than the minimum specific requirements set forth above when the fire chief determines that conditions exist which necessitate greater fire protection measures. (Ord. 1091 § 7 (part), 1992: prior code § 4221 (b))

SMMC§15.24.00 Adoption of the Uniform Fire Code and the California Fire Code

There is adopted by the city council of the city of Sierra Madre for the purpose of prescribing regulations governing conditions hazardous to life and property from fire or explosion, that certain code and standards known as the Uniform Fire Code, published by the Western Fire Chief's Association and the International Conference of Building Officials, being particularly the 2000 edition thereof, including Appendix Chapters with errata, and the Uniform Fire Code Standards, 1997 Edition as amended by the Uniform Fire Code Standards, 2000 Edition, and Title 24, Part 9 of the California Code of Regulations, except such portions as are hereinafter deleted, modified or amended by Section 15.24.070 of the Sierra Madre Municipal Code. From the date on which the ordinance codified in this chapter shall take effect, the provisions of the 2000 Uniform Fire Code and the 2001 California Fire Code shall be controlling within the limits of the city of Sierra Madre. (Ord. 1196 § 1 (part), 2003: Ord. 1168 § 1, 1999: Ord. 1125 § 1, 1995: Ord. 1091 § 1, 1992: Ord. 1015 § 1, 1984: prior code § 4100)

SMMC§15.28.00 Fire restive materials

General. Buildings or structures hereafter erected, constructed, moved within or into Fire Zone Four shall meet the requirements of this section.

A. Exterior walls of all buildings shall be of one-hour fire-resistive construction. Exterior glass in such walls shall be double glazed, wood shake shingles being used as an exterior wall covering shall be treated with a fire retardant chemical. …
B. Roof soffits (including eaves) open patios, carports, porches, unenclosed underfloor areas…shall be protected…as approved for one-hour-fire-resistive construction or shall be of incombustible material throughout.
C. Roof coverings for all structures within the city shall be fire-retardant.…

State Fire Codes
2001 California Fire Code, Title 24-Part 9

See "SMMC§15.24.00 Adoption of the Uniform Fire Code and the California Fire Code"

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.[24]

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.

Hazard Mitigation Grant Program

Following a major disaster declaration, the FEMA Hazard Mitigation Grant Program provides funding for long-term hazard mitigation projects and activities to reduce the possibility of damages from all future fire hazards and to reduce the costs to the nation for responding to and recovering from the disaster.

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.

Prescribed Burning

The health and condition of a forest will determine the magnitude of wildfire. If fuels - slash, dry or dead vegetation, fallen limbs and branches - are allowed to accumulate over long periods of time without being methodically cleared, fire can move more quickly and destroy everything in its path. The results are more catastrophic than if the fuels are periodically eliminated. Prescribed burning is the most efficient method to get rid of

these fuels. In California during 2003, various fire agencies conducted over 200 prescribed fires and burned over 33,000 acres to reduce the wildland fire hazard.[25]

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 Mitigation Action Items

As stated in the Federal Wildland Fire Policy, “The problem is not one of finding new solutions to an old problem but of implementing known solutions. Deferred decision making is as much a problem as the fires themselves. If history is to serve us in the resolution of the wildland/urban interface problem, we must take action on these issues now. To do anything less is to guarantee another review process in the aftermath of future catastrophic fires.”[26]

The wildfire mitigation action items provide direction on specific activities that organizations and residents in Southern California can undertake to reduce risk and

prevent loss from wildfire events. Each action item is followed by ideas for implementation, which can be used by the steering committee and local decision makers in pursuing strategies for implementation.

Action Item # l*:* Enhance emergency services to increase the efficiency of wildfire response and recovery activities.

Ideas for Implementation:

- Install more fire reporting stations for better access and coverage;
- Develop a daytime "auxiliary" to staff the fire station 24/7. Require all volunteers to "sleep over" when they are on call/duty
- Develop a reverse 911 capacity.

Coordinating Organization: Sierra Madre Volunteer Fire Department
Timeline: 4 years
Plan Goals Addressed: Emergency Services
Constraints: monetary commitment from city budget.

Action Item # 2*:* Educate agency personnel on federal cost-share and grant programs, Mutual-Aid Agreements and other related federal programs so the full array of assistance available to local agencies is understood.

Ideas for Implementation:

- Investigate potential funding opportunities for individual mitigation projects;
- Promote Mutual-Aid Agreements and partnerships to clarify roles and responsibilities and to provide for fire mitigation activities and suppression preparedness

Coordinating Organization: Sierra Madre Volunteer Fire Department
Timeline: ongoing
Plan Goals Addressed: Protect Life and Property, Public Awareness
Constraints: None

Action Item # 3*:* Encourage development and dissemination of maps relating to the fire hazard to help educate and assist builders and homeowners in being engaged in wildfire mitigation activities and to help guide emergency services during response.

Ideas for Implementation:

- Update wildland/urban interface maps.
- Conduct risk analysis incorporating data and the created hazard maps using GIS technology to identify risk sites and further assist in prioritizing mitigation activities

Coordinating Organization: Public Works Department
Timeline: Ongoing
Plan Goals Addressed: Protect Life and Property
Constraints: None as this is already being done.

Action Item # 4*:* Enhance outreach and education programs aimed at mitigating wildfire hazards and reducing or preventing the exposure of citizens, public agencies, private property owners and businesses to natural hazards.

Ideas for Implementation:

- Encourage the hiring of fire prevention and education personnel to oversee education programs
- Visit urban interface neighborhoods and conduct education and outreach activities
- Conduct specific community-based demonstration projects of fire prevention and mitigation in the urban interface
- Establish neighborhood "drive-through" activities that pinpoint site-specific mitigation activities. Fire crews can give property owners personal suggestions and assistance
- Perform public outreach and information activities at fire stations by creating "Wildfire Awareness Week" activities, Fire stations can hold open houses and allow the public to visit, see the equipment and discuss wildfire mitigation with the station crews.

Coordinating Organization: Sierra Madre Volunteer Fire Department
Timeline: Ongoing
Plan Goals Addressed: Protect Life and Property, Public Awareness
Constraints: Due to budget constraints the Sierra Madre Volunteer Fire Dept. is limited as to how much public outreach can be accomplished. The Dept. will continue to encourage and foster public outreach to the highest extent feasible in the years to come.

Action Item # 5*:* Increase communication, coordination and collaboration between wildland/urban interface property owners, local and county planners and fire prevention crews and officials to address risks, existing mitigation measures and federal assistance programs.

Ideas for Implementation:

- Encourage single-family residences to have fire plans and practice evacuation routes
- Encourage fire inspections in residential homes by the fire department to increase awareness among homeowners and potential fire responders
- Encourage a standard for the State Fire Marshal to evaluate fire plans and emergency plans

- Require fire department notification of new business applications to ensure that appropriate fire plans have been developed

- Encourage local zoning and planning entities to work closely with landowners and/or developers who choose to build in the wildland/urban interface to identify and mitigate conditions that aggravate wildland/urban interface wildfire hazards, including:
    - The administration and review of conditional use planning permits.
    - Limited access for emergency equipment due to width and grade of roadways;
    - Inadequate water supplies and the spacing, consistency and species of vegetation around structures;
    - Inadequate fuel breaks, or lack of defensible space;
    - Highly flammable construction materials;
    - Building lots and subdivisions that are not in compliance with state and local land use and fire protection regulations;
    - and Inadequate entry/escape routes.

- Encourage all new homes and major remodels involving roofs additions that are located in the interface to have fire resistant roofs and residential sprinkler systems

- Encourage the public to evaluate access routes to rural homes for fire-fighting vehicles

Coordinating Organization: Sierra Madre Volunteer Fire Department and Development Services
Timeline: Ongoing
Plan Goals Addressed: Protect Life and Property, Public Awareness, Emergency Services,
Constraints: None. This is already being done.

Action Item # 6*:* Encourage implementation of wildfire mitigation activities in a manner consistent with the goals of promoting sustainable ecological management and community stability.

Ideas for Implementation:

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

Coordinating Organization: Sierra Madre Volunteer Fire Department and Public Works Dept.
Timeline: Ongoing
Plan Goals Addressed: Natural Systems
Constraints: Due to budget constraints the Public Works Dept. along with the Sierra Madre Volunteer Fire Dept. have been unable to perform routine subsidized clearings.

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

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

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

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

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

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

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

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

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

[21] Ibid

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

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

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

[25]

[26] http://www.fs.fed.us/land/wdfire7c.htm

SECTION 8: EARTH MOVEMENT/LANDSLIDES

Why are Landslides a Threat to the City of Sierra Madre?

Landslides are a serious geologic hazard in almost every state in America. Nationally, landslides cause 25 to 50 deaths each year.[27] The best estimate of direct and indirect costs of landslide damage in the United States range between $1 and $2 billion annually.[28] 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.

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).[29]

1956 Portuguese Bend, California
Cost, $14.6 million (2000 dollars) California Highway 1, 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.[30]

1958-1971 Pacific Palisades, California
Cost, $29.1 million (2000 dollars) California Highway 1 and house damaged.[31]

1961 Mulholland Cut, California
Cost, $41.5 million (2000 dollars) On Interstate 405, 11 miles north of Santa Monica,

Los Angeles County.[32]

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 (1963 dollars) dollars in property.

1969 Glendora, California

Cost, $26.9 million (2000 dollars) Los Angeles County, 175 houses damaged, mainly by debris flows.[33] This debris flow was preceded by a fire.

1969 Seventh Ave., Los Angeles County, California

Cost, $14.6 million (2000 dollars) California Highway 60.[34]

1970 Princess Park, California

Cost, $29.1 million (2000 dollars) California Highway 14, 10 miles north of Newhall, near Saugus, northern Los Angeles County.[35]

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.[36]

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.[37]

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.[38]

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.[39]

1979 Big Rock, California, Los Angeles County

Cost, approximately $1.08 billion (2000 dollars) California Highway 1 rockslide.[40]

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.[41]

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).[42]

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 [43]

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.[44]

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.[45]

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.[46]

Historic Sierra Madre Landslide Activity

January 1954	2000 residents urged to evacuate; evacuation area north of Grand View between Grove and Mountain Trail Avenues and evacuation centers were established at the Monastery and the Woman's Club; areas hardest hit were North Lima, Bailey Canyon, Carter Avenue, North Auburn Avenue, Woodland Avenue, Brookside Lane; silt, boulders, mud and debris strewn down as far as Sierra Madre Blvd.; silt was 8-10 feet in some places; catch basin was filled with mud (30,000 cubic feet); boulders broke City water lines in the north section of town; runoff led to water contamination and many residents became sick with abdominal pain.
March 6, 1994	A cloudburst below Mount Wilson caused a flash flood and mudslide in Bailey Canyon. An inch of rain fell between 4 and 6 that afternoon causing 15 feet of mud to collect in the Bailey Canyon catch basin. The mudslide claimed the lives of two hikers, both Sierra Madre residents: John Henderson, age 33, and his son Matthew Henderson, age 9. Underbrush and grass in the area had been burned by the October 1993 fire.

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."[47]

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.[48]

"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."[49]

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.[50] 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.[51] 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.[52] Flows often occur during heavy rainfall, can occur on gentle slopes, and can move rapidly for large distances.

Landslides 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.[53]

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

Natural Conditions

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

Particularly Hazardous Landslide Areas

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

- On or close to steep hills

- Steep road-cuts or excavations
- Existing landslides or places of known historic landslides (such sites often have tilted power lines, trees tilted in various directions, cracks in the ground, and irregular-surfaced ground)
- Steep areas where surface runoff is channeled, such as below culverts, V -shaped valleys, canyon bottoms, and steep stream channels
- Fan-shaped areas of sediment and boulder accumulation at the outlets of canyons
- 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 Sierra Madre. Proper planning and geotechnical engineering are 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.[54]

Changes in Vegetation

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

Landslide Hazard Assessment

Hazard Identification

Identifying hazardous locations is an essential step towards implementing more informed mitigation activities. The City of Sierra Madre has recently purchased a new GIS system and will be utilizing this system to create new mapping for potential landslide areas. This mapping will assist our Development Services Dept. in identifying potential hazard areas.

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.[55] Data that includes specific landslide-prone and debris flow locations in the city can be used to assess the population and total value of property at risk from future landslide occurrences.

The City of Sierra Madre Development Services Department uses percent slope as an indicator of hill slope stability. The city uses a twenty-five (25) percent or greater threshold to identify potentially unstable hill slopes. An estimated 400 acres in the city exceeds this 25% slope threshold, indicating that almost 20% of the land in City of Sierra Madre has potentially unstable soil. Any developers wanting to construct on hillside exceeding the 25% threshold are denied construction permits.

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

Sierra Madre losses incurred from landslide hazards have been associated primarily with roads. The City of Sierra Madre Public Works Department is responsible for responding to slides that inhibit the flow of traffic or damage roadways. The Public Works 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. There has been only one documented loss to one of eight small bridges in Sierra Madre. This loss occurred as a debris flow conveyed through the County-owned flood control channel and wiped out the small bridge in its entirety. The County of Los Angeles Public Works is responsible for maintaining the flood control channel that the eight small bridges traverse.

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 Sierra Madre Public Works Department 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 Services

Lifelines and critical facilities should remain accessible, if possible, during a natural hazard event. The impact of closed transportation arteries may be increased if the closed road or bridge is critical for hospitals and other emergency facilities. Therefore, inspection and repair of critical transportation facilities and routes is essential and should receive high priority. Losses of power and phone service are also potential consequences of landslide events. Due to heavy rains, soil erosion in hillside areas can be accelerated, resulting in loss of soil support beneath high voltage transmission towers in hillsides and remote areas. Flood events can also cause landslides, which can have serious impacts on gas lines that are located in vulnerable soils.

Landslide Mitigation Activities

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

Landslide Building/Zoning Codes

The City of Sierra Madre Municipal Code addresses development on steep slopes in subsection 17.52. This section outlines standards for development in the City's Hillside Management Zone. Generally, the ordinance requires soils and engineering geologic studies for developments proposed on parcels in the Hillside Management Zone. More detailed surface and subsurface investigations shall be warranted if indicated by engineering and geologic studies to sufficiently describe existing conditions. This may include soils, vegetation, geologic formations, and drainage patterns. Site evaluations may also occur where stability might be lessened by proposed grading/filling or land clearing.

Hazard Mapping

The City has recently acquired a new GIS system designed to map infrastructure, hazards and mitigation areas. This system has modeling capability and can assist the community in mapping and forecasting potential landslide areas.

Community Issues Summary

Landslides are a problem in the City of Sierra Madre, and often impact the city's infrastructure as well as private property.

Landslide Mitigation Action Items

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

Action Item #I: Improve knowledge of landslide hazard areas and understanding of vulnerability and risk to life and property in hazard-prone areas.

Ideas for Implementation:

- Conduct a landslide hazard mapping study in the City of Sierra Madre
- Develop public information to emphasize economic risk when building on potential or historical landslide areas

Coordinating Organization: Development Services Department

Timeline: 3-5 yrs.
Plan Goals Addressed: Public Outreach, education
Constraints: Funding & limited staff resources.

Action Item #2: Encourage construction and subdivision design that can be applied to steep slopes to reduce the potential adverse impacts from development.

Ideas for Implementation:

- Increase communication and coordination between the city's Development Services and Public Works Departments.

Coordinating Organization: Development Services Department
Timeline: Ongoing
Plan Goals Addressed: Public Outreach, education
Constraints: None

Action Item #3: Identify safe evacuation routes in high-risk debris flow and landslide areas.

Ideas for Implementation:

- Identify potential debris removal resources; Inventory, vendor's list, Mutual Aid agreement
- Identify and publicize information regarding emergency transportation routes
- Coordinate with Sierra Madre Search and Rescue to determine which resources they already have and what they may potentially need.

Coordinating Organization: Sierra Madre Police Dept. & Sierra Madre Fire Dept.
Timeline: Ongoing
Plan Goals Addressed: Logistics
Constraints: Terrain will limit the amount of safe evacuation routes.

Action Item #4: Review local ordinances regarding building and development in landslide prone areas.

Ideas for Implementation:

- Create committee of local stakeholders to study landslide-related issues and make recommendations to staff.

Coordinating Organization: Development Services Dept.
Timeline: 3-5 yrs.
Plan Goals Addressed: Regulation, permitting
Constraints: None

Action Item #5: Limit activities in identified potential and historical landslide areas through regulation and public outreach.

Ideas for Implementation:

- Analyze existing regulations regarding development in landslide prone areas

- Identify existing mechanisms for public outreach (cable, newspaper, mailers, City website).

Coordinating Organization: Development Services Dept.
Timeline: Ongoing
Plan Goals Addressed: Regulation, permitting
Constraints: None

Action Item #6: To the extent feasible, provide protective measures designed to limit debris flow resulting from the fire/mudflow sequence, thereby reducing the threat to life and property relative to existing development in threatened areas..

Ideas for Implementation:

- Plan for and install barriers to mud/debris flows following wildfire events.

- Identify emerging technologies utilized in slope stabilization and erosion control

Coordinating Organization: Public Works Dept.
Timeline: Ongoing
Plan Goals Addressed: Protection of Life and Property, Emergency Services
Constraints: None

SECTION 9: FLOODS

Why are Floods a Threat to the City of Sierra Madre?

The City of Sierra Madre's topography is comprised of a naturally downgraded slope. It is bisected by the Los Angeles River, which is susceptible to flooding events; however a flooding event from this source has never been documented in the history of Sierra Madre. Although Sierra Madre's topography is comprised of a naturally downgraded slope the areas of Little Santa Anita Canyon and Bailey Canyon have tended to produce minor flooding events.

The City of Sierra Madre was most recently affected by the flooding & mudslides from the burn area above Sierra Madre & Arcadia. Mudflow destroyed public drainage, portions of Chantry Flats Road and damaged homes in Arcadia & Sierra Madre. There was an estimated $600,000 in damage, which is 13% of the City's annual operating budget.

History of Flooding in Southern California/ Sierra Madre

The City of Sierra Madre is susceptible to flooding from primarily flash floods and or flooding as a result of debris flows clogging the public drainage system. Minor floods have affected the citizens of Sierra Madre since as early as 1889. Below is a list of floods affecting the City of Sierra Madre from 1889 to present:

1889-1900	Rainfall total for 2 month period totals 23.63 and causes flooding.
April 1926	Heavy rains poured down the Little Santa Anita Canyon, changing the course of the stream, filling the canyon swimming pool with debris and damaging many homes. An early assessment of the damage indicated that 20 houses and cabins were damaged for an estimated total of more than $35,000. The Sierra Madre chapter of the American Red Cross provided relief to those whose homes were destroyed in the flood.
March 2, 1938	A total of 28.81 inches of rain had fallen and the watershed was saturated; an additional 13.95 inches of rain triggered the worst flood of the Big Santa Anita Canyon; cabins are destroyed;
January 19, 1954	several in. of rain within 24 hours caused mudslides
January 28, 1954	2.71 inches of rain fell causing more flooding and mudslides.
February 1962	Flooding on Canyon Crest Drive and Carriage House Road.

January 1969 Flooding on Churchill Road and one home at 390 Churchill declared a total loss; heavy storm caused dam overflow although flood gates were wide open.

October 1978 Flood produced a total of 38 mm of rain and lasted 2 days. At its' peak, 10 min. intensity rainfall was estimated at12-25 mm/hr.

February 2000 Flooding & mudslides from the burn area above Sierra Madre & Arcadia. Mudflow destroyed public drainage, portions of Chantry Flats Road and damaged homes in Arcadia & Sierra Madre.

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.

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.[56] Table 9-1 lists all documented major floods of the Los Angeles River from 1811 to present.

Table 9-1: Major Floods of the Los Angeles River	
1811	Flooding
1815	Flooding
1825	L.A. 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)	

While the City of Sierra Madre is 12 miles northeast of Los Angeles, it is not so far away as to not be affected by the heavy rains that brought flooding to Los Angeles. In addition, the towering mountains that give the Los Angeles region its spectacular views also 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"[57]

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. In the City of Sierra Madre, geography and climate combine to create chronic seasonal flooding conditions. Butted up against the foothills, Sierra Madre's flooding is usually a result of mudflow that has come off the base of hillsides and compromised the city's drainage system. These floods/debris flows are usually a result of winter storms following a previous summer's wildfire.

Winter Rainfall

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

The City of Sierra Madre is in the eastern section of the San Gabriel Valley. It is up against the San Gabriel Mountains, which increases its potential for collection and swift conveyance of stormwater.

Monsoons

Another relatively regular source for heavy rainfall, particularly in the mountains and adjoining cities is from summer tropical storms. Table 9-2 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 9-2: Tropical cyclones that have affected Southern California during the 20th Century

Month-Year	Date(s)	Area(s) Affected	Rainfall
July 1902	20th & 21st	Deserts & Southern Mountains	up to 2"
Aug. 1906	18th & 19th	Deserts & Southern Mountains	up to 5"
Sept. 1910	15th	Mountains of Santa Barbara County	2"
Aug. 1921	20th & 21st	Deserts & Southern Mountains	up to 2"
Sept. 1921	30th	Deserts	up to 4"
Sept. 1929	18th	Southern Mountains & Deserts	up to 4"
Sept. 1932	28th - Oct 1st	Mountains & Deserts, 15 Fatalities	up to 7
Aug. 1935	25th	Southern Valleys, Mountains & Deserts	up to 2"
Sept. 1939	4th - 7th	Southern Mountains, Southern & Eastern Deserts	up to 7
	11th & 12th	Deserts, Central & Southern Mountains	up to 4"
	19th - 21st	Deserts, Central & Southern Mountains	up to 3"
	25th	Long Beach, W/ Sustained Winds of 50 Mph	5"

Table 9-2: Tropical cyclones that have affected Southern California during the 20th Century			
		Surrounding Mountains	6 to 12"
Sept. 1945	9th & 10th	Central & Southern Mountains	up to 2”
Sept. 1946	30th - Oct 1st	Southern Mountains	up to 4"
Aug. 1951	27th - 29th	Southern Mountains & Deserts	2 to 5"
Sept. 1952	19th - 21st	Central & Southern Mountains	up to 2"
July 1954	17th - 19th	Deserts & Southern Mountains	up to 2"
July 1958	28th & 29th	Deserts & Southern Mountains	up to 2"
Sept. 1960	9th & 10th	Julian	3.40"
Sept. 1963	17th - 19th	Central & Southern Mountains	up to 7"
Sept. 1967	1st - 3rd	Southern Mountains & Deserts	2"
Oct. 1972	6th	Southeast Deserts	up to 2"
Sept. 1976	10th & 11th	Central & Southern Mountains. Ocotillo, CA was Destroyed 3 Fatalities	6 to 12"
Aug. 1977	n/a	Los Angeles	2"
		Mountains	up to 8"
Oct. 1977	6th & 7th	Southern Mountains & Deserts	up to 2
Sept. 1978	5th & 6th	Mountains	3"
Sept. 1982	24th - 26th	Mountains	up to 4"
Sept. 1983	20th & 21st	Southern Mountains & Deserts	up to 3"
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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"[58]

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.

Development

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 impervious 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. FEMA has indicated to the City of Sierra Madre that there is not a 100-year floodplain within the City.

Floodway

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

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

Flood Fringe

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

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

The type of flooding that primarily affects the City of Sierra Madre is urban flooding (see descriptions below). In addition, any low-lying area has the potential to flood. The flooding of developed areas may occur when the amount of water generated from

rainfall and runoff exceeds a storm water system's capability to remove it.

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.

Almost 40% percent of the area in the City of Sierra Madre has a high concentration of impermeable surfaces that either collect water, or concentrate the flow of water in unnatural channels. During periods of urban flooding, streets can become swift moving rivers and basements can fill with water. Storm drains often back up with vegetative debris causing additional, localized flooding.

Riverine Flooding

Riverine flooding is the overbank flooding of rivers and streams. The natural processes of riverine flooding add sediment and nutrients to fertile floodplain areas. Flooding in large river systems typically results from large-scale weather systems that generate prolonged rainfall over a wide geographic area, causing flooding in hundreds of smaller streams, which then drain into the major rivers. Shallow area flooding is a special type of riverine flooding. FEMA defines shallow flood hazards as areas that are inundated by the 100-year flood with flood depths of only one to three feet. These areas are generally flooded by low velocity sheet flows of water.

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 Sierra Madre. The major dam which could have a significant impact on the City in the event of dam failure is the Little Santa Anita Dam/Sierra Madre Dam. Failure of this dam during a catastrophic event, such as a severe earthquake is considered a very unlikely event. Due to the method of construction of this dam, it has performed well in earthquakes, and failure is not expected to occur.

Flooding which occurs as a result of the structural failure of a dam is called dam inundation. Structural failure may be caused by seismic activity. Seismic activity may also cause dam inundation by the action of a seismically induced wave which overtops the dam without also causing dam failure. This action is referred to as a seiche. Landslides flowing into a reservoir are also a source of potential dam failure from overtopping.

The area one quarter of a mile west of Santa Anita Canyon is an area requiring flood control. According to the Los Angeles County Public Works Department, the City of Sierra Madre is included in Big Santa Anita Dam's inundation area. However, even though the dam is located 2 miles northeast of the City, the dam is not considered to be a threat to the City in the event of dam failure. The Sierra Madre Dam operates as a "dry" dam and contains water only during rain as a flood control device.

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 9 -3.

Table 9-3: Major 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, over 500 deaths
Cogswell	Monrovia	1934	Breaching of concrete cover
Baldwin Hills	Los Angeles	1963	Leak through embankment turned into washout, 5 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."[59]

The Baldwin Hills dam failed during the daylight hours, and was one of the first disaster events documented a live helicopter broadcast.

Baldwin Hills Dam - Dark spot in upper right hand quadrant shows the beginning of the break in the dam.

"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."[60]

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."[61]

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. As Sierra Madre is located at the base of the San Gabriel Valley Mtns., this type of flooding would not occur within the City.

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 level.

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. In Sierra Madre great care is 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 National Flood Insurance Program (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.

As of October 2000 the City of Sierra Madre has received notification from FEMA that our community is not required to implement any floodplain management regulations as a condition for participation in the NFIP. (See Appendix F)

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 and Sierra Madre is within one of these floodplains.

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. FEMA has never printed a FIRM for the City of Sierra Madre nor does it plan to as indicated in its letter of October 2000 (see Appendix H). 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. However the case, 0% of all flood-related damage from past floods in the City of Sierra Madre is located outside the boundaries of the FEMA's FIRMs.

In order to address this lack of data, the City of Sierra Madre, as well as other jurisdictions, has taken efforts to develop more localized flood hazard maps. One method that has been employed includes using GIS (Geographic Information System) for flood hazard mapping. FIRM maps can be imported directly into GIS, which allows for GIS analysis of flood hazard areas. Map 14 is a FEMA 100-year flood plain map of Area D. Map 15 is a FEMA 100-year flood plain map of Sierra Madre. Map 16 is a dam failure inundation map of Area D and Map 17 is a dam failure inundation map of Sierra Madre.
Bailey Canyon Debris Basin and Sierra Madre Dam are two of seven debris-retention facilities within the boundaries of Sierra Madre.

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; however it is not available for Sierra Madre. 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.

Within the City of Sierra Madre there are specific areas which are considered to be a special risk for flooding. All of these areas are against the foothills and are of significant risk of flooding and landslides after a brush fire.

The canyon areas above the city are most prone to major flooding. In the years immediately following a brush fire in the foothills, these areas can pose an extreme hazard to persons and property following abundant rainfall. Flood in the special risk areas can occur rapidly or slowly depending on the heaviness and severity of rainfall and prior existence of fire. Special flood hazard areas located in the residential portion of the city are subject to minor flooding.

Data Sources

FEMA mapped the 100 -year and 500-year floodplains through the Flood Insurance Study (FIS) in conjunction with the United States Army Corps of Engineers (USACE) in August of 1987. There were previous studies done, including a Housing and Urban Development (HUD) study, which mapped the floodplain in March of 1978, this is when the City of Sierra Madre initially entered into the NFIP. September 1984, is the first time in which FEMA notified the City that they have no special flood hazard areas existing at that time (See Exhibit B). The county has updated portions of the USACE and FEMA maps through smaller drainage studies in the county since that time.

Vulnerability Assessment

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

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 Sierra Madre will continue to be at minimal risk from flooding because flood damage doesn't occur on a regular basis throughout the county. Property loss from floods strikes both private and public property. Losses in the City of Sierra Madre over the past 25 years have totaled approximately $0.

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
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 Sierra Madre 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. 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. The City of Sierra Madre has eight small bridges that traverse a Los Angeles County flood control channel. This channel is maintained by the County and the bridges are inspected by the City and the County every two years.

Storm Water Systems
Local drainage problems are common throughout the City of Sierra Madre. Drainage is addressed in the City's General Plan, and City of Sierra Madre public works staff is aware of local drainage problem areas. The problems are often present where storm water runoff enters culverts or enters low lying properties.

Water/Wastewater Treatment Facilities
Wastewater derived from Sierra Madre is conveyed to the Los Angeles County Sanitation Districts wastewater treatment facility in Whittier. The City of Sierra Madre provides water to the residents as part of its city services.

Water Quality
Environmental quality problems include bacteria, toxins, and pollution. The City of Sierra Madre has a comprehensive stormwater pollution prevention program that is designed to educate residents, contractors, developers, businesses and schools that only stormwater should be allowed to enter the stormdrain system. We also contract

with the County of Los Angeles Public Works to perform annual catch basin cleaning. In conjunction with this annual cleaning the City of Sierra Madre also cleans out catch basins in high traffic areas monthly.

Flood Mitigation Activities

The City of Sierra Madre Codes

The City of Sierra Madre uses building codes, zoning codes, and various planning strategies to address the goals which aim at restricting development in areas of known hazards, and applying the appropriate safeguards.

Mitigation Requirements

The City of Sierra Madre Municipal Code § 15.04.070 prohibits:

- Construction upon, destruction or curtailment in the capacity of storm drain facilities installed under and by virtue of Title 17 of the code
- Construction, excavation or fill which changes the grade of the natural slope of the surface of any lot or lots so that the water drainage thereon is changed to run onto a different location or in greater quantity or at an accelerated rate, or in a way that cerates a hazard to the public health, safety or property. The decision of the building inspector shall be based upon the recommendation of the city engineer concerning the continued necessity of such drainage installations or of reasonable substitutes therefore.
- …run onto a different location or in greater quantity or at an accelerated rate, or in a way that cerates a hazard to the public health, safety or property. The decision of the building inspector shall be based upon the recommendation of the city engineer concerning the continued necessity of such drainage installations or of reasonable substitutes therefore.

Water Districts

The City of Sierra Madre owns its own self-contained water production and distribution systems. The City is in the process of replacing old cast iron, asbestos concrete and riveted steel pipes with more ductile iron pipes, which will be more resilient in disaster situations. During a disaster, water providers in the region work together to provide water for each other. The City of Sierra Madre has built inter-ties with the Cities of Arcadia and Pasadena for emergency situations, and is in the process of establishing an emergency connection to MWD for emergency water.

Riparian Areas

Riparian areas are important transitional areas that link water and land ecosystems. Vegetation in riparian areas is dependent on stream processes, such as flooding, and often is composed of plants that require large amounts of water, such as willows and cottonwood trees. Healthy vegetation in riparian buffers can reduce streamside erosion.

Sierra Madre does not contain any riparian areas within its corporate boundary, but there are riparian areas located in the Angeles Forest, located immediately north of Sierra Madre.

Stormwater Systems
The County of Los Angeles Department of Public Works/Flood Control Division (FCD) and the City of Sierra Madre handles all stormwater runoff collection systems in Sierra Madre. The City provides its NPDES-related stormwater quality management in house.

Flood Management Projects
Sierra Madre is located in the foothills of the Angeles National Forest, at the base of a mountainous area noted for repetitive fire/flood sequences. Following a particularly devastating fire/flood sequence, the FCD began an ambitious program of constructing debris-retention facilities in all natural canyons along the foothills. Six such County owned and operated structures lie within the City's corporate boundary, from west to east:

- Bailey Canyon DB
- Auburn DB
- Carter DB
- Sierra Madre Dam
- Sturtevant DB
- Lannan DB

A seventh facility, located between Bailey Canyon DB and Auburn DB is the Floral Debris basin, owned and operated by the City. Only one major canyon above Sierra Madre remains unprotected from mudflow and flood discharge, that being the private property that discharges onto Stonehouse Road adjacent to East Grandview.

Community Issues Summary

The City of Sierra Madre works to mitigate problems regarding flood issues when they arise. However, funding, time and manpower are often unavailable, causing the problems to go unresolved. Some areas in the City of Sierra Madre are more susceptible to flooding issues, and have incurred minor repetitive losses.

Flood Mitigation Action Items

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

Due to there being no repetitive flood properties and $0 lost within the City of Sierra Madre from flooding in the last 25 years, the Sierra Madre Disaster Mitigation Committee has determined that only two action items are needed to address the flooding situation in Sierra Madre.

Action Item # 1*:* Enhance data and mapping for floodplain information within the county, and identify and map flood-prone areas outside of designated floodplains.

Ideas for Implementation:

- Apply for FEMA's cooperative technical partnership using the 2-foot Coordinate with appropriate organizations to evaluate the need for more stream gauges; and contour interval floodplain mapping data acquired by the City of Sierra Madre GIS

Coordinating Organization: Public Works Dept.
Timeline: 5 years
Plan Goals Addressed: Protect Life and Property
Constraints: Limited staff to coordinate with FEMA and appropriate organizations

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Action Item # 2*:* Identify surface water drainage obstructions for all parts of the City of Sierra Madre.

Ideas for Implementation:

- Map culverts in areas of the City
- Prepare an inventory of culverts that historically create flooding problems and target them for retrofitting; and
- Prepare an inventory of major urban drainage problems, and identify causes and potential mitigation actions for urban drainage problem areas.
- Develop surface water management plans for areas that are not currently within surface water management plan boundaries.

Coordinating Organization: Public Works Dept.

Timeline:	5 years
Plan Goals Addressed:	Protect Life and Property
Constraints:	Limited Public Works crew staff to dedicate toward identifying

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58. Ibid

59. http://www.usc.edu/isd/archives/la/scandals/st_francis_dam.html

60. http://www.latimes.com/news/local/surroundings/la-me-surround11dec11,0,1754871.story?coll=la-adelphia-right-rail

61. http://www.fema.gov/rrr/talkdiz/landslide.shtm#what

SECTION 10: WINDSTORMS

Why are Severe Windstorms a Threat to the City of Sierra Madre?

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.

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 Sierra Madre 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."[c] 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."[d]
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 10-1 below depicts the 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.[lxii]

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.[lxiii]

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.[lxiv]

"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."[lxv]
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

While the effects of Santa Ana Winds are often overlooked, it should be noted that in 2003, two deaths in Southern California were directly related to the fierce condition. A falling tree struck one woman in San Diego.[lxvi] The second death occurred when a passenger in a vehicle was hit by a flying pickup truck cover launched by the Santa Ana Winds.[lxvii]

Major Windstorms

Table 10-2: Santa Ana wind events featured in news resources during 2003

January 6, 2003 OC Register	"One of the strongest Santa Ana windstorms in a decade toppled 26 power poles in Orange early today, blew over a mobile derrick in Placentia, crushing two vehicles, and delayed Metrolink rail service." This windstorm also knocked out power to thousands of people in northeastern Orange County.
January 8, 2003 CBSNEWS.com	"Santa Ana's roared into Southern California late Sunday, blowing over trees, trucks and power poles. Thousands of people lost power."
March 16, 2003 dailybulletin.com	Fire Officials Brace for Santa Ana Winds - - "The forest is now so dry and so many trees have died that fires, during relatively calm conditions, are running as fast and as far as they might during Santa Ana Winds. Now the Santa Ana season is here. Combine the literally tinder dry conditions with humidity in the single digits and 60-80 mph winds, and fire officials shudder."

Windstorm Hazard Assessment

Hazard Identification

1Map from NASA's "Observatorium"

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 Sierra Madre area can cause extensive damage including heavy tree stands, exposed properties, road infrastructure, and critical utility facilities.

The illustration below clearly shows 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 Sierra Madre is in the direct path of the ocean-bound Santa Ana winds.

Vulnerability Assessment

Vulnerability assessment is
the second step of windstorm-hazard assessment. It combines
the San Gabriel Mountains boundary, generated through hazard identification, with an inventory of the property within the windstorm region. Understanding the population and property exposed to natural hazards will assist in reducing risk and preventing loss from future events. The amount of property in the windstorm region, as well as the type and value of structures on those properties, should be calculated to provide a working estimate for potential windstorm losses.

With an analysis of the high wind and tornado events depicted in the "Local History" section, 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.

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 windstorm risk analysis for the City of Sierra Madre should include two components: (1) the life and value of property that may incur losses from a windstorm event (defined through the vulnerability assessment); and (2) the number and type of windstorm 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. HAZUS wind velocity models can assist in predicting the amount of damage expected from different magnitudes of windstorm events. The data used to develop these models is based on topographical analysis of landscape features in relation to the traditional windflow

paths associated with the Santa Ana winds. Changes in the landscape, often associated with human development, can alter the windflow velocity and the severity of damage that can be expected from a windstorm event.

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

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 Sierra Madre 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.

Table 10 – 3 below identifies the Beaufort Scale. Coined and developed by Sir Francis Beaufort in 1805, it illustrates the effect that varying wind speed can have on sea swells and structures:

Table 10-3: BEAUFORT SCALE

Beaufort Force	Speed (mph)	Wind Description - State of Sea - Effects on Land
0	Less 1	Calm - Mirror-like - Smoke rises vertically
1	1-3	Light - Air Ripples look like scales; No crests of foam - Smoke drift shows direction of wind, but wind vanes do not
2	4-7	Light Breeze - Small but pronounced wavelets; Crests do not break - Wind vanes

		move; Leaves rustle; You can feel wind on the face
3	8-12	Gentle Breeze - Large Wavelets; Crests break; Glassy foam; A few whitecaps - Leaves and small twigs move constantly; Small, light flags are extended
4	13-18	Moderate Breeze - Longer waves; Whitecaps - Wind lifts dust and loose paper; Small branches move
5	19-24	Fresh Breeze - Moderate, long waves; Many whitecaps; Some spray - Small trees with leaves begin to move
6	25-31	Strong Breeze - Some large waves; Crests of white foam; Spray - Large branches move; Telegraph wires whistle; Hard to hold umbrellas
7	32-38	Near Gale - White foam from breaking waves blows in streaks with the wind - Whole trees move; Resistance felt walking into wind
8	39-46	Gale - Waves high and moderately long; Crests break into spin drift, blowing foam in well marked streaks - Twigs and small branches break off trees; Difficult to walk
9	47-54	Strong Gale - High waves with wave crests that tumble; Dense streaks of foam in wind; Poor visibility from spray - Slight structural damage
10	55-63	Storm - Very high waves with long, curling crests; Sea surface appears white from blowing foam; Heavy tumbling of sea; Poor visibility - Trees broken or uprooted; Considerable structural damage
11	64-73	Violent Storm - Waves high enough to hide small and medium sized ships; Sea covered with patches of white foam; Edges of wave crests blown into froth; Poor visibility - Seldom experienced inland; Considerable structural damage
12	>74	Hurricane - Sea white with spray. Foam and spray render visibility almost non-existent - Widespread damage. Very rarely experienced on land.

Source: http://www.compuweather.com/decoder-charts.html

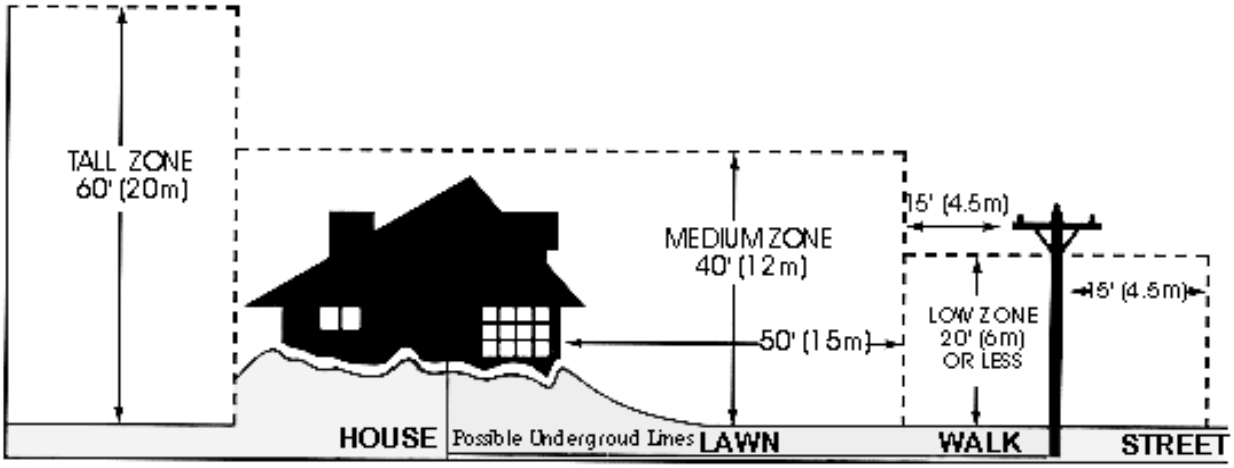
Utilities

Historically, falling trees have been the major cause of power outages in the region. Windstorms such as strong microbursts and Santa Ana Wind conditions can cause flying debris and downed utility lines.

For example, tree limbs breaking in winds of only 45 mph can be thrown over 75 feet. As such, overhead power lines can be damaged even in relatively minor windstorm events. Falling trees can bring electric power lines down to the pavement, creating the possibility of lethal electric shock. Rising population growth and new infrastructure in the region creates a higher probability for damage to occur from windstorms as more life and property are exposed to risk.

Infrastructure

Windstorms can damage buildings, power lines, and other property and infrastructure



due to falling trees and branches. During wet winters, saturated soils cause trees to become less stable and more vulnerable to uprooting from high winds.

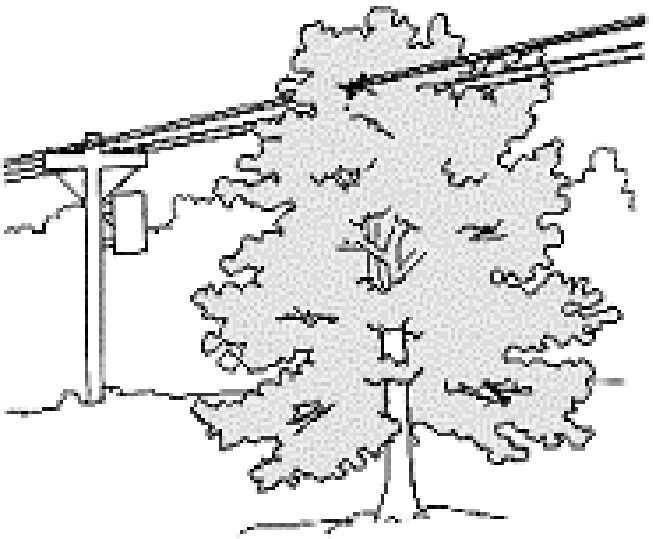
Windstorms can result in collapsed or damaged buildings or blocked roads and bridges, damaged traffic signals, streetlights, and parks, among others. Roads blocked by fallen trees during a windstorm may have severe consequences to people who need access to emergency services. Emergency response operations can be complicated when roads are blocked or when power supplies are interrupted. Industry and commerce can suffer losses from interruptions in electric services and from extended road closures. They can also sustain direct losses to buildings, personnel, and other vital equipment. There are direct consequences to the local economy resulting from windstorms related to both physical damages and interrupted services.

Increased Fire Threat

Perhaps the greatest danger from windstorm activity in Southern California comes from the combination of the Santa Ana winds with the major fires that occur every few years in the urban/wildland interface. With the Santa Ana winds driving the flames, the speed and reach of the flames is even greater than in times of calm wind conditions. The higher fire hazard raised by a Santa Ana wind condition requires that even more care and attention be paid to proper brush clearances on property in the wildland/urban interface areas.

Transportation

Windstorm activity can have an impact on local transportation in addition to the problems caused by downed trees and electrical wires blocking streets and highways. During periods of extremely strong Santa Ana winds, major highways can be temporarily closed to truck and recreational vehicle traffic. However, typically these disruptions are not long lasting, nor do they carry a severe long term economic impact on the region.



Existing Windstorm Mitigation Activities

As stated, one of the most common problems associated with windstorms is power outage. High winds commonly occur during winter storms, and can cause trees to bend, sag, or fail (tree limbs or entire trees), coming into contact with nearby distribution power lines. Fallen trees can cause short-circuiting and conductor overloading. Wind-induced damage to the power system causes power outages to customers, incurs cost to make repairs, and in some cases can lead to ignitions that start wild land fires.

One of the strongest and most widespread existing mitigation strategies pertains to tree clearance. Currently, California State Law requires utility companies to maintain specific clearances (depending on the type of voltage running through the line) between electric power lines and all vegetation.

Enforcement of the following California Public Resource Code Sections provides guidance on tree pruning regulations:[lxviii]

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 Mitigation Action Items

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

Action Item #1: Public Awareness Campaign: To provide public education materials to City of Sierra Madre residents and all School District staff, parents and age-appropriate students with mitigation materials pertaining to the protection of life and property before, during, and after a windstorm.

Ideas for Implementation:

- Compile mitigation brochures from the following organizations: FEMA; California Public Utilities Commission; County of Los Angeles Public Works; Southern California Edison; Tree Line Connection

- Distribute these materials to City of Sierra Madre residents and school district members. Materials can be distributed at City Council Meetings, Commission Meetings, City Hall, Recreation Center, Fire Department, Police Department, Chamber of Commerce Meetings, School Administration Offices and other appropriate venues.

- Create community PowerPoint seminar to be given at RACES joint hazard training event. Utilize presentation at future City Council Meetings or other

public events as appropriate.

Coordinating Organization: City of Sierra Madre Volunteer Fire Departement
Timeline: Ongoing
Plan Goals Addressed: Public Awareness, Protection of Life and Property
Constraints: None

Action Item #2: Create local City and utility awareness of tree pruning and Fire Code Sections relevant to wind-resistant utility operations

Ideas for Implementation:

- Provide information to City Planning Departments and local utility companies encouraging compliance with State and Local tree clearance and integrity guidelines
- Compile comprehensive list of pertinent State and local regulations
- Create community PowerPoint seminar to be given at RACES joint hazard training event. Utilize presentation at future City Council Meetings or other public events as appropriate.
- City and School officials encouraging utility compliance with guidelines

Coordinating Organization: Public Works Dept.
Timeline: Ongoing
Plan Goals Addressed: Public Awareness, Protection of Life and Property
Constraints: None

Action Item #3: Encourage Critical City Facilities to purchase and/or test backup power facilities for use during a power failure. Create an equipment/testing log to ensure backup power equipment is in working service.

Ideas for Implementation:

- Gather all databases of backup power equipment for critical facilities.
- Test all critical facility backup power generators.
- Keep an accurate record of equipment specification and testing date information.

Coordinating Organization: Public Works Dept.
Timeline: Ongoing
Plan Goals Addressed: Public Awareness, Protection of Life and Property
Constraints: None

APPENDIX
A

PLAN RESOURCE DIRECTORY

Master Resource Directory

The Resource Directory provides contact information for local, regional, state, and federal programs that are currently involved in hazard mitigation activities. The City of Sierra Madre Disaster Mitigation Committee may look to the organizations on the following pages for resources and technical assistance. The Resource Directory provides a foundation for potential partners in action item implementation.

The Sierra Madre Disaster Mitigation Committee will continue to add contact information for organizations currently engaged in hazard mitigation activities. This section may be used by various community members interested in hazard mitigation information and projects.

American Public Works Association			
Level: National	Hazard: Multi	http://www.apwa.net	
2345 Grand Boulevard		Suite 500	
Kansas City, MO 64108-2641		Ph: 816-472-6100	Fx: 816-472-1610
Notes: The American Public Works Association is an international educational and professional association of public agencies, private sector companies, and individuals dedicated to providing high quality public works goods and services.			
Association of State Floodplain Managers			
Level: Federal	Hazard: Flood	www.floods.org	
2809 Fish Hatchery Road			
Madison, WI 53713		Ph: 608-274-0123	Fx:
Notes: 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			
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.			
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 Environmental Resources Evaluation System (CERES)			
Level: State	Hazard: Multi	http://ceres.ca.gov/	
900 N St.		Suite 250	
Sacramento, Ca. 95814		Ph: 916-653-2238	Fx:
Notes: CERES is an excellent website for access to environmental information and websites.			
California Department of Water Resources (DWR)			
Level: State	Hazard: Flood	http://wwwdwr.water.ca.gov	
1416 9th Street			
Sacramento, CA 95814		Ph: 916-653-6192	Fx:
Notes: The Department of Water Resources manages the water resources of California in cooperation with other agencies, to benefit the State's people, and to protect, restore, and enhance the natural and human environments.			
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.			

City of El Monte			
Level: Local	Hazard: Multi	http://www.ci.el-monte.ca.us/aboutem/aboutem.html	
11333 Valley Blvd			
El Monte, CA 91731		Ph: (626) 580-2100	Fx:
Notes: The District is within the City of El Monte which was the source for historical information and Community Profile. The City's disaster plan also provided natural hazard background information.			
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 of a number of programs and activities of which provide citizens Protection, with flood insurance; Prevention, with mitigation measures and Partnerships, with communities throughout the country.			
Floodplain Management Association			
Level: Federal	Hazard: Flood	www.floodplain.org	
P.O. Box 50891			
Sparks, NV 89435-0891		Ph: 775-626-6389	Fx: 775-626-6389
Notes: The Floodplain Management Association is a nonprofit educational association. It was established in 1990 to promote the reduction of flood losses and to encourage the protection and enhancement of natural floodplain values. Members include representatives of federal, state and local government agencies as well as private firms.			
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.			

Los Angeles County Economic Development Corporation			
Level: Regional	Hazard: Multi	www.laedc.org	
444 S. Flower Street		34th Floor	
Los Angeles, CA 90071		Ph: 213-236-4813	Fx: 213- 623-0281
Notes: The LAEDC is a private, non-profit 501 (c) 3 organization established in 1981 with the mission to attract, retain and grow businesses and jobs in the Los Angeles region. The LAEDC is widely relied upon for its Southern California Economic Forecasts and Industry Trend Reports. Lead by the renowned Jack Kyser (Sr. Vice President, Chief Economist) his team of researchers produces numerous publications to help business, media and government navigate the LA region's diverse economy.			
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			
National Resources Conservation Service			
Level: Federal	Hazard: Multi	http://www.nrcs.usda.gov/	
14th and Independence Ave., SW		Room 5105-A	
Washington, DC 20250		Ph: 202-720-7246	Fx: 202-720-7690
Notes: NRCS assists owners of America's private land with conserving their soil, water, and other natural resources, by delivering technical assistance based on sound science and suited to a customer's specific needs. Cost shares and financial incentives are available in some cases.			
National Fire Protection Association (NFPA)			
Level: National	Hazard: Wildfire	http://www.nfpa.org/catalog/home/index.asp	
1 Batterymarch Park			
Quincy, MA 02169-7471		Ph: 617-770-3000	Fx: 617 770-0700
Notes: The mission of the international nonprofit NFPA is to reduce the worldwide burden of fire and other hazards on the quality of life by providing and advocating scientifically-based consensus codes and standards, research, training and education			

National Floodplain Insurance Program (NFIP)			
Level: Federal	Hazard: Flood	www.fema.gov/nfip/	
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.			
National Oceanic /Atmospheric Administration			
Level: Federal	Hazard: Multi	www.noaa.gov	
14th Street & Constitution Ave NW		Rm 6013	
Washington, DC 20230		Ph: 202-482-6090	Fx: 202-482-3154
Notes: NOAA's historical role has been to predict environmental changes, protect life and property, provide decision makers with reliable scientific information, and foster global environmental stewardship.			
National Weather Service			
Level: Federal	Hazard: Multi	http://www.nws.noaa.gov/	
520 North Elevar Street			
Oxnard, CA 93030		Ph: 805-988- 6615	Fx:
Notes: The National Weather Service is responsible for providing weather service to the nation. It is charged with the responsibility of observing and reporting the weather and with issuing forecasts and warnings of weather and floods in the interest of national safety and economy. Briefly, the priorities for service to the nation are: 1. protection of life, 2. protection of property, and 3. promotion of the nation's welfare and economy.			
San Gabriel Valley Economic Partnership			
Level: Regional	Hazard: Multi	www.valleynet.org	
4900 Rivergrade Road		Suite A310	
Irwindale, CA 91706		Ph: 626-856-3400	Fx: 626-856-5115
Notes: The San Gabriel Valley Economic Partnership is a non-profit corporation representing both public and private sectors. The Partnership is the exclusive source for San Gabriel Valley-specific information, expertise, consulting, products, services, and events. It is the single organization in the Valley with the mission to sustain and build the regional economy for the mutual benefit of all thirty cities, chambers of commerce, academic institutions, businesses and residents.			

Sanitation Districts of Los Angeles County			
Level: County	Hazard: Flood	http://www.lacsd.ora/	
1955 Workman Mill Road			
Whittier, CA 90607		Ph:562-699-7411 x2301	Fx:
Notes: The Sanitation Districts provide wastewater and solid waste management for over half the population of Los Angeles County and turn waste products into resources such as reclaimed water, energy, and recyclable materials.			
South Coast Air Quality Management District (AQMD)			
Level: Regional	Hazard: Multi	www.aqmd.gov	
21865 E. Copley Drive			
Diamond Bar, CA 91765		Ph: 800-CUT-SMOG	Fx:
Notes: AQMD is a regional government agency that seeks to achieve and maintain healthful air quality through a comprehensive program of research, regulations, enforcement, and communication. The AQMD covers Los Angeles and Orange Counties and parts of Riverside and San Bernardino Counties.			
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.			
Southern California Association of Governments (SCAG)			
Level: Regional	Hazard: Multi	www.scag.ca.gov	
818 W. Seventh Street		12th Floor	
Los Angeles, CA 90017		Ph: 213-236-1800	Fx: 213-236-1825
Notes: The Southern California Association of Governments functions as the Metropolitan Planning Organization for six counties: Los Angeles, Orange, San Bernardino, Riverside, Ventura and Imperial. As the designated Metropolitan Planning Organization, the Association of Governments is mandated by the federal government to research and draw up plans for transportation, growth management, hazardous waste management, and air quality.			

State Fire Marshal (SFM)			
Level: State	Hazard: Wildfire	http://osfm.fire.ca.gov	
1131 "S" Street			
Sacramento, CA 95814		Ph: 916-445-8200	Fx: 916-445-8509
Notes: The Office of the State Fire Marshal (SFM) supports the mission of the California Department of Forestry and Fire Protection (CDF) by focusing on fire prevention. SFM regulates buildings in which people live, controls substances which may, cause injuries, death and destruction by fire; provides statewide direction for fire prevention within wildland areas; regulates hazardous liquid pipelines; reviews regulations and building standards; and trains and educates in fire protection methods and responsibilities.			
The Community Rating System (CRS)			
Level: Federal	Hazard: Flood	http://www.fema.gov/nfip/crs.shtm	
500 C Street, S.W.			
Washington, D.C. 20472		Ph: 202-566-1600	Fx:
Notes: The Community Rating System (CRS) recognizes community floodplain management efforts that go beyond the minimum requirements of the NFIP. Property owners within the County would receive reduced NFIP flood insurance premiums if the County implements floodplain management practices that qualify it for a CRS rating. For further information on the CRS, visit FEMA's website.			
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.			
US Army Corps of Engineers			
Level: Federal	Hazard: Multi	http://www.usace.army.mil	
P.O. Box 532711			
Los Angeles CA 90053- 2325		Ph: 213-452- 3921	Fx:
Notes: The United States Army Corps of Engineers work in engineering and environmental matters. A workforce of biologists, engineers, geologists, hydrologists, natural resource managers and other professionals provide engineering services to the nation including planning, designing, building and operating water resources and other civil works projects.			

USGS Water Resources			
Level: Federal	Hazard: Multi	www.water.usgs.gov	
6000 J Street		Placer Hall	
Sacramento, CA 95819-6129		Ph: 916-278-3000	Fx: 916-278-3070
Notes: The USGS Water Resources mission is to provide water information that benefits the Nation's citizens: publications, data, maps, and applications software.			
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.			

APPENDIX

B

THE PUBLIC PARTICIPATION PROCESS

The Public Participation Process

Public participation is a key component to the strategic planning process. Community participation offers citizens the chance to voice their ideas, interests, and opinions. The Federal Emergency Management Agency also requires public input during the development of mitigation plans.

The City of Sierra Madre Natural Hazard Mitigation Plan integrates a cross-section of citizen input throughout the planning process. To accomplish this goal, the City of Sierra Madre Disaster Mitigation Committee developed a public participation process through these components: (1) developing a committee comprised of knowledgeable individuals representative of the City & the community; (2) designate tasks to Committee members for the purpose of conducting research and plan development; and (3) conduct one public hearing and send out community hazards questionnaires to identify common concerns and ideas regarding hazard mitigation and to discuss specific goals and actions of the mitigation plan.

Integrating public participation during the development of the City of Sierra Madre Natural Hazard Mitigation Plan has ultimately resulted in increased public awareness. Through citizen involvement, the mitigation plan reflects community issues, concerns, and new ideas and perspectives on mitigation opportunities and plan action items.

Sierra Madre Disaster Mitigation Committee

Hazard mitigation at the City of Sierra Madre is overseen by the Sierra Madre Disaster Mitigation Committee, which consists of representatives from various city agencies, representatives from local business and community organizations and the public. Committee members have an understanding of how the community is structured and how residents, businesses, and the environment may be affected by natural hazard events. The committee guided the development of the plan, and assisted in developing plan goals and action items, and sharing local expertise to create a more comprehensive plan.

Table B-1 lists the various people that participated on the City of Sierra Madre Disaster Mitigation Committee.

Table B-1: **Sierra Madre Disaster Mitigation Committee**

Mr. Damien Arrula, City of Sierra Madre, Environmental Analyst
Mr. Bruce Inman, City of Sierra Madre, Director of Public Works
Mr. Matthew Marquez, City of Sierra Madre, Assistant Planner
Mr. Kurt Christiansen, City of Sierra Madre, Director of Development Services
Mr. Roger Keith, resident, City of Sierra Madre
Mr. Stephen Abernethy, City of Sierra Madre Police Dept., Lieutenant

Mr. Steven Heydorff, City of Sierra Madre Volunteer Fire Dept., Battalion Chief

Meetings

The Sierra Madre Disaster Mitigation Committee convened a total of five times. Below are summaries of completed meetings with agendas.

Meeting #1: May 5, 2004

This was the first meeting of the City of Sierra Madre Disaster Mitigation Committee. The Committee was formed to facilitate the planning process through research, assignment of tasks, schedule meetings and public hearings, and present material to the committee for review and approval.

II. Introduction of Members

III. Naming of Alternates

IV. Meeting Schedule

V. Planning Process Overview

VI. Planning Process Outline

VII. Hazard Assessment

- d. Hazard Mitigation Plan Questionnaire
- e. Risk Analysis Matrix
- f. City's Emergency Management Plan/General Plan/Safety Plan/Transportation Plan/ Strategic Plan, etc.
- g. GIS Mapping
- h. Disaster History

VIII. Public Participation Questionnaire

With the exception of July and August the Committee would meet on the second and third Wednesday of each month. The committee members were provided a hazard planning outline, list of meeting dates, summation of disaster history and a copy of the potential community hazards questionnaire.

Our first meeting was an orientation to DMA 2000. The planning process was discussed along with an approximate time frame to complete the process It was determined that a public hearings would be held prior to completion and adoption of the plan. To incorporate as much stakeholder feedback as possible the group conferred on the distribution of community questionnaires.

It was also determined that research should commence immediately on threat analysis, vulnerabilities, City history and profile. This information would be ready for presentation at the second meeting in May.

Meeting #2: May 19, 2004

The focus of the second meeting was public participation, plan review, GIS mapping and hazard analysis.

I. Community Hazards Mitigation Questionnaire
   a. Website
   b. Flyers
   c. Cable Channel
   d. Newspapers
   e. Commissioners

II. Plan review
   a. City's General Plan
   b. 27 Points Document
   c. 5-yr. CIP
   d. Vulnerability Assessment
   e. Parks Master Plan
   f. Transportation Element

III. GIS Mapping

IV. Hazard analysis
   a. Wildfire analysis
   b. Earthquake analysis
   c. Asset and asset value documentation
   d. Asset proximity to hazards and man-caused risks
   e. Identify critical facilities belonging to the City
   f. Identify critical facilities that are non-district owned but critical to operations

Hazard analysis was reviewed. Earthquake was considered the number one hazard with wildfires, earth movements/landslides, flooding, and windstorms following. After performing threat rating the Committee discussed the FEMA Crosswalk so they would have an understanding of how the plan is rated and the components that are required in an approved plan.

A working draft of the earthquake and wildfire sections of the plan was presented to the Committee, but these sections were not ready for their final review and approval.

Meeting #3: June 18, 2004

The Committee received feedback on the developments surrounding the posting of the community hazards questionnaire on the City's website, cable channel, local newspapers and the inclusion of all commissioners from the various City commissions. The 2nd draft the Earthquake analysis was provided for review and comment. An update was provided by all Committee members responsible for researching and extracting a variety of material from City plans. A list of critical facilities was distributed to the Committee members.

I. Community Hazards Mitigation Questionnaire

a) Website
b) Flyers
c) Cable Channel
d) Newspapers
e) Commissioners

II. Plan review

a. City's General Plan
b. Red Cross Family Disaster Plan Documents
c. 5-yr. CIP
d. Vulnerability Assessment
e. Parks Master Plan
f. Sierra Madre Water Disaster Mgmt. Plan
g. SCE Hazard Mitigation Planning Document
h. So Cal Gas
i. Pasadena Unified School District
j. Private schools
k. Other agencies

III. GIS Mapping

a. Area D GIS Maps

IV. Hazard analysis

a. Earthquake analysis 2nd draft
b. Asset and asset value documentation
c. Asset proximity to hazards and man-caused risks
d. Identify critical facilities belonging to the City
e. Identify critical facilities that are non-City owned but critical to operations

Meeting #4: June 30, 2004

The time line was discussed with the Committee. By the end of September the final draft should be completed and ready for review by the Committee and adoption by the Board at the October meeting and public hearing. Area D GIS maps were discussed and it was noted that the legend needs to be transferred to the left side of the map so as not to cover the City.

The Committee reviewed the final working drafts of earthquake and wildfire analysis. There was a brief discussion on the other agencies mitigation plans and where they are in completing and adopting their plans.

I. Plan review

   a. Red Cross 28 pts. Documents-fire, flood, landslide, windstorms

   b. 5-yr. CIP

   c. SEMS Transportation Element

   d. Vulnerability Assessment

   e. So Cal Gas

   f. Pasadena Unified School District

   g. Private Schools

II. GIS Mapping

   b. Area D GIS Maps

III. Hazard analysis

   a. Earthquake analysis 2nd draft

   b. Wildfire analysis 2nd draft

   c. Flood analysis 2nd draft

   d. Asset and asset value documentation

   e. Asset proximity to hazards and man-caused risks

   f. Identify critical facilities belonging to the City

   g. Identify critical facilities that are non-City owned but critical to operations

Meeting #5: July 14, 2004

Public education flyers were discussed as well as the feasibility of the short-term and long-term multi-hazard actions items. The 3rd drafts of the wildfire and flood analysis were presented and approved.

I. Plan review

a. Red Cross 28 pts. Documents-fire, flood, landslide, windstorms

b. So Cal Gas

c. Pasadena Unified School District

d. Private Schools

IV. GIS Mapping

a. Area D GIS Maps

V. Hazard analysis

a. Wildfire analysis 3rd draft

b. Flood analysis 3rd draft

c. Landslides 1st draft

d. Windstorms 1st draft

Community Hazards Questionnaire

Attached as Exhibit B-1 is a copy of the community hazards questionnaire. This questionnaire was made available to all residents, business owners, schools and other institutions within the City.

Public Hearing: October 25, 2004

A completed Natural Hazard Mitigation Plan for the City of Sierra Madre will be presented to the Sierra Madre City Council for review and approval. The plan was approved and adopted by the council on ….

Exhibit B-1

Community Hazards Mitigation and Preparedness Questionnaire

This questionnaire is designed to help the Sierra Madre Disaster Mitigation Committee identify the community's concerns about natural and human-caused hazards, to better understand community needs in reducing risk and loss from such hazards. The questionnaire should be completed by an adult, preferably the homeowner or the head of the household. Please, take a few minutes to complete this questionnaire. All individual responses are strictly confidential, and are for research purposes only. Once you have completed the questionnaire, please forward it to Damien Arrula, Sierra Madre City Hall, 232 W. Sierra Madre Blvd., Sierra Madre, CA 91024.

1. How concerned are you about the following disasters affecting your community? Please give each hazard a priority rating as follows: ***0 = Not concerned;*** 1 **= *Somewhat concerned; 2 = Moderately concerned; 3 = Very concerned***

Natural:		Human caused:	
Brush Fire	____	Civil unrest	____
Drought	____	Dam failure	____
Earthquake	____	Hazardous materials incident	____
Flood	____	Highrise fire	____
Health Alert/Mass Disease	____	Radiological incident	____
Landslides/Mudslides	____	Special event	____
Severe Weather	____	Terrorism	____
Tsunami	____	Utilities Interruption	____

2. Who would you most trust to provide you with information about how to make your household and home safer from natural or human-caused disasters? (***Please check all that apply***.)

- ☐ News media
- ☐ Government agency
- ☐ Insurance agent or company
- ☐ Utility company
- ☐ University or research institution
- ☐ American Red Cross
- ☐ Church/religious organization
- ☐ Other non-profit organization
- ☐ Not sure
- ☐ Other:

3. What is the most effective way for you to receive information about how to make your household and home safer from natural disasters? (***Please check all that apply***.)

Media:

- ☐ Newspaper stories
- ☐ Newspaper ads
- ☐ Television news
- ☐ Television ads
- ☐ Radio news
- ☐ Radio ads

Other methods:

- ☐ Schools
- ☐ Outdoor advertising (billboards, etc)
- ☐ Books
- ☐ Mail
- ☐ Fire Department
- ☐ Internet
- ☐ Fact sheet/brochure
- ☐ Church/religious organization
- ☐ Employer
- ☐ Public meetings
- ☐ University or research institution
- ☐ Other :

4. In the following list, please check those activities that you ***have done***, ***plan to do*** in the near future, ***have not done***, or are ***unable to do***. (***Please check one answer for each preparedness activity***)

Have you or someone in your household:	Have done	Plan to do	Not done	Unable to do
Attended meetings or received written information on natural disasters or emergency preparedness?	☐	☐	☐	☐
Talked with family members about what to do in case of a disaster or emergency?	☐	☐	☐	☐
Developed a "Household/Family Emergency Plan" in order to decide what everyone would do in the event of a disaster?	☐	☐	☐	☐
Prepared a "Disaster Supply Kit" (extra food, water, medications, batteries, first aid items and other emergency supplies)?	☐	☐	☐	☐
In the last year, has anyone in your household been trained in First Aid or Cardio-Pulmonary Resuscitation (CPR)?	☐	☐	☐	☐

5. Building a disaster supply kit, receiving First Aid training and developing a household/family emergency plan are all inexpensive activities that require a personal time commitment. How much time (per year) are you willing to spend on disaster/emergency preparedness? (***Check only one***)

☐ 0-1 hour ☐ 2-3 hours ☐ 4-7 hours ☐8-15 hours ☐16+ hours ☐ Other, please specify

6. Did you consider the possible occurrence of a natural hazard when you bought/moved into your current home?

☐ Yes ☐ No

7. Would you be willing to spend more money on a home that has features that make it more disaster resistant?

☐Yes ☐ No ☐ Don 't know

8. Would you be willing to make your home more resistant to natural disasters?

☐ Yes ☐ No (***If you answered NO skip to question* 9**)

9. How much <u>are you willing to spend</u> to better protect your home from natural disasters?
(***Check only one***)

- ☐ Less than $100
- ☐ $100-$499
- ☐ $500-$999
- ☐ $1000-$2499
- ☐ $2500-$4999
- ☐ $5000 and above
- ☐ Nothing
- ☐ Don't know
- ☐ Whatever it takes

☐ Other,

10. What nonstructural or structural modifications for earthquakes have you made to your home? (***Please check all that apply***)

10a. Nonstructural

☐ Anchor bookcases, cabinets to wall
☐ Secure water heater to wall
☐ Install latches on drawers/cabinets
☐ Fit gas appliances with flexible connections
☐ Others (please explain)

_____

☐ _____
None

10b. Structural

☐ Secure home to foundation
☐ Brace inside of cripple wall with sheathing
☐ Brace unreinforced chimney
☐ Brace unreinforced masonry and concrete walls and foundations
☐ Others (please explain)

_____

_____

☐ None

11. Which of the following incentives, if any, would motivate you to take additional steps to better protect your home from a natural disaster? (***Check all that apply***)

☐ Insurance discount
☐ Low interest rate loan
☐ Lower new home construction cost
☐ Mortgage discount
☐ Tax break or incentive
☐ None
☐ Other (please explain)

12. Natural and human-caused disasters can have a significant impact on a community but planning for these events can help lessen the impact. The following statement will help us determine community priorities for planning for those hazards. Please tell us how important each one is to you.

Statement	Very Important	Somewhat Important	Neutral	Not Very Important	Not Important
Protecting private property	☐	☐	☐	☐	☐
Protecting critical facilities (hospitals, transportation networks, fire stations)	☐	☐	☐	☐	☐
Preventing development in hazard areas	☐	☐	☐	☐	☐
Protecting natural environment	☐	☐	☐	☐	☐
Protecting historical and cultural landmarks	☐	☐	☐	☐	☐
Promoting cooperation among public agencies, citizens, non-profit organizations and businesses	☐	☐	☐	☐	☐
Protecting and reducing damage to utilities	☐	☐	☐	☐	☐

Strengthening emergency services (police, fire, ambulance)	☐	☐	☐	☐	☐

13. Please check the box that best represents your opinion of the following strategies to reduce the risk and loss associated with natural disasters

Communitywide Strategies	Agree	Neutral	Disagree	Not Sure
I support a regulatory approach to reducing risk.	☐	☐	☐	☐
I support a non-regulatory approach to reducing risk.	☐	☐	☐	☐
I support policies to prohibit development in areas subject to natural hazards.	☐	☐	☐	☐
I support the use of local tax dollars to reduce risks and losses from natural disasters.	☐	☐	☐	☐
I support protecting historical and cultural structures.	☐	☐	☐	☐
I would be willing to make my home more disaster-resistant.	☐	☐	☐	☐
I support steps to safeguard the local economy following a disaster event	☐	☐	☐	☐
I support improving the disaster preparedness of schools.	☐	☐	☐	☐

10. Please feel free to add any additional comments in the space provided:

THANK YOU FOR PROVIDING THIS INFORMATION

APPENDIX
C

Acronyms

Federal Acronyms

AASHTO	American Association of State Highway and Transportation Officials
ATC	Applied Technology Council
b/ca	benefit/cost analysis
BFE	Base Flood Elevation
BLM	Bureau of Land Management
BSSC	Building Seismic Safety Council
CDBG	Community Development Block Grant
CFR	Code of Federal Regulations
CRS	Community Rating System
EDA	Economic Development Administration
EPA	Environmental Protection Agency
ER	Emergency Relief
EWP	Emergency Watershed Protection (NRCS Program)
FAS	Federal Aid System
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
FMA	Flood Mitigation Assistance (FEMA Program)
FTE	Full Time Equivalent
GIS	Geographic Information System
GNS	Institute of Geological and Nuclear Sciences (International)
GSA	General Services Administration
HAZUS	Hazards U.S.
HMGP	Hazard Mitigation Grant Program
HMST	Hazard Mitigation Survey Team
HUD	Housing and Urban Development (United States, Department of)
IBHS	Institute for Business and Home Safety
ICC	Increased Cost of Compliance
IHMT	Interagency Hazard Mitigation Team
NCDC	National Climate Data Center
NFIP	National Flood Insurance Program
NFPA	National Fire Protection Association
NHMP	Natural Hazard Mitigation Plan (also known as "409 Plan")
NIBS	National Institute of Building Sciences
NIFC	National Interagency Fire Center
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPS	National Park Service
NRCS	Natural Resources Conservation Service
NWS	National Weather Service
SBA	Small Business Administration
SEAO	Structural Engineers Association of Oregon
SHMO	State Hazard Mitigation Officer
TOR	Transfer of Development Rights
UGB	Urban Growth Boundary

URM	Unreinforced Masonry
USACE	United States Army Corps of Engineers
USBR	United States Bureau of Reclamation
USDA	United States Department of Agriculture
USFA	United States Fire Administration
USFS	United States Forest Service
USGS	United States Geological Survey
WSSPC	Western States Seismic Policy Council

California Acronyms

A&W	Alert and Warning
AA	Administering Areas
AAR	After Action Report
ARC	American Red Cross
ARP	Accidental Risk Prevention
ATC20	Applied Technology Council20
ATC21	Applied Technology Council21
BCP	Budget Change Proposal
BSA	California Bureau of State Audits
CAER	Community Awareness & Emergency Response
CalARP	California Accidental Release Prevention
CalBO	California Building Officials
CalEPA	California Environmental Protection Agency
CalREP	California Radiological Emergency Plan
CALSTARS	California State Accounting Reporting System
CalTRANS	California Department of Transportation
CBO	Community Based Organization
CD	Civil Defense
CDF	California Department of Forestry and Fire Protection
CDMG	California Division of Mines and Geology
CEC	California Energy Commission
CEPEC	California Earthquake Prediction Evaluation Council
CESRS	California Emergency Services Radio System
CHIP	California Hazardous Identification Program
CHMIRS	California Hazardous Materials Incident Reporting System
CHP	California Highway Patrol
CLETS	California Law Enforcement Telecommunications System
CSTI	California Specialized Training Institute
CUEA	California Utilities Emergency Association
CUPA	Certified Unified Program Agency
DAD	Disaster Assistance Division (of the state Office of Emergency Svcs)
DFO	Disaster Field Office
DGS	California Department of General Services
DHSRHB	California Department of Health Services, Radiological Health Branch
DO	Duty Officer
DOC	Department Operations Center
DOE	Department of Energy (U.S.)
DOF	California Department of Finance
DOJ	California Department of Justice
DPA	California Department of Personnel Administration
DPIG	Disaster Preparedness Improvement Grant
DR	Disaster Response
DSA	Division of the State Architect
DSR	Damage Survey Report

DSW	Disaster Service Worker
DWR	California Department of Water Resources
EAS	Emergency Alerting System
EDIS	Emergency Digital Information System
EERI	Earthquake Engineering Research Institute
EMA	Emergency Management Assistance
EMI	Emergency Management Institute
EMMA	Emergency Managers Mutual Aid
EMS	Emergency Medical Services
EOC	Emergency Operations Center
EOP	Emergency Operations Plan
EPA	Environmental Protection Agency (U.S.)
EPEDAT	Early Post Earthquake Damage Assessment Tool
EPI	Emergency Public Information
EPIC	Emergency Public Information Council
ESC	Emergency Services Coordinator
FAY	Federal Award Year
FDAA	Federal Disaster Assistance Administration
FEAT	Governor's Flood Emergency Action Team
FEMA	Federal Emergency Management Agency
FFY	Federal Fiscal Year
FIR	Final Inspection Reports
FIRESCOPE	Firefighting Resources of So. Calif Organized for Potential Emergencies
FMA	Flood Management Assistance
FSR	Feasibility Study Report
FY	Fiscal Year
GIS	Geographical Information System
HAZMAT	Hazardous Materials
HAZMIT	Hazardous Mitigation
HAZUS	Hazards United States (an earthquake damage assessment prediction tool)
HAD	Housing and Community Development
HEICS	Hospital Emergency Incident Command System
HEPG	Hospital Emergency Planning Guidance
HIA	Hazard Identification and Analysis Unit
HMEP	Hazardous Materials Emergency Preparedness
HMGP	Hazard Mitigation Grant Program
IDE	Initial Damage Estimate
IA	Individual Assistance
IFG	Individual & Family Grant (program)
IRG	Incident Response Geographic Information System
IPA	Information and Public Affairs (of state Office of Emergency Services)
LAN	Local Area Network
LEMMA	Law Enforcement Master Mutual Aid
LEPC	Local Emergency Planning Committee
MARAC	Mutual Aid Regional Advisory Council

MHID	Multihazard Identification
MOU	Memorandum of Understanding
NBC	Nuclear, Biological, Chemical
NEMA	National Emergency Management Agency
NEMIS	National Emergency Management Information System
NFIP	National Flood Insurance Program
NOAA	National Oceanic and Atmospheric Association
NPP	Nuclear Power Plant
NSF	National Science Foundation
NWS	National Weather Service
OA	Operational Area
OASIS	Operational Area Satellite Information System
OCC	Operations Coordination Center
OCD	Office of Civil Defense
OEP	Office of Emergency Planning
OES	California Governor's Office of Emergency Services
OSHPD	Office of Statewide Health Planning and Development
OSPR	Oil Spill Prevention and Response
PA	Public Assistance
PC	Personal Computer
PDA	Preliminary Damage Assessment
PIO	Public Information Office
POST	Police Officer Standards and Training
PPA/CA	Performance Partnership Agreement/Cooperative Agreement (FEMA)
PSA	Public Service Announcement
PTAB	Planning and Technological Assistance Branch
PTR	Project Time Report
RA	Regional Administrator (OES)
RADEF	Radiological Defense (program)
RAMP	Regional Assessment of Mitigation Priorities
RAPID	Railroad Accident Prevention & Immediate Deployment
RDO	Radiological Defense Officer
RDMHC	Regional Disaster Medical Health Coordinator
REOC	Regional Emergency Operations Center
REPI	Reserve Emergency Public Information
RES	Regional Emergency Staff
RIMS	Response Information Management System
RMP	Risk Management Plan
RPU	Radiological Preparedness Unit (OES)
RRT	Regional Response Team
SAM	State Administrative Manual
SARA	Superfund Amendments & Reauthorization Act
SAVP	Safety Assessment Volunteer Program
SBA	Small Business Administration
SCO	California State Controller's Office
SEMS	Standardized Emergency Management System

SEPIC	State Emergency Public Information Committee
SLA	State and Local Assistance
SONGS	San Onofre Nuclear Generating Station
SOP	Standard Operating Procedure
SWEPC	Statewide Emergency Planning Committee
TEC	Travel Expense Claim
TRU	Transuranic
TTT	Train the Trainer
UPA	Unified Program Account
UPS	Uninterrupted Power Source
USAR	Urban Search and Rescue
USGS	United States Geological Survey
WC	California State Warning Center
WAN	Wide Area Network
WIPP	Waste Isolation Pilot Project

APPENDIX

D

Glossary

GLOSSARY

Acceleration	The rate of change of velocity with respect to time. Acceleration due to gravity at the earth's surface is 9.8 meters per second squared. That means that every second that something falls toward the surface of earth its velocity increases by 9.8 meters per second.
Asset	Any manmade or natural feature that has value, including, but not limited to people; buildings; infrastructure like bridges, roads, and sewer and water systems; lifelines like electricity and communication resources; or environmental, cultural, or recreational features like parks, dunes, wetlands, or landmarks.
Base Flood	Flood that has a 1 percent probability of being equaled or exceeded in any given year. Also known as the 100-year flood.
Base Flood Elevation (BFE)	Elevation of the base flood in relation to a specified datum, such as the National Geodetic Vertical Datum of 1929. The Base Flood Elevation is used as the standard for the National Flood Insurance Program.
Bedrock	The solid rock that underlies loose material, such as soil, sand, clay, or gravel.
Building	A structure that is walled and roofed, principally above ground and permanently affixed to a site. The term includes a manufactured home on a permanent foundation on which the wheels and axles carry no weight.
Coastal High Hazard Area	Area, usually along an open coast, bay, or inlet that is subject to inundation by storm surge and, in some instances, wave action caused by storms or seismic sources.
Coastal Zones	The area along the shore where the ocean meets the land as the surface of the land rises above the ocean. This land/water interface includes barrier islands, estuaries, beaches, coastal wetlands, and land areas having direct drainage to the ocean.
Community Rating System (CRS)	An NFIP program that provides incentives for NFIP communities to complete activities that reduce flood hazard risk. When the community completes specified activities, the insurance premiums of policyholders in these communities are reduced.
Computer-Aided Design And Drafting (CADD)	A computerized system enabling quick and accurate electronic 2-D and 3-D drawings, topographic mapping, site plans, and profile/cross-section drawings.
Contour	A line of equal ground elevation on a topographic (contour) map.

Critical Facility	Facilities that are critical to the health and welfare of the population and that are especially important following hazard events. Critical facilities include, but are not limited to, shelters, police and fire stations, and hospitals.
Debris	The scattered remains of assets broken or destroyed in a hazard event. Debris caused by a wind or water hazard event can cause additional damage to other assets.
Digitize	To convert electronically points, lines, and area boundaries shown on maps into x, y coordinates (e.g., latitude and longitude, universal transverse mercator (UTM), or table coordinates) for use in computer applications.
Displacement Time	The average time (in days) which the building's occupants typically must operate from a temporary location while repairs are made to the original building due to damages resulting from a hazard event.
Duration	How long a hazard event lasts.
Earthquake	A sudden motion or trembling that is caused by a release of strain accumulated within or along the edge of earth's tectonic plates.
Erosion	Wearing away of the land surface by detachment and movement of soil and rock fragments, during a flood or storm or over a period of years, through the action of wind, water, or other geologic processes.
Erosion Hazard Area	Area anticipated being lost to shoreline retreat over a given period of time. The projected inland extent of the area is measured by multiplying the average annual long-term recession rate by the number of years desired.
Essential Facility	Elements that are important to ensure a full recovery of a community or state following a hazard event. These would include: government functions, major employers, banks, schools, and certain commercial establishments, such as grocery stores, hardware stores, and gas stations.
Extent	The size of an area affected by a hazard or hazard event.
Extratropical Cyclone	Cyclonic storm events like Nor'easters and severe winter low-pressure systems. Both West and East coasts can experience these non-tropical storms that produce gale-force winds and precipitation in the form of heavy rain or snow. These cyclonic storms, commonly called Nor'easters on the East Coast because of the direction of the storm winds, can last for several days and can be very large – 1,000-mile wide storms are not uncommon.

Fault	A fracture in the continuity of a rock formation caused by a shifting or dislodging of the earth's crust, in which adjacent surfaces are differentially displaced parallel to the plane of fracture.
Federal Emergency Management Agency (FEMA)	Independent agency created in 1978 to provide a single point of accountability for all Federal activities related to disaster mitigation and emergency preparedness, response and recovery.
Fire Potential Index (FPI)	Developed by USGS and USFS to assess and map fire hazard potential over broad areas. Based on such geographic information, national policy makers and on-the-ground fire managers established priorities for prevention activities in the defined area to reduce the risk of managed and wildfire ignition and spread. Prediction of fire hazard shortens the time between fire ignition and initial attack by enabling fire managers to pre-allocate and stage suppression forces to high fire risk areas.
Flash Flood	A flood event occurring with little or no warning where water levels rise at an extremely fast rate.
Flood	A general and temporary condition of partial or complete inundation of normally dry land areas from (1) the overflow of inland or tidal waters, (2) the unusual and rapid accumulation or runoff of surface waters from any source, or (3) mudflows or the sudden collapse of shoreline land.
Flood Depth	Height of the flood water surface above the ground surface.
Flood Elevation	Elevation of the water surface above an established datum, e.g. National Geodetic Vertical Datum of 1929, North American Vertical Datum of 1988, or Mean Sea Level.
Flood Hazard Area	The area shown to be inundated by a flood of a given magnitude on a map.
Flood Insurance Rate Map (FIRM)	Map of a community, prepared by the Federal Emergency Management Agency that shows both the special flood hazard areas and the risk premium zones applicable to the community.
Flood Insurance Study (FIS)	A study that provides an examination, evaluation, and determination of flood hazards and, if appropriate, corresponding water surface elevations in a community or communities.
Floodplain	Any land area, including watercourse, susceptible to partial or complete inundation by water from any source.

Frequency	A measure of how often events of a particular magnitude are expected to occur. Frequency describes how often a hazard of a specific magnitude, duration, and/or extent typically occurs, on average. Statistically, a hazard with a 100-year recurrence interval is expected to occur once every 100 years on average, and would have a 1 percent chance – its probability – of happening in any given year. The reliability of this information varies depending on the kind of hazard being considered.
Fujita Scale of Tornado Intensity	Rates tornadoes with numeric values from F0 to F5 based on tornado wind speed and damage sustained. An F0 indicates minimal damage such as broken tree limbs or signs, while and F5 indicated severe damage sustained.
Functional Downtime	The average time (in days) during which a function (business or service) is unable to provide its services due to a hazard event.
Geographic Area Impacted	The physical area in which the effects of the hazard are experienced.
Geographic Information Systems (GIS)	A computer software application that relates physical features on the earth to a database to be used for mapping and analysis.
Ground Motion	The vibration or shaking of the ground during an earthquake. When a fault ruptures, seismic waves radiate, causing the ground to vibrate. The severity of the vibration increases with the amount of energy released and decreases with distance from the causative fault or epicenter, but soft soils can further amplify ground motions
Hazard	A source of potential danger or adverse condition. Hazards in this how to series will include naturally occurring events such as floods, earthquakes, tornadoes, tsunami, coastal storms, landslides, and wildfires that strike populated areas. A natural event is a hazard when it has the potential to harm people or property.
Hazard Event	A specific occurrence of a particular type of hazard.
Hazard Identification	The process of identifying hazards that threaten an area.
Hazard Mitigation	Sustained actions taken to reduce or eliminate long-term risk from hazards and their effects.

Hazard Profile	A description of the physical characteristics of hazards and a determination of various descriptors including magnitude, duration, frequency, probability, and extent. In most cases, a community can most easily use these descriptors when they are recorded and displayed as maps.
HAZUS (Hazards U.S.)	A GIS-based nationally standardized earthquake loss estimation tool developed by FEMA.
Hurricane	An intense tropical cyclone, formed in the atmosphere over warm ocean areas, in which wind speeds reach 74-miles-per-hour or more and blow in a large spiral around a relatively calm center or "eye." Hurricanes develop over the north Atlantic Ocean, northeast Pacific Ocean, or the south Pacific Ocean east of 160°E longitude. Hurricane circulation is counter-clockwise in the Northern Hemisphere and clockwise in the Southern Hemisphere.
Hydrology	The science of dealing with the waters of the earth. A flood discharge is developed by a hydrologic study.
Infrastructure	Refers to the public services of a community that have a direct impact on the quality of life. Infrastructure includes communication technology such as phone lines or Internet access, vital services such as public water supplies and sewer treatment facilities, and includes an area's transportation system such as airports, heliports; highways, bridges, tunnels, roadbeds, overpasses, railways, bridges, rail yards, depots; and waterways, canals, locks, seaports, ferries, harbors, dry-docks, piers and regional dams.
Intensity	A measure of the effects of a hazard event at a particular place.
Landslide	Downward movement of a slope and materials under the force of gravity.
Lateral Spreads	Develop on gentle slopes and entail the sidelong movement of large masses of soil as an underlying layer liquefies in a seismic event. The phenomenon that occurs when ground shaking causes loose soils to lose strength and act like viscous fluid. Liquefaction causes two types of ground failure: lateral spread and loss of bearing strength.
Liquefaction	Results when the soil supporting structures liquefies. This can cause structures to tip and topple.

Lowest Floor	Under the NFIP, the lowest floor of the lowest enclosed area (including basement) of a structure.
Magnitude	A measure of the strength of a hazard event. The magnitude (also referred to as severity) of a given hazard event is usually determined using technical measures specific to the hazard.
Mitigation Plan	A systematic evaluation of the nature and extent of vulnerability to the effects of natural hazards typically present in the state and includes a description of actions to minimize future vulnerability to hazards.
National Flood Insurance Program (NFIP)	Federal program created by Congress in 1968 that makes flood insurance available in communities that enact minimum floodplain management regulations in 44 CFR §60.3.
National Geodetic Vertical Datum of 1929 (NGVD)	Datum established in 1929 and used in the NFIP as a basis for measuring flood, ground, and structural elevations, previously referred to as Sea Level Datum or Mean Sea Level. The Base Flood Elevations shown on most of the Flood Insurance Rate Maps issued by the Federal Emergency Management Agency are referenced to NGVD.
National Weather Service (NWS)	Prepares and issues flood, severe weather, and coastal storm warnings and can provide technical assistance to Federal and state entities in preparing weather and flood warning plans.
Nor'easter	An extra-tropical cyclone producing gale-force winds and precipitation in the form of heavy snow or rain.
Outflow	Follows water inundation creating strong currents that rip at structures and pound them with debris, and erode beaches and coastal structures.
Planimetric	Describes maps that indicate only man-made features like buildings.
Planning	The act or process of making or carrying out plans; the establishment of goals, policies and procedures for a social or economic unit.
Probability	A statistical measure of the likelihood that a hazard event will occur.
Recurrence Interval	The time between hazard events of similar size in a given location. It is based on the probability that the given event will be equaled or exceeded in any given year.

Repetitive Loss Property	A property that is currently insured for which two or more National Flood Insurance Program losses (occurring more than ten days apart) of at least $1000 each have been paid within any 10-year period since 1978.
Replacement Value	The cost of rebuilding a structure. This is usually expressed in terms of cost per square foot, and reflects the present-day cost of labor and materials to construct a building of a particular size, type and quality.
Richter Scale	A numerical scale of earthquake magnitude devised by seismologist C.F. Richter in 1935.
Risk	The estimated impact that a hazard would have on people, services, facilities, and structures in a community; the likelihood of a hazard event resulting in an adverse condition that causes injury or damage. Risk is often expressed in relative terms such as a high, moderate or low likelihood of sustaining damage above a particular threshold due to a specific type of hazard event. It also can be expressed in terms of potential monetary losses associated with the intensity of the hazard.
Riverine	Of or produced by a river.
Scale	A proportion used in determining a dimensional relationship; the ratio of the distance between two points on a map and the actual distance between the two points on the earth's surface.
Scarp	A steep slope.
Scour	Removal of soil or fill material by the flow of flood waters. The term is frequently used to describe storm-induced, localized conical erosion around pilings and other foundation supports where the obstruction of flow increases turbulence.
Seismicity	Describes the likelihood of an area being subject to earthquakes.
Special Flood Hazard Area (SFHA)	An area within a floodplain having a 1 percent or greater chance of flood occurrence in any given year (100-year floodplain); represented on Flood Insurance Rate Maps by darkly shaded areas with zone designations that include the letter A or V.
Stafford Act	The Robert T. Stafford Disaster Relief and Emergency Assistance Act, PL 100-107 was signed into law November 23, 1988 and amended the Disaster Relief Act of 1974, PL 93-288. The Stafford Act is the statutory authority for most Federal disaster response activities, especially as they pertain to FEMA and its programs.

State Hazard Mitigation Officer (SHMO)	The representative of state government who is the primary point of contact with FEMA, other state and Federal agencies, and local units of government in the planning and implementation of pre- and post-disaster mitigation activities.
Storm Surge	Rise in the water surface above normal water level on the open coast due to the action of wind stress and atmospheric pressure on the water surface.
Structure	Something constructed. (See also Building)
Substantial Damage	Damage of any origin sustained by a structure in a Special Flood Hazard Area whereby the cost of restoring the structure to its before-damaged condition would equal or exceed 50 percent of the market value of the structure before the damage.
Super Typhoon	A typhoon with maximum sustained winds of 150 mph or more.
Surface Faulting	The differential movement of two sides of a fracture – in other words, the location where the ground breaks apart. The length, width, and displacement of the ground characterize surface faults.
Tectonic Plate	Torsionally rigid, thin segments of the earth's lithosphere that may be assumed to move horizontally and adjoin other plates. It is the friction between plate boundaries that cause seismic activity.
Topographic	Characterizes maps that show natural features and indicate the physical shape of the land using contour lines. These maps may also include manmade features.
Tornado	A violently rotating column of air extending from a thunderstorm to the ground.
Tropical Cyclone	A generic term for a cyclonic, low-pressure system over tropical or subtropical waters.
Tropical Depression	A tropical cyclone with maximum sustained winds of less than 39 mph.
Tropical Storm	A tropical cyclone with maximum sustained winds greater than 39 mph and less than 74 mph.
Tsunami	Great sea wave produced by submarine earth movement or volcanic eruption.

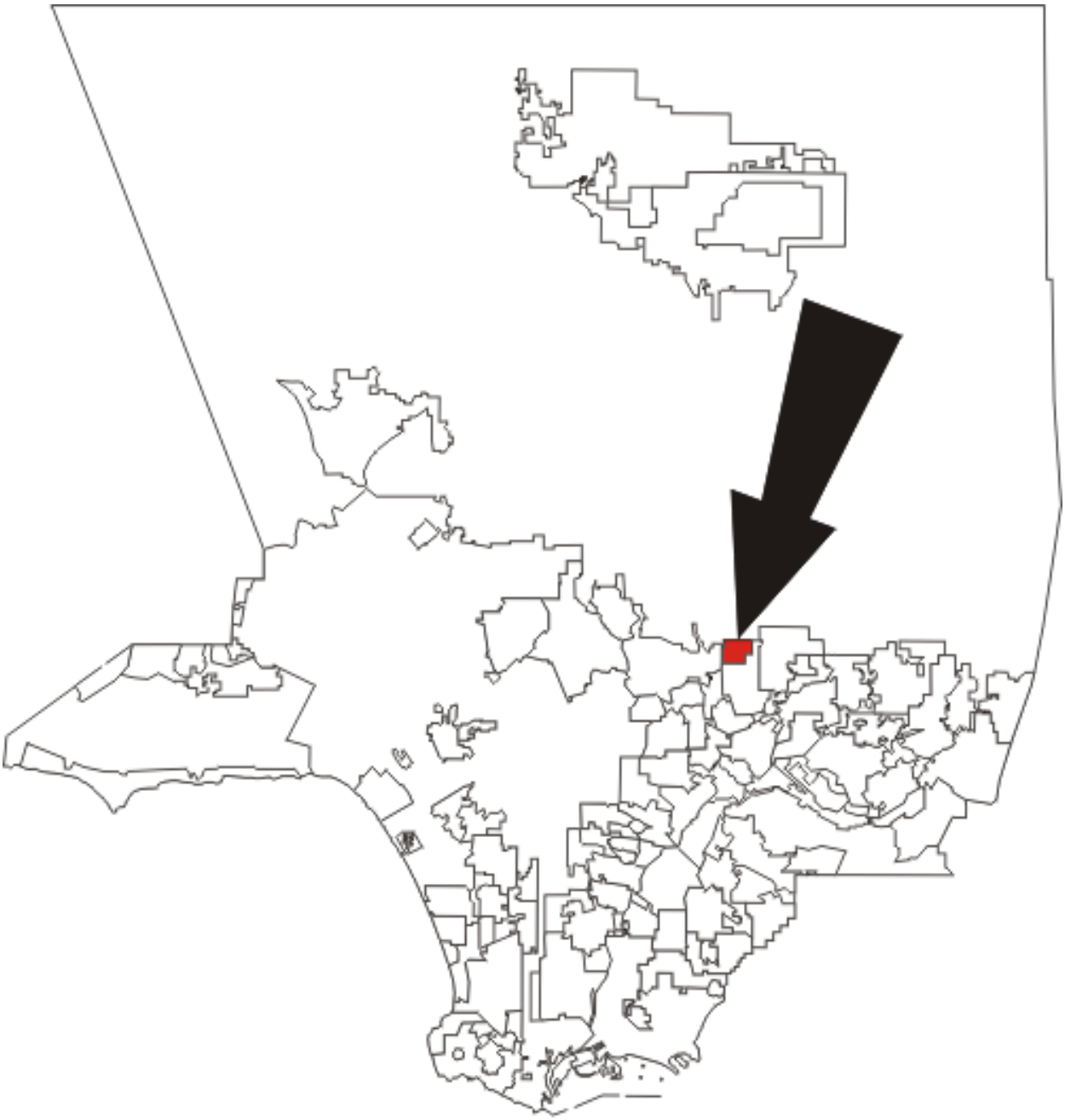
Typhoon	A special category of tropical cyclone peculiar to the western North Pacific Basin, frequently affecting areas in the vicinity of Guam and the North Mariana Islands. Typhoons whose maximum sustained winds attain or exceed 150 mph are called super typhoons.
Vulnerability	Describes how exposed or susceptible to damage an asset is. Vulnerability depends on an asset's construction, contents, and the economic value of its functions. Like indirect damages, the vulnerability of one element of the community is often related to the vulnerability of another. For example, many businesses depend on uninterrupted electrical power – if an electric substation is flooded, it will affect not only the substation itself, but a number of businesses as well. Often, indirect effects can be much more widespread and damaging than direct ones.
Vulnerability Assessment	The extent of injury and damage that may result from a hazard event of a given intensity in a given area. The vulnerability assessment should address impacts of hazard events on the existing and future built environment.
Water Displacement	When a large mass of earth on the ocean bottom sinks or uplifts, the column of water directly above it is displaced, forming the tsunami wave. The rate of displacement, motion of the ocean floor at the epicenter, the amount of displacement of the rupture zone, and the depth of water above the rupture zone all contribute to the intensity of the tsunami.
Wave Run-up	The height that the wave extends up to on steep shorelines, measured above a reference level (the normal height of the sea, corrected to the state of the tide at the time of wave arrival).
Wildfire	An uncontrolled fire spreading through vegetative fuels, exposing and possibly consuming structures.
Zone	A geographical area shown on a Flood Insurance Rate Map (FIRM) that reflects the severity or type of flooding in the area.

APPENDIX

E

List of Maps

Map 1
City of Sierra Madre Location - Los Angeles County


Copyright 2004 - Given Place Publishing Co / Los Angeles Almanac

Map 2
City of Sierra Madre Location – Disaster Management Area D

Los Angeles County

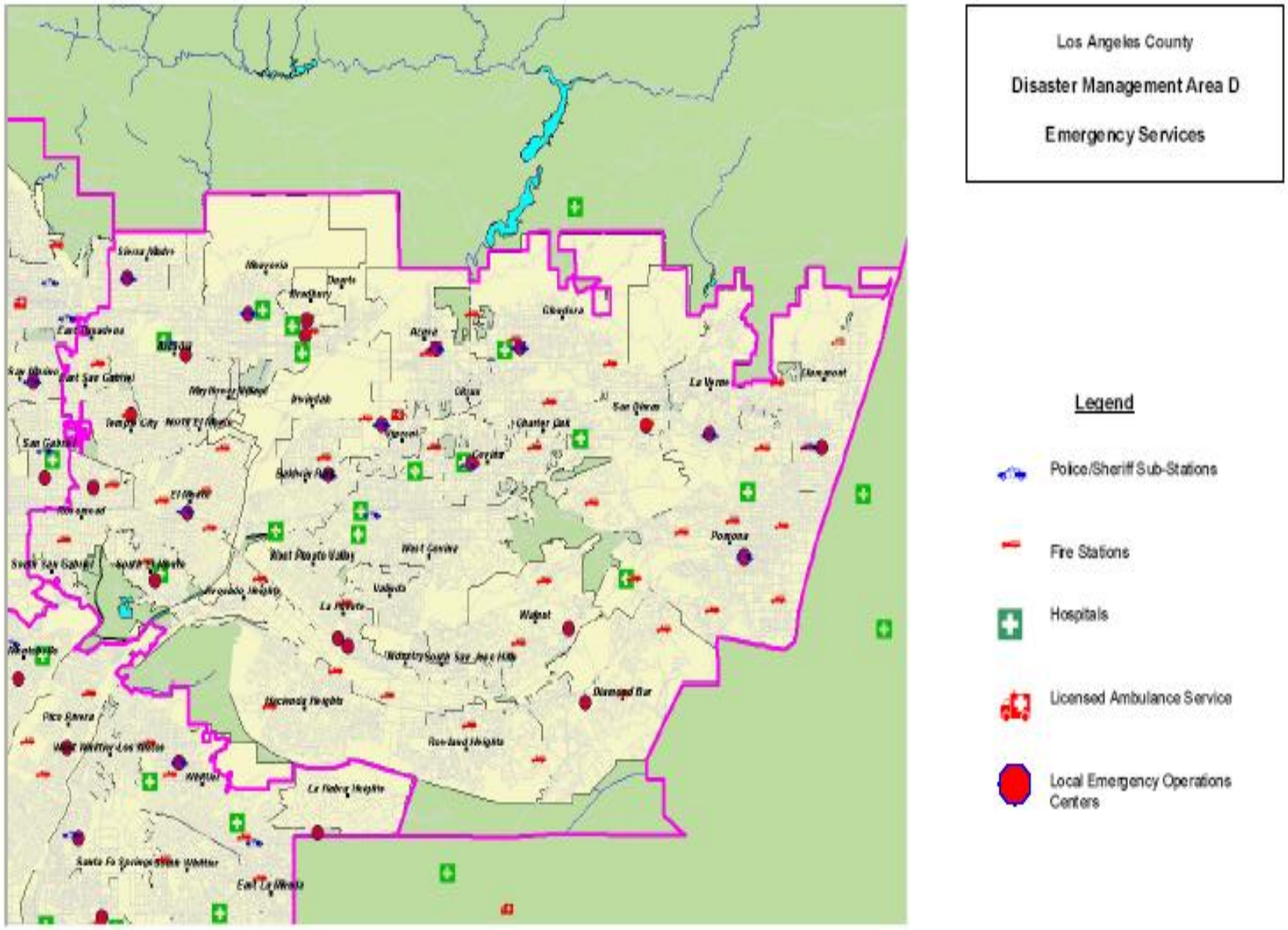
Disaster Management Area D

Map 3
City of Sierra Madre Base Map w/Essential Facilities – City facilities, schools and major roads

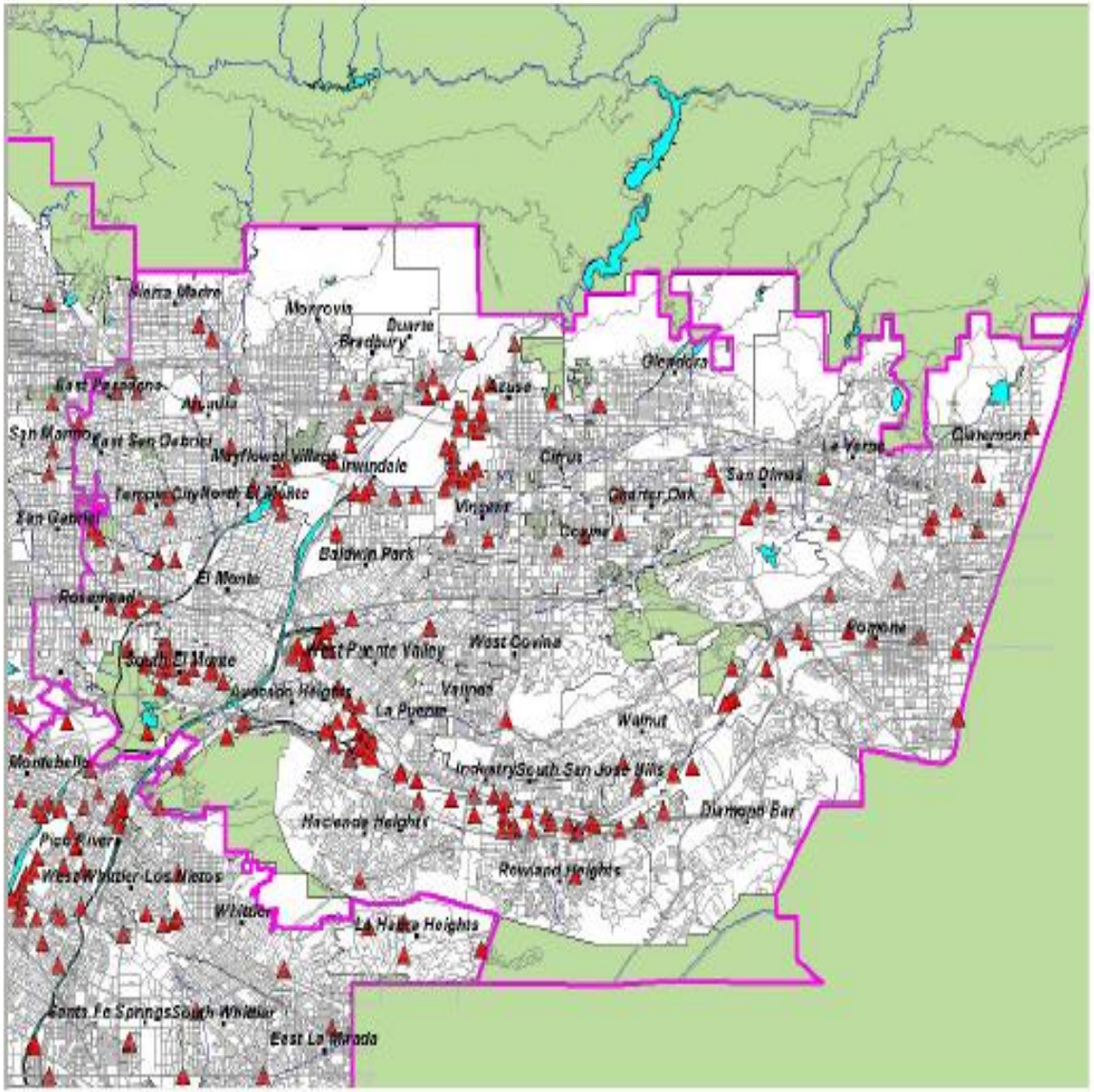
Map 4
City of Sierra Madre Land Use Map w/Essential Facilities – all commercial and major retail areas

City of Sierra Madre
Land Use
Designation Map
ADOPTED JUNE 11, 1996
Legend
Residential Low Density – RL
Residential Canyon – RC
Hillside – H
Residential Medium Density – RM
Residential Med/High Density – RH
Residential Entrepenuer – RE
Commercial – C
Artisan Mixed Use – A MU
Municipal – M
Institutional – I
Open Space – OS
City of
Sierra Madre
General Plan
North
0
450
900
Scale in Feet
NOTE: Lot lines are shown as graphic representation only and are not intended to be used to determine legal property boundaries.
ANGELES NATIONAL FOREST
CITY OF SIERRA MADRE CORPORATE BOUNDARY
CITY OF ARCADIA
CITY OF PASADENA
Canon Ave.
Baldwin Ave.
Mountain Trail Ave.
Michillinda Ave.
Grand View Ave.
Highland Ave.
Sierra Madre Blvd.
Orange Grove Ave.

Map 5
Critical Facilities (Emergency Services) – Disaster Management Area D


Los Angeles County
Disaster Management Area D
Emergency Services
Legend
Police/Sheriff Sub-Stations
Fire Stations
Hospitals
Licensed Ambulance Service
Local Emergency Operations Centers

Map 6
Hazardous Materials Sites – Disaster Management Area D



Los Angeles County

Disaster Management Area D

Hazardous Materials Sites

Legend

Hazardous Materials Site Location

Unincorporated Areas

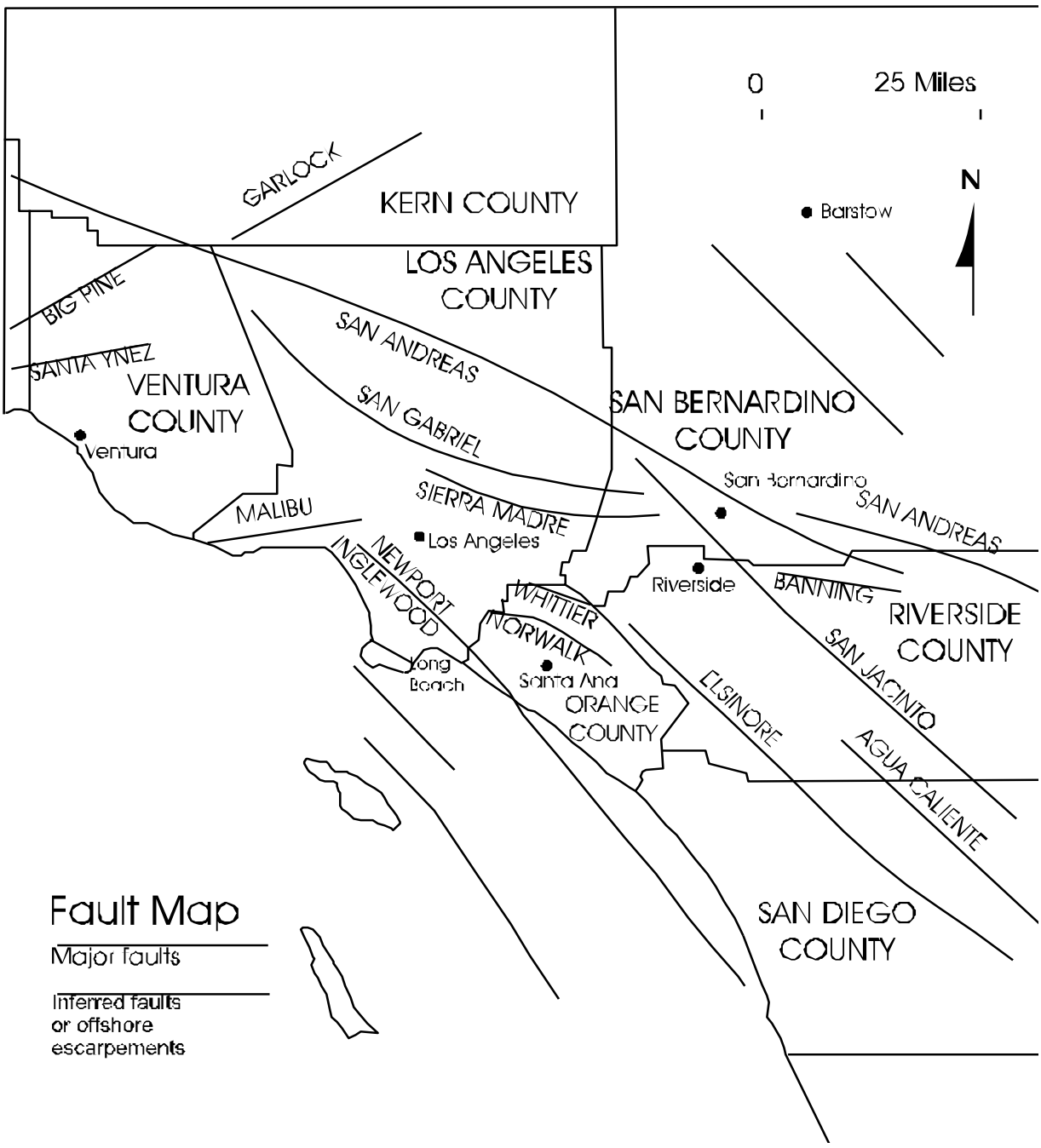
Disaster Management Area Boundaries

Map 7
Sierra Madre Infrastructure – Water pump stations, reservoirs, water lines and sewer lines

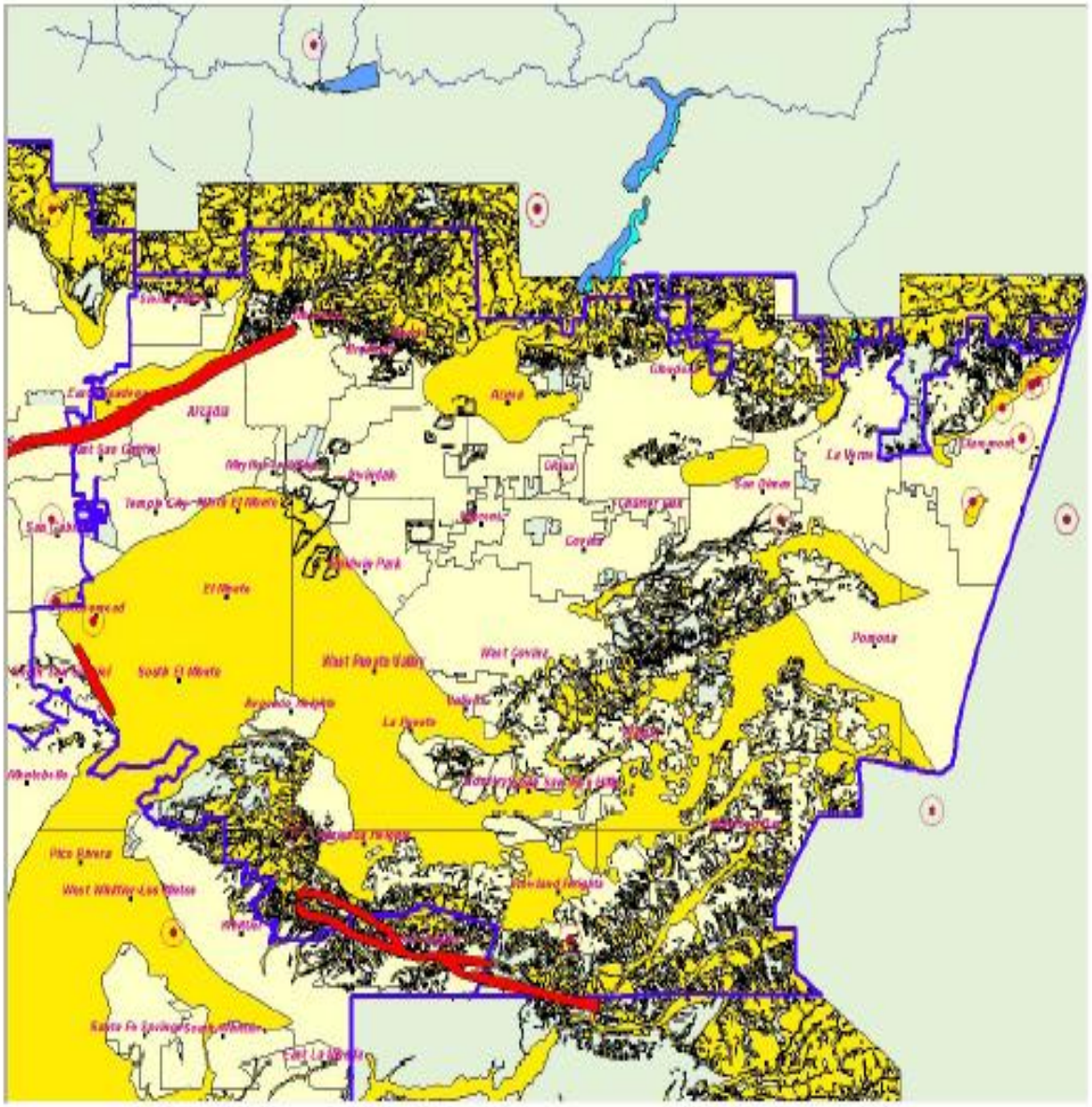
City of Sierra Madre
Legend
City Boundary
Sewer Casings
Sewer Lines
Water Pump Stations
Water Lines
0
2985ft
Copyright (C) 2003 2004 XYMaps

Map 8
Earthquake Fault Map – Southern California

Southern California Earthquake Fault Map



Map 9
Earthquake Faults/Hazards – Disaster Management Area D



Los Angeles County

Disaster Management Area D

Earthquake Hazards

Legend

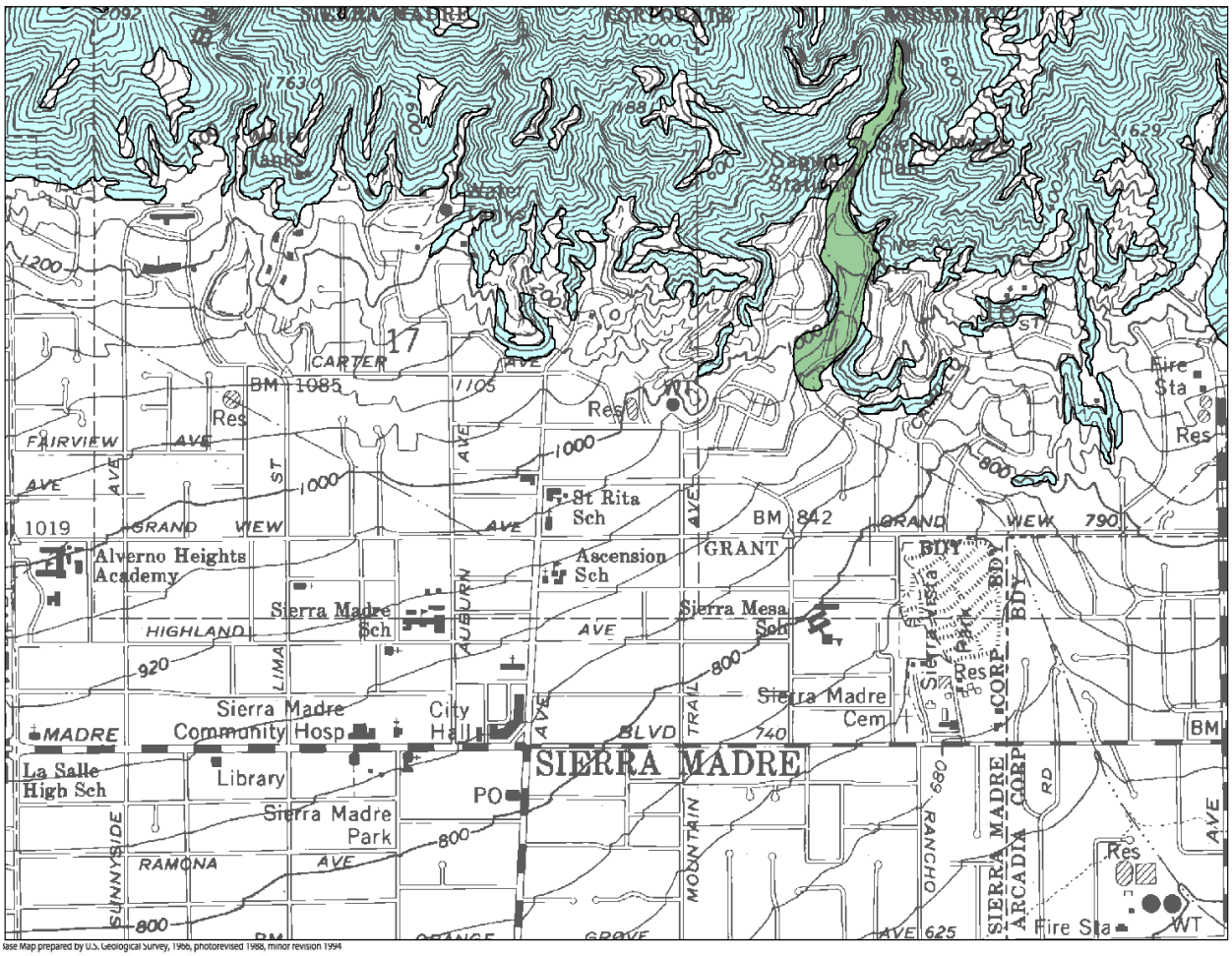
Historic Epicenter

Historic Major Fault Areas

Areas Vulnerable to Damage from Shaking

Disaster Management Area Boundaries

Map 10
Mt. Wilson Quadrangle Seismic Hazard Zones – Sierra Madre



Base Map prepared by U.S. Geological Survey, 1966, photorevised 1988, minor revision 1994

PURPOSE OF MAP

This map will assist cities and counties in fulfilling their responsibilities for protecting the public safety from the effects of earthquake-triggered ground failure as required by the Seismic Hazards Mapping Act (Public Resources Code Sections 2690-2699.6).

For information regarding the scope and recommended methods to be used in conducting the required site investigations, see DMG Special Publication 117, Guidelines for Evaluating and Mitigating Seismic Hazards in California.

For a general description of the Seismic Hazards Mapping Program, the Seismic Hazards Mapping Act and regulations, and related information, please refer to the draft User's Guide (see http://www.consrv.ca.gov/dmg/shezp/userguid/).

Production of this map was funded by the Federal Emergency Management Agency's Hazard Mitigation Program and the Department of Conservation in cooperation with the Governor's Office of Emergency Services.

IMPORTANT - PLEASE NOTE

1) This map may not show all areas that have the potential for liquefaction, landsliding, strong earthquake ground shaking or other earthquake and geologic hazards. Also, a single earthquake capable of causing liquefaction or triggering landslide failure will not uniformly affect the entire area zoned.

2) Liquefaction zones may also contain areas susceptible to the effects of earthquake-induced landslides. This situation typically exists at or near the toe of existing landslides, downslope from rockfall or debris flow source areas, or adjacent to steep stream banks.

3) This map does not show Alquist-Priolo earthquake fault zones, if any, that may exist in this area. Please refer to the latest official map of earthquake fault zones for disclosures and other actions that are required by the Alquist-Priolo Earthquake Fault Zoning Act. For more information on this subject and an index to available maps, see DMG Special Publication 42.

4) Landslide zones on this map were determined, in part, by adapting methods first developed by the U.S. Geological Survey (USGS). A new generation of landslide hazard maps being prepared by the USGS (Jibson and Harp, in preparation) uses an experimental approach designed to explore new methods to assess earthquake-induced landslide hazards. Although aspects of this new methodology may be incorporated in future seismic hazard zone maps, the experimental USGS maps should not be used as substitutes for these official earthquake-induced landslide zone maps.

5) U.S. Geological Survey base map standards provide that 90 percent of cultural features be located within 40 feet (horizontal accuracy) at the scale of this map. The identification and location of liquefaction and earthquake-induced landslide zones are based on available data. However, the quality of data used is varied. The zone boundaries depicted have been drawn as accurately as possible at this scale.

6) Information on this map is not sufficient to serve as a substitute for the geologic and geotechnical site investigations required under Chapters 7.5 and 7.8 of Division 2 of the Public Resources Code.

7) DISCLAIMER: The State of California and the Department of Conservation make no representations or warranties regarding the accuracy of the data from which these maps were derived. Neither the State nor the Department shall be liable under any circumstances for any direct, indirect, special, incidental or consequential damages with respect to any claim by any user or any third party on account of or arising from the use of this map.

SCALE 1:24,000

1 .5 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

STATE OF CALIFORNIA

SEISMIC HAZARD ZONES

Delineated in compliance with
Chapter 7.8, Division 2 of the California Public Resources Code
(Seismic Hazards Mapping Act)

MT. WILSON QUADRANGLE

OFFICIAL MAP

Released: March 25, 1999

STATE GEOLOGIST

MAP EXPLANATION

Zones of Required Investigation:

Liquefaction

Areas where historic occurrence of liquefaction, or local geological, geotechnical and groundwater conditions indicate a potential for permanent ground displacements such that mitigation as defined in Public Resources Code Section 2693(c) would be required.

Earthquake-Induced Landslides

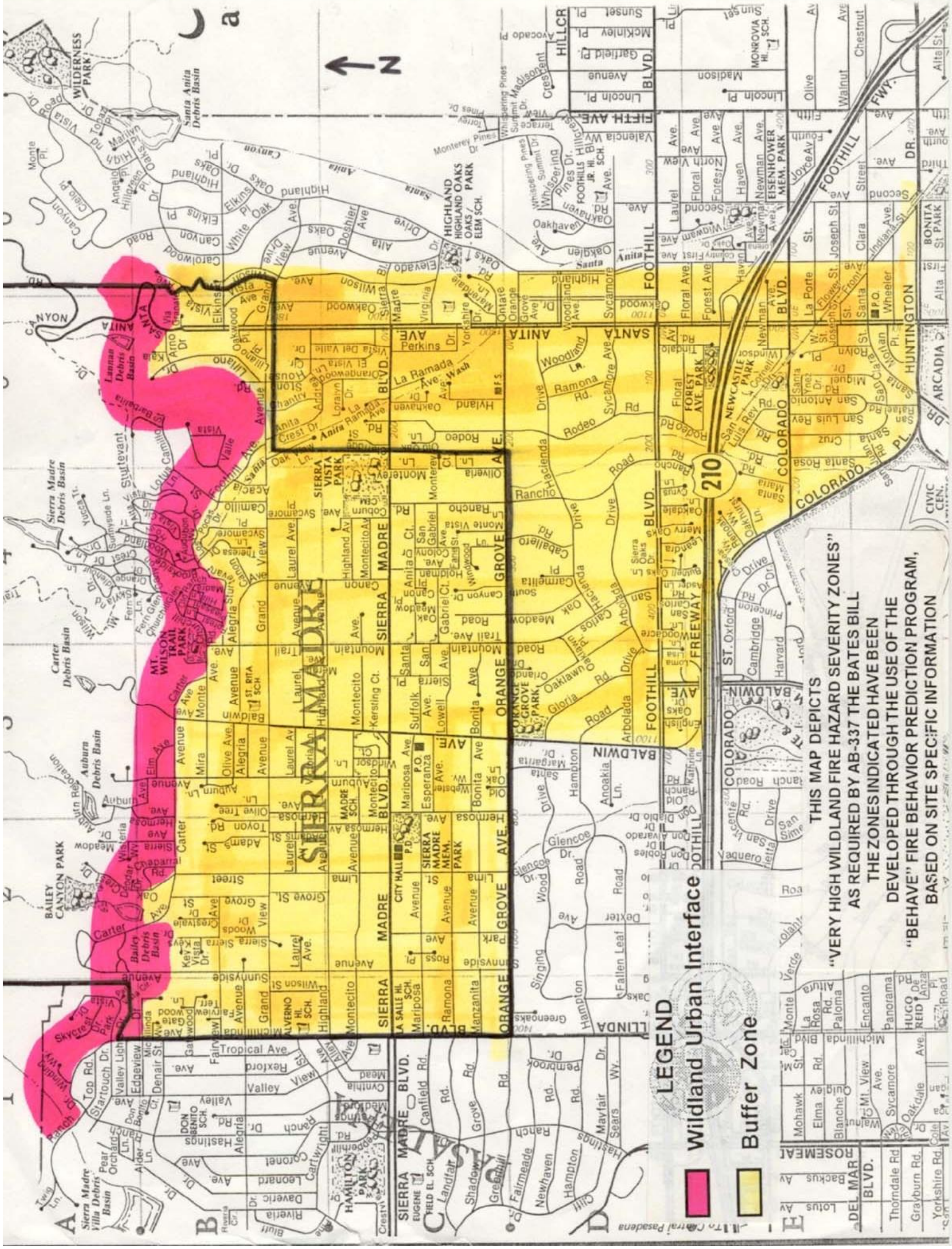
Areas where previous occurrence of landslide movement, or local topographic, geological, geotechnical and subsurface water condition indicate a potential for permanent ground displacements such that mitigation as defined in Public Resources Code Section 2693(c) would be required.

DATA AND METHODOLOGY USED TO DEVELOP THIS MAP ARE PRESENTED IN THE FOLLOWING:

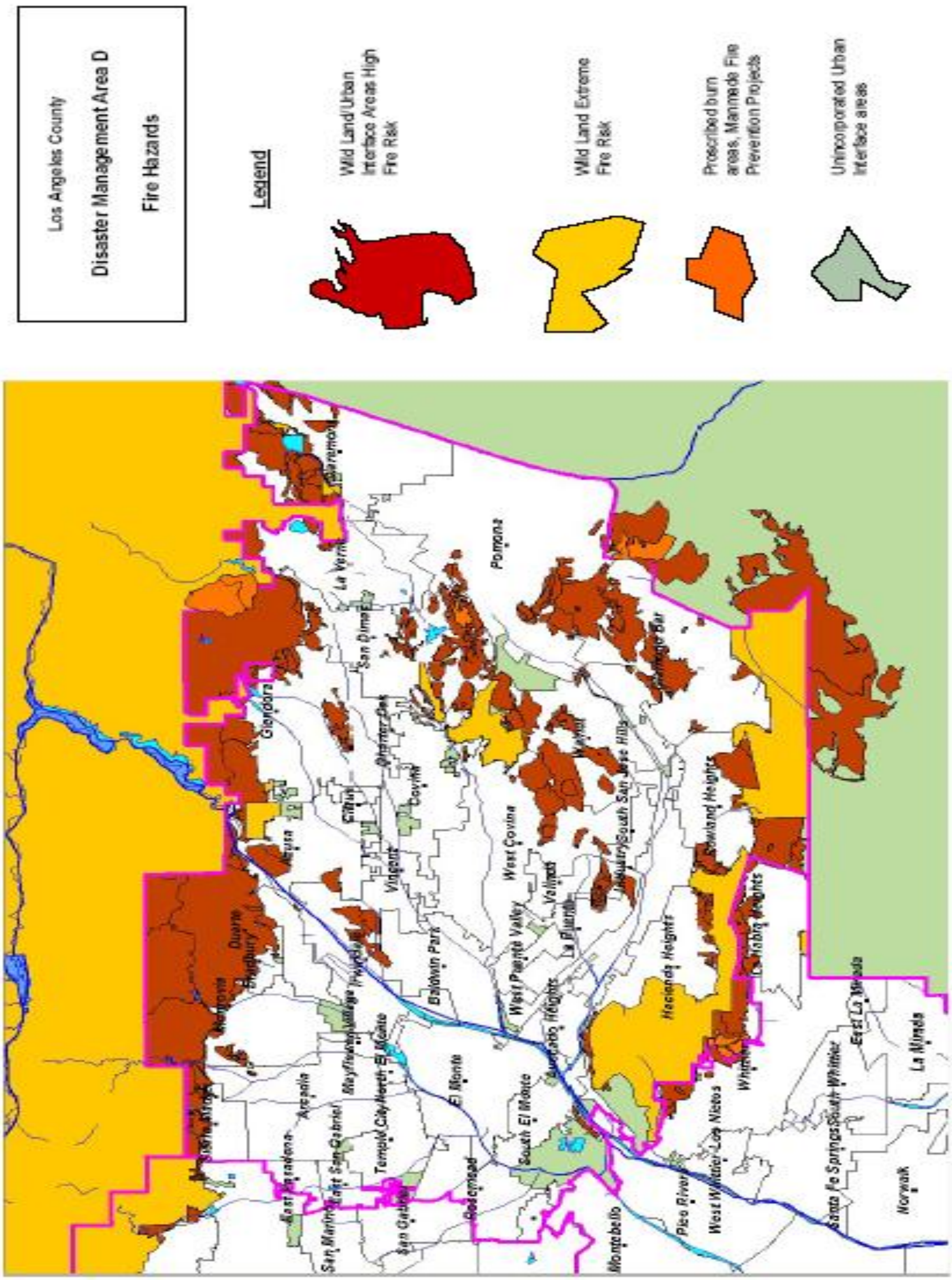
Seismic Hazard Evaluation of the Mt. Wilson 7.5 minute quadrangle, Los Angeles County, California: California Division of Mines and Geology, Open-File Report 98-21.

For additional information on seismic hazards in this map area, the rationale used for zoning, and additional references consulted, refer to DMG's World Wide Web site (http://www.consrv.ca.gov/dmg/).

Map 11
Wildland Urban Interface – Sierra Madre


LEGEND
Wildland Urban Interface
Buffer Zone
THIS MAP DEPICTS
"VERY HIGH WILDLAND FIRE HAZARD SEVERITY ZONES"
AS REQUIRED BY AB-337 THE BATES BILL
THE ZONES INDICATED HAVE BEEN
DEVELOPED THROUGH THE USE OF THE
"BEHAVE" FIRE BEHAVIOR PREDICTION PROGRAM,
BASED ON SITE SPECIFIC INFORMATION

Map 12
Fire Hazards – Disaster Management Area D


Los Angeles County
Disaster Management Area D
Fire Hazards
Legend
Wild Land/Urban Interface Areas High Fire Risk
Wild Land Extreme Fire Risk
Prescribed burn areas, Manmade Fire Prevention Projects
Unincorporated Urban Interface areas

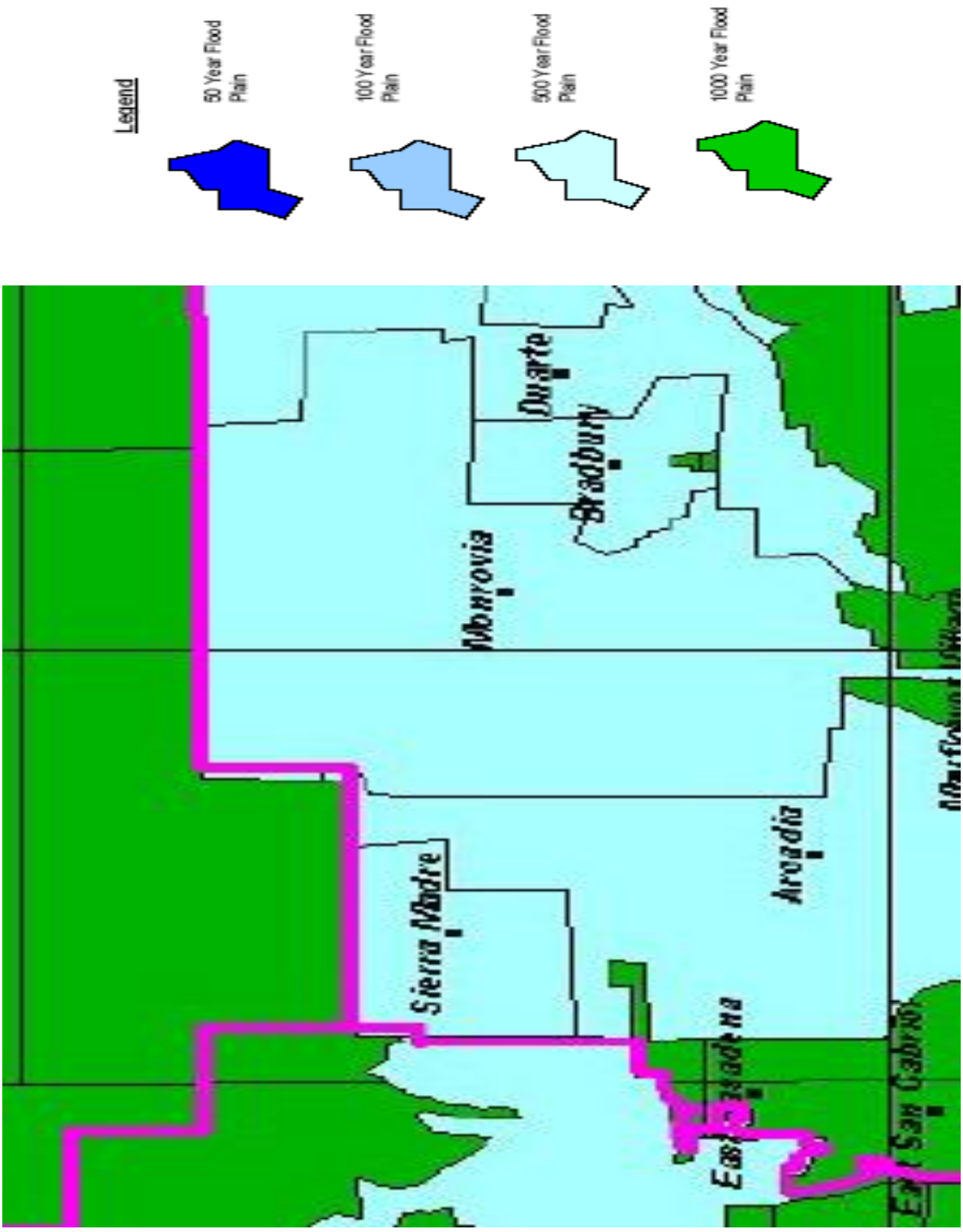
Map 13
Historic Fire Areas – Disaster Management Area D

Los Angeles County
Disaster Management Area D
Historic Fire Areas
Legend
Historic Burn Areas 1878-1996 (Consistent Fire Danger Areas)
Urban Areas
Prescribed burn areas, Manmade Fire Prevention Projects

Map 14
FEMA Flood Plains – Disaster Management Area D

Los Angeles County
Disaster Management Area D
FEMA Flood Plains
Legend
50 Year Flood Plain
100 Year Flood Plain
500 Year Flood Plain
1000 Year Flood Plain

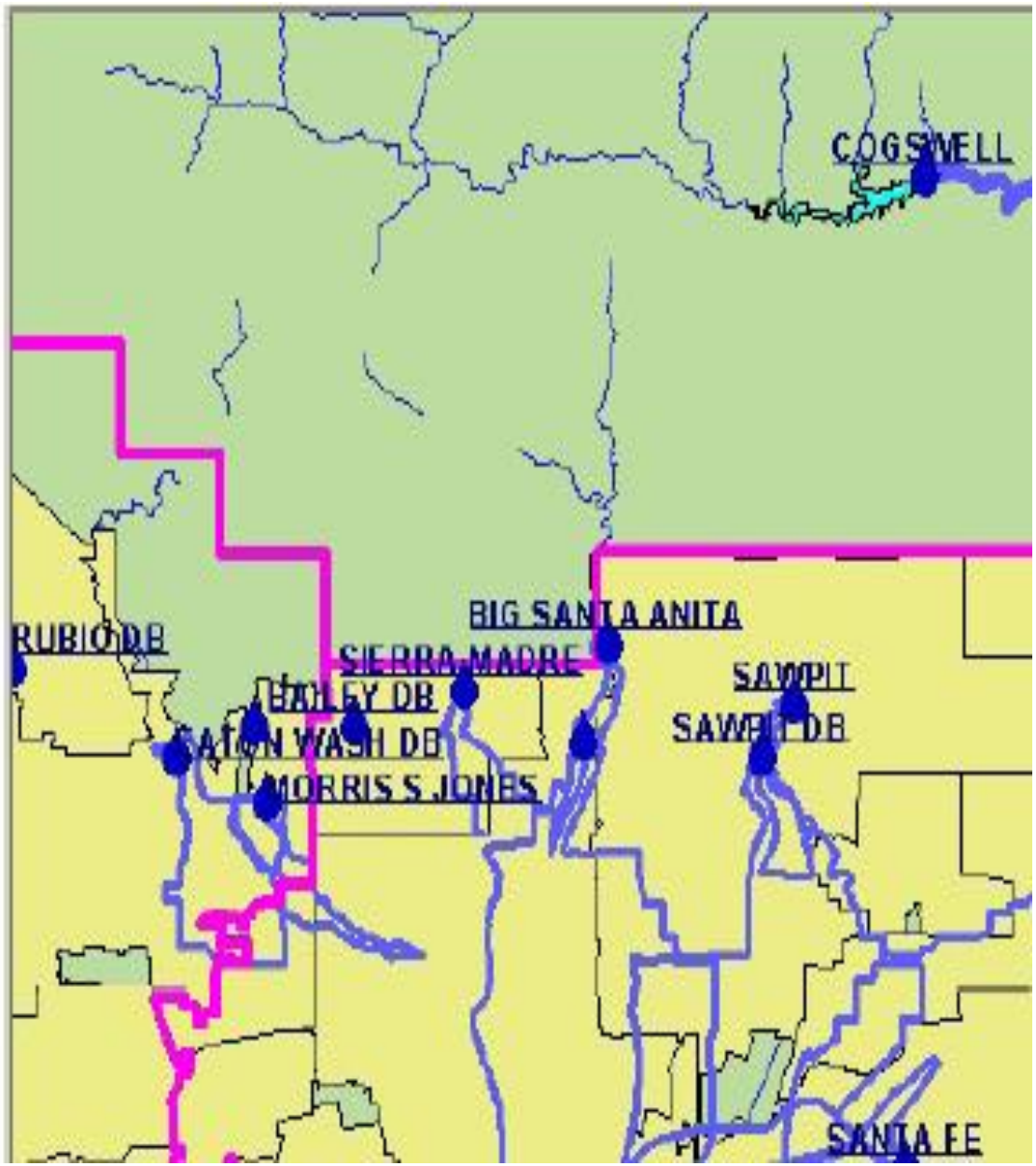
Map 15
FEMA Flood Plains – City of Sierra Madre


Legend
50 Year Flood Plain
100 Year Flood Plain
500 Year Flood Plain
1000 Year Flood Plain
Duarte
Bradbury
Monrovia
Arcadia
Sierra Madre

Map 16
Dam Failure Inundation – Disaster Management Area D

Los Angeles County
Disaster Management Area D
Dam Failure Inundation
Legend
Dam Location
Inundation Flow Route
Disaster Management Area Boundaries
City Boundaries

Map 17
Dam Failure Inundation – City of Sierra Madre



Los Angeles County

Disaster Management Area D

Dam Failure Inundation

Legend

Dam Location

Inundation Flow Route

Disaster Management Area Boundaries

City Boundaries

Chart 1
City of Sierra Madre Potential Losses Table

Estimated Risk & Potential Losses for All Hazards as reported by City of Sierra Madre in a Single or Multi Jurisdictional - LHMP

(In K for thousands or M for millions. Document Method of Completing this Table)

(List of Hazards – edit as necessary)	Estimated Population at Risk for this hazard (in K or M) & the % of total Jurisdiction's Population	Potential $ losses to Critical Facilities or Infrastructure (in K or M)	Potential $ losses to Commercial Buildings (in K or M)	Potential $ losses to Residential or Private Property (in K or M)	Potential Other $ losses (Environmental, Historical, Economic, Human) (in K or M)	Total Potential $ losses for this hazard, per MJP Participating Jurisdiction (in K or M)
Avalanche	0 / 0%	0	0	0	0	0
Coastal Erosion	0 / 0%	0	0	0	0	0
Coastal Storm	0 / 0%	0	0	0	0	0
Dam Failure	2 / .0002%	0	0	80K	0	80K
Drought	10,650 / 100%	100K	0	0	0	100K
Earthquake	4,260 / 40 %	3.5M	5.5M	6M	300K	15.3M
Expansive Soils	0 / 0%	0	0	0	0	0
Extreme Heat	5,500 / 52 %	40K	64K	78K	0	182K
Flood	20 / .002%	30K	80K	89K	0	199K
Hailstorm	10,650 / 100%	4K	24K	38K	0	66K
Hurricane	0 / 0%	0	0	0	0	0
Land Subsidence	0 / 0%	0	0	0	0	0
Landslide	3,600 / 39%	6M	200K	15M	0	21.2M
Severe-Winter Storm	6,500 / 61%	10K	5K	24K	0	39K
Tornado	0 / 0%	0	0	0	0	0
Tsunami	0 / 0%	0	0	0	0	0
Volcano	0 / 0%	0	0	0	0	0
Wildfire	3,000 / 28%	100K	200K	25M	80K	25.4M
Windstorm	1,500 / 14%	20K	45K	80K	45K	190K
Other _____	/ %					
Other _____	/ %					
		9.8M	6.1M	46.4M	425K	62.8M
ALL HAZARDS TOTALS:	/ %	(Total this Column in K or M)	(Total this Column in K or M)	(Total this Column in K or M)	(Total this Column in K or M)	(Grand Total this Column in K or M)

For each hazard where data were available, cost estimates of potential damage have been calculated. The primary tool available to estimate the potential losses of natural hazards is the GIS based software HAZUS. A HAZUS scenario was constructed to estimate losses due to earthquake, mudslides/landslide, and wildfire damage in the City. This methodology enabled the Committee to determine to the best potential estimate based on the information documented.

APPENDIX

F

FEMA Flood letters

APPENDIX

G

Economic Analysis Guidelines for Hazard Mitigation Projects

Appendix G: Economic Analysis Guidelines for Natural Hazard Mitigation Projects

Benefit/cost analysis is a key mechanism used by the state Office of Emergency Services (OES), the Federal Emergency Management Agency, and other state and federal agencies in evaluating hazard mitigation projects, and is required by the Robert T. Stafford Disaster Relief and Emergency Assistance Act, Public Law 93-288, as amended.

This appendix outlines several approaches for conducting economic analysis of natural hazard mitigation projects. It describes the importance of implementing mitigation activities, different approaches to economic analysis of mitigation strategies, and methods to calculate costs and benefits associated with mitigation strategies. Information in this section is derived in part from: The Interagency Hazards Mitigation Team, State Hazard Mitigation Plan, (Oregon State Police – Office of Emergency Management, 2000), and Federal Emergency Management Agency Publication 331, Report on Costs and Benefits of Natural Hazard Mitigation.

This section is not intended to provide a comprehensive description of benefit/cost analysis, nor is it intended to provide the details of economic analysis methods that can be used to evaluate local projects. It is intended to (1) raise benefit/cost analysis as an important issue, and (2) provide some background on how economic analysis can be used to evaluate mitigation projects.

PURPOSE

Mitigation activities reduce the cost of disasters by minimizing property damage, injuries, and the potential for loss of life, and by reducing emergency response costs, which would otherwise be incurred.

Evaluating natural hazard mitigation provides decision-makers with an understanding of the potential benefits and costs of an activity, as well as a basis upon which to compare alternative projects. Evaluating mitigation projects is a complex and difficult undertaking, which is influenced by many variables. First, natural disasters affect all segments of the communities they strike, including individuals, businesses, and public services such as fire, police, utilities, and schools.

Second, while some of the direct and indirect costs of disaster damages are measurable, some of the costs are non-financial and difficult to quantify in dollars. Third, many of the impacts of such events produce “ripple-effects” throughout the community, greatly increasing the disaster’s social and economic consequences.

While not easily accomplished, there is value, from a public policy perspective, in assessing the positive and negative impacts from mitigation activities, and obtaining an instructive benefit/cost comparison. Otherwise, the decision to pursue or not pursue various mitigation options would not be based on an objective understanding of the net benefit or loss associated with these actions.

Economic Analysis Approaches for Mitigation Strategies

The approaches used to identify the costs and benefits associated with natural hazard mitigation

strategies, measures, or projects fall into two general categories: benefit/cost analysis and cost-effectiveness analysis. The distinction between the two methods is the way in which the relative costs and benefits are measured. Additionally, there are varying approaches to assessing the value of mitigation for public sector and private sector activities.

Benefit/Cost Analysis

Benefit/cost analysis is used in natural hazards mitigation to show if the benefits to life and property protected through mitigation efforts exceed the cost of the mitigation activity. Conducting benefit/cost analysis for a mitigation activity can assist communities in determining whether a project is worth undertaking now, in order to avoid disaster related damages later. Benefit/cost analysis is based on calculating the frequency and severity of a hazard, avoided future damages, and risk.

In benefit/cost analysis, all costs and benefits are evaluated in terms of dollars, and a net benefit/cost ratio is computed to determine whether a project should be implemented (i.e., if net benefits exceed net costs, the project is worth pursuing). A project must have a benefit/cost ratio greater than 1 in order to be funded.

Cost-Effectiveness Analysis

Cost-effectiveness analysis evaluates how best to spend a given amount of money to achieve a specific goal. This type of analysis, however, does not necessarily measure costs and benefits in terms of dollars. Determining the economic feasibility of mitigating natural hazards can also be organized according to the perspective of those with an economic interest in the outcome. Hence, economic analysis approaches are covered for both public and private sectors as follows.

Investing in public sector mitigation activities

Evaluating mitigation strategies in the public sector is complicated because it involves estimating all of the economic benefits and costs regardless of who realizes them, and potentially to a large number of people and economic entities. Some benefits cannot be evaluated monetarily, but still affect the public in profound ways. Economists have developed methods to evaluate the economic feasibility of public decisions that involve a diverse set of beneficiaries and nonmarket benefits.

Investing in private sector mitigation activities

Private sector mitigation projects may occur on the basis of one of two approaches: it may be mandated by a regulation or standard, or it may be economically justified on its own merits. A building or landowner, whether a private entity or a public agency, required to conform to a mandated standard may consider the following options:

1. Request cost sharing from public agencies;
2. Dispose of the building or land by either sale or demolition;
3. Change the designated use of the building or land and change the hazard mitigation compliance requirement; or
4. Evaluate the most feasible alternatives and initiate the most cost effective hazard mitigation alternative.

The sale of a building or land triggers another set of concerns. For example, real estate disclosure laws can be developed which require sellers of real property to disclose known defects and deficiencies in the property, including earthquake weaknesses and hazards to prospective purchasers. Correcting deficiencies can be expensive and time consuming, but their existence can prevent the sale of the building. Conditions of a sale regarding the deficiencies and the price of the building can be negotiated between a buyer and seller.

CONDUCTING AAN ECONOMIC ANALYSIS

Benefit/cost analysis and cost-effectiveness analysis are important tools in evaluating whether or not to implement a mitigation activity. A framework for evaluating alternative mitigation activities is outlined below:

1. Identify the Alternatives: Alternatives for reducing risk from natural hazards can include structural projects to enhance disaster resistance, education and outreach, and acquisition or demolition of exposed properties, among others. Different mitigation project can assist in minimizing risk to natural hazards, but do so at varying economic costs.

2. Calculate the Costs and Benefits: Choosing economic criteria is essential to systematically calculating costs and benefits of mitigation projects and selecting the most appropriate alternative. Potential economic criteria to evaluate alternatives include:

- **Determine the project cost.** This may include initial project development costs, and repair and operating costs of maintaining projects over time.

- **Estimate the benefits.** Projecting the benefits or cash flow resulting from a project can be difficult. Expected future returns from the mitigation effort depend on the correct specification of the risk and the effectiveness of the project, which may not be well known. Expected future costs depend on the physical durability and potential economic obsolescence of the investment. This is difficult to project. These considerations will also provide guidance in selecting an appropriate salvage value. Future tax structures and rates must be projected. Financing alternatives must be researched, and they may include retained earnings, bond and stock issues, and commercial loans.

- **Consider costs and benefits to society and the environment.** These are not easily measured, but can be assessed through a variety of economic tools including existence value or contingent value theories. These theories provide quantitative data on the value people attribute to physical or social environments. Even without hard data, however, impacts of structural projects to the physical environment or to society should be considered when implementing mitigation projects.

- Determine the correct discount rate. Determination of the discount rate can just be the risk-free cost of capital, but it may include the decision maker's time preference and also a risk premium. Including inflation should also be considered.

3. Analyze and Rank the Alternatives: Once costs and benefits have been quantified, economic analysis tools can rank the alternatives. Two methods for determining the best alternative given varying costs and benefits include net present value and internal rate of return.

- Net present value. Net present value is the value of the expected future returns of an investment minus the value of expected future cost expressed in today's dollars. If the net present value is greater than the project costs, the project may be determined feasible for implementation. Selecting the discount rate, and identifying the present and future costs and benefits of the project calculates the net present value of projects.

- Internal Rate of Return. Using the internal rate of return method to evaluate mitigation projects provides the interest rate equivalent to the dollar returns expected from the project. Once the rate has been calculated, it can be compared to rates earned by investing in alternative projects. Projects may be feasible to implement when the internal rate of return is greater than the total costs of the project.

Once the mitigation projects are ranked on the basis of economic criteria, decision-makers can consider other factors, such as risk; project effectiveness; and economic, environmental, and social returns in choosing the appropriate project for implementation.

Economic Returns of Natural Hazard Mitigation

The estimation of economic returns, which accrue to building or land owner as a result of natural hazard mitigation, is difficult. Owners evaluating the economic feasibility of mitigation should consider reductions in physical damages and financial losses. A partial list follows:

- Building damages avoided
- Content damages avoided
- Inventory damages avoided
- Rental income losses avoided
- Relocation and disruption expenses avoided
- Proprietor's income losses avoided

These parameters can be estimated using observed prices, costs, and engineering data. The difficult part is to correctly determine the effectiveness of the hazard mitigation project and the resulting reduction in damages and losses. Equally as difficult is assessing the probability that an event will occur. The damages and losses should only include those that will be borne by the owner. The salvage value of the investment can be important in determining economic feasibility. Salvage value becomes more important as the time horizon of the owner declines. This is important because most businesses depreciate assets over a period of time.

Additional Costs from Natural Hazards

Property owners should also assess changes in a broader set of factors that can change as a result of a large natural disaster. These are usually termed "indirect" effects, but they can have a very direct effect on the economic value of the owner's building or land. They can be positive or negative, and include changes in the following:

- Commodity and resource prices
- Availability of resource supplies
- Commodity and resource demand changes
- Building and land values
- Capital availability and interest rates
- Availability of labor
- Economic structure
- Infrastructure
- Regional exports and imports
- Local, state, and national regulations and policies
- Insurance availability and rates

Changes in the resources and industries listed above are more difficult to estimate and require models that are structured to estimate total economic impacts. Total economic impacts are the sum of direct and indirect economic impacts. Total economic impact models are usually not combined with economic feasibility models. Many models exist to estimate total economic impacts of changes in an economy. Decision makers should understand the total economic impacts of natural disasters in order to calculate the benefits of a mitigation activity. This suggests that understanding the local economy is an important first step in being able to understand the potential impacts of a disaster, and the benefits of mitigation activities.

ADDITIONAL CONSIDERATIONS

Conducting an economic analysis for potential mitigation activities can assist decision-makers in choosing the most appropriate strategy for their community to reduce risk and prevent loss from natural hazards. Economic analysis can also save time and resources from being spent on inappropriate or unfeasible projects. Several resources and models are listed on the following page that can assist in conducting an economic analysis for natural hazard mitigation activities. Benefit/cost analysis is complicated, and the numbers may divert attention from other important issues. It is important to consider the qualitative factors of a project associated with mitigation that cannot be evaluated economically. There are alternative approaches to implementing mitigation projects. Many communities are looking towards developing multi-objective projects. With this in mind, opportunity rises to develop strategies that integrate natural hazard mitigation with projects related to watersheds, environmental planning, community economic development, and small business development, among others. Incorporating natural hazard mitigation with other community projects can increase the viability of project implementation.

RESOURCES

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Source: Disaster Management Area D Coordinator

APPENDIX

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FEMA Crosswalk