On the Process of Researching Hazard Mitigation Data for Use in the Land Use Portfolio Model (LUPM)

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ABSTRACT

The Land Use Portfolio Model (LUPM) software was developed by the United States Geological Survey (USGS) Geography Discipline to be used by communities to determine the potential benefits of their investment in various measures that could be undertaken to mitigate the risk from natural hazards. The goal of this project was to obtain information and data used by communities to make hazard mitigation decisions. This information will be used in LUPM in order to assess the impact an LUPM analysis could have had on those decisions. After a lengthy search was conducted, it became apparent that the data necessary to run LUPM was not readily available for a variety of reasons. We recommend that the USGS collaborate with a local government or agency that could act as a case study for this project.

INTRODUCTION

Background

The United States Geological Survey (USGS) Geography Discipline has been developing the Land Use Portfolio Model (LUPM) software over the past several years. The model employs a quantitative approach to estimate the potential benefits of investment in alternative mitigation measures for various hazard scenarios. This software could be a useful tool for communities to use when creating mitigation plans for natural hazards.

By preparing plans for hazard events and implementing the mitigation measures outlined in those plans, communities hope to prevent loss and damage from natural hazards. Currently, the Federal Emergency Management Agency (FEMA) distributes software called HAZUS-MH (Hazards U.S., Multi-Hazard) that can estimate losses from potential hazards. FEMA offers grants to communities, which require them to develop hazard mitigation plans, and HAZUS is often used in this process.
LUPM takes into account damage and loss estimates, such as those generated by

HAZUS, as well as estimated levels of risk and the monetary values associated with mitigation. By then allowing communities to compare and combine various mitigation options, LUPM should offer a way for them to maximize their investment potential.

This Study

The initial objectives of our study were to collect data and information on past natural hazard mitigation decisions made by communities, and then, by running scenarios through LUPM, evaluate the effect an LUPM analysis could have had on those decisions. More simply put, we researched how communities decided what mitigation measures to undertake and then how those measures fared during a natural hazard.

The specific types of data that were searched for, based on our understanding of the inputs needed to run LUPM, are as follows:

1. The probability that a natural hazard event will occur
2. The conditional probability of damage to an area, given an event
3. The assets and asset values in a community
4. The cost of mitigation
5. Mitigation effectiveness

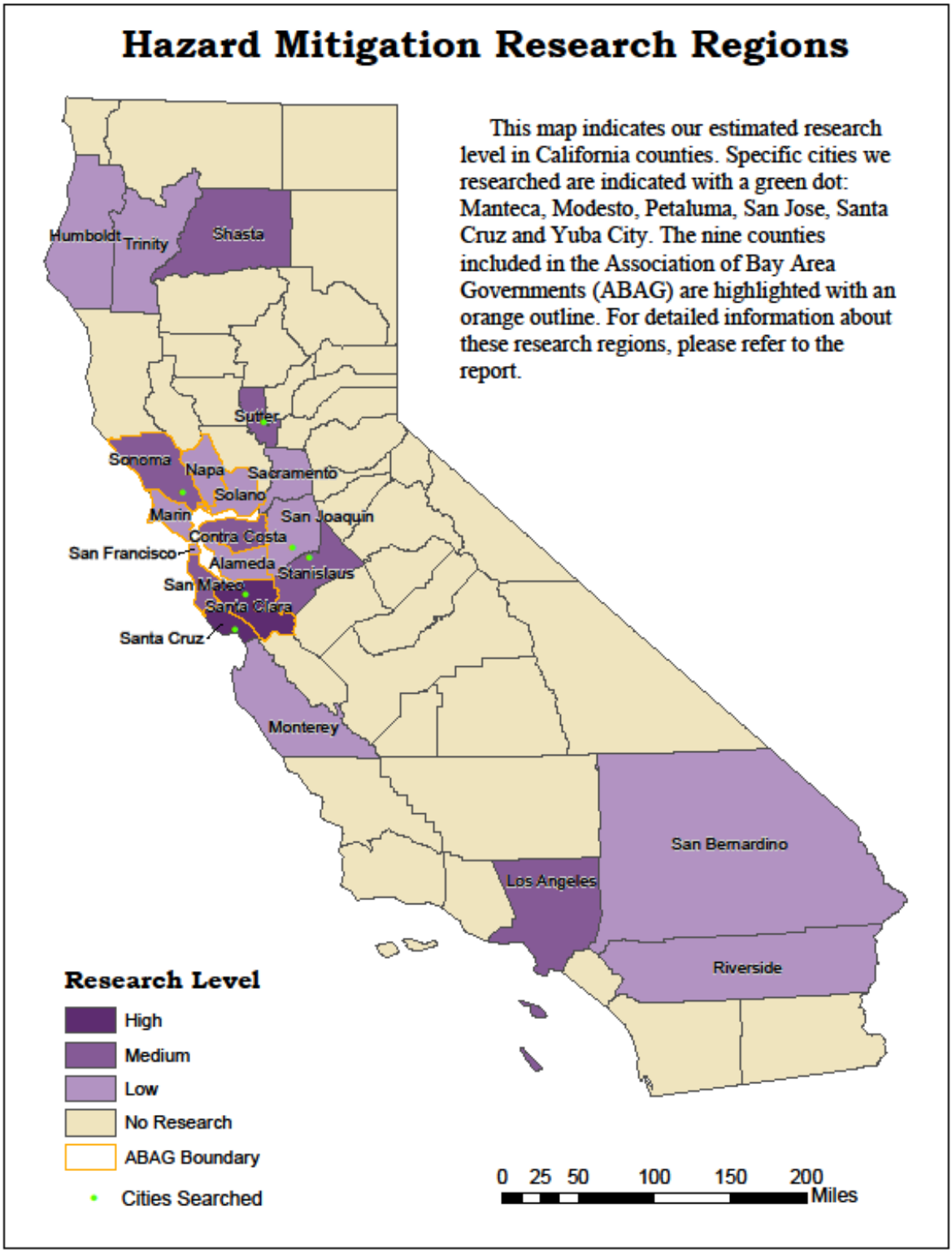

Figure 1: Map of our research area showing the level of research by county.

RESEARCH PROCESS

Methodology

The search for data began with an Internet search. Each group member did a preliminary Google search to assess what could be found easily. In particular, we researched the hazard mitigation plans of local governments, generally cities or counties. In this phase and throughout our research, we focused on California, and generally counties that were local to us. We also started contacting people we knew in organizations or fields that might be helpful to us.

Next we broke up our research area by county, with each group member searching within specific counties. This included finding contacts in the communities that might have access to county documents or other background information, and looking for information on community websites. We developed an email template (see attachment) to send to counties and our other contacts. Within our search areas, we eventually decided that researching specific hazard events might be fruitful. Because wanted the option of using HAZUS to help create loss estimates, we limited our hazard searching to those hazards that are used in HAZUS, which are earthquakes, hurricane winds, and floods.

Our last phase of research involved going to libraries to find historical plans and other background documents.

Our initial search area included Santa Cruz, Shasta, Santa Clara, Alameda, San Francisco, San Mateo, Sonoma, Sutter, and Contra Costa counties. Our expanded county search included Alameda, Contra Costa, Humboldt, Los Angeles, Marin, Monterey, Napa, Riverside, Sacramento, San Bernardino, San Francisco, San Joaquin, San Mateo, Santa Clara, Santa Cruz, Shasta, Solano, Sonoma, Stanislaus, Sutter, and Trinity counties (see Figure 1).

Initial Internet Search

In almost every community we searched, there was either a current plan available or one was in development. However, the current plans gave no data on past hazard events or mitigation measures. They also did not include documentation of the analyses or specific information used to develop the plan.

There were organizations that we came across in our Internet search that seemed as though they should have access to the kind of data we needed. These organizations included: Bay Area Automated Mapping Association (BAAMA), Association of Bay Area Governments (ABAG), California Spatial Information Library (CaSIL), The California Emergency Alert System (CalEMA), Community Action Plan for Seismic Safety (CAPSS), and San Francisco Planning and Urban Research Association (SPUR).

During this initial phase, one group member focused on Sonoma County and found a poster, *Loss Avoidance Study: Northern California Flood Mitigation*, describing a project done by FEMA about floods in the city of Petaluma. This project had involved calculating the return on mitigation investment for the city, and therefore may have required very similar data to what would be needed to run LUPM. After looking for the report itself, two dense text documents were found that that gave the overview and methodology of the project (see the Useful Data section).

A 1998 report on flood control measures taken by the city of Petaluma was found as well. This listed past mitigation plans, but the plan themselves were not found. Had we been able to successfully contact someone in Sonoma County, those documents might have been available. This report also mentioned the California State Mitigation Assessment Review Team (SMART), which assesses natural hazard mitigation project performance after a disaster.

Searches of the CalEMA and SPUR websites were informative but did not lead to the

data we needed for LUPM. SPUR has a section discussing disaster planning, and CalEMA had information about hazard mitigation grants as well as a link to the hazard mitigation plan for the State of California.

Approaching Known Contacts

Our first contact was Matt Price who works in the GIS department for Santa Cruz County. He was able to provide us with a few PDF maps that the county had produced showing different threats for most of the county. These maps also provided a cost associated with mitigation for these areas. This seemed to be a promising path, so we inquired about the data used to produce these maps. Matt directed us to contact Gulla Gisladottir, an assessor for Santa Cruz County, but he noted that he did not believe they would provide the data linked to the map. An email was sent to Gulla Gisladottir, but there was no response.

We were directed to contact Map Sales at the USGS for possible data. When a call was made, we were directed to call back and speak with another person named Matt, who was supposed to work on Thursdays. However, calls were made on multiple Thursdays with no success, and the person we spoke to on those calls said that no one by that name worked there. We asked the person with whom we were able to speak if they had any ideas where we could find the data we needed, and they did not have any idea.

One of our group members has taken courses by professors in the field of Urban Planning. He approached these professors with questions of where to search. John Davidson, professor of Urban Planning and Urban Planner for the City of San Jose, led him to the San Jose General Plan, specifically the chapter on Goals and Policies. This proved to be another plan for future or present hazard mitigation, much like we had found during our initial search process.

He also suggested we contact his University office partner Hing Wong, a senior regional planner for the Association of Bay Area Governments (ABAG). Mr. Wong suggested that we try contacting two of his colleagues, Jeanne Perkins and Danielle Hutchings, who both work with earthquake issues for ABAG. The details of our contact with these people are discussed below.

We also spoke to John Williams, Professor of Geology at San Jose State and a retired Geologic Engineer. Dr. Williams gave us contact information for a Graduate student from the Geology department who had done thesis work on mitigation for earthquakes, Nan Shostak. We spoke to Ms. Shostak on the phone, and she also suggested we talk to Jeanne Perkins of ABAG. She also mentioned Jack Boatwright with the San Francisco Community Action Plan for Seismic Safety (CAPSS). When we searched for him through CAPSS, we did not find any contact information for him, and so did not contact him. At the end of our research we found that he is a seismologist with USGS, so we did include his information at the end of this report.

Searching by County

Santa Cruz

In addition to Matt Price in the Santa Cruz County GIS department, we approached the County Assessor's Office because it was reported to play a significant role in the creation of mitigation plans. However, we were unsuccessful making contact with anyone at the Santa Cruz County Assessor's Office.

Shasta

We called Leslie Morgan with the Shasta County assessor's office, and also emailed the general GIS webmaster on the Shasta County website (using the contact form provided on the Shasta County website). We did not get a reply from either of these contacts.

Santa Clara

One group member visited the front desk of the Santa Clara County Planning and Building Inspection Department, where the front desk clerk was very helpful in trying to think of people in this department that might have had access to the to the kind of data we were searching for. He came up with the names of three people, but none of them were available to talk in person that day. We left with their contact information and sent our template email to each one.

The first was Judy Saunders, Assistant Fire Marshal for Santa Clara County. She responded with a link to The California Department of Forestry and Fire Protection website and their hazard tracker page. This site contains an immense amount of information on fire analysis in California. We were unable to find the data we were looking for, but with more time devoted to this site we think there could be some useful data here.

The second contact was Daren Wardell, Senior Building Inspector for Santa Clara County. He responded to our email by saying, "We'll need to look into this further," and that he would be out of the office for the next two weeks. Mr. Wardell seemed willing to help, so we emailed him again before and after he would have returned to his office, but unfortunately we did not hear back from him again.

The third person emailed was Bill Shoe, the Principal Planner for Santa Clara County, but we got no response.

San Bernardino and San Mateo

An email was sent to the San Mateo and Riverside County planning offices at the address listed for "general information" on their websites. No one at San Mateo County responded. However, we got a reply from Damian Lanning at the Transportation Land Management Agency for Riverside County. He sent a link to the

county's GIS download site. This had many data layers and tables for public use, but none of them had the information we were looking for.

Contra Costa

Online, we found notes from a meeting discussing the current hazard mitigation plan of Contra Costa County, which listed Susan Roseberry as the Contra Costa County Emergency Planning Coordinator. It said she should be contacted with questions regarding the plan. An email was sent asking if she would be able to share the kinds of data that was used to create the current plan. She replied that the current LHMP had been created by a consultant, Tetra Tech, and put us in contact with a man named Rob Flaner at this firm. An email was sent to him, but he did not respond.

Stanislaus

We contacted two planners from Stanislaus County. Emily Pino-Williams, a former Assistant Planner for the City of Riverbank was responsible in some mitigation planning while working there. A lengthy conversation with her was enlightening as to the process of mitigation planning in small communities, as well as data storage for historic mitigation information. She let us know that the necessary data may not be readily available. In her experience it was in multiple locations within the planning department. It was not organized and often it may not be apparent where to look for specific information. It would most likely have to be gleaned from several documents. The other planner we contacted was a planner for the Stanislaus Council of Governments (StanCOG), but we got no response.

San Francisco, Los Angeles, and Sacramento

We were able to find current mitigation plans or plans in progress for these three counties. However, we were unable to find historic mitigation plans or mitigation data. A lengthy mitigation plan for Los Angeles County was found, which contained

data but not the data we were looking for. We were able to find some data concerning losses in the San Francisco Mitigation Plan. We also researched the Sacramento Area Flood Control Agency (SAFCA), which seemed to provide some useful mitigation data. We were unable to pull out the data we needed, but with further research it could be possible to derive the necessary data.

ABAG

During our initial search we came across ABAG, and while it seemed as though it would be a good resource for our purposes, we did not find the kind of data we needed on their website. However, we were advised by several people to pursue this, and since two people had suggested Jeanne Perkins at ABAG as a resource, we gave her a call.

Ms. Perkins explained that it is only recently that the Federal Government has offered grants for hazard mitigation to local governments and in order to qualify they had to prepare a detailed hazard analysis for the region, known as a Local Hazard Mitigation Plan (LHMP). These analyses usually involved running HAZUS in order to estimate the economic losses affiliated with potential hazards. Ms. Perkins thought that unless the grant had been approved for the region, the report and data would most likely not be publicly available. She also pointed us towards CalEMA. The other person we contacted at ABAG, Danielle Hutchings, responded to our email with three links to specific pages within the ABAG website. Unfortunately, it seems that the ABAG website was undergoing some interface changes at that time (September), and so many of these links were broken. However a recent visit of the ABAG site showed that many of the links had been updated.

The first, http://quake.abag.ca.gov/mitigation, has several links to documents and tables outlining the details of the LHMP requirements. Although very informative for future hazard planning, none of these links seem to lead to useful data for our

purposes. The second, http://quake.abag.ca.gov/infrastructure, led to transportation-specific losses from earthquakes focusing mostly on road closures, which was also was not what we were looking for. The third link Ms. Hutchings sent, http://quake.abag.ca.gov/housing/losses/, seemed promising, especially the link titled "Survey of Existing Mitigation Efforts" under the Mitigation Planning heading. We have tried to return to this link and we are unable to find it. It seems that ABAG is still updating their site.

Library Search

We searched the San Jose Library for books or documents on natural hazard mitigation in California and found a couple things we thought would prove helpful. The first book, *Practical Lessons from the Loma Prieta Earthquake,* gave detailed accounts of damages that occurred during this 1989 earthquake and various discoveries on construction materials and techniques that failed as a result. This information was useful for understanding the need for mitigation, but the book did not describe any measures taken toward implementing them.

We also read excerpts from *California Earthquakes: Science, Risk and the Politics of Hazard Mitigation* which gives details on California State and local government's efforts toward analyzing earthquake damage and organizing appropriate mitigation to reduce damages in the future. One section in chapter nine, *Earthquake Hazard Mitigation in California,* seemed particularly helpful, as it mentions Los Angeles's retrofitting efforts for types of buildings that were severely damaged in the 1971 San Fernando earthquake.

We checked the references for this section, hoping they would lead to more details. The author referenced many L.A Times articles, which are listed below, but we were unable to find them because of limited archives. He also referenced *The Politics and Economics of Earthquake Hazard Mitigation: Unreinforced Masonry Buildings in*

Southern California. We were able to find this, but only find in a poorly scanned PDF format, which made it difficult to review.

Searching by Hazard

One of the hazards we focused on in our searching was flooding. We thought that floods were a very common type of hazard and even small communities would have to have some kind of flood plan. A search for "California flood" on Google got us to the California Department of Water Resources Data Exchange Center, which seemed extremely promising, but after searching on their site we did not find anything.

The next step was to search for news of hazards in specific cities. The Wikipedia article on floods in California had great information and a list of cities that had had floods. We were particularly interested in Manteca and Modesto, since they had suffered multiple floods over many years and would almost certainly have had to do some kind of mitigation. A search for "Manteca flood" and "Manteca flood plan" found a 2009 article in the Manteca Bulletin that was helpful in outlining the kinds of improvements that needed to be made but did not give any real specifics. SAFCA was found to have a good list of the history of Sacramento area floods, and showed other communities in the area that had experienced multiple floods.

Olivehurst was one city that was affected by floods in both 1986 and 1997, so we decided to research that. Olivehurst is a very small community southeast of Yuba City, which is in Sutter County. We were able to find the current Yuba City flood plan, but did not find any historical projects. However, a website on the history of Sutter County did provide some detailed flood information. We also found the website for the Sutter Butte Flood Control Agency (SBFCA), which is an agency composed of the Counties of Butte and Sutter, the Cities of Biggs, Gridley, Live Oak and Yuba City, and Levee Districts 1 and 9.

An email was sent to the SBFCA on October 27, saying that we were specifically interested in the kinds of mitigation decisions Yuba City and Sutter County in general has made response to the floods of 1987 and 1996 and the flood plans that were created by that community during that time. We also called and left a message.

We got a call back on November 22 from Sarah Modeste, a staff analyst with the organization. Ms. Modeste said they had only been in existence since 2007 and did not have historical docs on hand. She said that she would ask another staff member who knew more about area history and get back to us, but we have not received an email from her.

USEFUL DATA FOUND

This section includes citations for documents that seemed especially useful and a summary or sample of the kind of data found in them.

1. Santa Clara Valley Water District, October 1995. *Flood Protection in Santa Clara County through 2010: An overview of program scope and revenue options for the North Central and Central Zones*. See attachment.

(Example)
101 Miller Reach, Completed Nov 1992
Project costs: $10,487,521
W*ith this flood control project completed:*
Estimated 1% Flood Damage Expected: $21 Million
Number of Homes and Buildings Flooded: 1,600 structures

2. Alesch, Daniel J. and William J. Petak. 1986. *The Politics and Economics of Earthquake Hazard Mitigation: Unreinforced Masonry Buildings in Southern California.* Institute of Behavioral Science, University of Colorado.
http://www.preventionweb.net/files/1062_mg43.pdf

This book outlines the process by which communities assess and mitigate earthquake risk. It has chapters devoted to risk, types of mitigation, and costs; the development of earthquake mitigation policies in three community case studies, which includes an explanation of how ordinances took shape and the ways in which communities developed "hazard indices" to asses the vulnerability of structures; and the impacts to the communities after ordinances were adopted and updated.

3. U.S. Army Corps of Engineers, June 3, 1968. *Mad River, Humboldt and Trinity Counties, California. Letter from the Secretary of the Army.* Transmittal. See attachment.

This is a USACE document that discusses the history and character of flooding in these counties, as well as improvements made by various agencies in order to mitigate flooding. It includes appendices which outline the methodology used to estimate potential flood damages.

(Example)

Type and Value of Improvements, 1968: $14,500,000
Damages:
1953 Flood: $1,564,000
1955 Flood: $1,728,000
1964 Flood: $5,824,000
Standard Project Flood (est. 1968): $8,550,000

USACE constructed new levees, improved existing levees.

Completed November 1955,Cost: $191,000

As a result of 1955 floods, USACE constructed and strengthened levees.

Completed 1963, Cost: $385,000 (Federal), $60,000 (non-Federal)

4. FEMA, June 2009. *Loss Avoidance: Northern California Flood Control Mitigation*.

Loss avoidance project done by FEMA about floods in the city of Petaluma.

http://www.fema.gov/library/viewRecord.do?id=3656 (poster)

http://www.fema.gov/library/file?type=originalAccessibleFormatFile&file=loss_avoidance_study_northern_california_flood_control_mitigation_part_1_unlocked.txt&fileid=5540e760-ef07-11de-8441-001cc456982e

http://www.fema.gov/library/file?type=originalAccessibleFormatFile&file=loss_avoidance_study_northern_california_flood_control_mitigation_part_2_unlocked.txt&fileid=b1828d20-8022-11de-bb9e-001185636fb7

Abstract: The Federal Emergency Management Agency (FEMA) developed a loss avoidance methodology to evaluate the effectiveness of the mitigation projects. The methodology is based on the analysis of actual events that have occurred in the project study area since project completion. It determines losses avoided by comparing damage that would likely have been caused by the same storms without the project with damages that actually occurred with the project in place.

5. Michael R. Boswell, William J. Siembieda, and Kenneth C. Topping. March 10, 2010. *Post-Disaster Assessment of the Performance of Hazard Mitigation Projects: The California SMART Approach*.

http://www.fujipress.jp/finder/xslt.php?mode=present&inputfile=DSSTR000500020006.xml

Abstract: California's SMART (State Mitigation Assessment Review Team) program for assessing natural hazard mitigation project performance after a disaster is a method of integrating multiple state agencies' expertise into a working tool for assessing the value of public investments in risk reduction. The intent of the SMART program is to provide the California Emergency Management Agency with information about the performance of publicly financed mitigation projects so that it can better allocate future funding and improve the overall safety of California…. In order to test the SMART system, a pilot study was conducted using the Yountville Flood Barrier Wall Project performance during a 2005 flood on the Napa River.

6. From *History of Levee District One,* http://www.leveedistrict1.com/history.html Accessed November 2010.

"In 1987, Levee District One obtained funds from the state of California for levee repairs. Levee District One let a contract to construct a chimney blanket on the side of the levee which started at the old county hospital and south to the fifth street bridge in Yuba City. This construction adds great strength to the side of the levee and should water seep through, it cannot carry the dirt through the blanket. This same procedure was used at Shanghai Bend the same year. At Star Bend, we constructed a filter trench where we had dangerous boils. Water may still seep under the levee; however no dirt will carry through the filter in the trench. The above work was all done at a cost of nearly 3.5 million dollars in 1986 money.

In the summer of 1994, a filter seepage pipe was installed from the Shanghai Bend Road north about one mile. In the flood of 1997, this seepage pipe worked very well. In December 1996, another event occurred like the 1955 and 1986 events."

DISCUSSION

Initially, the search for data was meant to be only one piece of a larger project that would have included conducting LUPM runs and providing an assessment of its potential usefulness for use in hazard mitigation decisions. However, finding the kind of information needed to run LUPM proved to be so difficult that it became worthwhile to report on the search process itself. Unfortunately, the potentially useful data presented in this report was found too late for us to do a meaningful assessment of LUPM, given our time limitations.

Our research focused not only on looking for the data itself, but also doing research to figure out where to look for that kind of information. The Internet was a logical place to start, and while this was very helpful at generating contact names and potential regions to research, it became apparent that seemingly no communities or agencies were putting up on a website any information on background analysis used to make hazard mitigation planning decisions. Even once we were able to focus on ostensibly productive sources, other kinds of roadblocks were encountered. These included difficulty in communicating to our contacts the function of LUPM and the kind of data we were looking for, a lack of willingness to share data, and a general lack of responsiveness to our requests for information.

The Internet is a tricky place to perform research, since websites are being constantly updated and changed. For instance, in the process of re-accessing links to include in this report, it was discovered that the ABAG website had changed significantly within the last few months. During the initial search phase in September, some of the links were dead and led nowhere. However, by late November, the interface on the ABAG site had been significantly changed and those previously dead links went to areas of information that might have been extremely useful had they been accessible earlier in our project.

In addition, not much historical data seems to find its way onto the Internet. During our searching, we were able to find many current hazard mitigation plans. Most of these plans included a general description of hazards that could be expected and should be prepared for. Rarely were the calculated probabilities of an event or the monetary values associated with mitigation listed. While property values can be estimated, it would have been more helpful to use the same data that communities had used. What would have been most helpful were historic hazard mitigation plans that were in place before a disaster occurred. Through extensive Internet searching, it became more and more apparent that these plans were not online.

We often focused on researching subjects for long amounts of time that produced little or no results. For example, searching for news on specific flood events in Petaluma produced articles from Petaluma local newspapers. While these had interesting anecdotal information they were rarely specific enough to be useful, but it took a fair amount of time and effort to draw that conclusion. Many of the people we contacted had very helpful suggestions on places to search and other people to talk to on where to search. However, these tips would often lead us back to places that we had already researched or to people that we had already talked to.

When we were able to contact people that seemed to play an important role in the creation on plans, we did run into difficulty communicating to them what we needed for this project. For example, our team member who spoke with Jeanne Perkins at ABAG found the conversation discouraging. When he explained the design and purpose of LUPM, she mentioned HAZUS and FEMA's other software, Benefit-Cost Analysis, and wondered why the USGS would bother creating LUPM when those other software tools are available. Attempts to clarify the specific portfolio-modeling function of LUPM did not help.

Also, it seems that communities will often contract out the creation of their mitigation plans to consultants. While Susan Roseberry at Contra Costa County seemed eager to help, she didn't seem to know a whole lot of the details that had gone into the writing of this plan, and referred us to their consultant. We contacted this consultant and never got a response. However, it seems likely a private consulting firm would be unable to release any data to us without permission, which might be difficult to secure from a county or agency without a specific data request. In addition, consulting companies that may have helped to create plans years ago may no longer exist or may not have kept the information or analysis used to generate the plan.

It should also be noted that for this project, we kept our focus area in California and the majority of the counties contacted or researched were in the Bay Area. The intent behind this was to give us the option of traveling to those communities and doing research in person if we were able to arrange meetings with county representatives. However, it is possible that other states or areas of the country would have more historical information available.

CONCLUSION

Upon reflection, it is clear that our most fruitful research occurred in libraries, when we found copies of historical documents themselves. The most useful of these were studies that communities had already undertaken in order to assess their own mitigation record. Given the length and difficulty of our research process, we recommend that the USGS find a local government or agency that would be willing to collaborate with them and act as a case study for this project. Members of the USGS staff would probably have an easier time contacting people and maintaining those relationships, since communities would most likely respond to the authority

of that organization.

CONTACTS, REFERENCES, AND WEBSITE LINKS

LUPM Documentation and Literature

Richard Taketa, Peter Ng, and Makiko Hong. *Land-Use Portfolio Modeler, Version 1.0— Software Documentation and Tutorial*
http://pubs.usgs.gov/tm/tm11c4/tm11-c4.pdf

Laura B. Dinitz, 2008. *Applying the Land Use Portfolio Model to Estimate Natural-Hazard Loss and Risk—A Hypothetical Demonstration for Ventura County, California*
http://pubs.usgs.gov/of/2008/1309/

USGS

Jack Boatwright, senior seismologist at USGS
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San Jose State University

John Williams, Professor of Geology and retired Geologic Engineer
williams@geogsun.sjsu.edu

John Davidson, Urban Planning Instructor and Urban Planner for City of San Jose.
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Nan Shostak, Geology Graduate student who focused on Earthquake mitigation.
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ABAG

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Jeanne Perkins, hazards consultant for ABAG
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Danielle Hutchings, earthquake and hazards specialist for ABAG
danielleh@abag.ca.gov, (510) 464-7951

http://quake.abag.ca.gov/mitigation
http://quake.abag.ca.gov/infrastructure
http://quake.abag.ca.gov/housing/losses/

Santa Clara County

Bill Shoe, Santa Clara County Principal Planner
bill.shoe@pln.sccgov.org

Daren Wardell, Santa Clara County Senior Building Inspector
Daren.Wardell@pln.sccgov.org

Judy Saunders, Santa Clara County Assistant Fire Marshal
judy.saunders@pln.sccgov.org, (408) 299-5761

The California Department of Forestry and Fire Protection website:
http://frap.fire.ca.gov/projects/hazard/tracker.html

San Jose General Plan and the chapter on Goals and Policies (http://www.sanjoseca.gov/planning/gp/2020_text/Pdf_version/2009/GPChp4_2009-12-01.pdf).

Santa Cruz County

Matt Price, GIS coordinator Santa Cruz County ISD400@co.santa-cruz.ca.us

Gulla Gisladottir, county assessor Santa Cruz County ASR127@co.santa-cruz.ca.us

San Mateo County

San Mateo County Planning

plngbldg@co.sanmateo.ca.us

Riverside County

Riverside County TMLA

http://www.rctlma.org/online/content/email_tlma_staff.aspx?tlmawebmaster&TLMA%20Webmaster

Shasta County

Leslie Morgan, county assessor Shasta County 530-225-3600

GIS webmaster, Shasta County

http://www.co.shasta.ca.us/html/GIS/gis_contact_form.htm

GIS download site: http://www.rctlma.org/online/content/gis_downloads.aspx

Los Angeles County

Los Angeles County Hazard Mitigation Plan

http://lacoa.org/PDF/hazmitgplan.pdf

Stanislaus County

Stanislaus County Hazard Mitigation Plan

http://www.stanoes.com/mjhmp.shtm

The Stanislaus Council of Governments

http://www.stancog.org/

Alameda County

Alameda County Hazard Mitigation Plan (in progress)

http://www.acgov.org/mitigationplan.htm

Sacramento County

Sacramento County Multi-Hazard Mitigation Plan Mitigation Capability Assessment

http://www.msa2.saccounty.net/dwr/Drainage/Section%204-3%20Capablity%20Assessment3rdFinal.pdf

San Francisco County

San Francisco Hazard Mitigation Plan

http://www.abag.ca.gov/bayarea/eqmaps/mitigation/SanFrancisco-Annex.pdf

Sonoma County

Central Petaluma Specific Plan chapter on Flooding and Noise

http://cityofpetaluma.net/cdd/pdf/cpsp/cpsp/cpsp-chap7-flooding-and-noise.pdf

Report on Flood Control Impacts in Petaluma:

http://sscrcd.org/pdf/App.D-Flood%20Control%20Impacts_web.pdf

Sutter and Butte Counties

Sutter Butte Flood Control

info@sutterbutteflood.org

Books

Geschwind, Carl-Henry. 2001. *California Earthquakes: Science, Risk and the Politics of Hazard Mitigation.* The John Hopkins University Press, Baltimore, Maryland.

National Research Council. 1994. *Practical Lessons from the Loma Prieta Earthquake.* National Academy Press, Washington D.C.

Alesch, Daniel J. and William J. Petak. 1986. *The Politics and Economics of Earthquake Hazard Mitigation: Unreinforced Masonry Buildings in Southern California.* Institute of Behavioral Science, University of Colorado.
http://www.preventionweb.net/files/1062_mg43.pdf

Other Websites

California State hazard mitigation plan:
http://hazardmitigation.calema.ca.gov/plan/state_multi-hazard_mitigation_plan_shmp

Hazard data: http://hazardmitigation.calema.ca.gov/mapping_and_analysis
ABAG local hazard mitigation http://quake.abag.ca.gov/mitigation/
Cal-Atlas http://www.atlas.ca.gov/download.html
BAAMA http://www.baama.org/
The DWR California Data Exchange Center: http://cdec.water.ca.gov.
CAPSS.org
Spur.org
CalEma: www.oes.ca.gov
Fema.gov

***L.A. Times articles* (referenced in *California Earthquakes: Science, Risk and the Politics of Hazard Mitigation*):**

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Claire Spiegel, "7,876 Brick Buildings in L. A. Predate Quake Codes," LAT, Nov. 25, 1979, II:I, 3.

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Paul Manuele, "Proposed Ordinance Will Require Upgrading of Unsafe Structures," LAT, July 27, 1980, IX:37, 39

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Joanne Sweeney, "Council Will Act on Tougher Quake Standards," LAT, Jan. 5, 1981, II:I 2, 8.

Harry Weinstein, " New Quake Safety Standards Enacted," LAT, Jan. 8, 1981, II:I, 5.

Attachment A. Excerpts from *Flood Protection in Santa Clara County through 2010: An overview of program scope and revenue options for the North Central and Central Zones*. Santa Clara Valley Water District, October 1995.

Flood Protection In Santa Clara County Through 2010:

An overview of program scope and revenue options for the North Central and Central Zones

October 1995

1995 flooding caused by the Guadalupe River

Santa Clara Valley Water District

floodwaters provided much-needed irrigation for fields and orchards. But as residential and industrial land uses proliferated, damage from flooding became a larger concern. Nevertheless, development was permitted in and near areas threatened by floods; in some cases homes and businesses were built up to established creek banks. In other cases, during the 1950s and 1960s waterways were straightened—many were lined with concrete—and forced to fit into relatively narrow rights of way followed by construction of rows of houses on either side of the newly relocated channels.

Since the late 1970s new structures have been required to meet Federal Emergency Management Agency (FEMA) standards to avoid flood damage. These standards require that if a building is proposed to be built in a floodplain, it must be raised above the flooding elevation. However, many residential, industrial, and commercial buildings in the County were built earlier and are still susceptible to flood damage. About 300 miles of the County's streams and rivers are inadequately protected for a 1 percent flood event—the flood that has a 1 percent chance of occurring in any year. It is also known as a 100-year flood, since over a period of several thousand years, it is the flood that would occur on the average of once in 100 years.

As the home of more than 1.6 million people and the site of a significant regional and national economy, the County has a high stake in averting and controlling flood-related damages: in the event of a 1 percent flood, the damage Countywide could be as much as $2 billion. Much has been done to alleviate flooding (see **Figure 1-1**); however, more than $750 million worth of new flood control projects are needed to protect County residents from a 1 percent flood.

1995 Floods Serve As Reminder of Flood Damage Potential

Severe floods have occurred in the County 22 times in the last century—5 times in the last 14 years. Among these were the floods of January and March 1995. Both 1995 flood events resulted in the Governor and the President declaring the County a disaster area. More than 150 homes and other buildings were flooded in January and nearly 300 were flooded in March. Damage to District facilities occurred in all zones, with the heaviest damage in the Central and North Central Zones. Damages to public and private property totaled at least $10 million.

The January storm was a 5 percent, or 20-year, flooding event; the March storm was a 4 percent, or 25-year event. (This means that the storms had a 5 percent or 4 percent chance, respectively, of occurring in any given year.) If flood control facilities had not already been installed, damages would have been significantly higher. The 1995 flooding refocused public attention on the importance of flood protection efforts and accentuated the following:

- While flood control measures to date have significantly reduced the area of the County subject to flooding from a 1 percent flood event, tens of thousands of homes and businesses remain vulnerable to flood damage.

- Flooded highways and power failures were reminders that even residents and businesses not in the direct path of floodwater can suffer the consequences of flooding.

TABLE 1-1

Major Flood Protection Projects completed & in-progress since beginning of 1982 Benefit Assessment Program

Zone Creek	Reach	Project Costs	Year of Project Completion	Estimated 1% Flood Damage Expected	# of Homes & Buildings Flooded
Northwest Zone					
Palo Alto Flood Basin		$556,358	Jan-87	-	460 struct.
Stevens Creek	Diericx Dr.	$4,000,000	ongoing	N/A	N/A
	101-SLP	$1,411,301	Jan-83	-	-
	Culvert @ Central Expwy	$1,756,833	May-85	-	-
Adobe Creek	101-Miller	$10,487,521	Nov-92	$21 million	1,600 struct.
Matadero Creek	PAFB-El Camino	$10,127,012	Jan-92	$18 million	4,100 homes/apart
	El Camino-Stan. Chan.	$4,877,838	ongoing 7/96		300 com/ind
	Stan. Chan.-Barron Sed. Ba	$3,123,210	ongoing 7/96		
	Bol Park- Foothill Expwy	est. $1,847,544	future const.		
Barron Creek	Stanford Channel-Barron Sed. Basin	$2,395,000	ongoing 7/96	$14.5 million	1,400 homes/apart 100 com/ind
	101-Louis	$926,933	Dec-88	Included in Matadero Creek	
Adobe Creek	El Camino-Moody	est. $6,800,000	understudy	$2.7 million	220 struct.
Permanente	Diversion	$975,065	Feb-86	$44 million	465 homes 2schls/1 hospital
North Central Zone					
Saratoga Creek	Cabrillo-Pruneridge	$4,726,389	Jul-87	$40.5 million	3,800 homes
	Drop Struct.	$820,502	Dec-88		600 com/ind
Calabazas Creek	Pomeroy/Benton/ Lawrence RCB's	$756,794	May-83	$35.2 million	2,250 struct.
	Guad. Slough-Arques	$6,140,246	ongoing 12/95		
	Central-Lawrence	$3,185,760	ongoing 2/96		
	Lawrence-Homestead	$3,191,970	ongoing 11/96		
	Homestead-Miller	est. $5,000,000	under design		
Central Zone					
Guadalupe River	Marina-101	$3,404,854	Sep-87	$61 million	6,000 struct.
	880-Hedding	$3,964,371	Apr-94	$526.6 million	4,300 struct.
	Hedding-Coleman	$5,748,754	ongoing 1/96		
	Coleman-280	est. $42,000,000	future const.		
	Gold St. Bridge	$768,387	Sep-87	N/A	
	Hetch-Hetchy	$1,459,100	Apr-94	N/A	
	Hedding St. Bridge	est. $5,200,000	future const.	N/A	
	Central Pipeline	$1,963,000	Jul-95	N/A	
	280-Blossom Hill	$71,000,000	understudy	$114 million	8,300 struct.
East Zone					
Wrigley-Ford Creek	Berryessa Crk-WPRR (pump station)	$1,979,379	Jun-93	$520,000	170 homes
Lower Silver Creek (SCS)	Coyote Crk-Cunningham	$25,500,000	2003	$32 million	3,800 struct.
Berryessa Creek	Calaveras-Old Piedmont	$16,200,000	understudy	$53 million	1,181 struct.
Upper Penitencia Creek (SCS)	Coyote Crk-Dorel Dr.	-	understudy	$48.6 million	4,200 struct.
Coyote Creek	Bay-237	$9,516,659	Jan-93	$250 million	1,600 residences
	237-Tasman	$2,792,245	ongoing 11/95		800 mobile homes
	Tasman-Montague	$3,971,066	ongoing 11/95		250 com/ind
	Hetch-Hetchy	$1,104,440	Apr-94		
	Standish Dam	$445,546	Dec-94		
Lower Penitencia Creek	Berryessa-Montague	$4,069,651	Aug-85	$14 million	700 struct.
Thompson Creek	Quimby-Westgrove	$241,134	Jun-91	-	-
South Zone					
Uvas Creek (CORPS)	Santa Teresa-Thomas	$849,622	Mar-89	$19.6 million	600 homes
	Thomas Rd. Bridge	$2,189,875	Aug-89		
	Miller Ave. Raising	$151,759	Aug-88		
Llagas Creek (SCS)	(Lower Llagas)			$8.45 million	1,123 resid. bldgs.
	Pajaro River-Buena Vista	(SCS) $16,521,774	Sep-94		64 mobile homes
		(Dist.)$11,028,510	Sep-94		463 com
					24 ind
	(Upper Llagas)				
	Buena Vista-Wright	(Dist.) $2,820,338	Jan-91		

Chapter 6
THE CENTRAL ZONE FLOOD CONTROL PROGRAM

This chapter discusses the District's flood control program in the Central Flood Control Zone (Central Zone). It describes the Central Zone and its flooding history, followed by a review of the 1982 and 1986 flood control plans. It provides an overview of the factors impacting revenue levels and project costs and summarizes the remaining flooding problems that cannot be solved with current revenue levels. The chapter concludes with an analysis of the flood control work that could be accomplished under each of four revenue alternatives.

FLOODING HISTORY

The Central Zone includes portions of the communities of Santa Clara, San Jose, Campbell, Monte Sereno, and Los Gatos. It includes the tributaries and watersheds of the Guadalupe River, which flows through the downtown San Jose area. **Figure 6-1** shows a map of the zone and indicates the areas currently subject to flooding from a 1 percent flood.

Since 1778, when it washed out the first nearby settlements, the Guadalupe River has been a continuous flood threat. (See **Photo 6-1**.) At least 11 floods occurred between 1932 and 1963 along the Guadalupe River, and since 1980 the river has flooded five times. Canoas Creek, Los Gatos Creek, and Ross Creek have all exceeded their banks in recent floods. Major flood events include the following:

1955 — In December, approximately 200 families were evacuated from Alviso and Agnew for up to 2 weeks. Floodwaters were 5 feet deep in Alviso, and considerable damage to streets and sewers was reported. Alamitos Creek, tributary to the Guadalupe River in the Almaden Valley, caused $200,000 damage to homes, businesses, and roadways (See **Photo 6-2**).

1958 — In April, the Guadalupe flooded again, but with greater impact. Inundation caused extensive damage to property. Alviso was under water for 17 days. Damages exceeded $1.3 million.

1980 — Since 1980, the Guadalupe River has flooded five times. In 1982 and 1983, homes and businesses were damaged and people evacuated.

1995 — In January, the Guadalupe overbanked the easterly levee between Alma Street and the Union Pacific Railroad bridge, flooding the Elk's Lodge property and Alma Street. The Red Cross set up shelters at three San Jose high schools. The river also spilled its banks south of Interstate 280 and forced its way into homes and onto Highway 87, disrupting travel for thousands of commuters.

Flooding repeated in March, with the largest flood since records began in the 1930s. Waters spilled upstream of Virginia and Jerome Streets, flooding Highway 87 (See **Photo 6-3**). Homes along Virginia and St. John Streets were evacuated, and the Elks Lodge flooded. Homes and businesses along River Street and homes along Harliss Street (See **Photo 6-4**) flooded. Downtown museums, the County government building, and the courts all closed to evacuate workers when the surrounding streets flooded. Damages for the 1995 floods are estimated at $10 million.

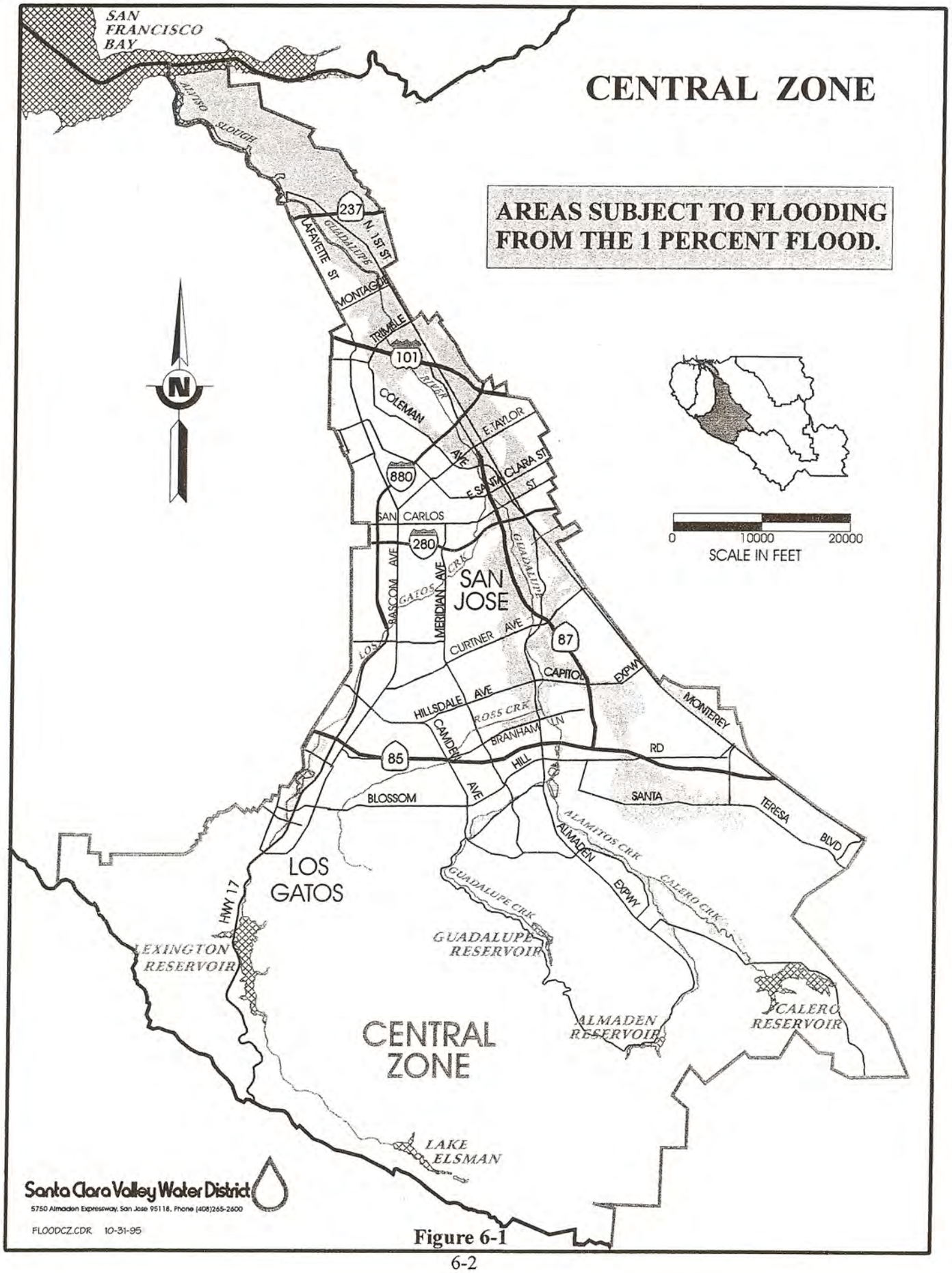

Figure 6-1

Cost Increase (NPS)	**$1M**
Total Impact	**$93M**

3REVTCZ.CDR 10-31-95

Table 6-3

Attachment B. Excerpts from *Mad River, Humboldt and Trinity Counties, California. Letter from the Secretary of the Army*. U.S. Army Corps of Engineers, June 3, 1968.

extremely rare combinations. Hence, the standard project storm is centered over the Mad River Basin in such a way as to produce a high rate of runoff. This flood establishes the upper limit to which protection against floods would be sought, if economically feasible. Derivation of the standard project flood is explained in detail in Appendix A.

45. STANDARD PROJECT FLOOD PEAK DISCHARGE

The estimated peak discharges of the standard project flood are estimated at 132,000 cubic feet per second and 92,000 cubic feet per second at the Arcata gage and Butler Valley damsite, respectively, and were obtained by applying the standard project storm to the unit hydrographs developed from analysis of characteristics of known floods. The standard project flood peak discharge exceeds the maximum of record by approximately 70 percent.

46. MAXIMUM PROBABLE FLOOD

The maximum probable flood at the Butler Valley damsite is derived by assuming the occurrence of the maximum probable rainfall, estimated by the U.S. Weather Bureau procedures, and assuming conditions most favorable to maximum runoff. This flood is derived primarily to establish criteria for spillway design. Pertinent data relative to the maximum probable flood are: rainfall 72 hours - 27.3 inches; runoff 5 days - 475,000 acre-feet; runoff 7 days - 510,000 acre-feet; peak inflow - 136,000 cubic feet per second at the dam. Derivation of the spillway design flood is described in Appendix A.

EXTENT AND CHARACTER OF FLOOD AREA

47. LOCATION AND EXTENT

The flooding of the Mad River extends from the delta area between the Mad River and Arcata Bay upstream to about river mile 17. The standard project flood plain consists of approximately 8,500 acres and the floods of December 1964 and 1955 encompassed 7,400 and 6,300 acres, respectively. The Mad River Basin flood areas have been divided into four reaches to facilitate the analysis of data obtained from flood damage surveys. Reach IV extends along the Mad River upstream from the proposed Butler Valley Dam to the headwaters of the basin and would not be affected by the improvements proposed in this report. Therefore, the remaining Reaches I through III, only, will be considered herein. Reach I extends from the mouth of the river upstream to State Highway 299 bridge, a distance of 6.1 miles; Reach II extends along the river from State Highway 299 bridge upstream to the confluence of North Fork Mad River, a distance of 4.0 miles; and Reach III extends along the river from the North Fork confluence upstream to the proposed Butler Valley Dam, a distance of 15.9 miles.

Reach I in the delta area consists mainly of low, flat lands that are devoted chiefly to dairying and cattle raising, the chief farming practice in the area. Reach II contains industry consisting of lumber mills and other related type mills. This reach also contains a minor amount of agricultural lands and commercial facilities, including a part of the community of Blue Lake. Reach III can best be described as an undeveloped area, consisting of small patches of farmland and the area that is presently used for lumber cutting. It is considered that this reach of river would be developed for recreational purposes and for accommodating tourists and vacationers if the proposed project is constructed.

48. TYPE AND VALUE OF IMPROVEMENTS

Improvements subject to flooding and flood damage consist of homes and business establishments, State highways, county roads, streets and improved farmlands. Business establishments include stores, restaurants, motels, service stations and trailer parks. The gross value of land and improvements in the standard project flood plain is estimated at $14,500,000, consisting of $5,000,000 for lands, $6,500,000 for improvements thereon and $3,000,000 for personal property.

49. PHYSICAL AND ECONOMIC ASPECTS

Past floods in the Mad River Basin have inundated commercial, residential, and farmland areas, causing considerable damage to commodities and stock in business establishments, residential property and improvements, loss of livestock and pastures, erosion and deposition of debris. Flooding causes periodic and costly delays in transportation facilities and disruption of business. Flooding in the basin is severe and residents are generally aware of the danger from such catastrophe. It is expected that flood damages would continue to increase in the future as development continues in the flood plain, unless flood control is provided or a program of flood plain management is undertaken for the affected areas.

FLOOD DAMAGES

50. FLOOD DAMAGE SURVEYS

Surveys were made of the damages sustained as a result of the floods of 1953, 1955 and 1964. These data are presented in Appendix D. Damage estimates are based largely on information obtained by personal interviews with local residents. The 1964 flood damages are based upon a complete damage survey, and the 1953 and 1955 flood damages are based upon representative sample coverage. Values placed on physical damages were applicable at the time the losses were sustained, and have been adjusted to reflect present price levels and development.

51. NATURE OF FLOOD DAMAGES

Floods in the Mad River Basin caused damage to the agriculture lands by inundation, erosion and deposition of silt and debris. In addition, the overbank flooding, which during the flood of record ranged from five to ten feet in depth, caused loss of livestock, damaged lumber mills, washed stockpiles of logs and lumber from the mills downstream, and inflicted heavy damage on residences and other structures. Examples of the devastation left behind by the December 1964 flood are shown in Figures 1 and 2. The damage at the time of occurrence of the two largest floods of record, 1955 and 1964, are estimated to be $1,600,000 and $5,300,000, respectively. A summary of the monetary value of the damages, based on 1967 price levels and conditions for floods of similar magnitude to the 1953, 1955 and 1964 floods, and the estimated damage that would be caused by the occurrence of the standard project are summarized in Table 6.

TABLE 6

FLOOD DAMAGES

Type	1953	1955	1964	Standard Project Flood
Residential	$ 12,000	$ 5,000	$ 30,000	$ 50,000
Commercial	596,000	252,000	773,000	1,075,000
Agricultural	425,000	414,000	1,576,000	2,425,000
Industrial	---	---	931,000	1,420,000
Emergency Aid	12,000	335,000	281,000	315,000
Roads and Bridges	519,000	395,000	1,608,000	2,500,000
Transportation	---	---	---	---
Public Facilities and Utilities	---	295,000	218,000	265,000
Bank Erosion	---	---	351,000	415,000
Protective Works	---	32,000	---	---
Emergency Operations	---	---	56,000	85,000
Total	$1,564,000	$1,728,000	$5,824,000	$8,550,000

52. AVERAGE ANNUAL DAMAGES

Average annual damages were computed by standard analysis from correlation of various relations between damages, discharge and frequency of flood occurrence. Curves were developed from these relations and form the basis for estimating the average annual flood damages. The estimates of damages include physical losses to homes,

commercial establishments, roads, bank erosion and utilities; the cost of flood fighting by local people and governmental organizations and agricultural and business losses resulting from decreased production, sales and earnings. The damages thus obtained were then adjusted to reflect the expected future growth in the flood plain in the absence of a flood control project. Compilation and analysis of the average annual damages based on June 1964 prices and conditions, on economic life of 100 years and interest rate of three and one-quarter percent are developed in Appendix D, and summarized in the following tabulation:

	Average Annual Damages	
Damage Reach	1964 Prices and Conditions	1967 Prices and Future Conditions
REACH I	$225,000	$364,000
REACH II	30,000	48,000
REACH III	20,000	26,000
TOTAL	$275,000	$438,000

EXISTING IMPROVEMENTS

53. CORPS OF ENGINEERS PROJECTS

The Corps of Engineers has constructed a flood control project on the right bank of the Mad River (North Fork) adjacent to the community of Blue Lake. This project was initially prosecuted under the authority contained in Section 212 of the Flood Control Act of 1950. It provided for construction of 2,800 feet of new levee at two locations, revetting 1,100 feet of existing levee, and strengthening and enlarging 2,400 feet of existing levee. This project was authorized and construction completed in November 1955 at an estimated Federal cost of $191,000. As the result of occurrence of the December 1955 flood, it was considered advisable to increase the degree of flood protection. Under authority of Section 212 of the Flood Control Act of 1950, as amended, and with funds provided under Public Works Acceleration Act of 1962, 2,000 feet of additional levee were constructed, the then existing levee raised four to six feet and the slopes revetted with riprap protection. The work was completed in 1963 at a Federal cost of $385,000 and a non-Federal cost of $60,000.

54. FLOOD EMERGENCY WORK

At the request of local interests, emergency repair and restoration of damaged flood control works and channel clearing and debris removal has been performed in the Mad River Basin under the authorities contained in Public Laws 99 and 875. Federal funds in the amount of

$30,000 were expended following the flood of December 1955 and $886,000 was expended after the disastrous December 1964 flood, including the cost of repairing the existing Ruth Dam.

55. IMPROVEMENTS BY OTHER FEDERAL AGENCIES

No improvements for flood control or water conservation by other Federal agencies have been constructed in the Mad River Basin. However, the U.S. Department of Agriculture, Soil Conservation Service and the U.S. Department of Interior, Bureau of Reclamation, presently have other types of studies underway within the basin.

56. IMPROVEMENTS BY NON-FEDERAL AGENCIES

The existing water resources development projects in the Mad River Basin, constructed by local interests, consist of Sweasey Dam, Ruth Dam and non-continuous bank protection works in the delta area. Sweasey Dam, located at river mile 19, was constructed by a private engineering organization for the City of Eureka in 1939 for purpose of water supply for the city. The capacity of Sweasey Dam, initially, was 1,530 acre-feet. However, since its construction the reservoir completely silted-up and at the present time it is not being utilized. Local interests are considering removing the dam from the river. The City of Eureka presently obtains its water supply from Ruth Reservoir. This project, located at river mile 79, has a storage capacity of 51,800 acre-feet and was constructed in 1962 by the Humboldt Bay Municipal Water District for purposes of water supply for the towns of Eureka and Arcata. Water from the reservoir is released into the river and is withdrawn by means of Ranney collector wells in the vicinity of Essex. The reservoir has no storage allocated for flood control; however, it has an overflow-type, ungated spillway that results in minor reduction owing to spillway surcharge storage. Local interests, mainly in the delta area, have constructed numerous sections of low levees along the river and along Mad River Slough for purposes of providing protection for their farmlands.

IMPROVEMENTS DESIRED

57. PUBLIC HEARINGS

The District Engineer held a public hearing on 11 February 1965 in Eureka, California to obtain the views of local interests regarding the need for water resources development. In attendance were about 110 persons, including a U.S. Congressman and representatives of interested agencies from Federal, State, county and city governments, in addition to local civic and conservation groups, private companies, and landowners. A second public hearing, attended by about 150 people, was held on 10 November 1967 in Eureka. The District Engineer summarized the findings of the study and the proposed plan of improvement.

d. Reach IV. From Butler Valley damsite to headwaters. Major damage categories were roads and bridges, and commercial and bank erosion. Minor damage was sustained by public facilities and agricultural operation. Emergency aid was substantial. This reach will not be affected by the proposed project. It should be noted that Reaches III and IV did not suffer major damage in the 1953 and 1955 floods.

D-21. MONETARY VALUES IN THE STANDARD PROJECT FLOOD PLAIN

Based on the Humboldt County 1967-68 tax roll the present monetary value of land, improvements, and personal property in the standard project flood plain is estimated as follows:

Land	$ 5,000,000
Improvements	6,500,000
Personal property	3,000,000
Estimated total value	$14,500,000

D-22. HISTORICAL FLOOD DAMAGE

Tables D-6, D-7 and D-8 present the damages sustained during the floods of 1953, 1955 and 1964, based on values and economic conditions at time of occurrence, 1964 prices and economic conditions, and June 1967 prices and economic conditions. The total damages sustained were $1,560,000, $1,728,000 and $5,824,000 for the 1953, 1955 and 1964 floods, respectively (1967 prices).

D-23. STANDARD PROJECT FLOOD DAMAGES

Historical flood data and hydrological data were used to estimate damages which would be caused by the occurrence of the standard project flood, described in Appendix A, "Hydrology." Estimated damages from the standard project flood are shown in Table D-9 and total $8,540,000 (1964 prices).

D-24. SUMMARY OF FLOODS AND DAMAGES

For ready reference, there is presented in Table D-10 the relationship between acres flooded, discharge at Arcata gaging station and total damages. The standard project flood would inundate approximately 8,500 acres and would have a discharge of 132,000 cubic feet per second.

D-25. DERIVATION OF AVERAGE ANNUAL EQUIVALENT DAMAGES

Average annual damages are derived graphically by the following method:

a. Discharge-frequency relationship. Curves showing discharge frequencies were developed for each damage area of the basin from existing records, historical reports, comparison of areas and runoff characteristics, and correlation of recorded discharges. Details of these derivations are shown in Appendix A, "Hydrology."

b. Discharge-damage relationship. Discharge-damage curves for each damage, such as residential, commercial, agriculture, etc., were prepared by plotting damages from past floods and also the estimated damages from the standard project flood, adjusted to 1964 conditions, against corresponding flood discharges for the respective reaches and fitting a curve to these points.

c. Damage-frequency relationship. Curves showing damage-frequency relationship were prepared by graphical correlation of the discharge-damage and discharge-frequency curves for existing conditions and also for conditions of various plans of improvements and degrees of protection.

d. Average annual damage. The area under the damage-frequency curve, converted to its equivalent value in dollars, is the average annual damage.

D-26. FLOOD DAMAGES UNDER EXISTING CONDITIONS AND PRICES

Plates D-2 and D-4, "Damage Relationship," show the curves from which flood damages were derived. The curves are based upon 1964 prices and conditions. The average annual flood damages for the three reaches affected by the proposed project based on 1964 price levels are presented by category in Table D-11 and are summarized as follows:

Reach		Damages (1964 price levels)
I	Delta	$225,000
II	Blue Lake	30,000
III	Butler Valley	20,000
	Total	$275,000

TABLE D-7

SUMMARY OF HISTORICAL FLOOD DAMAGES 1/
1964 Prices and Conditions

Date and Type of Damage	Reach I	Reach II	Reach III	Reach IV	Total
January 1953					
Residential	$ 9,000	$ 2,000	-	-	$ 11,000
Commercial	164,000	383,000	-	-	547,000
Agricultural	281,000	120,000	-	-	401,000
Emergency aid	5,000	5,000	-	-	10,000
Roads & bridges	271,000	180,000	-	-	451,000
	$ 730,000	$690,000			$1,420,000
December 1955					
Residential	$ 4,000	-	-	-	$ 4,000
Commercial	76,000	$155,000	-	-	231,000
Agricultural	295,000	95,000	-	-	390,000
Emergency aid	144,000	147,000	-	-	291,000
Roads & bridges	344,000	-	-	-	344,000
Protective works	30,000	-	-	-	30,000
Public facilities	197,000	73,000	-	-	270,000
	$1,090,000	$470,000 3/			$1,560,000
December 1964					
Residential	$ 26,000	-	-	$ 2,000	$ 28,000
Commercial	191,000	$140,000	-	378,000	709,000
Agriculture	1,152,000	62,000	$141,000	99,000	1,454,000
Emergency aid	5,000	12,000	-	227,000	244,000
Roads & bridges	906,000	-	-	492,000	1,398,000
Public facilities	4,000	19,000	12,000	165,000	200,000
Industrial	854,000	-	-	-	854,000
Livestock	31,000	-	-	-	31,000
PL/99	6,000	-	-	2/	6,000
PL/875	45,000	-	-	-	45,000
Bank erosion	-	-	25,000	306,000	331,000
	$3,220,000	$233,000	$178,000	$1,669,000	$5,300,000

1/ Damages sustained during the 1953 and 1955 floods were brought to 1964 price levels by applying appropriate price indices compiled by the U.S. Department of Commerce, U.S. Department of Labor, U.S. Department of Agriculture and the Engineering News-Record. In addition, damages were brought to present levels of development.

2/ $835,000 of repairs to Ruth Dam spillway under PL/875 not included due to non-recurring nature of damages.

3/ Blue Lake levee excluded.

TABLE D-9

STANDARD PROJECT FLOOD DAMAGES
1964 Prices and Conditions

Type of Damage	Reach I	Reach II	Reach III	Reach IV	Total
Residential	$ 45,000			$ 5,000	$ 50,000
Commercial	315,000	$300,000		460,000	1,075,000
Industrial	1,420,000				1,420,000
Agriculture	1,910,000	135,000	$210,000	120,000	2,375,000
Livestock	50,000				50,000
Roads & bridges	1,500,000	400,000		600,000	2,500,000
Emergency aid	10,000	25,000		280,000	315,000
PL/99	10,000				10,000
PL/875	75,000				75,000
Public facilities	5,000	40,000	20,000	200,000	265,000
Bank erosion			40,000	375,000	415,000
Total	$5,340,000	$900,000	$270,000	$2,040,000	$8,550,000

TABLE D-10

STANDARD PROJECT AND HISTORICAL FLOODS

Flood	Acres Flooded	Discharge (c.f.s.)	Total Damages 1/ (000)
Standard Project Flood	8,500	132,000	$8,550
December 1964	7,400	87,000	5,300
December 1955	6,300	76,000	1,560
December 1953	5,900	70,000	1,420

1/ 1964 prices.

Attachment C. *FEMA Flood Hazard Areas,* County of Santa Cruz, 2009.

FEMA Flood Hazard Areas

County of Santa Cruz

FEMA Flood Zones based on FEMA DFIRM data. Zones shown include A, Areas of 100 year flood, X Areas between the limits of the 100 year flood and the 500 year flood,and V, Areas of 100-year coastal flood with velocity (wave action).

Features in FEMA Flood Zones

6,462 Parcels
8,434 Structures
4 Schools
6 Fire Stations

Value of improvements based on Assessment Roll 10/13/2009
$ 841,289,346

SAN MATEO COUNTY
SANTA CLARA COUNTY
SAN BENITO COUNTY
MONTEREY COUNTY

Las Cumbres
Big Basin State Park
Boulder Creek
Brookdale
Lompico
Ben Lomond
Zayante
Felton
City of Scotts Valley
Forest of Nisene Marks
Swanton
Bonny Doon
Davenport
Soquel
U. C. Santa Cruz
Aptos
Capitola
Live Oak
New Brighton
Seacliff
Rio Del Mar
Corralitos
Freedom
Salsipuedes
Aromas
Seascape
La Selva
Manresa
Pajaro Dunes
Sunset
Palm Beach
CITY OF SANTA CRUZ
CITY OF CAPITOLA
CITY OF WATSONVILLE

Waddell Beach
Greyhound Rock Beach
Scott Creek Beach
Bonny Doon Beach
Table Rock Beach
Natural Bridges
Main Beach
Cowell Beach
Twin Lakes
Pleasure Point

MONTEREY BAY

SUMMIT RD
CHINA GRADE RD
JAMISON CREEK RD
TWO BAR RD
ALBA RD
LOMPICO RD
EAST ZAYANTE RD
GLENWOOD DR
BEAN CREEK RD
MT HERMON RD
LOCKHART GULCH RD
BONNY DOON RD
PINE FLAT RD
SWANTON RD
SMITH GRADE
EMPIRE GRADE
GRAHAM HILL RD
GRANITE CREEK RD
BRANCIFORTE DR
JUNE HILL RD
SOQUEL SAN JOSE RD
OLIVE SPRINGS RD
HIGHLAND WY
LOMA PRIETA AV
LOMA PRIETA WY
HAZEL DELL RD
EUREKA CANYON RD
GREEN VALLEY RD
CASSERLY RD
PLEASANT VALLEY RD
WHITE RD
FREEDOM BLVD
AMESTY RD
LARKIN VALLEY RD
AIRPORT BLVD
MAIN ST
EAST LAKE AV
LAKE VIEW RD
CARLTON RD
BUENA VISTA DR
SAN ANDREAS RD
MCLAUGHLIN DR
OCEAN ST EXT
HIGH ST
DELAWARE AV
MISSION ST
BAKER ST
SOQUEL AV
SOQUEL DR
41ST AV
CAPITOLA AV
PARK AV
REDWOOD DR
FEDERAL DR
TROUT GULCH RD
BONITA DR
SUMMIT AV

Legend
- Fire Stations
- Public and Private Schools
- FEMA Flood Insurance Zones A, V and X

0 3 6 Miles

Prepared by the Santa Cruz County GIS November 2009, Project # 091-09