SAN PEDRO CREEK FLOOD CONTROL PROJECT: INTEGRATIVE ANALYSIS OF NATURAL HAZARD RESPONSE

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by

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San Francisco, California

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CERTIFICATION OF APPROVAL

I certify that I have read ***San Pedro Creek Flood Control Project: Integrative Analysis of Natural Hazard Response*** by Kelsey Nathel McDonald, and that in my opinion this work meets the criteria for approving a thesis submitted in partial fulfillment of the requirements for the degree: Master of Arts in Geography at San Francisco State University

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SAN PEDRO CREEK FLOOD CONTROL PROJECT:
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Many different elements influenced the San Pedro Creek Flood Control Project, a response to the flood hazard along San Pedro Creek in Pacifica, California. The influences of the different elements are evaluated using Risa Palm's integrative framework, which consists of three levels of elements (macro, meso, and micro) influencing hazard response, the specific environment of the hazard, and the linkages between and within all of the levels. Palm's framework brings to light the complexity of hazard response and helps to identify issues in planning and implementing the flood control project that may be minimized in the future. Meso-level elements significantly influenced the planning and implementation of the flood control project; however, the goals, experience, and values of the individual acting in a meso-level role often most significantly influenced the direction of those meso-level elements.

I certify that the Abstract is a correct representation of the content of this thesis.

______________________________ ______________
Chair, Thesis Committee Date

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ABBREVIATIONS

Caltrans	California Department of Transportation
CAR	Coordination Act Report
CDFG	California Department of Fish and Game
City/city	City of Pacifica
Corps	U.S. Army Corps of Engineers
EIR	Environmental Impact Report (California)
EIS	Environmental Impact Statement (Federal)
HEP	Habitat Evaluation Plan
LCLA	L.C. Lee and Associates, Inc.
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service

INTRODUCTION

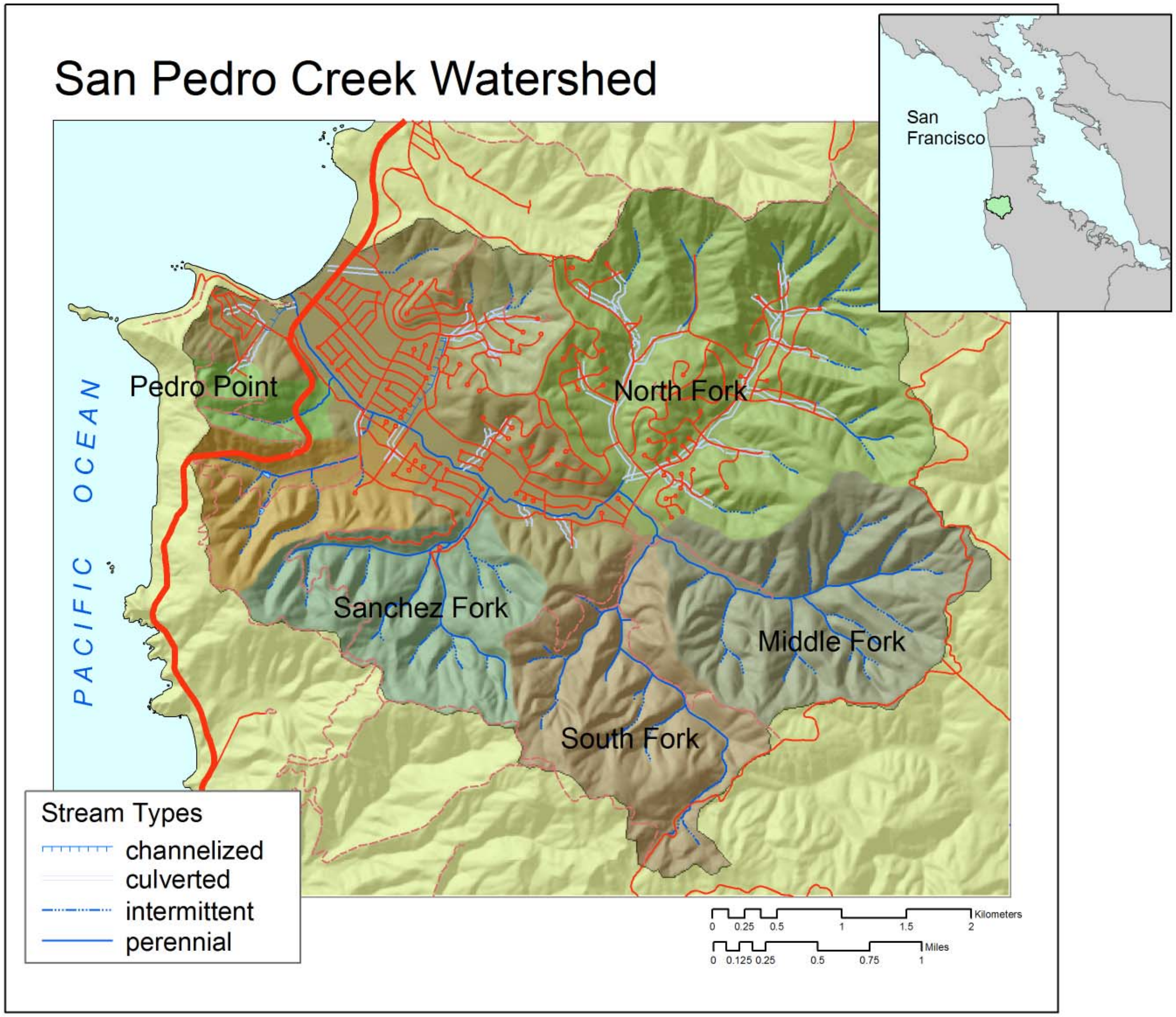
THE SAN PEDRO CREEK FLOOD CONTROL PROJECT

The San Pedro Creek Flood Control Project is a response to the flood hazard along San Pedro Creek in Pacifica, California. This response reflects a series of interactions between and among many different elements at different levels (macro, meso, and micro) within the specific environment of the San Pedro Creek Watershed. Understanding the influences of these elements and interactions provides insight into why and how the hazard response developed and potential issues to address in future responses. Many different individuals, groups, organizations, and policies influenced the planning and development of the San Pedro Creek Flood Control Project, including city staff, local residents, the U.S. Army Corps of Engineers, and the environmental movement. The goals, values, and experiences of individuals acting in intermediary or meso-level roles significantly influenced the flood control project by guiding an individual's action within their meso-level role.

Overview

Located several miles south of San Francisco on the Pacific Coast, Pacifica has experienced repeated flooding along the lower reaches of San Pedro Creek (Map 1). Since the urbanization of San Pedro Valley in the early 1950s, major floods have occurred in 1962, 1972, and 1982. The 1982 flood alone impacted almost 200 residential and commercial structures, causing over $5 million in damage

MAP 1. San Pedro Creek Watershed, Pacifica, California. ***Source:*** Jerry Davis 2004.



(USACE and City 1998a, 7). Over the last few decades, the San Pedro Creek Flood Control Project responded to this flood hazard with a plan to alter a lower reach of San Pedro Creek.

Pacifica is just one of many communities dealing with a flood hazard. The average annual property damage due to flooding (riverine and coastal) in the U.S. exceeded $1 billion as of 1993 (FEMA 1993), but severe flooding in the Midwest in 1993 alone caused an estimated $12-$16 billion in damage (Interagency Floodplain Management Review Committee 1994). Given the still increasing damages due to natural hazards worldwide (Tobin and Montz 1997), natural hazards research continues to be of essential importance for exploring ways to mitigate potential hazard damages, 60 years after Gilbert White's initial research into the flood hazard (White 1945).

Since White's human ecology approach to natural hazards, a research approach developed focusing on a political economic perspective. More recently some natural hazards researchers moved away from a focus on either a human ecology perspective or a political economic perspective, toward an integrative or integrated approach (Tobin and Montz 1997; Palm 1990; Mitchell, Devine and Jagger 1989). An integrative approach to hazard response utilizes both human ecology and the political economic perspective to evaluate hazard response, placing the response within the context of political, economic, societal, and environmental constraints. Risa Palm (1990) developed an integrative framework to facilitate research into hazard response, which segments response into different levels and places them within the context of the environment or physical setting. Palm identifies the different levels as: the micro or individual level, the meso or intermediary and policy level, and the macro or societal level. Depending in part on the level, these elements can be people, policies, and/or ideas. Examining the elements at these levels not only as separate elements but also as integrated or linked elements reveals the complexity of hazard response and can bring to light connections unrevealed by other perspectives. Knowledge of these connections can improve the ability of different elements to work together to more effectively respond to a hazard.

Relevant natural hazards literature is discussed further in Chapter 1. The environment or physical setting of the flood hazard along San Pedro Creek is described in Chapter 2, relying on a human ecology perspective. The remaining chapters explore issues and linkages emerging from the history of the flood control project, such as the hazard response of residents after floods, the changing objectives of the flood control project, and the role of the individual acting in a meso-level role. Within these themes the elements influencing the hazard response are evaluated using Palm's framework. Using Palm's integrative framework provides a comprehensive view of why and how the flood hazard response was developed and chosen for San Pedro Creek by looking for influences at all levels rather than focusing on the individual influences or the societal influences and perhaps missing important issues and linkages. This comprehensive view identifies the significant influence of meso-level elements on hazard response in the San Pedro Creek Flood Control Project, and more specifically the noteworthy influence of individuals on the meso-level element they represent. The integrative approach also reveals to the City of Pacifica elements that may require additional attention when the city attempts to mitigate future impacts of the flood hazard.

Site Description: The San Pedro Creek Watershed

The San Pedro Creek Watershed is located on the Pacific coast, a few miles south of San Francisco, in the southernmost part of Pacifica, California (Map 1). The watershed is approximately 8 square miles (21 sq. km) (USACE 1989), and contains a perennial stream, San Pedro Creek, which empties into the Pacific Ocean. The creek has four major forks, three of which meet in the eastern end of the San Pedro Valley (North, Middle, and South Forks), and then flow to the northwest and meet with one more major fork (Sanchez Fork) before reaching the ocean (Davis 2004). The Mediterranean climate brings winter storms with occasionally heavy rainfalls. The average annual precipitation of the watershed is 33 inches (84 cm), with a range across the watershed of 23-38 inches (58-97 cm) (USACE 1989, 3).

The watershed is bounded by the Pacific Ocean to the northwest and by mountains on the three remaining sides, providing some steep slopes (Photographs 1-2). The mountains surrounding the watershed are at the northernmost extent of the Santa Cruz Mountains (Collins, Amato, and Morton 2001). The elevation ranges from sea level at the Pacific Ocean to 1,898 feet (579 meters) at the north peak of Montara Mountain (USGS 1997). Urban development covers most of the valley floor, and extends up onto some hillsides. The watershed is approximately 19% developed

PHOTOGRAPH 1.
San Pedro Valley,
Lower Linda Mar,
Looking East,
Spring 2002.

PHOTOGRAPH 2.
San Pedro Valley,
Looking ESE,
Spring 2002.

(USACE 1989, 2). To the east and south the watershed contains the parklands of the Golden Gate National Recreation Area (GGNRA), San Pedro Valley County Park and McNee Ranch State Park. Open areas and parklands in and around the watershed harbor wildlife such as deer, bobcats, fox, and turkey vultures (VanderWerf 1994). San Pedro Creek supports a corridor of riparian vegetation and wildlife. For the 25 miles (40 km) between San Francisco and Half Moon Bay, the creek provides the only good habitat for a native steelhead population (USACE and City 1998a).

The watershed evolved over the last several hundred years, so that the features of the watershed found in the mid-1700s such as the meandering stream, marsh, and lake were altered according to the changing land uses – for example, subsistence farming gave way to organized agriculture and ranching, and in the 1950s to a suburban community. As a result, the lake and most of the wetlands disappeared and sections of San Pedro Creek were straightened, reducing the storage capacity of the watershed. In addition, the total area of impermeable surfaces in the watershed increased leading to a decrease in the lag time of runoff and an increase in the peak amount of runoff. With more water traveling more quickly down the stream system, the flood risk to areas downstream also increased. Indeed, flooding has been a persistent problem for residents and businesses in the Linda Mar neighborhood in the northwestern area of the valley since urbanization; major damages were caused by flooding in 1962, 1972, and 1982.

The study area of the San Pedro Creek Flood Control Project is located along the westernmost, downstream reach of San Pedro Creek (Maps 2-3), and roughly corresponds to the 100-year floodplain, or the area with a 1% probability of flooding in any given year (USACE and City 1998a). The 100-year floodplain covers 160 acres and contains over 450 structures (Map 4) (USACE and City 1998a, 11). Most of the structures on the floodplain are residential, although some commercial structures exist in the area, including the Linda Mar Shopping Center (USACE and City 1998a, 11).

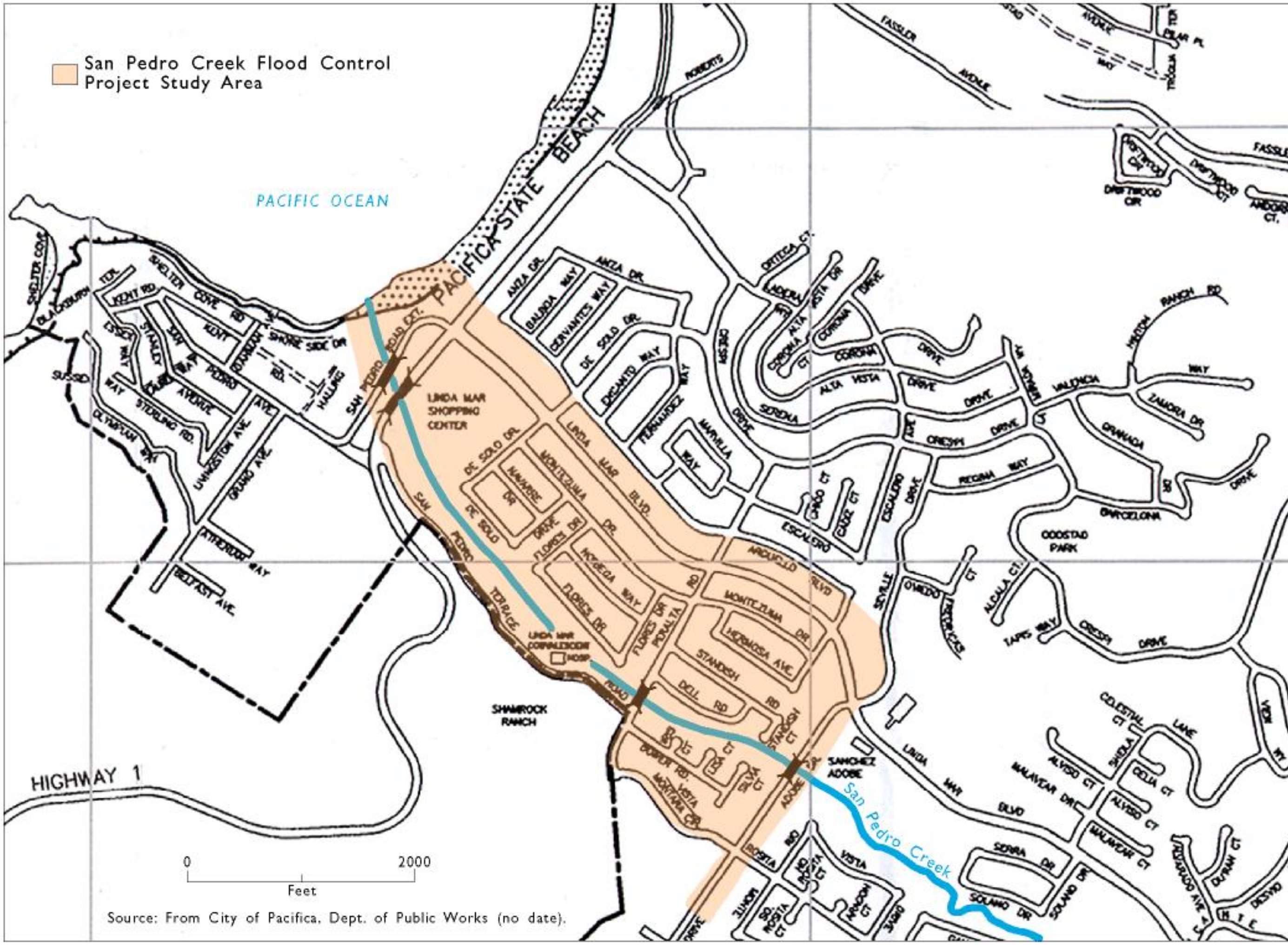
Chapter 2 explores the changing environment of the San Pedro Creek Watershed in more detail.

A Brief History of the San Pedro Creek Flood Control Project: 1962-2004

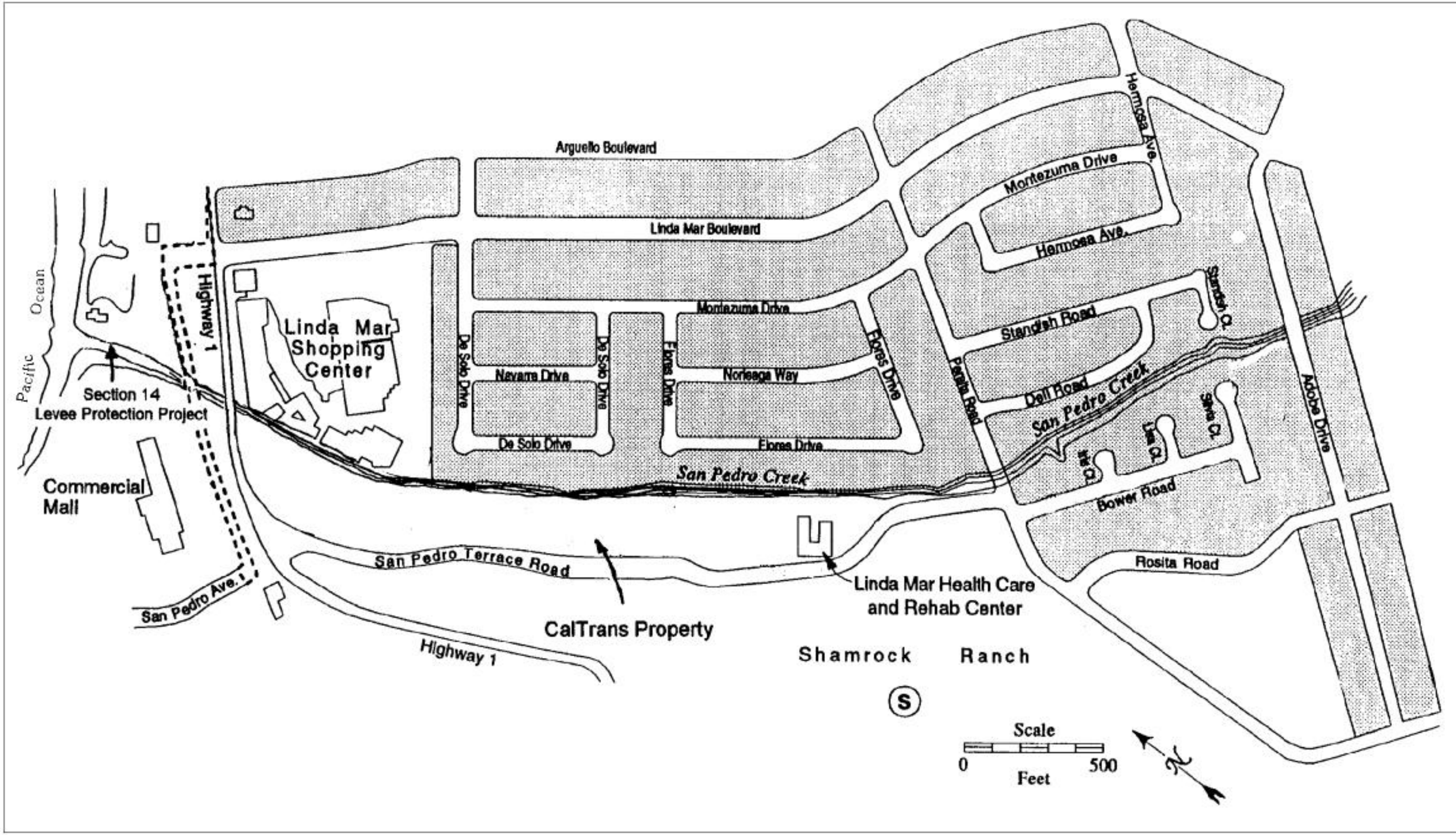
Starting in 1962 with the first major flood along San Pedro Creek in the Linda Mar neighborhood, Pacifica began seeking a solution to the flood problem. An engineering response developed over several decades, stopping and starting several times along the way, and eventually became the San Pedro Creek Flood Control Project. As of spring 2004 this project had developed several flood control improvements, although the entire area still did not have protection from a 100-year event.

Following the first major flood in October 1962, a citizens Drainage Committee was established by the city council to research the flooding problem, which City Engineer Al Roberts thought of as a drainage problem. This committee recommended improvements to the drainage system and $2 million in bonds to finance them

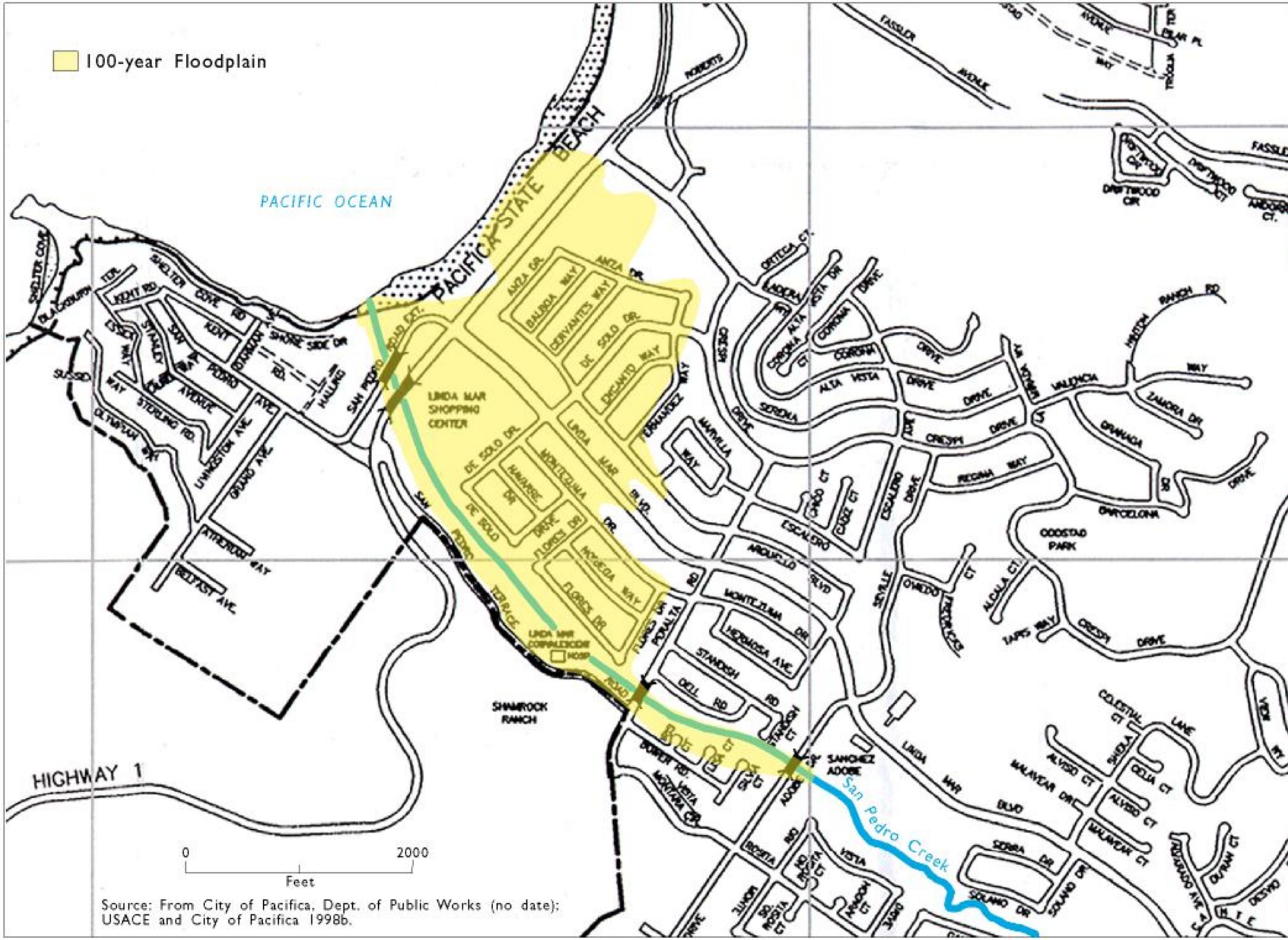
MAP 2. San Pedro Creek Flood Control Project Study Area, Lower Linda Mar, Pacifica, California.



MAP 3. San Pedro Creek Flood Control Project Study Area. *Source:* USACE and City of Pacifica 1998a.



MAP 4. 100-year Floodplain, Lower Linda Mar, Pacifica, California.



Source: From City of Pacifica, Dept. of Public Works (no date); USACE and City of Pacifica 1998b.

(Pacifica Tribune 1963b; Pacifica Tribune 1963a). In the decade after the 1962 flood, the Department of Public Works made improvements to the existing pumping stations and built a new pumping station in order to accommodate larger flows; however, the drainage or flood control project was stopped due to a lack of funding. The improvements in pumping capacity gave Frank Sampson from the Department of Public Works a false sense of confidence that the threat of flooding was significantly reduced if not eliminated (Pacifica Tribune 1972b).

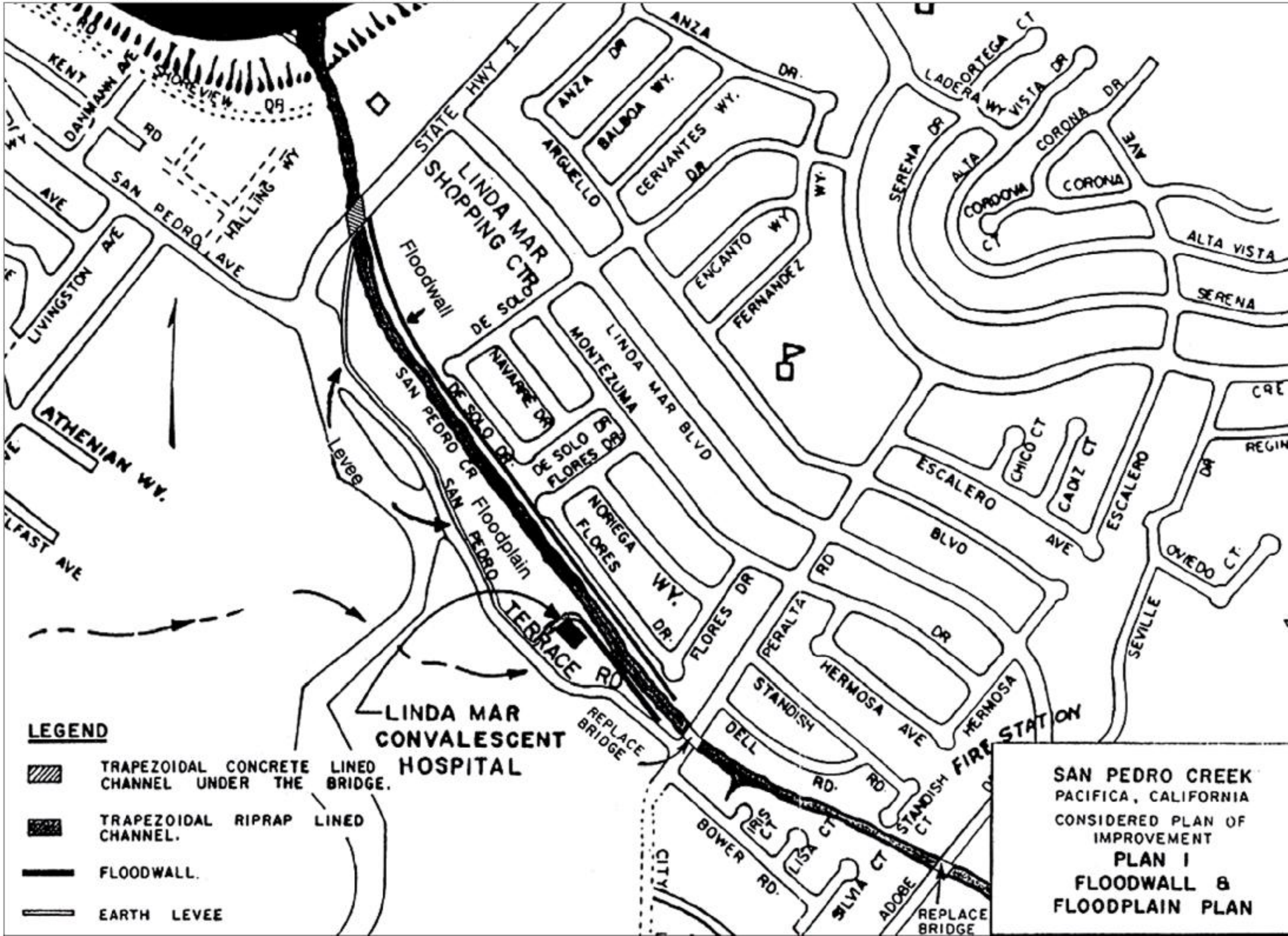
As the ***Pacifica Tribune*** containing the article “The Great Flood of ’62: Could It Happen Again?” (1972b) was being delivered in the early hours of October 11, 1972, the Linda Mar neighborhood experienced another major flood (Pacifica Tribune 1972c). Although not as extensive as the flooding in 1962, residents were still reminded of the flood hazard. In 1973 the city council formed another citizens committee and requested that the U.S. Army Corps of Engineers (Corps) start a flood control study. The committee and the Corps worked on the flood control study for several years and developed several alternatives, but in early 1976 in part due to opposition by environmentalists, the city council concluded that it could not provide the necessary funds and work on the project stopped.

With striking regularity January 1982 brought another major flood to Linda Mar, the most damaging yet. For the third time the city council formed a citizens committee, most recently called the San Pedro Creek Flood Control Committee, to address the flood problem. The committee began researching the flood problem and potential solutions in June 1984, and was joined by the Corps at the mayor's request in 1985. Mike Randolph, Community Development and Services Director for Pacifica, represented the city on the flood control project, acting as a liaison to the flood control committee and the Corps. City Engineer Ernie Renner also worked with Randolph on the project.

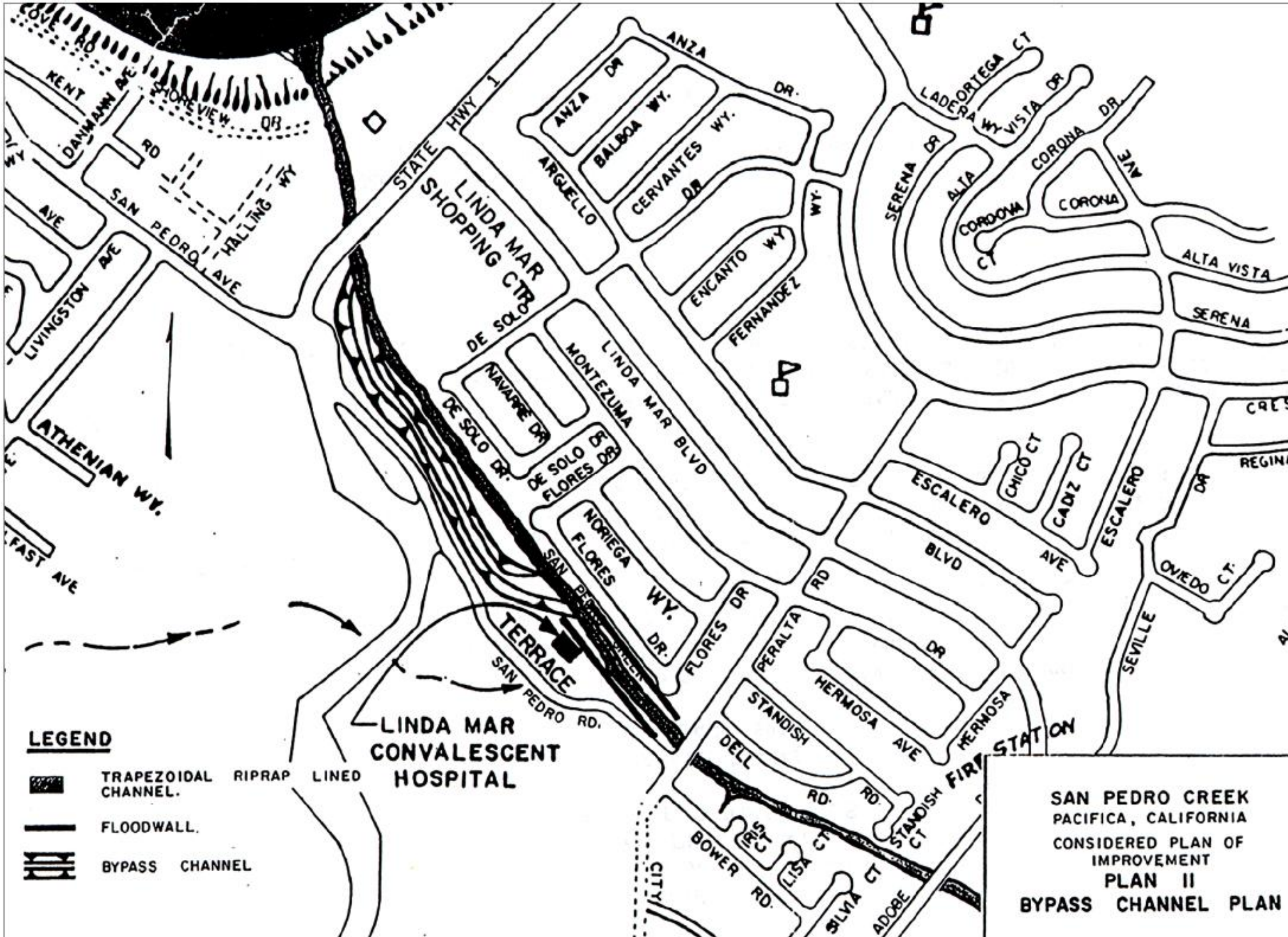
The Corps conducted a reconnaissance study, the first step in a flood control project, and published their report in 1988, identifying two economically justified alternatives, the Floodwall and Floodplain Plan and the Bypass Channel Plan (Maps 5-6). In 1989 as the Corps began work on the next stage of the project, the feasibility study, opposition to the Floodwall and Floodplain Plan by creekside residents brought the project to a standstill.

Scott Holmes was brought into the project by his boss at the city's Sewer Department to consider alternatives to the "hard engineering solution" and get the project moving forward again (Holmes 2003b). In his meso-level role for the city, Holmes significantly influenced the flood control project. He developed a new Wetlands/Marsh Plan that was more environmentally friendly and didn't require a floodwall on residents' property. Residents, environmentalists, and the city council all supported Holmes' plan. After receiving feedback from various organizations including the U.S. Fish and Wildlife Service (USFWS), Holmes modified the plan to include a diversion channel and called it the Diversion Marsh Alternative.

MAP 5. Floodwall and Floodplain Plan - San Pedro Creek Flood Control Project.
Source: USACE and City 1998b.



MAP 6. Bypass Channel Plan - San Pedro Creek Flood Control Project. *Source:* USACE and City 1998b.



From 1991 to 1995 Holmes worked on the marsh design, first with botanist Peggy Fiedler and biologist Mike Vasey, and later also with L.C. Lee & Associates (LCLA), a consulting firm based in Seattle specializing in environmental restoration of wetlands and streams (LCLA 2004). During the same time Holmes also pursued grants to fund the city's portion of the flood control project, particularly after some residents objected to a proposal by city staff (likely Scott Holmes) and the committee for a special assessment district to tax those in the areas prone to or causing the flooding to provide project funding. Holmes pursued grants with organizations such as the California Coastal Conservancy, the California Water Resources Control Board, and the Water Quality Control Board. City Manager Daniel Pincetich requested help from State Senator Quentin Kopp and Assemblywoman Jackie Speier in obtaining funding from the Water Resources Control Board.

Also during the same time starting in 1991, the Corps worked to incorporate the new alternative into the work they had already done, but internal reorganizations and staff turnover slowed down the process. Scott Holmes asked the current mayor and a former mayor to request help from U.S. Congressman Tom Lantos and State Assemblywoman Jackie Speier to push the Corps along, while the committee also requested help from Congressman Lantos. By 1995 the Corps identified a wetland bypass plan, in essence the same as the Marsh Diversion Plan, as their Selected Plan.

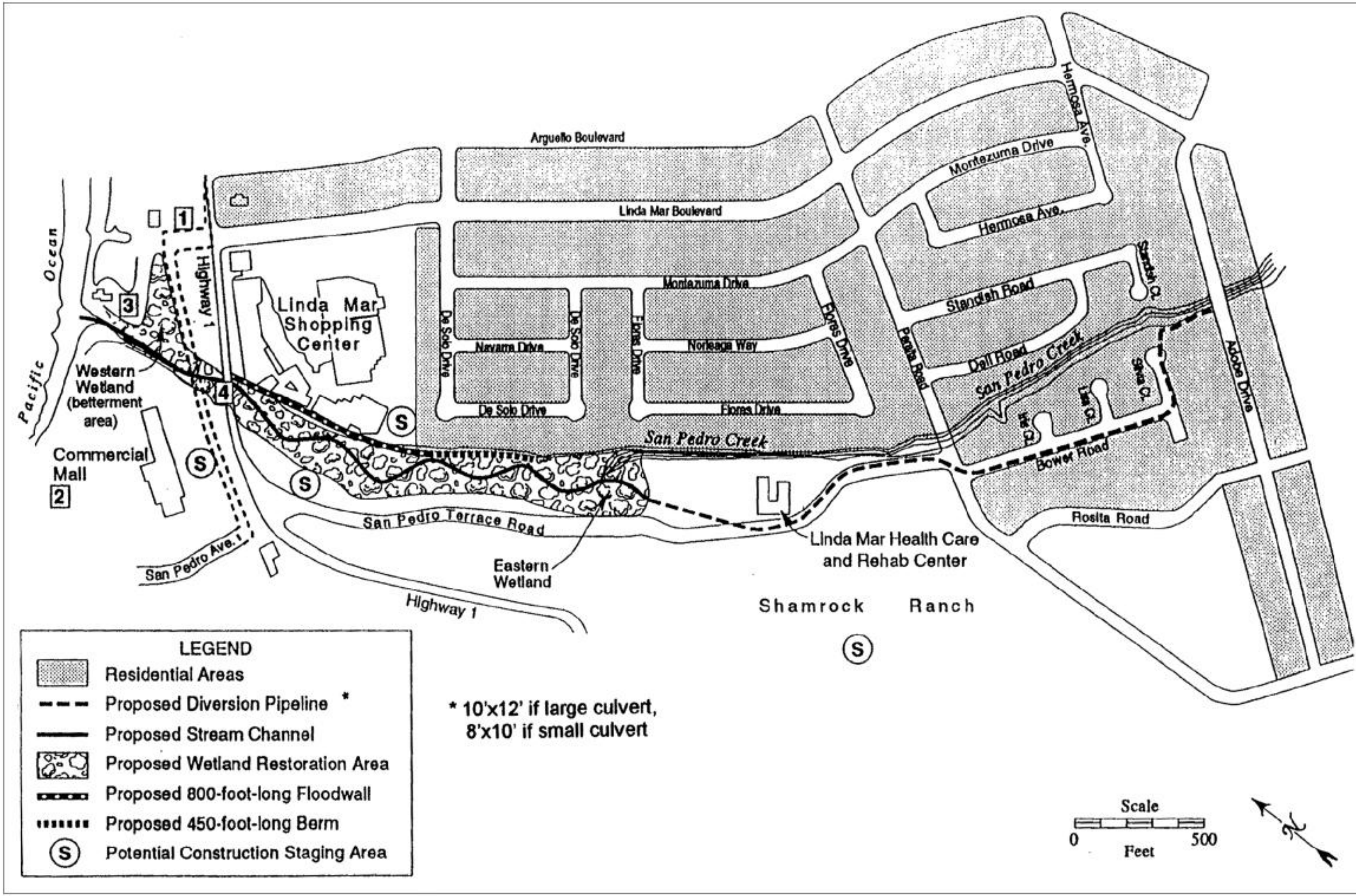
State and federal requirements pertaining to environmental impacts slowed the progress of the project. These included those requirements spawned by the National

Environmental Policy Act (NEPA) and the federal and state Endangered Species Act. Peggy Fiedler found the endangered red-legged frog in the study area and special measures were taken to address impacts to the frog, in addition to other plants and animals with a special status, including the steelhead trout. The Corps initiated the Environmental Impact Report/Statement (EIR/S) in fall 1995; however, the report was not published until January 1998 along with the final detailed project report for the flood control study. The final detailed project report identified the Wetland with Large Culvert Plan as the selected plan (Map 7).

When the final report was published, several key elements of the plan had not been decided. In 1998 the Corps was still finalizing a contract with Moffatt and Nichol, an engineering firm, for the flood control system design including the bypass pipe. In fall 1998, after repeated requests from city staff over the previous seven years, the California Department of Transportation (Caltrans) transferred land adjacent to the creek over to the city for the new floodplain, but only after state legislation sponsored by State Assemblyman Lou Papan ordered Caltrans to do so. The actual plan to implement the project was also not final. Scott Holmes separated the project into phases. Scott Holmes and the Corps eliminated the bypass pipe from the project design by March 2000, mostly due to an increase in the estimated cost of the pipe, but likely also due to opposition by residents along the pipe's proposed route.

After 16 years of planning, construction finally began on the first phase of the San Pedro Creek Flood Control and Ecosystem Restoration Project in summer 2000. Phase

MAP 7. Wetland with Small or Large Culvert Plan - San Pedro Creek Flood Control Project. *Source:* USACE and City of Pacifica 1998a.



I restored six acres of wetlands and created a new, meandering stream channel. Phase II of the project raised an earthen berm on the north side of the creek and moved the creek into the new channel. The creek was diverted into its new channel in late 2002, one year earlier than planned, because city staff (i.e. Scott Holmes) were concerned about flooding (Hall 2003). In 2003-2004 a new coastal lagoon was constructed in the area west of Highway One near the mouth of the creek in conjunction with another project for Pacifica State Beach. In early 2004 additional pumps were installed at the pump stations, dramatically increasing pumping capacity, and thereby significantly reducing the threat of flooding in the low-lying area around Anza Drive.

Although the work as of spring 2004 had decreased the flood hazard in several areas, additional work is required to provide all areas with 100-year flood protection. The next step for the Public Works Department is to reduce the slope of the creek banks between the Peralta Bridge and the Linda Mar Convalescent Home. Scott Holmes anticipates that Public Works will replace the Highway One Bridge when funding becomes available.

This brief history of the San Pedro Creek Flood Control Project identifies many of the key elements influencing the response to the flood hazard along San Pedro Creek from 1962 through early 2004. The key elements that have been involved in the lengthy process to address the flood hazard include city staff, citizens committees, residents, politicians, and the Corps, as well as state and federal regulations and policies. Chapters

2-6 further explore the nature of the flood hazard, the lengthy delay in making significant improvements, and the influences behind the outcome of the project to date.

CHAPTER 1

FLOODING AND THE DEVELOPMENT OF NATURAL HAZARDS RESEARCH

Understanding why and how the San Pedro Creek Flood Control Project was developed and implemented as a response to the flood hazard along San Pedro Creek requires knowledge gained from the human ecology, political economic, and integrative approaches to natural hazards research. Natural hazards research began with Geographer Gilbert F. White's application of a human ecology approach to evaluating federal flood control policy in the 1940s. White and other researchers gradually established a human ecology research paradigm for all natural hazards. This paradigm focuses on individual perception of and response to natural hazards. As research continued and damages related to natural hazards continued to rise, researchers developed new ideas based on political economy, arguing that political, economic, and social structures create vulnerability to hazards by imposing constraints on hazard response. More recently, an integrative approach has emerged, wherein investigators address both human ecology and political economic influences on hazard response in one integrated study. In Risa Palm's integrative framework, the micro level utilizes work based on the human ecology approach and the macro level utilizes work based on the political economic approach, while also exploring influences at a meso level.

Human Ecology and Early Natural Hazards Research

In the early 20th Century, the U.S. Army Corps of Engineers (Corps) provided levees as the primary means of federal flood control (Platt 1999). Extensive flooding, such as that along the lower Mississippi River in 1927 and the Upper Ohio River Basin in 1936, prompted the federal government to become more involved in flood control (Burton, Kates, and White 1978; Platt 1999). The Flood Control Act of 1936 allowed the federal government to fund flood control projects, provided the benefits exceeded the costs (White 1973). Federal flood control policy from this time forward focused on the construction of structural flood controls, such as dams and reservoirs (Platt 1999).

In the mid-1930s Gilbert White, a doctoral candidate in Geography at the University of Chicago, began working for the federal government under his mentor Harlan Barrows. White's work with the National Resources Planning Board exposed him to federal flood control policies and inspired his doctoral work (White 1973; Platt 1997).

White's doctoral dissertation ***Human Adjustment to Floods: A Geographical Approach to the Flood Problem in the United States*** (1945) provided the catalyst for research not only into the flood hazard, but also all natural hazards. In his dissertation White summarized the federal flood control policy of the time as concentrating on flood protection works, such as dams, and on flood relief, and he concluded that the federal policy of providing flood protection while also providing flood relief probably led to increasing costs for both. He argued that the federal government should strive to employ a broader range of adjustments, or efforts to reduce hazard risks, including land elevation, flood abatement, flood protection, emergency measures, structural changes to buildings and streets, land use restrictions, public relief, and insurance. White also proposed that the choice of adjustments to floods was affected by various physical and economic factors, not necessarily just flooding.

White's work reflected the human ecology perspective of his mentor Harlan Barrows, who first promoted the theory of geography as human ecology in the early 1920s. Barrows proposed that the role of geography was to understand "the relationships between natural environments and the distribution and activities of man" (Barrows 1923, 3). Barrows wanted to move geography away from environmental determinism and toward evaluating how humans adjust to their natural environment. Human ecology shaped the central principles of natural hazards research, as developed by White and his collaborators. One central principle was that a natural hazard exists when humans interact, or have the potential to interact, with an extreme natural event, such as a flood (White 1974). In his disseration White noted that "floods are 'acts of God,' but flood losses are largely acts of man" (White 1945, 2).

By the 1950s over $5 billion had been spent by the federal government on flood control (White 1973, 197), and public opposition to flood control structures began to grow due to the associated economic costs and environmental impacts (Platt 1999). In 1956 White and his collaborators began work on a study evaluating the changes that had taken place on floodplains since the Flood Control Act of 1936 (White 1973). The study confirmed some of White's earlier hypotheses and suggestions. Rather than decreasing, both spending and losses due to flooding had increased (White 1973). The study concluded that federal flood policy produced a social environment that encouraged growth on floodplains by underestimating flood hazards and providing relief for people who choose to locate on a floodplain (White et al. 1958). White and his colleagues suggested that the federal government educate individuals on the flood hazard and their choices of adjustments. In addition, when building protection works, the government should attempt to stop floodplain encroachment in part by using land use restrictions (White et al. 1958).

In the early 1960s, White and his colleagues moved away from studying the economics of flood control to further explore individual choice of adjustments and hazard perception (Whyte 1986). Collaborating with White in his new focus were his University of Chicago doctoral students Ian Burton and Robert W. Kates, who demonstrated that adjustments to a flood hazard are dependent upon a wide range of factors, including perception of the hazard and the available adjustments. Burton found that an agriculturalist's choice of adjustment to the flood hazard could depend upon many variables, including social and economic constraints, farm sizes, slope of adjoining land, land use, and flood frequency. Burton also identified differences in hazard perception between agricultural and urban areas, and between public and private entities (Burton 1962).

Kates addressed the flood hazard perception in urban communities and discovered that individuals within the same community could have vastly different perceptions of the flood hazard resulting in different perceptions of available adjustments. He found that individuals often simplified a situation to better understand it, which can impact an individual's perception of a flood hazard and perhaps lead them to disregard beneficial adjustments. Kates also discovered compelling evidence linking perceptions to adjustment on a certainty-uncertainty scale; individuals who perceived flooding as more certain, were more likely to take action to counter the flood, and vice versa. To understand an individual's perception of the flood hazard, Kates promoted the theory of ***bounded rationality***, which assumes that humans are limited by their experience and avoid uncertainties when making decisions (Kates 1962). For example, a person who recently experienced a flood will estimate the frequency and magnitude of the flood hazard more accurately than a person who has not experienced a flood recently. In the 1970s Paul Slovic, Howard Kunreuther, and Gilbert White (1974) provided further evidence supporting ***bounded rationality*** as a suitable theory for understanding hazard perception and choice of adjustment to natural hazards.

In another study, White (1964) examined which adjustments floodplain property managers chose under which conditions. Given the numerous possibilities for adjustments, White suggested that flood protection and loss bearing had been the primary choices due to "perception of choice, flood hazard, technology, and economic efficiency," as well as a manager's experience with floods (White 1964, 109). White concluded that public policy should be modified to apply the broader range of adjustments seen at the private, individual level to the federal and state levels.

Research into the flood hazard gradually broadened to address all natural hazards. In 1970 Kates provided an initial model of human adjustment to natural hazards, which maintained the principles of human ecology. His general systems model highlighted the interaction required between humans and nature to produce a natural hazard (Kates 1994). The model also showed a hazard event generating feedback, or further adjustments, which modifies the interaction between humans and nature, and therefore modifies the natural hazard (Kates 1994).

White and other researchers sought to broaden the understanding of natural hazards and further direct public policy by evaluating individual hazard response to different natural hazards around the world. Their study concluded that in coping with natural hazards technological (i.e. structural) solutions should not be the only means used, the perceptions and adjustments of individuals need to be taken into account, and the information learned about natural hazards needs to be shared among nations (White 1974).

In 1978, Burton, Kates, and White published ***The Environment as Hazard*** as an overall summary of natural hazards research up to that time. Damages due to natural hazards continued to increase worldwide, and this trend was projected to continue, although deaths were expected to decrease. Cited as among the possible causes of the increasing damages were population growth in hazardous areas, increases in material wealth, and adjustments that increase vulnerability to hazards. Although their research had focused primarily on individual response and choice of adjustments, Burton, Kates, and White reemphasized the importance of encouraging parties at the individual, community, and national levels to explore as many different types of adjustments as possible as a means to decrease the hazard risks and enhance the resilience to an extreme event (Burton, Kates, and White 1978).

In their research Burton, Kates, and White discovered an ordered process to individual response. If an individual becomes aware of a hazard risk, he/she decides whether or not to act to adjust to that risk. Then if an individual chooses to act, he/she decides how to modify the intensity of the hazard event or its impacts. However, if the level of hazard risk becomes unacceptable to an individual, he/she changes his/her relationship to the hazard, sometimes by relocating away from the hazard risk. Although not researched to the same degree as individual action, Burton, Kates, and White noted that collective action appeared to be more complex than individual action, but to reflect the same ordering in responses to a hazard risk (Burton, Kates, and White 1978). They also found that a response to a particular natural hazard was determined not only by the perception of the hazard, but also by the knowledge of the possible adjustments, which was usually incomplete (Burton, Kates, and White 1978).

Gilbert White's hazard research slowly influenced federal flood control policy. The national flood insurance program he suggested in his dissertation (White 1945), and again as a member of the Task Force on Federal Flood Control Policy, was finally created in 1968 with the establishment of the National Flood Insurance Program (NFIP) (Platt 1999). NFIP expanded the involvement of the government in flood control away from a reliance solely on federal government to include state and local governments, who gained the responsibility of managing structures on floodplains (Platt 1999). However, not until after the 1973 Flood Disaster Protection Act amended NFIP, requiring people borrowing money from a federal lender to purchase flood insurance, did state and local governments begin to follow the guidelines established by NFIP (Platt 1999). Other non-structural solutions emerged, so that by the 1990s a broader array of flood control solutions were being utilized, including floodproofing structures on floodplains or buying them out (Association of State Floodplain Managers 2000; Interagency Floodplain Management Review Committee 1994). By the late 1990s the objectives for floodplains had broadened across all levels of government into a strategy of floodplain management seeking to minimize flood losses and protect the natural environment (Association of State Floodplain Managers 2000; Kusler 1989).

Political Economy Challenges the Traditional Approach in Natural Hazards

In the early 1970s Richard Chorley challenged human ecology theory, which was central to natural hazards research. Chorley (1973) argued that the role of humans in the natural environment was too complex to be cast into an ecology framework. Humans have a controlling, dominant role over their natural environment, thus the socioeconomic and political factors hold more significance than the natural environment

(Chorley 1973). As damages from disasters continued to rise (Susman, O'Keefe, and Wisner 1983), more and more hazards scholars embraced the political economy perspective, arguing that the constraints imposed by economic, political, and social structures had been ignored by traditional hazards research (Marston 1983). They asserted that these constraints create aspects of social vulnerability to natural hazards and need to be addressed (Marston 1983).

Kenneth Hewitt (1983) argued that the traditional human ecology approach focused on identifying and solving geophysical problems, such as flooding, via technical procedures, such as flood control, and/or relief. Hewitt sought to shift the emphasis in natural hazards away from geophysical events to the social structure surrounding a hazard, noting that natural disasters "depend upon the ongoing social order, its everyday relations to the habitat and the larger historical circumstances that shape or frustrate these matters" (Hewitt 1983, 25). He proposed that the "means to avoid or reduce risk are found to depend upon the ongoing organization and values of society and its institutions" (Hewitt 1983, 25). For a person struggling to make ends meet on a daily basis, addressing the risks associated with an infrequent hazard was unlikely to be possible.

Hewitt (1983) further criticized traditional hazards research for regarding a hazard event as an unusual occurrence or a disruption to normal life. Susman, O'Keefe, and Wisner (1983) agreed that vulnerability to a hazard resides within the structure of normal, everyday life. Vulnerability to a hazard is determined by the socio-economic class structure, where those in higher socio-economic classes have less risk and are better able to recover from a hazard event than those in the lower classes (Susman, O'Keefe, and Wisner 1983, 264). Susman, O'Keefe, and Wisner provide a case study of an earthquake in Guatemala in 1976 as an example. The damages from this earthquake fell disproportionately upon lower-income people whose homes were not structurally able to sustain the earthquake as opposed to higher-income people who were able to afford more expensive structures better designed to survive earthquakes. In this example vulnerability came from lacking the means to afford structurally sound homes and having fewer resources to rebuild homes, instead of solely from the hazard event.

Michael Watts (1983) faulted the traditional human ecology approach for projecting "a rather mechanical…view of the world in which individuals, organisms, populations and critical environmental variables interact or interface" (Watts 1983, 235). Watts argued, that "much of the [traditional] work demonstrates unequivocally that social context and political economy mediate individual perception" (Watts 1983, 240), but that the human ecology approach doesn't account for this. He called for addressing "the highly complex ***social production of material life***" (Watts 1983, 235).

<u>An Integrative Approach Emerges</u>

As hazards research progressed utilizing a political economy perspective, some researchers expressed a concern that the constraints posed by political-economic structures were sometimes emphasized to the exclusion of individual choice or action

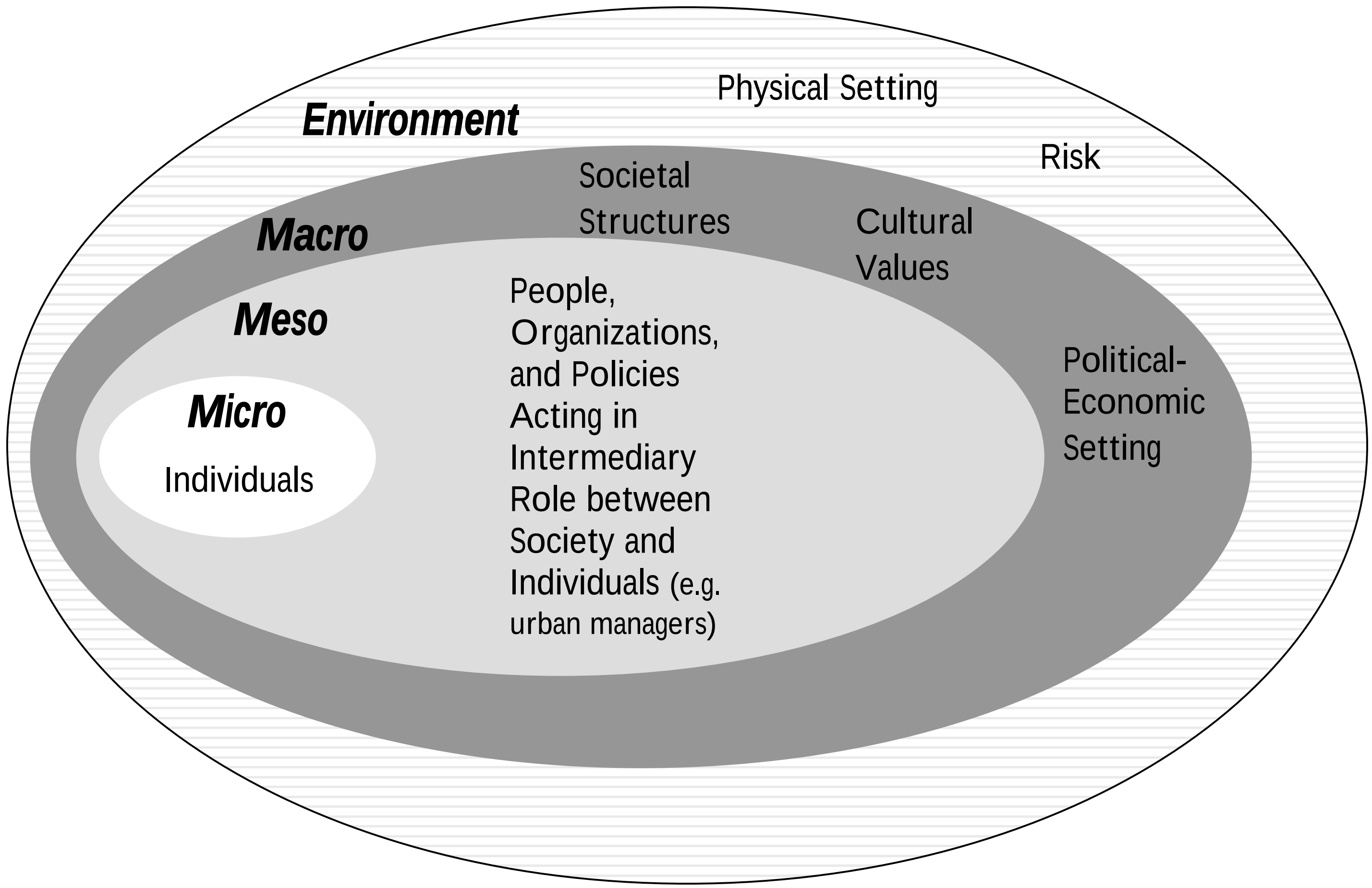
(Palm et al. 1983). Others argued that neither political economy nor environmental determinism should exclusively guide geographic research; for example, Doreen Massey argued, “that neither ‘the social’ nor ‘the natural’ can be conceptualized in isolation from the other” (Massey 1984, 8).

Partly as a result of these arguments, some researchers began to integrate the political economy and the human ecology perspectives. Susan Cutter called this line of research “hazards in context” (Cutter 1994, 76), and noted: “this interactive model utilizes many traditional hazard elements, such as physical processes, population vulnerability, adjustments, and losses, but imbeds them in larger political, cultural, social, economic, or historical frameworks” (Cutter 1994, 76). James K. Mitchell, Neal Devin, and Kathleen Jagger (1989) used a contextual model to analyze a major storm in England, arguing that putting a hazard response into context allows consideration of impacts outside the realm of the human-environment interaction, such as scientific advances that create additional options for adjustments or population migration into an area prone to a hazard due to an outside cause. They noted that the response to the storm they studied was muted by several factors, including a major stock market crash. Their study promoted a “natural hazard system” model, connecting two subsystems, hazard components and hazard contexts. These subsystems roughly correspond to elements emphasized in the human ecology approach and the political economy approach respectively (Mitchell, Devin, and Jagger 1989).

Other approaches follow the same broad principles as hazards in context. The "integrative framework" proposed by Risa Palm (1990) and the "integrated approach" proposed by Graham Tobin and Burrell Montz (1997) also call for addressing human-environment factors along with the political-economic factors when analyzing flood hazard response. The foundation for Palm's integrative framework comes from a combination of several different bodies of work, including realism and structuralism from geography and from the social sciences the linkages between micro and macro elements. The result is an "integrative," "cross-level" analysis rooted in probabilism (Palm 1990, 79). Probabilism allows for the influence of the environment while also acknowledging that humans have some control over their environment – neither environmental determinism nor possibilism (Johnston et al. 2000).

Palm's integrative framework of hazard response denotes elements at macro, meso, and micro levels, all of which are linked and situated within the environment of the hazard (Figure 1). The macro level identifies the societal structures constraining hazard response, including the political-economic setting and cultural values. The meso level examines the people, such as "urban managers," organizations, and policies acting in intermediary roles between society and individuals, and their influence on hazard response. The micro level examines hazard response by individuals, or households, focusing on the individual's awareness (or perception) of the hazard and their corresponding action or response. The linkages between the different levels and the environment in which they all reside are an important part of this framework, as they

FIGURE 1. Palm's Integrative Framework for Evaluating Hazard Response. Modified from Palm 1990.



impose constraints on or provide opportunities for hazard responses at the different levels. People in positions of “power” or in decision-making roles exist at the micro and meso levels. Palm notes that individuals acting in meso-level roles are driven not only by their meso-level duties but also by their own individual experiences, goals, and values, and can significantly alter the response of the meso-level element. This linkage between individuals acting in a meso-level role and the meso-level element they represent is key to understanding the outcome of the San Pedro Creek Flood Control Project.

Palm points to a lack of research being done in natural hazards that integrates the macro and micro levels in one analysis (Palm 1990). Although linkages or interactions between and within levels are complex, understanding all levels and their interactions is critical to having a comprehensive, realistic understanding of the factors influencing hazard response at a specific place. This understanding can also be useful in predicting possible responses at the same place (Palm 1990).

Susan Cutter (1991) criticized Palm for calling her approach an integrative framework, suggesting that the existing terminology “hazards in context” would have fit her approach. Likewise, John Cross refers to Palm’s integrative framework as a “contextual model in examining human responses to hazards” (Cross 1991). However, Cutter found Palm’s call for integrated analysis in hazards research “important” (Cutter 1991, 702) and Cross found that Palm “sufficiently validates the effectiveness of the approach in research,” which “can improve understanding and explanation of human responses to hazards” (Cross 1991).

The rationale behind the integrated approach put forth by Tobin and Montz (1997) strongly resembles Palm's integrative framework. Tobin and Montz examine characteristics of the physical environment as well as social and political-economic characteristics to assess hazard risk, vulnerability, and response. In addition to integrating the physical environment factors with the social and political-economic factors, Tobin and Montz (1997) go one step further and call for integration across different hazards in an attempt to better understand all hazards. Tobin and Montz seek to further develop broadly applicable theories using their integrated approach, unlike Palm whose framework focuses on a hazard response in one particular location.

Palm's framework is a useful tool for an empirical study of the San Pedro Creek Flood Control Project as a response to the flood hazard along San Pedro Creek. Given its focus on hazard response in a particular location, Palm's integrative framework fits together well with a historical geography of response to a hazard over time. Blake Gumprecht's historical geography of the Los Angeles River (Gumprecht 2001) provides details on the hazard response to flooding of the river and the many different elements influencing the response over time. This work could easily be placed within Palm's framework. Gumprecht describes the hazard in its physical environment, noting for example the frequency of flooding in the floodplain during winter storms, and provides details on societal (macro-level) influences, such as the summer migration of new people into the area, people (micro-level influences) who build on the floodplain not realizing the area is susceptible to winter flooding. Local politicians (meso-level influences) also played a role in response to the Los Angeles River flood hazard by supporting or opposing flood control measures. These are just a few elements and linkages brought to light using Palm's framework with a historical geography of the Los Angeles River that influenced why the river was turned into a concrete channel.

In addition, by establishing different levels of elements influencing hazard response, macro, meso, and micro, Palm removes any value judgments or preconceived notions implicit in utilizing either a human ecology or political economic perspective. If a researcher approaches hazard response using human ecology, the researcher generally assumes that the individual is of prime importance to the response. Likewise, if a researcher utilizes a political economic perspective, they look for societal or political-economic structures or constraints on response. Palm's integrative framework allows researchers to begin by looking at a response, then working backward to search for the elements involved in the response at each different layer, and from there to evaluate the influences on those elements, including the linkages between the elements. The origination of the influences on the different elements can then be related back to theories proposed within human ecology or political economic perspectives.

Finally, by establishing a meso level Palm's integrative framework also calls attention to the meso-level influences, which can substantially influence hazard response and may be overlooked in the human ecology and political economic perspectives. As the response to the flood hazard along San Pedro Creek demonstrates, the people and policies at the meso level can have a strong influence on hazard response, and the individuals acting in meso-level roles can modify their meso-level element based on their own values, experiences, and goals.

Palm's integrative framework helps develop a comprehensive understanding of the influences on a particular response at a particular location and helps identify elements that may be involved in future responses, as well as potential issues. Because the San Pedro Creek Flood Control Project developed over decades, a historical geography utilizing Palm's integrative framework exposes many elements involved in this hazard response. A broad range of sources provided historical detail on the flood control project for this study, including reports from the Corps and/or the City of Pacifica, San Pedro Creek Flood Control Committee meeting minutes, articles in the Pacifica Tribune, personal interviews, and historical maps. Different sources provided information on one or more of the different levels.

CHAPTER 2

ENVIRONMENT OF THE SAN PEDRO CREEK FLOOD HAZARD: A HUMAN ECOLOGY PERSPECTIVE

Human interactions with the San Pedro Creek Watershed heavily influenced the environment with the flood hazard that has plagued the suburban population in San Pedro Valley since shortly after the first development in the 1950s. Given the focus on human interactions with the environment, particularly at the individual level, the environment of the flood hazard is developed from the human ecology perspective of traditional natural hazards research.

Humans have dramatically transformed the San Pedro Creek Watershed since the Spanish explorers first encountered the area in 1769. The Spanish explorers found a valley with a meandering creek, wetlands, a lake, and a large willow patch. However, soon after the explorers' encounter, land use shifted from subsistence activities by indigenous Ohlone to agriculture and ranching by Spanish missionaries. A private landowner later obtained the land and continued ranching until the 1860s, after which the area transitioned to agriculture. Farmers transformed the valley floor and some surrounding hills of the watershed into agricultural fields, straightening streams and building irrigation canals. The latest shift in land use came after World War II when developers created a new suburban community in San Pedro Valley. The developers built up to and in some places on top of the creek and former lake and wetlands. All of the land use changes resulted in an increased flood risk by altering the stream drainage network and storage capacity in the watershed, which decreased the lag time of runoff after rainfalls and in turn increased the peak amount of runoff.

The San Pedro Creek Watershed: c. 1769

Notes from a Spanish expedition led by Captain Gaspar de Portola that passed through San Pedro Valley in 1769 provide the first written accounts of the valley. They paint a picture of a valley surrounded by hills with a stream running through it into a large marsh extending to the Pacific Ocean (Teggart 1911). Portola's chaplain, Juan Crespi, noted in his journal entry of October 31, 1769, that two creeks met and flowed into a freshwater "inlet" before emptying into the ocean (Stanger and Brown 1969, 96-97). Crespi also noted the presence of willows around the creeks and the inlet (Stanger and Brown 1969, 96-97). The expedition's discovery of the bay prompted further exploration of the area by Captain Fernando Rivera in 1774. Francisco Palou, the chaplain, suggested that a mission could locate in the valley given its many amenities, including pasture land and two creeks that ran into a lake (Bolton 1926, 285-286).

The indigenous people of the San Pedro Creek Watershed were the Ohlone. On the first Portola expedition in 1769, Crespi described being greeted by Ohlone in San Pedro Valley (Stanger and Brown 1969). The Ohlone were hunters and gatherers, and routinely set fires to encourage the growth of particular grasses for their seeds (Brown 1973-74). Fish were also an important part of their diet and the Ohlone may have used small, temporary dams along the creek to help catch fish, perhaps aided by fish poisons or nets (Margolin 1978). Ohlone interactions with the watershed probably caused minimal changes to the area, and any flooding likely had little impact on the Ohlone, who as hunters and gatherers relocated as necessary based on where resources were available.

The Mission's Agricultural Outpost in San Pedro Valley: 1786-1792

The sighting of San Francisco Bay and the abundance of resources in the area described by Spanish explorers ushered in an era of change for San Pedro Valley. Within a decade of the establishment of the Mission San Francisco de Asis (later called Mission Dolores) and the nearby presidio in San Francisco in 1776, the San Pedro Valley housed an agricultural outpost to supply food to the mission (Dietz 1979). The outpost was located on the valley floor southeast of the lake and its wetlands on the site of the former Ohlone village of Pruristac (Dietz 1979; Before the Sanchez Adobe 1957).

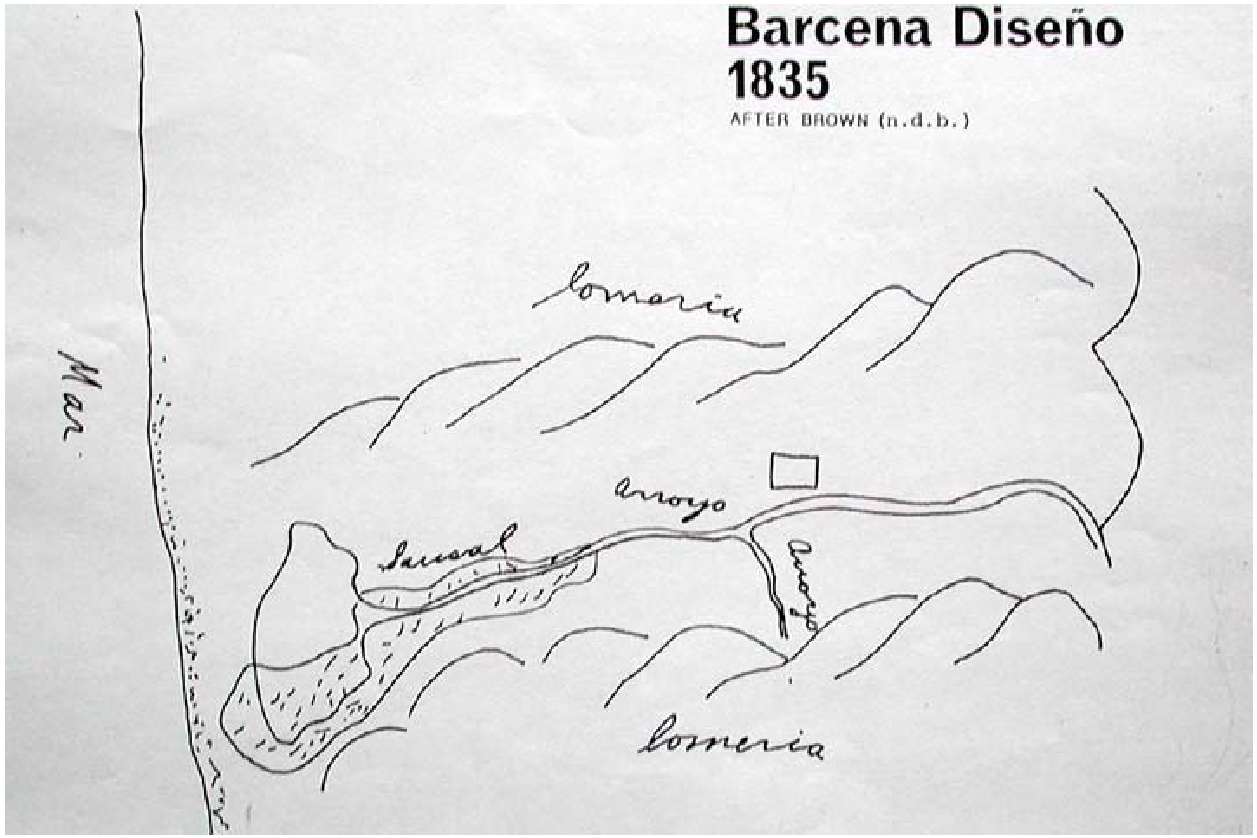
The mission farmers built ditches to drain excess water off of the fields, and also irrigation channels to water crops and willow hedges. The availability of water in the valley was clearly an asset for farmers, who grew a variety of crops including corn, beans, wheat, peas, barley, and grapes (Milliken and Sanchez 1979). The ditches likely increased the velocity of runoff in the area and thereby increased channel incision, which would also have increased the sediment in the stream (Collins, Amato, and Morton 2001). Likewise, the outpost presumably used some of the limited wood in the area for fuel or building, which may have increased erosion and thereby the amount of sediment in the stream. Some of the increased sediment was likely deposited downstream in the lake and wetlands in the northwestern portion of the valley floor. Mission farmers decreased the storage capacity for runoff after rainfall, in part by creating drainage channels to move water out of the immediate area and also by adding sediment to the lake and wetlands. These actions would have increased the potential for flooding, although perhaps not significantly yet.

<u>Ranching in San Pedro Creek Watershed: 1792-1860s</u>

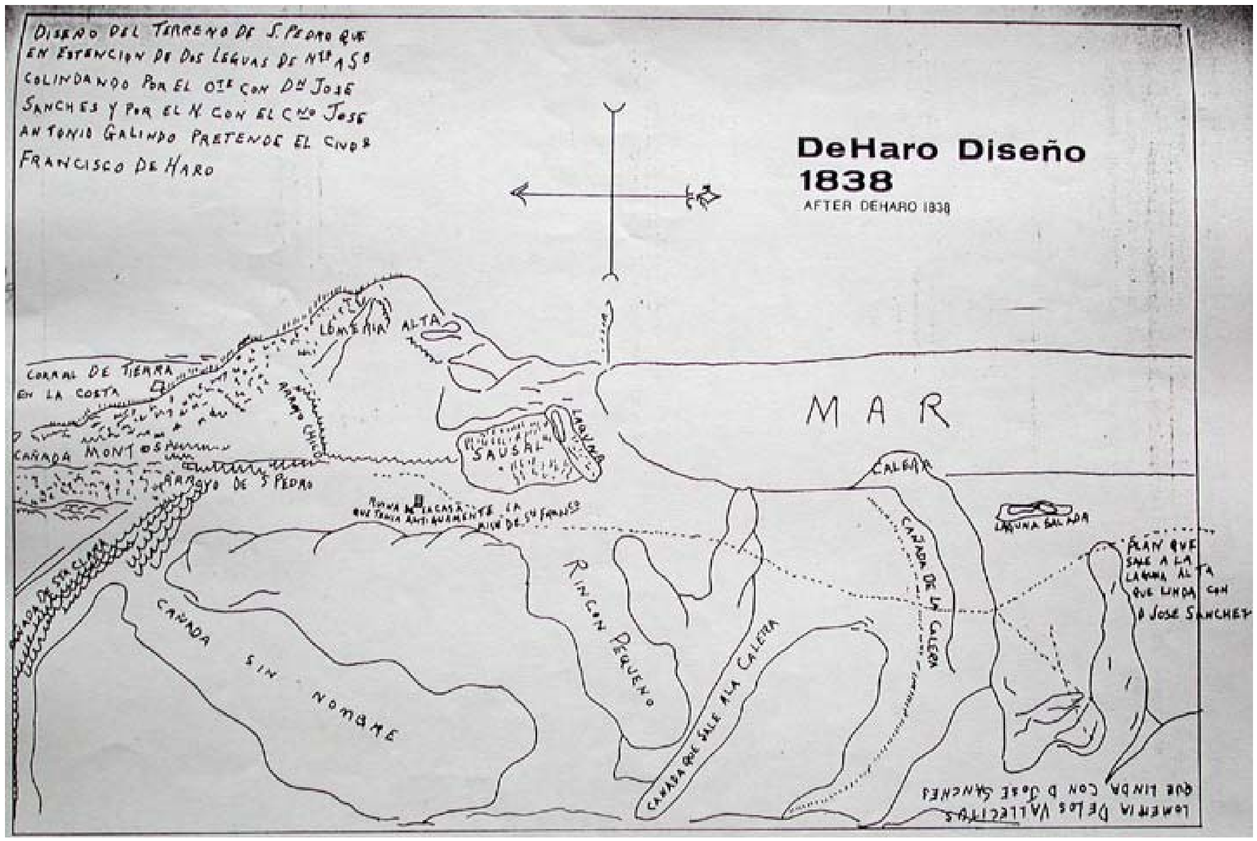
Ranching in San Pedro Valley started with the mission outpost and continued into at least the 1860s. After flourishing for several years, the mission's agricultural outpost experienced a rapid decline in population in 1792, likely due to an epidemic, and the it's primary function changed from labor-intensive crops to livestock, primarily cattle and sheep (Dietz 1979).

After Mexico's independence from Spain, land in the San Pedro Valley became available to settlers through grants from the Mexican government. Maps sketched by several people applying for land grants in San Pedro Valley provide early images of the valley (Dietz 1979). Guadalupe Barcena's sketch from 1835 (Map 8) shows a valley surrounded by mountains and a creek (arroyo) running through a group of willows (sausal) and into a lake. Francisco de Haro's 1838 map (Map 9) covers a larger area than Barcena's sketch, and shows San Pedro Creek (arroyo de S Pedro) running on the

MAP 8. Barcena’s 1835 Map for Rancho San Pedro Land Grant. ***Source:*** Dietz 1979.



MAP 9. De Haro’s 1838 Map for Rancho San Pedro Land Grant. ***Source:*** Dietz 1979.



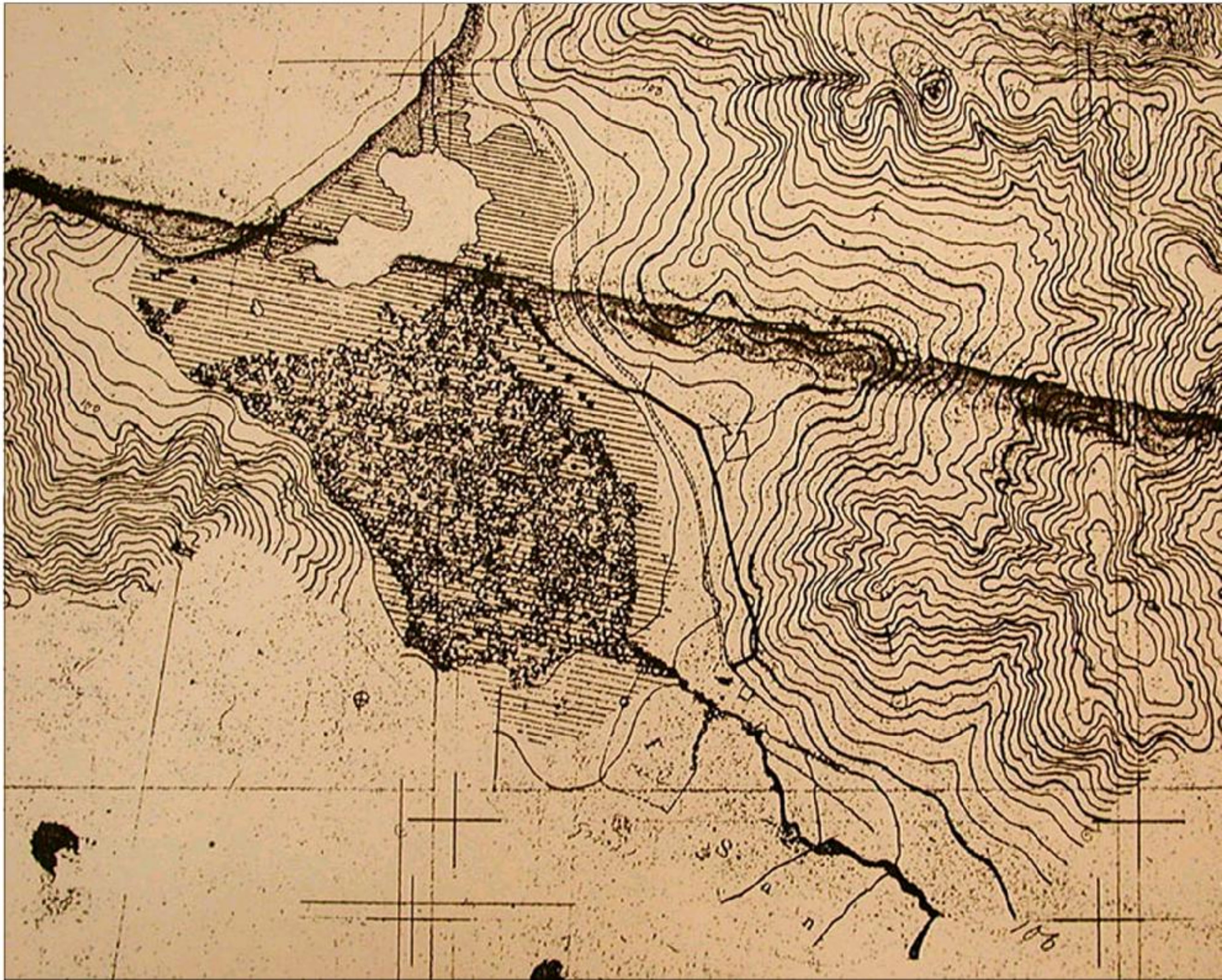
valley floor, into a grove of willows (sausal) and a lake (laguna). The map also points out the mission outpost ruins in the valley.

In 1839 Francisco Sanchez succeeded in obtaining a land grant including San Pedro Valley, where he soon built his adobe. Sanchez raised crops (Dietz 1979) and livestock, including a large number of cattle, as well as horses and sheep (Brown 1961), which would have been allowed to roam freely over the area to feed on the vegetation (Hynding 1982).

In 1853, almost 15 years after Sanchez acquired the land, the U.S. Coast Survey mapped the San Pedro Creek Watershed, providing a more precise look around this time (Map 10). San Pedro Creek runs along the valley floor and disappears into a thicket of willows surrounded by wetlands and to the northwest by a lake, which empties into the ocean. Sanchez' adobe is also shown with a road leading up to it. Lines east of the adobe and leading into the creek may be drainage ditches. Another topographical map by the U.S. Coast Survey from 1866 shows much of the same detail; a fork of the creek (now called the Sanchez Fork) enters the valley from the south side, and the road leading up to the adobe now continues across the valley floor.

Livestock ranchers altered the San Pedro Creek watershed by bringing livestock into the area and allowing them to roam freely on the hillsides and in the valleys. Historically in California, grazing livestock initiated changes in the vegetation, from taller, perennial bunchgrasses to shorter, exotic annual grasses – the intensity of grazing would have influenced the extent of the shift (Burcham 1957). In ***California Rivers and Streams***

MAP 10. San Pedro Creek Watershed, 1853. San Pedro Creek runs into a marsh and then a lake before reaching the Pacific Ocean. *Source:* U.S. Coast Survey 1853.



Jeffrey Mount (1995) concurs that grazing results in a conversion to non-native vegetation, and he notes that the compaction of the soil by the livestock increases runoff and the erosion rate, thereby increasing the sediment yield from the area. Likewise, adding unpaved roads impacts a stream system. New, unpaved roads function as drainage channels moving water downstream more quickly and increasing the sediment load in the stream (Mount 1995). The increase in the amount and velocity of runoff disrupted the equilibrium of the creek leading to channel incision, which increases the sediment supply until a new equilibrium is found (Collins, Amato, and Morton 2001).

In San Pedro Valley as the increased sediment moved downstream to areas with a more gradual slope it was likely deposited and helped to start filling in the wetlands and lake, reducing their capacity, and potentially contributing to flooding during high flows. Flooding was unlikely to have been a major concern for ranchers, as their livestock could graze up in the surrounding hills.

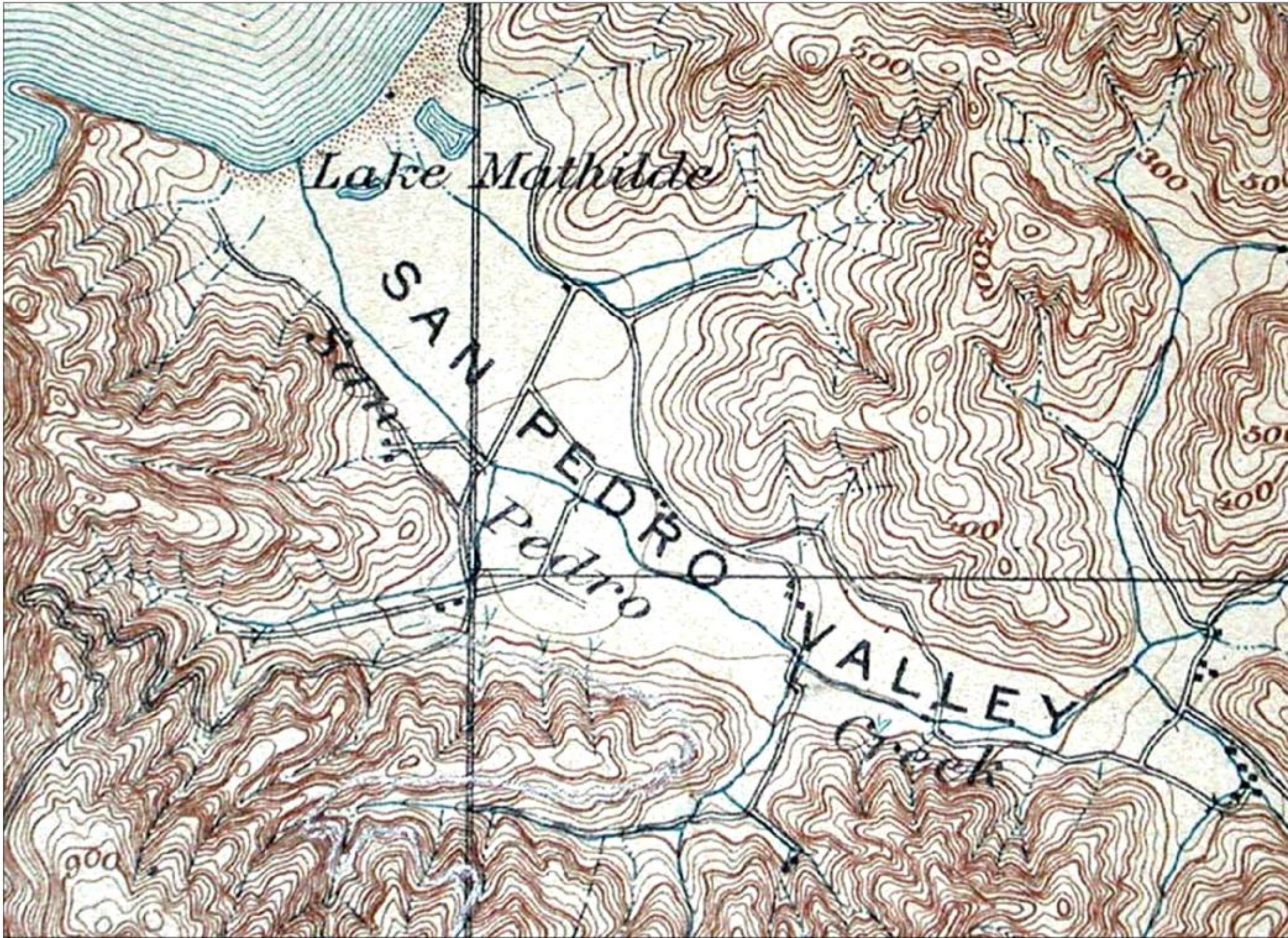
Commercial Agriculture: 1870s-1950s

After Sanchez's death in 1862, his land was sold off (Dietz 1979; Brown 1961), and crop farming returned to the valley. Commercial truck farming began developing with the arrival of Italian immigrants who took up parcels of Sanchez' subdivided land (Richards 1974; Brown 1961).

By the 1890s the changes farmers had made to the watershed over the past several decades of agriculture were evident, as seen on the USGS topographical map from 1896 (Map 11). Lake Mathilde in the northwestern part of the valley had become two smaller lakes. The creeks no longer flowed into the lakes; Crespi Creek flowed between the lakes and San Pedro Creek flowed into the ocean west of the lakes. San Pedro Creek appears to have been straightened to run more directly out to the ocean, especially in the lower reach, to drain the excess water out of the area and provide more arable land for farming. The valley now contained many more structures and roads, including the Half Moon Bay-Colma Road, built in 1879, which ran through the valley and south over the mountains (VanderWerf 1994). The new roads enhanced access to the valley and also increased the runoff and sediment entering the stream system.

Italians introduced artichokes in San Pedro Valley by the early 1900s (Parker 1915; Gervais c.1984), and they became the prevalent crop in the valley (Azevedo and Azevedo 2002). Globe artichokes were planted in rows six feet apart on the valley floor and even farther apart on higher ground, in part to allow for irrigation channels (Parker 1915). A photo in the Pacific Rural Press from 1915 (Photograph 3) looking down on the artichoke fields in San Pedro Valley shows the northwestern portion of the valley floor, covered with artichoke fields except for some wetlands near the ocean, where Lake Mathilde was once located. Irrigation and/or drainage ditches lead to San Pedro Creek, which is hidden by a narrow line of riparian vegetation. Large areas of exposed soil lead to increases in soil erosion and sediment in a creek (Mount 1995). Plowing the land and creating irrigation and drainage ditches reduces the storage

MAP 11. San Pedro Creek Watershed, 1896. San Pedro Creek runs directly into Pacific Ocean, Crespi Creek runs between two small lakes. *Source:* USGS 1896.



PHOTOGRAPH 3. San Pedro Valley, 1915. ***Source:*** Parker 1915. Courtesy of San Mateo County Historical Assn.

A 250 Acre Artichoke Field, Taken Shortly After Old Growth Had Been Cut Away.

capacity by eliminating depression storage and allows runoff to more quickly enter the larger stream (Mount 1995). These changes also decrease the lag time for the peak discharge, which increases as well, all of which create a greater flood risk downstream (Mount). The net effect of these changes to San Pedro Valley was likely that sediment continued to fill in the lake and wetlands.

Several innovations facilitated truck farming in San Pedro Valley, including the development of the Ocean Shore Railroad. Work began in 1905 on a railroad line intended to run from San Francisco down along the coast to Santa Cruz (Wagner 1974). In San Pedro Valley the railroad built a berm along the coastline for the tracks, and a trestle over San Pedro Creek. The berm increased the flood hazard in San Pedro Valley by impeding floodwaters in the valley from easily draining into the ocean. By 1907 passengers could travel from San Francisco to Tobin Station at the westernmost end of San Pedro Valley (Wagner 1974). Passengers from San Francisco enjoyed the scenic beauty of the coast, while truck farmers in the valley benefited from the manure transported out of San Francisco for use on the artichoke fields (Parker 1915) and from the quicker transportation of their produce out of the area. A topographical map from 1915 shows the Ocean Shore Railroad line running along the coast and Tobin Station (U.S. Dept. of Interior 1915, reprinted 1947). Other noticeable changes since the 1896 map include the disappearance of the lakes and a few new structures along the railroad line.

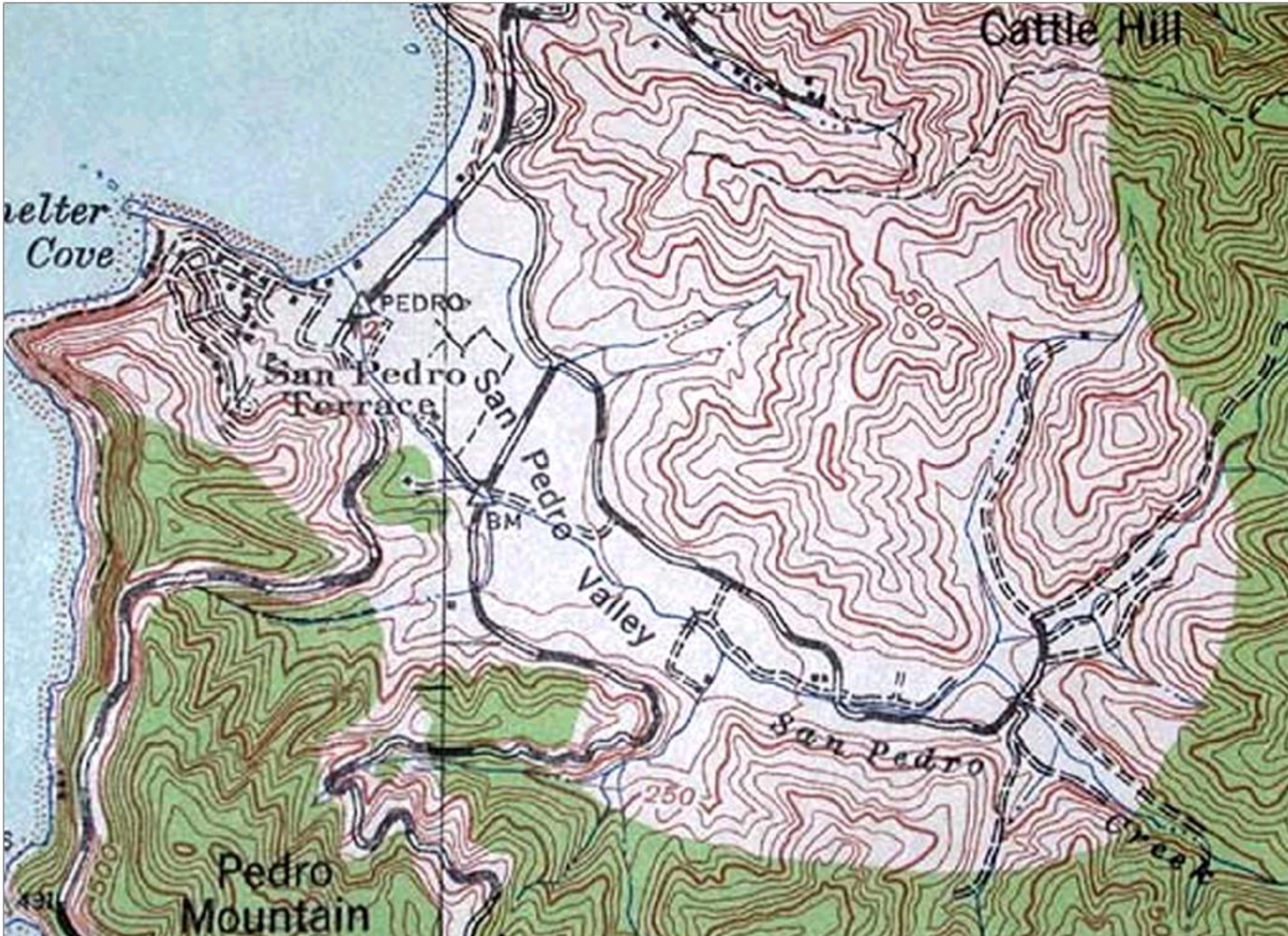
Coastside Boulevard, built in 1915 from Colma south to Half Moon Bay via San Pedro Valley (Pinkson 1915), also aided the development of truck farming in San Pedro Valley. The new road allowed truck farmers to more easily ship their produce out of the area, and became even more important after the Ocean Shore Railroad stopped operating in 1920.

A photo of the northwestern part of the valley along the ocean, dating from around the 1910s-1920s, shows the railroad berm running along the shore, and passing over San Pedro Creek, which is flowing directly into the ocean (Photograph 4). Artichoke fields are seen on the south side of the valley near the coast. The photo also shows standing water and wetlands in the area formerly covered by Lake Mathilde, suggesting that despite attempts to drain the water out of the valley over the previous forty years or more, farmers could not drain this area well enough to make it arable.

A topographical map from 1943 (Map 12) (War Dept. 1943) highlights additional changes since the 1915 map. These changes include a small development at San Pedro Terrace, near the Ocean Shore Railroad; California Highway One, built in 1937; and Coastside Boulevard, built in 1915. Bridge crossings are shown over San Pedro Creek for both of these roads. Instead of disappearing into the wetlands, Crespi Creek now runs directly into the ocean north of San Pedro Creek, suggesting that farmers altered its course, probably in an attempt to further drain water from the wetlands and lakes and increase the arable land.

PHOTOGRAPH 4. Northwestern portion of San Pedro Valley, looking northeast, c. 1910s-1920s. ***Source:*** Stanger 1963.

MAP 12. San Pedro Creek Watershed, 1943. San Pedro Creek and Crespi Creeks run directly into Pacific Ocean. *Source:* War Dept. 1943.



An archaeological study by R. J. Drake at the Sanchez Adobe site in 1950 found evidence that San Pedro Creek had meandered and overflowed its banks in the past (Drake 1951). When the adobe was built in 1842, the channel of San Pedro Creek was just a few feet below ground level; by 1950, the creek had incised a V-shaped channel down to 15 feet (Drake 1951). Drake hypothesized that the incision was due in part to agriculture and vegetation removal (Drake 1951).

After almost one hundred years of commercial agriculture in the San Pedro Creek Watershed, humans had transformed the landscape dramatically. The truck farmers aggressively altered the San Pedro Creek Watershed to maximize agricultural production. Areas were drained or irrigated as required, and sections of creeks were altered to facilitate the flow out of water out of the area. Flashboard dams placed across San Pedro Creek throughout this time to divert water to irrigation reservoirs also decreased the stability of the stream and increased the sediment load (Collins, Amato and Morton 2001). Large amounts of soil were left bare in the artichoke fields. The intentional modifications to the watershed by the farmers also had unintended consequences. As Jeffrey Mount discusses in ***California Rivers and Streams*** (1995), agricultural practices affected California streams by increasing the area of exposed soil and altering channels, which led to increased erosion rates, channel incision, and sediment loads. Mount also notes that increased sediment in a creek and runoff from fields using manure degrade the quality of steelhead habitat (Mount 1995). In San Pedro Valley these impacts likely helped to fill in Lake Mathilde and the most of its surrounding wetlands, as they were also being drained, and helped to degrade the steelhead habitat in San Pedro Creek.

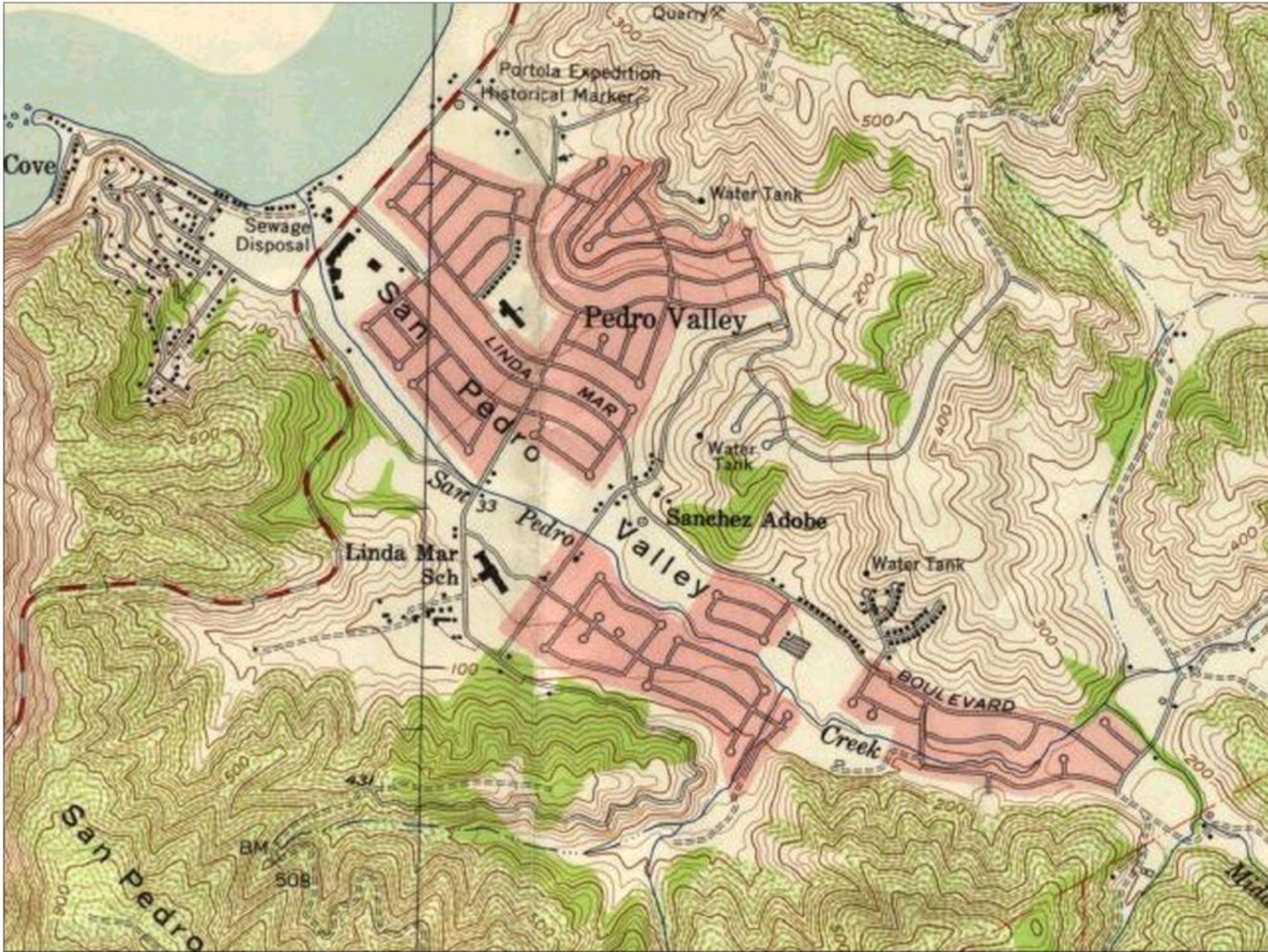
Several of these changes in the watershed also unintentionally increased the potential for flooding in the valley. As Mount notes, large areas of exposed soil in the fields and reduced storage capacity for runoff decrease the lag time for the water to reach a stream channel, which during the heavy winter rains in California can lead to downstream flooding and creek bank erosion (Mount 1995). The railroad berm, and the railroad trestle and bridges built over San Pedro Creek also increased the flood hazard by constricting large flows, causing water to back up and spill over the creek banks.

Urbanization of San Pedro Valley: 1953-present

Changes brought to the area by agriculture, including road access and drained, cleared land, provided a ripe opportunity for urbanization. As part of the post-World War II housing boom, starting in 1953 urban developers quickly transformed San Pedro Valley from an agricultural area to a suburban community (Map 13). Houses were built adjacent to the creek and in low-lying areas already likely to flood, and development increased the flood hazard in Linda Mar.

Andy Oddstad initiated the development in San Pedro Valley with his 3,000-home Linda Mar development (Sharp Park 1953b; Hynding 1982). People were lured to the area by its natural aesthetics, including the hills and the ocean (Sharp Park Breakers

MAP 13. San Pedro Valley, 1956. Crespi Creek now gone. *Source:* USGS 1956.



1953a); however, within a few years these views had been altered. Houses were built up into and even on top of the hillsides of San Pedro Valley.

Development of the watershed also affected the creeks and their branches. In order to make way for development, Crespi Creek (now called Crespi Ditch) was culverted and channelized – the creek no longer appears on the 1956 USGS map (Map 13). Housing was built immediately adjacent to San Pedro Creek. Many of those owning homes adjacent to the creek would later have problems with erosion and bank failure, given the channel incision started earlier with agriculture and ranching. In addition, fill was placed on the northwestern part of the valley (Pampeyan 1994), presumably to allow building on top of any remnants of the wetlands and Lake Mathilde. Homes built in the area of this fill north of Linda Mar Boulevard and east of Highway One lie below the creek and the high tide level, creating the need to pump runoff out of the area (Holmes 2003a). Because the pump stations and drains could not accommodate large amounts of water, such as that generated during winter storms in 1962, 1972, and 1982, the area was prone to flooding (Holmes 2003a).

By 1968 development extended even further up into the northeastern hills (USGS 1968). Developers had culverted the North Fork of San Pedro Creek and covered it with fill from the surrounding hills, in order to build housing on top (Azevedo and Azevedo 2002) - the North Fork no longer appears in most of the North Fork valley on the 1968 USGS map.

Urbanization has many impacts on a watershed. Mount (1995) notes that the area of impermeable surfaces (roads, driveways, houses) significantly increases, and a new drainage system, including gutters and drainage pipes, is developed to remove water from the area quickly. Runoff enters the stream network more rapidly (i.e. has a decreased lag time), which not only leads to an increase in the amount of runoff, but also to an increase in the size of the flood peak (Mount 1995). More runoff and a greater flood peak increase the chances of overwhelming the downstream channels, leading to flooding.

Indeed, the San Pedro Creek Watershed began to experience flood problems related to its urbanization almost immediately after development of the Linda Mar neighborhood. Flooding in 1955 (USACE and City 1998a) and 1956 (SPFCC 1985, 3) was soon followed by major floods in 1962, 1972, and 1982. Despite the early flooding city staff allowed development to continue, even as city staff and a citizens committee looked into methods to reduce the flood hazard. Philip Williams & Associates, hydrology consultants, studied the flood hazard in San Pedro Valley, focusing on the 1982 flood, and determined that insufficient channel capacity was the primary cause of flooding in the area (Vandivere 1985). Some reaches of the creek were insufficient to contain greater than a 3-4-year flow, estimated at 600-1000 cubic feet per second (cfs) (17-28 cubic meters per second or m^3/s) (SPFCC 1985, 4; USACE and City 1998a, 9). The areas with the least capacity, ranging from 600-2000 cfs (17-57 m^3/s), started at the mouth of the creek at the ocean and went upstream to Peralta Road Bridge (USACE and City 1998a, 10). A little further upstream the capacity of the Adobe Drive Bridge was also problematic – originally estimated at 500 cfs (14 m^3/s) capacity (USACE and City 1998a, 10), this figure was later revised to accommodate up to a 15-year event (Holmes 2003a) or approximately 2,300 cfs capacity (65 m^3/s) (USACE and City 1998a, 9). The 1982 flood, which caused over $5 million in damage, was only a 35-year event with a flow estimated at 2,900 cfs (82 m^3/s) (USACE 1989, 7). The flow of a 100-year event has been estimated as 3,500 cfs (99 m^3/s) (USACE and City 1998a, 9).

Winter storms in February 1998 again caused San Pedro Creek to overflow its banks, flooding the Linda Mar Shopping Center, Linda Mar Boulevard, and Anza Drive, where floodwaters reached doorsteps (Larsen 1998a).

Human alteration of the San Pedro Creek Watershed together with its steep slopes and seasonally-heavy rainfall contributed to the development of a flood hazard in the northwestern area of San Pedro Valley. Farmers and livestock ranchers intentionally and unintentionally initiated many changes in the watershed that were accelerated by developers and homeowners, including increasing runoff and peak flows, and channel incision. Addressing the flood problem would require remediation of past alterations of the watershed.

CHAPTER 3

INFLUENCE OF MICRO-LEVEL ELEMENTS ON RESPONSE FOLLOWING A MAJOR FLOOD

Evaluating individual or micro-level response to a flood hazard as part of Palm's integrative framework reveals that individuals influence and are influenced by elements at other levels. With each flood as awareness of the flood hazard increased among the new residents of Linda Mar, expectations originating at the cultural or macro level influenced their response. Likewise, residents influenced the response of elements at the meso level.

Traditional hazards research found that awareness or perception of a flood hazard increases after a flood event (to a greater degree after larger events) or when individuals see flooding as more probable. When residents first settle in a recently developed area, they lack understanding or awareness of a hazard (Burton, Kates, and White 1978). The higher the perception of a flood hazard the more likely an individual will act to attempt to reduce their risk. Although new to the area in the 1950s, Linda Mar residents (micro-level elements) quickly developed an awareness of the flood hazard in their area after repeated flooding and responded by asking the city (meso-level element) to control the problem.

The desire to control flooding is a cultural or macro-level element influencing hazard response. Federal policies toward flood control starting with the Flood Control Act of 1936 highlighted an antagonistic attitude toward flooding and a desire to control it. The act called floods “destructive” and “a menace to national welfare,” and provided the federal government with the ability to “improve” waterways with flood problems (Legal Information Institute 2004a). As the early work in natural hazards identified, these policies led to an increase in the confidence of residents that flooding could be controlled. This confidence also led to the expectation that flooding should be controlled.

Another macro-level element is the question of who is responsible for addressing the flood hazard. In the United States the responsibility has usually pointed toward the individual (micro-level element); however, when damages are incurred individuals often push the blame off on others, such as government entities (meso-level elements), and threaten litigation against these entities (Palm 1990).

Flood of 1962

With the urbanization of San Pedro Valley in the early 1950s, a large number of people moved into the Linda Mar area. Unfamiliar with the area and any potential flood hazard, they soon found their awareness of the flood hazard increasing due to minor flooding in the 1950s. Not until 1962 did flooding cause great alarm. Winter storms in October 1962 brought large amounts of rain to the area, which led to major flooding in lower Linda Mar on October 13. The flooding covered 140 acres (USACE 1988, 3), extending from San Pedro Creek north-northeast into DeSolo Drive, Flores Drive, Montezuma Drive, Linda Mar Boulevard, Anza Drive and Arguello Boulevard, and out to the Highway One (Map 4) (Pacifica Tribune 1962e; Pacifica Tribune 1962b). The worst flooding was in the northwestern section of the valley where a lake formed in the same general area Lake Mathilde formerly occupied, but that was now covered with homes (Pacifica Tribune 1962a). Two hundred people had to be evacuated from their homes, some in small boats due to the waist-deep water in areas, and 85 homes experienced major damages to their interiors (Pacifica Tribune 1962e; Pacifica Tribune 1972a). Stores in the Linda Mar Shopping Center were also flooded by several inches of water (Pacifica Tribune 1962d, 1). Damages to homes and businesses reached between $500,000 (1972 price level) (USACE 1988, 3) and $1 million (Pacifica Tribune 1972a, 23).

With a heightened awareness of the flood hazard, the micro-level residents began influencing response at the meso level by calling on the city council (meso-level element) to provide explanations and to resolve the problem. Residents expressed their frustration with the city, whose staff had not yet started annual maintenance to clean out the creeks, for not having been better prepared (Pacifica Tribune 1962b). In addition to calling for increased maintenance in the creeks, the residents (micro-level elements) also requested that meso-level elements halt construction in the area until the flood problem was resolved (Pacifica Tribune 1962d, 8). Residents of Anza Drive further influenced the city council (meso-level element) by threatening legal action against the city and developers (meso-level elements) for their negligence in not cleaning the creek earlier and not completing drainage work respectively (Pacifica Tribune

1962f). The residents wanted the problem solved in order to prevent future flood damage (Pacifica Tribune 1962f).

City staff (meso-level element) were initially defensive toward the residents. City Engineer Al Roberts defended the city arguing that the creeks cannot be cleaned out too far in advance of winter storms or they just fill up with trash before the storms start, and that this storm came very early in the rainy season (Pacifica Tribune 1962f). By late October, the meso-level response to pressure from the micro-level residents became more proactive. Mayor George Mason asked the city council to consider creating a citizens committee to look into the “drainage problem” (Pacifica Tribune 1962g), which it did in late 1962 or early 1963 (Pacifica Tribune 1963a). The citizens Drainage Committee proposed improvements to the drainage system and $2 million in bonds to finance them (Pacifica Tribune 1963a), but the city (likely the city council and/or city staff) did not obtain the necessary funding to go forward with the project.

The following year city staff also responded to the residents’ pressure by beginning work to clear out the stream channels and storm drains in September, more than a month earlier than in past years, as well as installing new drains in several sections of the city, including Linda Mar, and lining the stream channel near Capistrano (Pacifica Tribune 1963b). In the decade after the October 1962 flood, the Department of Public Works also improved the existing pumping stations and built a new station to accommodate larger flows (Pacifica Tribune 1972b; Barnard 1982b).

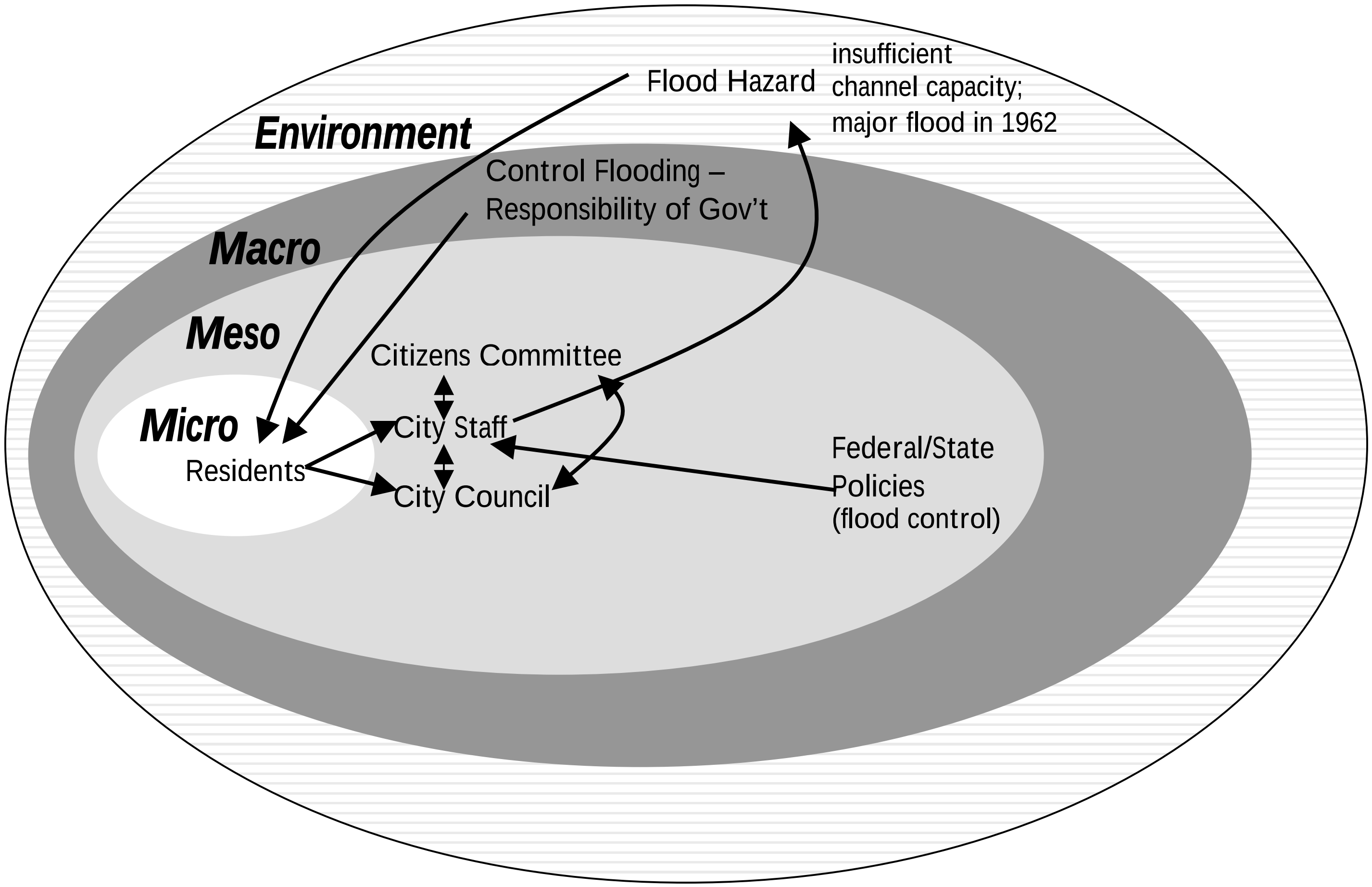
The 1962 flood increased the awareness of the micro-level residents enough to cause them to act by calling on meso-level elements to respond to the flood hazard (Figure 2). The meso-level elements, including the city council and city staff, eventually responded by creating a citizens committee and making some drainage improvements.

As the years passed since the last flood, residents' perception of the flood hazard became less accurate and confidence that the 1962 flood was a rare event began to rise. As the ten year anniversary of the 1962 flood approached, the ***Pacifica Tribune*** ran an article on October 11, 1972 expressing the question on many people's minds: "The Great Flood of '62: Could It Happen Again?" The article noted: "anything is possible… But it seems that the chances of another flood, like the one Pacifica had ten years ago, are greatly decreased" (Pacifica Tribune 1972b, 19). The article alluded to the unlikely realignment of the natural factors seen in 1962 that caused the flooding, including large amounts of rain over several days, high tides, waves, along with the lack of backups for the pumps (Pacifica Tribune 1972b). Frank Sampson, representative of the Department of Public Works, was confident that the improvements in pumping capacity would practically eliminate the threat of flooding (Pacifica Tribune 1972b).

<u>Flood of 1972</u>

As the ***Pacifica Tribune*** containing the article "The Great Flood of '62: Could It Happen Again?" (1972b) was being delivered in the early hours of October 11, 1972, Linda Mar experienced another major flood (Pacifica Tribune 1972c). A winter storm

FIGURE 2. Key Elements Influencing San Pedro Creek Flood Control Project after 1962 Flood. Modified from Palm 1990.



brought large amounts of rain in a short period of time, causing flooding on some of the same streets flooded in 1962, predominantly Linda Mar Boulevard and Anza Drive, as well as in stores in Linda Mar Shopping Center (Pacifica Tribune 1972c). This flood covered approximately 40 acres, a smaller area than the 1962 flood, and caused less in damages, approximately $144,000 (1972 price level) (USACE 1988, 3). A few homes were flooded, along with many garages, but this was significantly less than in 1962 (Pacifica Tribune 1972c). However, awareness of flooding was heightened in a larger area when the phone lines in Pacifica went dead after flood waters poured into the Pacific Telephone's underground area containing the phone cables (Pacifica Tribune 1972c).

This flooding again increased the awareness of residents (micro-level elements), who again responded by asking the city to explain how the flooding happened and how the city would resolve the problem. Similar to the response after the 1962 flood, resident Mario Victor of Anza Drive wanted to know why the creeks were not cleaned out (Pacifica Tribune 1972c), but this time the city council and city staff replied with different reasons. Councilman Nick Gust and Superintendent of Public Works Frank Sampson blamed the lack of creek maintenance on environmentalists who opposed work to remove trees and vegetation from the creeks because of the possibility of damaging the trees and wildlife during a cleanup (Pacifica Tribune 1972c). This points to an influence originating at the macro level (the environmental movement) that will be discussed further in the next chapter. Resident Karl Strutz also questioned the city's unwillingness to seek flood insurance, suggesting that it was only protecting big businesses, who would not be eligible for low-interest loans if they had flood insurance (Strutz 1972).

Several Anza Drive residents attended a city council meeting later in October to discuss the recent flood and what to do to prevent future flood disasters (Galstan 1972). Unlike after the 1962 flood when the mayor requested a citizens committee, this time micro-level residents originated the request. Anza resident Bill Byrne called on the city council (meso-level element) to create a committee including representatives from the city, Anza Drive, and a third party to look into the flood problem (Galstan 1972). The city council agreed to work with a citizens committee to look into the flood problem and work on developing solutions (Galstan 1972), and initiated a flood control project later in the year. The city requested assistance with the project from the Corps in January 1973, who then began work on a Section 205 Flood Control Study along with a citizens committee (USACE and City 1998a). (Note: Section 205 refers to the section in the 1948 Flood Control Act (33 U.S.C. 701s), which "authorizes the Chief of Engineers to study and construct small flood control projects without individual authorization by Congress provided that the Federal project cost does not exceed $5,000,000" (USACE 1988, 1). The maximum amount later increased to $7,000,000 (Galal 2003).) In early 1976 after the city council determined that funding was not available for the city's share of the project, the flood control project was halted (USACE and City 1998a).

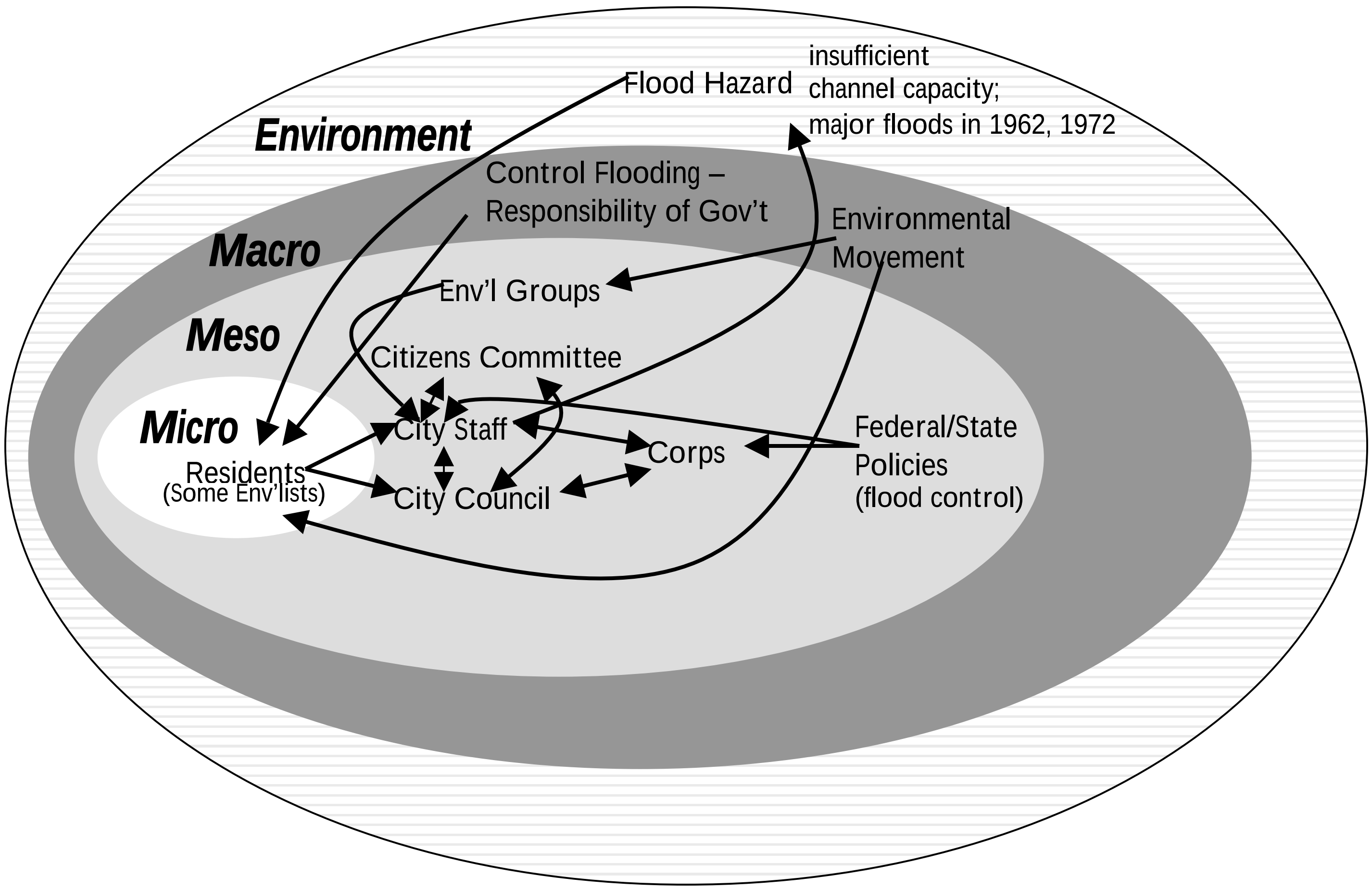
In responding to the pressure from residents after the 1972 flood, city staff from the Department of Public Works also began to conduct annual creek cleanups again the following year, trimming back trees and vegetation that could obstruct the stream flow (Pacifica Tribune 1973). Public Works Superintendent Frank Sampson reported that unlike in previous years when the environmentalists had protested when city staff wanted to trim back vegetation, this time they did not protest (Pacifica Tribune 1973). The experience of a recent flood increased the willingness of environmentalists, some micro-level residents and likely also meso-level organizations, to allow city staff (meso-level element) to attempt to reduce the flood hazard despite potential negative environmental impacts. In 1980 the city also began participating in the national flood insurance program, which required floodproofing measures for new structures built on the floodplain (SPFCC 1985).

After the second major flood in a decade, micro-level residents responded again by calling on the city council and city staff (meso-level elements) to fix the problem (Figure 3). The city staff began creek maintenance again, in an attempt to reduce the flood hazard. However, this time residents proposed that the city council create another citizens committee to address the flood problem.

Flood of 1982

With striking regularity 1982 brought another major flood to the San Pedro Valley. In early January 1982 winter storms dumped record rainfall on the San Pedro

FIGURE 3. Key Elements Influencing San Pedro Creek Flood Control Project after 1972 Flood. Modified from Palm 1990.

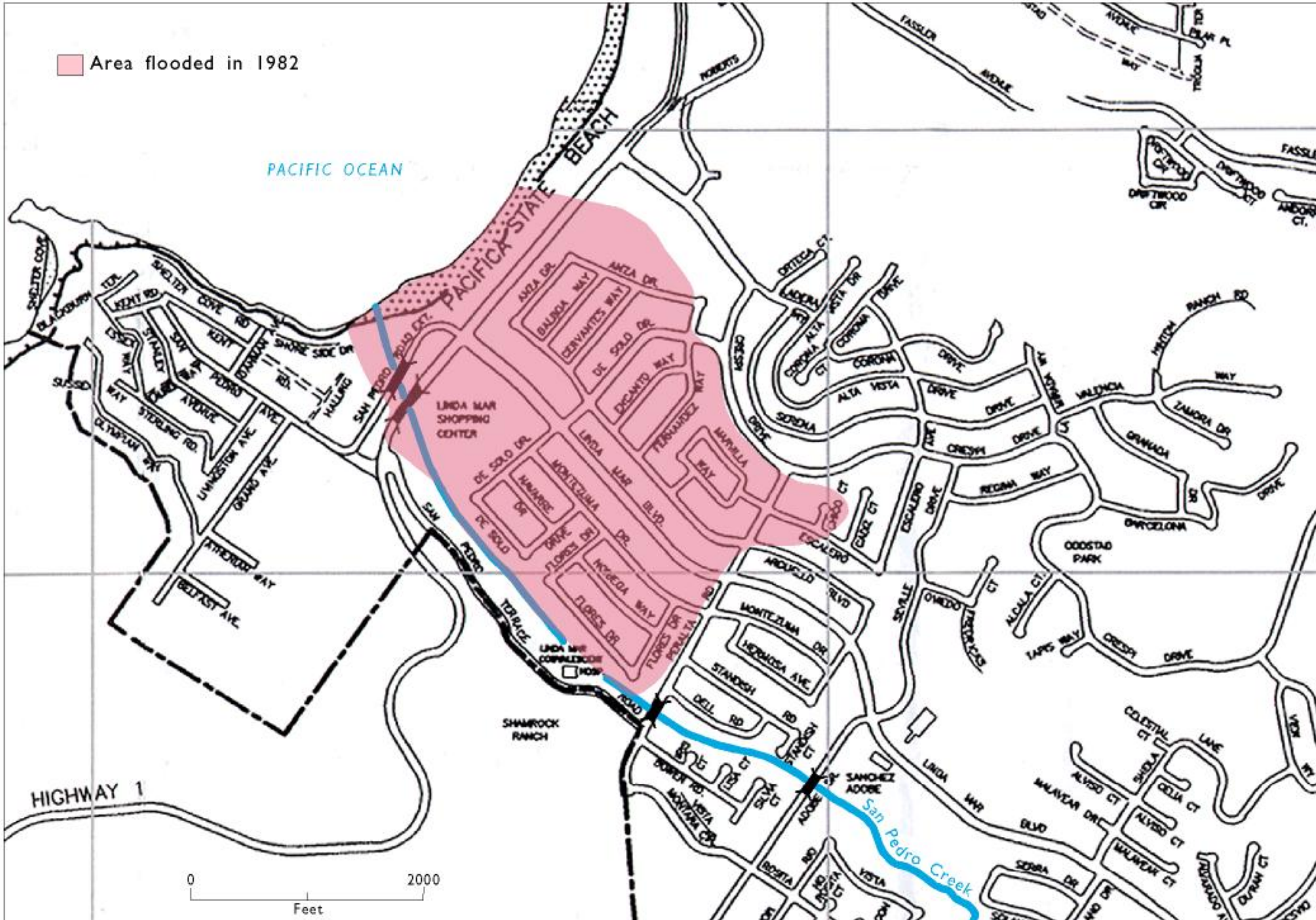


Creek Watershed (Pacifica Tribune 1982a), leading to more disastrous flooding in Linda Mar (Map 14). The Linda Mar Shopping Center was flooded once again and the parking lot and surrounding area again turned into a lake (Pacifica Tribune 1982b). Lower Linda Mar residents were evacuated on sections of Anza Drive, Balboa Way, Cervantes Way, and Rio Vista Drive (Barnard 1982a). All of these streets are located in the low-lying area around the site of the former Lake Mathilde, except Rio Vista Drive, which is just upstream of the Adobe Drive Bridge. The Adobe Bridge washed out during the storm, although the box culvert beneath the bridge remained in place, allowing the city to build over the culvert again later (Holmes 2004). The floodwaters ultimately reached into approximately 183 residential and 10 commercial structures, where they caused over $4,000,000 in damage (1982 dollars) (USACE 1987, B-1).

Given multiple experiences with flooding within the previous 20 to 30 years and the seeming predictability of a major flood every decade, residents in Linda Mar had a high awareness of the flood hazard. As expected this awareness prompted residents to act. Residents not only called on the city to prevent or at least minimize future flood disasters, but also threatened legal action against the city. As with after the 1962 flood, the macro-level cultural notion that the government should control flooding likely influenced micro-level residents to pursue litigation against the city (meso-level element).

As the city's legal expenses mounted, ultimately to over $1 million (Curtis 1991b), the city council decided to act (Hall 2003). In January 1983 one year after the

MAP 14. Extent of 1982 Flood.



Source: From City of Pacifica, Dept. of Public Works (no date); USACE and City of Pacifica 1998b.

latest flood, the city council petitioned residents and property owners in lower Linda Mar to apply for a seat on a committee devoted to addressing the flood problem (Pacifica Tribune 1983). Due to unexplained delays the committee members were not appointed until March 1984 (SPFCC 1985). Patrick Hall later noted that by forming another citizens committee to look into the flood problem, the city could demonstrate that they were trying to address the flood problem, and the legal arguments against the city would be weakened (Hall 2003).

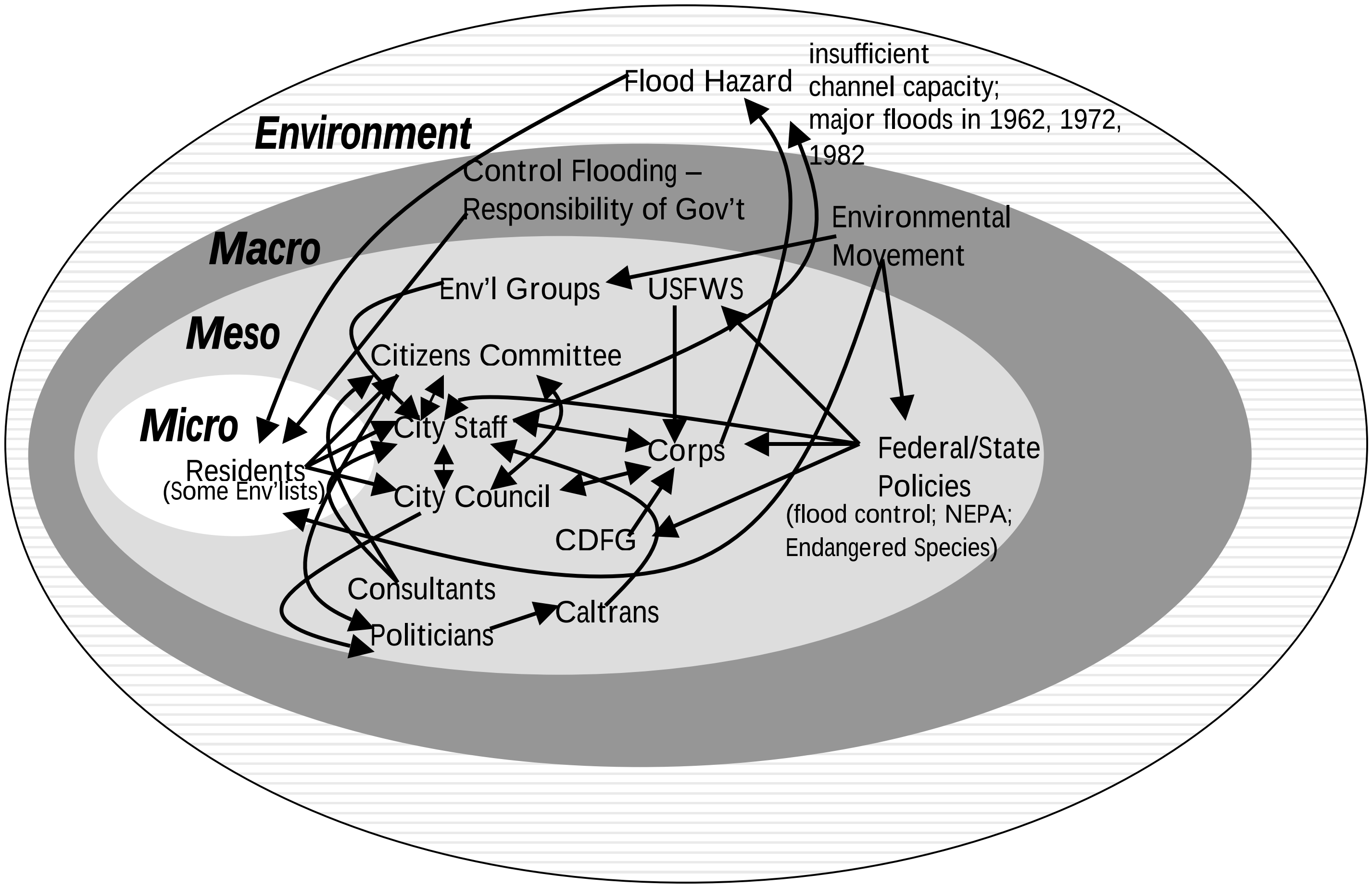
The committee started off with nine members: Tyler Ahlgren, Gil Anda, Joe Fulford, Patrick Hall, Ken Locher, Ken Miles, Ron Perotti, Eva Post, and Tom Scott (LLMAFCIC 1984a). Only two of those original nine committee members actually lived in an area subject to flooding; Eva Post lived on Anza Drive and Patrick Hall on Balboa Way (Hall 2003). The other members of the community were included because the city thought of flooding as a community problem (Hall 2003). On June 6, 1984 the Lower Linda Mar Area Flood Control Improvement Committee (soon to be called the San Pedro Flood Control Committee, and then later called the San Pedro Creek Flood Control Committee) met for the first time (LLMAFCIC 1984a). Although many committee members would resign and be replaced along the way, the committee endured with Patrick Hall and Joe Fulford continuing as committee members still as of Fall 2003, still determined after almost 20 years to decrease the flood risk (Hall 2003).

The committee submitted its first report to the city council in May 1985 with their possible solutions and funding strategies (SPFCC 1985), and shortly thereafter the mayor (meso-level element) asked the Corps (meso-level element) to start another Section 205 flood control study with the city to address the flood problem (USACE and City 1998a). The Corps and city staff held several public hearings throughout the planning process to allow residents and other interested organizations to receive updates on the project and to participate in the process. The concerns expressed by the residents who attended the meetings will be discussed in the other chapters together with the changing objectives of the flood control project.

The response by micro-level residents after each the 1982 flood followed the same basic pattern as the previous major floods in 1962 and 1972 (Figure 4). Flooding increased residents' awareness of the flood hazard, leading residents to act by calling on the city council and/or city staff (meso-level elements) to fix the problem. Although after each major flood a citizens commitee worked on possible solutions to the flood problem, only after the 1982 flood, when additional flooding seemed inevitable did a committee persevere in seeing a flood control project through to at least partial completion. Further details of the post-1982 flood control project will be discussed in later chapters.

While city staff, the flood control committee, and the Corps were working on the flood control project, some residents were making their own efforts to reduce the flood problem. The San Pedro Valley Park Volunteers cleaned out the creek in July 1985, removing loads of trash including appliances, shopping carts, and cement (SPVPV 1986). The volunteers proposed that storms in March 1986 caused limited damage in

FIGURE 4. Key Elements Influencing San Pedro Creek Flood Control Project after 1982 Flood. Modified from Palm 1990.



Pacifica because of the volunteers' efforts in cleaning out San Pedro Creek (SPVPV 1986). The volunteers admonished people not to use the storm drains to dispose of trash as this ends up in the creek and can cause flooding, and recommended that creekside residents consult local officials for advice before constructing a wall along the creek banks that may end up collapsing into the creek and cause flooding (SPVPV 1986).

The persistent flooding in Linda Mar increased residents' perception of the risk of flooding in the area, which prompted them to take action to reduce the risk. Residents (micro-level elements) pressured the city (meso-level element) to reduce the flood hazard by attending city council meetings and threatening litigation, and they served on citizens committees (meso-level elements) to help look for the means to resolve the problem. The decision by residents to demand action from the city originates from a societal expectation (macro-level element) that flooding problems should be controlled and that residents are not the ones responsible to control the problem.

CHAPTER 4

CHANGING FLOOD CONTROL OBJECTIVES AND METHODS OF MESO-LEVEL ELEMENTS

Evaluating how the objectives changed for flood control along San Pedro Creek helps identify additional influences on hazard response. Although meso-level elements, such as the city council, city staff, and the Corps, determined the official objectives and methods of the project, they were influenced by many different elements at all levels (Figures 2-4). As the San Pedro Creek Flood Control Project evolved over several decades the project's objectives broadened from strictly flood control to incorporate environmental restoration and the methods considered moved away from a reliance on traditional flood control methods to incorporate other methods. The result was a flood control project that was equally an environmental restoration project.

The environmental movement (macro-level element) significantly influenced many of the meso-level elements involved in determining the objectives and methods of the flood control project, both directly and indirectly, as when individuals (micro-level elements) influenced the meso-level elements. Starting in the 1960s and 1970s as part of the environmental movement, attitudes toward the environment began to shift away from valuing human conquest of nature to valuing protection of nature (Kline 2000). State and federal governments generated many new policies (meso-level elements) for environmental protection such as the National Environmental Policy Act of 1969 (NEPA). NEPA requires the Corps to complete an Environmental Impact Statement

(EIS) for a project to evaluate the impacts of the project on the environment. Another policy coming out of the environmental movement, and in turn influencing the flood control project, was the federal Endangered Species Act of 1973. The Endangered Species Act requires attention be paid to the impacts of a project on special status species (e.g. endangered, threatened) in the project area, and that the USFWS be consulted on the matter (USACE and City 1998a, p. 3-4). For the San Pedro Creek Flood Control Project this meant taking special measures to protect the threatened red-legged frog. By the 1990s the requirements of these environmental policies (meso-level elements) influenced the Corps' San Francisco District (meso-level element) to begin adopting a broader range of flood control methods, and even to incorporate environmental restoration as part of flood control projects (Galal 2003). At the micro level, residents of Pacifica influenced meso-level elements involved in the flood control project by adopting the ideals of the environmental movement (macro-level element), protesting environmental degradation and joining organizations interested in protecting the environment.

Several elements influenced the flood control methods considered and selected for the project, including the environmental movement and flood control policies. Meso-level policies generated traditional flood control methods. The Flood Control Act of 1936 required that the benefits of a project exceed the costs; however, this cost/benefit analysis relied on economic costs and benefits, and did not take into consideration environmental costs or benefits. Federal flood control policies established structural methods as the standard, in part because they tended to be less expensive than other options (Galal 2003). Work in natural hazards (meso-level influence) starting in the 1940s emphasized a multi-faceted approach toward flood control and helped to change attitudes to move flood control away from structural-only solutions. However, agencies (meso-level elements) affected by federal policy didn't begin to translate this new attitude into action for many decades. Some of the responsibility for this change can also be attributed to the environmental movement (macro-level influence).

Funding opportunities also influenced the objectives of the flood control project. Pacifica quickly developed into a "bedroom community" in the early 1950s as part of the housing boom following World War II (macro-level element) (City of Pacifica 2001). As a result Pacifica lacks a broad tax base, and finding funding for projects such as flood control is often difficult. Pacifica's limited tax base also impacts its ability to get funds from federal sources. Section 205 of the 1948 Flood Control Act requires that the local sponsor of a flood control project meet funding requirements for the project in order to receive federal funds (Legal Information Institute 2004b). For the Section 205 project started after the 1982, flood funding opportunities from organizations (meso-level elements) supporting environmental restoration provided the city with other avenues for obtaining funding for its share, provided that the flood control project involved environmental restoration. A flood control project without an emphasis on environmental restoration would have had far fewer funding opportunities.

Meso-level elements changed their objectives for the flood control project and the options considered to address the flood problem in part because of the environmental movement (macro-level influence), changing flood control methods (meso-level influence), and funding opportunities (meso-level influence). As the project progressed these and other meso- and micro-level elements impacted the project's objectives.

Flood of 1962

After the 1962 flood city staff (meso-level element) expressed the need to address the flooding or drainage problem as they called it. The primary objective of flood control at this time was to reduce flooding by improving the drainage system to allow water to move out of the area more quickly. As expected, the city engineer (meso-level element) proposed using flood control methods common at the time. City Engineer Al Roberts suggested that the drainage system be upgraded to increase the size of the stream channel and to line the channel with concrete – all traditional flood control responses of the time (Pacifica Tribune 1962b). Former Mayor Gerry Schumacher mentioned paving over the creek (i.e. placing the creek in a culvert) in the "Pacifica Gardens" neighborhood (near the creek in the vicinity of Peralta Road and Adobe Drive) (Pacifica Tribune 1962g). In August 1963 the citizens Drainage Committee (meso-level element) recommended "a progressive program of construction of major storm drainage improvements" (Pacifica Tribune 1963b, 3) that would be financed by issuing $2 million in bonds (Pacifica Tribune 1963a). City staff (likely the Department of Public Works) did line the stream channel near Capistrano in 1963 (Pacifica Tribune 1963b); however, the city council apparently was unable to obtain funding for the major drainage work and the project was eventually dropped. As Figure 2 shows, only a few elements were involved in the hazard response during this time period; however, this began to change.

Beginning of the Environmental Movement in Pacifica

As the environmental movement (macro-level element) gained momentum in the late 1960s, environmentalists (micro-level elements, as well as meso-level organizations) in San Pedro Valley expressed a desire to protect San Pedro Creek. As predicted in traditional flood hazards research, residents were less vocal about the flooding problem given that several years had passed since the 1962 flood. Ultimately environmentalists (micro- and meso-level elements) influenced the objectives and methods of the flood control projects determined by the meso-level elements.

Local environmentalists and residents (micro-level elements) expressed concern over the diminished state of San Pedro Creek and its native steelhead population (Pacifica Tribune 1969; Lynn 1969). The creek was polluted and filled with trash, including “tires, water heaters and scores of shopping carts” (Lynn 1969, 1, 3); (Pacifica Tribune 1969), despite creek cleanup campaigns (Pacifica Tribune 1969). In his 1969 article “Death of a Creek” Patrick Lynn argued that very few people, including official agencies, had stepped forward to stop the creek's decline. Lynn placed responsibility for the degraded creek on the North Coast County Water District for reducing the flow in the creek by withdrawing water from the creek, the city for allowing untreated sewage from a city dump to leak into the stream, and developers for culverting the stream in several locations. Lynn also blamed residents for polluting the creek, including by draining their car oil onto the street, which empties into the gutters and eventually the creek (Lynn 1969).

Local committees (meso-level elements) proposed actions to improve the creek and its steelhead habitat, including controlling erosion, reducing sewage entering the creek, and increasing resident awareness of the direction connection between the storm drains and the creek (Pacifica Tribune 1969). The new Parks, Beach and Recreation Department Director, Bob Toole, also expressed his dismay at the degraded state of the creek and sought proposals from the Parks, Beach and Recreation Commission (Lynn 1969).

At the request of the Pacifica Creek Protection Committee, on February 14, 1972 the city council approved the development of a plan to preserve San Pedro Creek (San Pedro Creek Master Plan Committee 1974, 1). The San Pedro Creek Master Plan Committee, a citizens committee, began working with the Parks, Beach & Recreation Commission to develop a plan to preserve and protect the creek, and in particular the steelhead trout (San Pedro Creek Master Plan Committee 1974). The Pacifica Creek Protection Committee involved the public in the process on June 8, 1972, and subsequently many other groups became involved, such as the North Coast County Water District, Ecology Action, area high schools and academic specialists (San Pedro Creek Master Plan Committee 1974, 1).

The San Pedro Creek Master Plan Committee as well as individuals and other groups supporting environmental protection began to influence the city's view of the creek. Before the October 1972 flood one city official, City Manager Jim Swayne, proposed building a drainage system under Linda Mar to supplement the drainage function of the creek and allow the creek to remain natural (Pacifica Tribune 1972c). After the 1972 flood Acting City Manager Dwight French described the creek as having two incompatible purposes: one as a scenic asset and one as a drainage channel during floods (Galstan 1972). French proposed two alternate solutions to address this incompatibility: 1) regrade and raise the creek banks, or 2) construct an additional drainage pipe (Galstan 1972, 2).

During the 1972 flood the main storm sewers were overwhelmed by the high volume of water, pushing water into the sanitary sewers, which then overflowed and caused sewage to flow into San Pedro Creek (McNally 1972). Shortly following the flood, Elden Dallanina, chair of the Pacifica Creek Protection Committee, raised the issue with the State Water Quality Control Board (McNally 1972). Dallanina expressed concern that while people are trying to clean up the creek, the city was dumping sewage into it (McNally 1972). Although the city anticipated that improvements in the sewer system would help correct the problem, it admitted that in order to solve the problem a larger main sewer line was needed (McNally 1972).

The 1972 flood undoubtedly influenced the ***San Pedro Creek Master Plan***, adopted June 19, 1973 (San Pedro Creek Master Plan Committee 1974). The master plan provided suggestions for addressing erosion, pollution, and flooding, including a public education program on the impacts of pollution on the creek and the steelhead. For flood control the plan advocated an "underground by-pass system," which would leave the existing stream channel in place, and denounced any ideas to culvert the stream channel or line it with concrete (San Pedro Creek Master Plan Committee 1974, 9).

The shift from viewing the creek solely as a drainage channel and flood hazard to incorporate the creek as a natural environment and asset originated with the macro-level environmental movement. The environmental movement influenced micro- and meso-level elements, including residents and organizations, who influenced other micro- and meso-level elements, including the city staff who determined objectives and methods of flood control (Figure 3).

<u>Flood of 1972</u>

In response to the 1972 flood, the city (city staff or the city council) initiated a flood control project and requested help from the Corps in January 1973 (USACE and City 1998a). Regardless of any objectives put forth by the city (meso-level element), policies at the Corps (meso-level influences) constrained the options for the flood control project. These policies included ensuring that the economic benefits exceeded the economic costs and that any project provided 100-year flood protection (Galal 2003). A citizens committee (meso-level element) appointed by the city council (meso-level element) worked together with the Corps (meso-level element) on a Section 205 flood control study, studying several alternatives. The alternatives considered reflect the Corps' continued reliance on traditional structural flood control methods (meso-level influences), including a reservoir, concrete or rock lining of the channel, an underground bypass, bridge replacement, and a floodwall (Appendix A). The Corps determined that the "economically justified" alternatives were the Trapezoidal Rock-Lined Channel Modification, the Floodwall and Floodplain Modification, and the Levee and Bypass Channel Modification (USACE 1988, 7). From these three, the citizens committee selected the Floodwall and Floodplain Modification as their preferred alternative (USACE and City 1998a). The committee's preference for one of the few alternatives that would not alter the stream channel undoubtedly reflected the increased desire to protect the creek expressed by residents (micro-level elements).

The citizens committee worked with the Corps on this flood control study through 1975 (USACE and City 1998a, 10-1). Early in 1976 the city council declared that funds would not be available for the city's entire share of the flood control project (SPFCC 1985, 10), and work on the project stopped (USACE and City 1998a, 2). The environmental movement (macro-level element) and more specifically work by the Pacifica Creek Protection Committee and the San Pedro Creek Master Plan Committee (meso-level elements) likely influenced public sentiment about the flood control project. This public sentiment probably impacted the city's willingness and ability to seek funding for the project (meso-level influence). Scott Holmes later credited environmentalists (micro- and meso-level elements) with blocking the flood control project (Holmes 2003b).

With the advent of the environmental movement and by involving the Corps in the hazard response, the objectives of the project began to broaden and the number of elements linked together in the response following the 1972 flood increased substantially (Figure 3).

Flood of 1982

After the 1982 flood the city council proposed another citizens flood control committee, whose objective was to "develop a proposed flood and erosion control improvement plan(s) for the lower Linda Mar area with a recommended method of financing that is economically feasible for the city to attempt to implement in the near future" (SPFCC 1985, Appendix E). Although the objective of the flood control project as set out by the city council was primarily flood control, as planning for the project progressed the committee and city staff broadened the objectives to accommodate the influences of other elements.

The flood control committee met for the first time in June 1984 (LLMAFCIC 1984a). Within the first five months, the committee reviewed the Corps' 1975 flood control study report, conducted a walking tour of the creek, and started developing matrices for structural flood solutions, non-structural flood solutions, and funding strategies (LLMAFCIC 1984b; LLMAFCIC 1984c; SPFCC 1984a; SPFCC 1984b). The committee initially focused on the work done by the previous committee in the 1970s and their solution, the floodwall/floodplain plan, which involved a concrete floodwall along the north side of the creek up to Peralta (Hall 2003).

As work progressed other elements influenced the committee, city council, and city staff and their objectives for the flood control project. The committee and city staff involved other agencies in the planning process such as the California Department of Fish and Game (CDFG). Dennis Eimoto from the CDFG expressed his agency's preference to protect the fish and vegetation in the project area by keeping the stream natural (SPFCC 1984c). City representative on the project Mike Randolph (meso-level element) and members of the committee learned about the Upper Penitencia Creek Flood Plain Management Study in San Jose, which proposed building an overflow channel adjacent to an existing stream channel to keep the stream as natural as possible (Randolph 1984b).

Philip Williams & Associates, a hydraulic engineering and environmental hydrology firm, also influenced city staff and the committee with its report on the 1982 flooding and the flood hazard (LLMAFCIC 1985) (Vandivere 1985). As part of its hydraulic analysis, Philip Williams & Associates proposed several solutions to the flood problem, most of which were similar to proposals studied after the 1972 flood, including levees, a floodplain, bridge replacement, detention basins, and channel maintenance (Appendix B). Philip Williams & Associates recommended several methods in combination to provide 100-year flood protection: increasing stream capacity, building a new floodway, and replacing the Highway One Bridge (Vandivere 1985). When committee member Gil Anda questioned Bill Vandivere from Philip Williams & Associates about the possibility of building a wall on the north side of the creek, Vandivere noted that the wall would have to be high and additional storage capacity would still be needed (LLMAFCIC 1985). Philip Williams & Associates validated many of the solutions previously explored by the Corps and citizens committees.

By late May 1985 the flood control committee presented the Pacifica City Council with their report: ***Report No. 1: Feasibility and Recommendation*** (SPFCC 1985). Their report detailed the general causes of flooding, the structural and non-structural solutions considered, the potential sources of funding, and the committee's recommended solutions (SPFCC 1985). The structural solutions considered by the committee included variations of channelizing or bedlining portions of the creek, enhancing the berm on the north bank, excavating the south bank, replacing bridges, and diverting water into a separate channel (Appendix C) (SPFCC 1985, Appendix A). The non-structural solutions included removing vegetation from the riparian area and creating a floodplain (Appendix C) (SPFCC 1985, Appendix A).

Although the solutions the committee studied included many structural options that would require modifications to the stream channel, the committee recommended options that were noticeably less damaging to the stream channel. The committee recommended a solution (structural solution 9A) combining several structural and non-structural options, which focused on increasing channel capacity downstream of Peralta, in part by utilizing the land south of the creek between Peralta and Highway One for a floodplain (SPFCC 1985). In addition, the committee recommended replacing the Highway One Bridge, enhancing berms and levees on the north side of the creek, and creating a diversion channel (structural options 7, 8, 9A, and 10, and non-structural options # 3 and # 4) (SPFCC 1985). The committee's goals in selecting these options were to increase the channel capacity and create a floodplain for high flow events (SPFCC 1985). The committee estimated that a flood control project with a combination of the proposed solutions would cost between $450,000-$3,050,000 (SPFCC 1985, 11). This committee's recommendations reflected not only the influences of traditional flood control methods but also of newer approaches to flood control, including a diversion channel, due to the continued desire to preserve the creek.

The committee noted that funding the flood control project was likely to be challenging due to a shift by federal sources (meso-level elements) away from funding flood control projects with structural solutions (SPFCC 1985). The committee proposed pursuing funding from the Corps and the Soil Conservation Service (meso-level elements); however, it expected that the city council (meso-level element) and/or city residents (micro-level elements) would be the primary source of funds given the unreliability of the potential outside sources (SPFCC 1985). Local funding sources recommended by the committee were a citywide special levy, a citywide drainage utility, and/or a benefit assessment district (SPFCC 1985, 12). The city council supported the committee's work and approved plans to provide $200,000 toward an Environmental Impact Report (EIR) and preliminary project design to be developed by a consulting firm, and $3.15 million for 1987-88 to complete the design and construct the project (Verdeckberg 1985, 16A).

Mike Randolph initially hesitated in contacting the Corps, because the city had been unable to secure the local share of funding for the flood control project started in the 1970s; however, at the committee's urging Randolph conceded to contact the Corps (Hall 2003). The mayor contacted the Corps about starting another Section 205 flood control study in June 1985, and a partnership was subsequently initiated between the Corps and the city (Hall 2003; USACE and City 1998a). As mentioned previously working with the Corps provided an opportunity for federal funding; however, it also placed additional constraints on the flood control possibilities.

In the report on their initial reconnaissance study published in 1988, the Corps identified the planning objectives for the project as addressing the flood problem and improving the south bank area to allow for recreation (USACE 1988, 4). Additional constraints on the Corps not previously mentioned include the need to mitigate any impacts increasing erosion and to minimize any negative effects on the existing natural environment (USACE 1988, 4). Although the Corps must mitigate impacts of the project on erosion, it was not authorized to work on reducing existing erosion problems (USACE 1988).

Despite the failure to implement the post-1972 flood control project, in part due to environmental concerns, the Corps initially studied two plans from that flood control project, the Floodwall and Floodplain Plan and the Levee and Bypass Channel Plan (USACE 1988). The Floodwall and Floodplain Plan included a concrete floodwall on the north bank, levees surrounding the convalescent hospital and San Pedro Terrace Road, riprap in the channel around the Highway One Bridge, a floodplain on the south side with some small vegetation, and new bridges at Adobe and Peralta (Map 5) (USACE 1988). The Levee and Bypass Plan included a 7-foot deep earthen trapezoidal bypass channel from below the convalescent home to Highway One, and levee along the north bank, and riprap in the channel around the Highway One Bridge (USACE 1988). After the USFWS expressed concerns about potential habitat loss in the Levee and Bypass Plan, the Corps created a new variation called the Bypass Channel Plan (USACE 1988). In addition to the changes in the Levee and Bypass Plan, the Bypass Channel Plan included replacement of the Highway One Bridge, which reduced the size of the bypass channel and the length of the levee on the north bank (Map 6) (USACE 1988).

The Corps concluded in their reconnaissance report that both the Floodwall and Floodplain Plan and the Bypass Channel Plan were “economically justified,” and that a feasibility study should be initiated (USACE 1988, 29). The Floodwall and Floodplain Plan would be the “most cost effective plan” providing protection for up to 100-year floods, while the Bypass Channel Plan would not only provide 100-year flood protection, but would also be "a less environmentally damaging alternative" (USACE 1988, 29).

As the Corps began its feasibility study, some residents (micro-level elements) and organizations (meso-level elements) expressed their dissatisfaction with the proposed solutions, calling for solutions that were more environmentally friendly to protect the fish and the creek banks. The Central Coast Conservation Center (CCCC) was conducting a study of its own to develop an ecologically sound, non-structural plan for San Pedro Creek (Pacifica Tribune 1989). The CCCC study was supported by a grant from the State Department of Water Resources (Pacifica Tribune 1989).

As part of its feasibility study, the Corps (meso-level element) held a joint public hearing with the city (meso-level element) in February 1989, where micro-level residents voiced their concerns about the project. Up until this public hearing, most homeowners were not active in the planning process despite the committee's attempts to get them involved; however, with this hearing homeowners started becoming more vocal (Hall 2003). Micro-level residents brought up many different issues with the representatives from the meso-level Corps and city, including the lack of notification to the community about the public hearing, negative experiences working with the Corps in the past, and a lack of consensus within the community about the value of the flood control project (Larsen 1989). Residents also expressed different concerns about the project, including a desire to protect the natural environment, prevent intrusion on private property rights, and receive compensation for negative impacts on private property (Larsen 1989). Bill Brick from the Corps addressed a concern about the impacts of a concrete solution on the environment, but noted concrete allows water to move at higher velocities (Larsen 1989). Linda Mar resident Todd Greene attended either the joint Corps-city public hearing or another flood committee meeting around this time and was alarmed with the proposal to put a 4-5 foot high concrete wall through his backyard, which bordered the creek (Greene 2004). Greene quickly united DeSolo Drive and Flores Drive residents who would be affected by the wall in a homeowners' association, and they presented the city council with a petition against the floodwall (Greene 2004). The committee was frustrated with receiving negative feedback from the public at this point in the process, since the public was given previous opportunities to get involved in the past few years (Hall 2003). Despite its frustrations the committee (meso-level element) worked with these homeowners (micro-level elements), and Todd Greene and another resident Joe Parris eventually joined the committee (Hall 2003).

With many different people voicing various opinions about the flood control project and some expressing strong opposition to the floodwall and even potential litigation, the project was at an impasse. Shortly after the public hearing, ***Pacifica Tribune*** columnist Paul Azevedo (1989) expressed his disapproval of putting the creek in a concrete channel or culvert, as was done with the Los Angeles River, and noted that many people already helped protect the creek and regarded it as an asset. However, Azevedo also advocated that a balance be struck between flood and erosion control and maintaining the natural environment of San Pedro Creek (Azevedo 1989). The person who would help find just such a balance between the different interests was Scott Holmes.

Although Scott Holmes did not officially take over as staff liaison to the flood control committee until late in 1990 (SPFCC 1990a), he started working on the project in 1989, brought onto the project by his boss at the Sewer Department to get the project moving again by developing alternatives to the "hard engineering solution" (Holmes 2003b). As became quickly apparent, although Holmes acted in a meso-level role for the city, his individual values and experiences (i.e. Holmes as a micro-level element) significantly influenced how he carried out this meso-level role. Holmes, who is a self-described environmentalist with hydraulic knowledge, started working on a new alternative, the Wetlands/Marsh Plan (Holmes 2003b). For help with the wetlands portion of the project, Holmes turned to Mike Vasey, a biologist at San Francisco State University (SFSU), and Dr. Peggy Fiedler, a botanist then at SFSU (Holmes 2003b). Fiedler, Vasey, and Holmes together developed a new "restorative approach" to the flood control project (Holmes 2003b).

As Holmes worked on the new plan, the next major influence and challenge for the flood control project surfaced when the USFWS (meso-level element) provided their preliminary Habitat Evaluation Plan (HEP) on July 17, 1990 (City of Pacifica 1990). In the HEP the USFWS indicated that substantial mitigation would be required for the proposed flood control project alternatives: the Bypass Channel Plan, the Floodwall Floodway Plan, and the new Wetlands/Marsh Plan (City of Pacifica 1990). This mitigation would greatly reduce the economic feasibility of the alternatives (City of Pacifica 1990), as well as decrease support for the flood control project, especially if mitigation was required outside of San Pedro Valley as was proposed (Hall 2003).

In fall 1990 details emerged on the new Wetlands/Marsh Plan, which was soon renamed the Diversion Marsh (or Marsh Diversion) Alternative (City of Pacifica 1990). The plan consisted of three major components: a diversion structure at Adobe Bridge; a diversion pipeline traveling from the Adobe Bridge down Silvia Court, Bower Road, and San Pedro Terrace Road; and a new marsh west of the convalescent hospital where the pipeline would drain (Map 7) (Holmes 1990). The plan eliminated the north floodwall of the former Floodwall and Floodplain Plan, and although it was replaced with a lower earthen berm, the plan provided a compromise between the concerns of the residents for their backyards with the concerns of the Corps for a barrier to keep the water in the new wetlands or floodplain area (Hall 2003). The greatest advantage of the Marsh Diversion Plan was the lack of new structures in the streambed, due to the addition of the diversion pipe, thereby reducing the environmental impacts and likely eliminating the HEP mitigation requirements (Holmes 1990). Scott Holmes cited many other environmentally friendly benefits of the Marsh Diversion Plan, including water quality improvement in the stream due to the diversion of some runoff to the marsh, and creation of a pool near the mouth of the stream to act as a holding area for steelhead returning to the creek to spawn (Holmes 1990).

The committee, city council, and many residents supported the new plan or alternative, so the city council asked the Corps to include the new alternative in the Section 205 flood control study (Curtis 1990a; SPFCC and City Council 1990). Many different meso- and micro-level elements provided their comments and analysis to Scott Holmes and the Corps, influencing them as they developed the details of the Marsh Diversion Alternative. In January 1991 the Corps advised city staff that based on its hydraulic analysis of the new plan, the Marsh Diversion Alternative was feasible with some design modifications (SPFCC 1991a). In April 1991 the USFWS responded positively to the plan; however, it did have a few initial concerns about preventing steelhead from entering the marsh area, maintaining a natural riparian habitat, and allowing for diversity of species in the design (Holmes 1991a). After the USFWS provided this feedback, Scott Holmes began working with biologist Dr. Peggy Fiedler to develop a preliminary marsh design, which would take into consideration the concerns expressed by the USFWS (Holmes 1991a). Many residents expressed their support of the Marsh Diversion Alternative, including homeowner Todd Greene (Curtis 1990b). Although, the committee expected that residents along the route of the proposed diversion pipe might raise some concerns (SPFCC 1990b).

Although the Marsh Diversion Plan was receiving broad support, the city still needed to find funding for its half of the estimated $8.2 million for the project (Curtis

1991a; Curtis 1991b). Possible sources of funding available to the city included the California Department of Water Resources, which previously provided significant funding to local sponsors of federal projects (Curtis 1991a). City staff and the committee also proposed a special assessment district to help fund the project (SPFCC 1991b). The special assessment district would require micro-level floodplain residents to contribute toward the project for 10 to 15 years; the specific amount could be $300 or more per year depending upon any other funding the city provided (Curtis 1991b). Residents rallied around the Marsh Diversion Plan, attending meetings and writing Letters to the Editor, and together with the committee and city staff called on the city council to provide a $300,000 loan to keep the project moving forward.

The city council approved the $300,000 loan and began pursuing a special assessment district (Larsen 1991). Although many residents supported the special assessment district, some were opposed to singling out the homeowners on the floodplain to pay for the project and asked that the entire city pay (Larroche 1991). Undoubtedly partly as a result of the micro-level opposition to the special assessment district, the committee and Scott Holmes continued to pursue additional funding from meso-level sources, such as the State Water Resources Control Board, the Water Quality Board, the Coastal Conservancy and the Resources Agency of California (SPFCC 1991c; Curtis 1992; SPFCC 1992c; Holmes 1992d). City Manager Daniel Pincetich even asked State Senator Quentin Kopp and Assemblywoman Jackie Speier to pressure the State Water Resources Control Board to increase its priority for funding the project (Pincetich 1992a; Pincetich 1992b).

In 1993 city staff officially contracted with L.C. Lee & Associates, an environmental restoration consulting firm that Peggy Fiedler had been working with, for the design of the stream and wetlands restoration (LCLA 1995). In choosing to contract with an environmental restoration firm, city staff (i.e. Scott Holmes – a micro-level element acting in a meso-level role) influenced the design of the project and further emphasized environmental restoration as part of the project. In fact, the primary goals of the project that LCLA designed for included flood control for Linda Mar, wetland restoration, and habitat enhancement for steelhead (LCLA 1995). These goals make it clear that the objectives of the project had broadened since the city proposed the committee's goals in 1982 as finding a solution to the flood problem and the means to finance it. Now the goals of the project, as presented by LCLA, were to not only provide flood control in an environmentally friendly way, but also to restore habitat. For these restoration efforts the city and LCLA received a $100,000 grant from the California Coastal Conservancy in October 1993 (LCLA 1995). Committee member Patrick Hall later credited LCLA with enlightening the committee to the potential benefits of the project to fish and wildlife habitat, instead of just creating a floodplain (Hall 2003). Here the meso-level LCLA influenced the objectives of the project by influencing the meso-level committee.

The Marsh Diversion Plan received additional support in 1995 from the CDFG, because the plan would result in a net increase of wetlands and riparian habitat and the project's "methods support the Department's mandate to protect, maintain, and enhance habitat values" (Anderson 1995). Patricia Anderson, Area Fishery Biologist with the CDFG, stated, "it is refreshing to be involved with flood control projects of this nature" (Anderson 1995).

In 1995 city staff and LCLA began addressing federal and state requirements (meso-level influences) surrounding any threatened or endangered species, which might be in the project area and have an impact on the project. They consulted with the USFWS and the CDFG on species to look for in the study area falling under the Endangered Species Act (LCLA 1995). The CDFG advised city staff to complete surveys of plants and animals with a special status, including "the San Francisco Garter Snake, Red-legged Frog, Western Pond Turtle, and Steelhead" (Anderson 1995). Steelhead were commonly found in San Pedro Creek, and Peggy Fiedler later discovered a Red-legged Frog in the study area during a survey, prompting additional requirements.

In designing the restoration plan LCLA developed a "hydrogeomorphic approach" relying on reference data they established for the region on wetland functions (LCLA 1995). The Endangered Species Act also influenced their design, which in their 1995 report LCLA noted would enhance the steelhead habitat, and make provisions for migratory waterfowl, the San Francisco Garter Snake (federally endangered) and the California Red-Legged Frog (proposed endangered) as necessary (LCLA 1995).

In 1995 the Corps also began work on the required Environmental Impact Report/Statement (EIR/S), a combined state EIR and federal EIS, for the preferred alternative, now called the Wetland Bypass Plan. The EIR/S study identifies impacts of the project on the environment, including water quality, air quality, wildlife, threatened and endangered species, and public safety (USACE 1995). The study also allows the public to provide their feedback on the project (USACE 1995).

During the EIR/S process many different meso-level organizations as well as micro-level residents provided their comments on the project, further influencing the objectives and methods of the project. The Environmental Protection Agency (EPA) provided recommendations for addressing impacts to water resources, air quality, and natural habitat (Farrel 1995). The Historical Resources Information System noted a requirement to assess the area for historic and archaeological sites (Jordan 1995). The California Coastal Commission required that the EIR/S address the impacts of the project on the coastal zone and watershed and provide wetlands monitoring requirements (Delaplaine 1995; Muth 1996). The Sierra Club and the National Wildlife Federation provided their support of the project as a result of its environmental benefits (Larsen 1996a). The National Oceanic Atmospheric Administration (NOAA) reported that the National Marine Fisheries Service Southwest Division supported the plan and emphasized the importance of building a stable stream channel to protect the fish and wildlife (Wieting 1996).

After the USFWS expressed a concern in 1996 that it had not yet been consulted on the newly listed threatened California Red-legged Frog (Medlin 1996), the CDFG, the Corps, the city, and LCLA began to work with the USFWS on this issue to determine the impacts of the project on the red-legged frog. The USFWS would then detail any impacts on the red-legged frog that would need to be mitigated in a Coordination Act Report (CAR). The CAR uses the analysis from the HEP to determine mitigation measures required for a project (USACE and City 1998a).

The Corps and the city held public meetings in 1995 and 1996 as part of the EIR/S process where residents expressed many different concerns about the project. The concerns of the micro-level residents included bank erosion, steelhead getting stuck in the wetlands after high water, mosquito problems due to standing water, alternative routes for the diversion pipeline, debris clogging the pipeline, and impact of the construction on residents - specifically safety issues, dust levels, access to the Linda Mar Health Care and Rehabilitation Center, property values, and other inconveniences (USACE and City 1998a, 1-2 to 1-3). Although city staff and the Corps' representatives tried to minimize the residents' concerns, most concerns related to the project design were incorporated into the EIR/S. City staff and the Corps also responded that the affects of construction on residents would be minimized as much as possible.

Among the benefits of the Wetland Bypass Plan, the Corps' representatives at the public meetings cited not only reducing the flood hazard, but also enhancing the steelhead habitat, creating wetlands, and increasing the aesthetics of the area (USACE and City 1996). These benefits fit with the Corps' goals for 100-year flood protection and environmental restoration, as noted in the EIR/S (USACE and City 1996). This dramatic shift in the Corps' policy to include restoration as a goal of a flood control project was partly the result of NEPA (meso-level element influenced by macro-level environmental movement), which increased awareness and consideration of environmental impacts at the Corps (Galal 2003). Although slow to get going since 1969, NEPA initiated change at the Corps by requiring projects to produce an EIS, mitigate for any destroyed habitat, and notify the public, who often got involved in the projects (Galal 2003). In addition, environmentalists (micro-level elements influenced by macro-level environmental movement) moving into the Corps helped shift the Corps' policy (meso-level element), so that around 1990 the Corps' projects started to become environmentally aware and incorporate restoration (Holmes 2003b). However, this shift toward restoration was not yet universal throughout the Corps. Specifically for the San Pedro Creek Flood Control Project, Holmes worked with the Corps for several years before a project manager from the Corps who was interested in a "restorative approach" to flood control was assigned to the project (Holmes 2003b). This provides another example of the potential impact of an individual on the meso-level element they represent, based on the individual's values and goals. In the final detailed project report the Corps' objectives of the project were described as solving the flooding problem while maximizing economic benefits and minimizing any negative environmental impacts (USACE and City 1998a), while the city's objectives also included restoring a rare tidally influenced wetland, improving steelhead habitat, and providing habitat beneficial to the threatened and endangered species in the area (USACE and City 1998a). The city's objectives had also broadened greatly from the objectives first set forth for the post-1982 flood control committee to find an economically viable solution to the flood problem.

In January 1998 after over 12 years of planning, revisions, and more of the same, the Corps and the City of Pacifica published the final detailed project report and final EIR/S (USACE and City 1998a). The report identified the Wetland with Larger Bypass Culvert Plan, a variation of the Wetland Bypass Plan, as the recommended plan (Map 7). The Corps estimated the cost of the plan at $12,166,000 (USACE and City 1998a).

The city's and the committee's attempts to find additional funding were ongoing throughout the planning process. The mayor called on U.S. Representative Tom Lantos (D-San Mateo) to obtain federal funds for the project (Larsen 1996a). Lantos testified before the House Appropriations Subcommittee on Energy and Water Development, requesting $4.1 million for the project (Larsen 1996a). Shortly thereafter the project received $220,000 from federal sources (Larsen 1996b). In 1998 the committee sought a grant from the California Coastal Conservancy (Larsen 1998b). Finally by January 2000 the funding logistics for the project were resolved, with city staff (i.e. Scott

Holmes) expecting to fund the city's portion through grants and sale of materials to the contractor (City of Pacifica 2000).

In addition to procuring funding, another significant complication of the project and more specifically the Marsh Diversion (or Wetland Bypass) Plan was that Caltrans owned the land required for the wetlands area. Without the Caltrans land the entire project was in jeopardy. City staff first formally requested that Caltrans transfer their land over to the city in July 1991 (Holmes 1991b). Caltrans was holding on to the land as part of the Devil's Slide Bypass project (Holmes 1991b). In 1994 Caltrans still retained the land, and was requesting mitigation credits for the project's net gain in wetlands before transferring the land to the city (Browne 1994). City staff and the committee worked with Assemblyman Lou Papan in 1998 on legislation to transfer the Caltrans land to the city (Larsen 1998b). The legislation passed in September 1998 and the city finally obtained the Caltrans land (SPCFCC 1998).

Throughout the planning process of the San Pedro Creek Flood Control Project, many different elements influenced the project's objectives and proposed methods, as determined by meso-level elements (primarily city staff, the city council, the committee, and the Corps). The influence of these various elements shifted the objectives and methods over time. After the 1962 flood the city council, city staff, and committee considered structural changes to the drainage systems, including the creek, and city staff even lined the stream near Capistrano. By the 1972 flood the environmental movement (macro-level element) had increased the desire of many residents and community members (micro-level elements) to protect San Pedro Creek, and the committee (meso-level element) looking into flood control with the Corps (meso-level element) recommended a solution that was less harmful to the environment than the other proposed solutions. After the 1982 flood city staff, the committee, and the Corps began to explore a broader range of flood control methods, in order to address the many different concerns and requirements relating to the project. These concerns and requirements from residents (micro-level elements) and organizations (meso-level elements) included protecting San Pedro Creek, private property rights, steelhead trout, and the California Red-legged Frog. Scott Holmes (meso-level element) provided significant direction on the project, finding a solution that incorporated these many concerns, and helped to procure the necessary funding for the city's share largely through grants. Although Scott Holmes acted on behalf of the city in a meso-level role, his individual goals, values, and experiences influenced his development of an environmentally friendly plan using non-traditional flood control methods. Looking at how the project's objectives and methods changed reveals not only the large number of people, policies, and organizations involved in a flood control project, but also the potential influence of just a few individuals in determining the fate of a project. Figure 4 displays the key elements and complicated linkages in the response following the 1982 flood. If a linkage between many of the elements had been broken, the project may have stalled indefinitely.

CHAPTER 5

IMPEDIMENTS TO THE PLANNING PROCESS

Several issues repeatedly frustrated meso- and micro-level elements in the San Pedro Creek Flood Control Project: a lack of communication and a cumbersome planning process. Both of these issues derive from complications created by a break in a linkage between elements and/or by the large number of linkages (Figure 4). Given the many linkages between elements at all levels, opportunities existed for linkages to break down and impede the planning process. In addition, each linkage brings with it more policies and procedures that further complicate the planning process. Understanding the linkages, where they break down, and how this affects the ability of meso- and micro-level decision makers to respond to a hazard, provides an opportunity to improve these linkages for future responses, facilitating better communication and a more efficient planning process.

Communication Issues

While sometimes perhaps intentional and other times unintentional, communication gaps between elements often resulted in delays in the planning process. Many times during the planning process residents (micro-level elements) expressed frustration with city staff (meso-level element) for not communicating the details of the project to them. The cause of this communication break partly stems from city staff using the local newspaper, the ***Pacifica Tribune***, as the primary tool to communicate with residents at large about the flood control project. Occasional updates on the project were published in the ***Pacifica Tribune***, but if a resident did not read the newspaper they might know little to nothing about the project. Notices of upcoming flood control committee meetings and public hearings were also announced in the ***Pacifica Tribune***, but again if a resident did not read the newspaper, they likely did not know about the meetings and missed these opportunities to get more information on the project. By indirectly communicating with micro-level residents through the newspaper, communication from city staff was also limited by the newspaper staff (meso-level element), who had ultimate control over the content of the communication. A related complication is that even if residents knew of the weeknight meetings, they may have been unable to attend. The meeting time points to a macro-level influence, the socio-economic assumption that most people work during the day, so the best time to hold a meeting to reach most of the public is in the evening.

Differences of opinion developed at several points between the committee (meso-level element) and the city's project representative (meso-level element) regarding communicating with and seeking additional involvement from residents (micro-level elements). Early in the planning process following the 1982 flood and after the committee had accumulated enough information to start narrowing down its recommendations, committee member Patrick Hall proposed to Mike Randolph that they involve members of the public in the project within a few months (Randolph 1984a). Randolph acknowledged the potential benefits of meeting with small groups of residents and area business owners, but countered that the city would prefer to wait until they were ready for a public meeting in a larger forum such as a city council meeting to maximize public involvement (Randolph 1984a). Randolph also later cited the Upper Penitencia Creek Flood Plain Management Study in San Jose as an example of a project that narrowed down the options to one solution before presenting it to the public for discussion (LLMAFCIC 1984d).

Tensions developed between the committee and the city regarding repairs to a levee, when the city left the committee out of the planning process. In February 1986 storms damaged a levee on the north side of San Pedro Creek west of Highway One, which protected the Linda Mar Sanitary Sewer Pump Station (Renner 1986; USACE and City 1998a). Soon thereafter the Corps initiated a Section 14 Reconnaissance study to consider making emergency repairs to the levee (USACE and City 1998a). Although City Engineer Ernest Renner advised the flood control committee that the Corps planned to design repairs for the levee that would meet 100-year flood standards and that the committee would be provided with an opportunity to comment on the project (Renner 1986), neither city staff nor the Corps communicated further with the committee about this project. Soon after the work was completed in fall 1988 Patrick Hall expressed his frustration that city staff or the Corps had not notified the committee of the work being done west of Highway One and voiced his concern that the work might not be compatible with the committee's recommendations for the flood control project (Hall 1988). The lack of communication between city staff and the committee prompted Hall to call for a committee meeting (Hall 1988). Committee meetings apparently were the primary method of communication between city staff and the committee. The committee had been relatively inactive for the prior two years (Randolph 1988), meeting infrequently while the Corps worked on the reconnaissance study. By reinitiating committee meetings, the committee could better influence the actions of other meso-level elements, such as city staff and the Corps.

At a joint public hearing in February 1989 residents expressed a concern that the community was not notified about the meeting (Larsen 1989), although the meeting was announced in the ***Pacifica Tribune*** the week before the meeting. Linda Mar resident Todd Greene was alarmed to learn about the proposal to put a 4-5 foot concrete wall through his backyard, which neither he nor his neighbors had heard about previously (Greene 2004). In response Greene and his neighbors united in a homeowners' association to petition against the floodwall and temporarily stopped the planning process. In this case lack of communication with residents caused a delay in the process. As a result the flood control committee involved the homeowners' association in the planning process (Hall 2003), so that when Scott Holmes proposed the Marsh Diversion Plan, the homeowners along DeSolo and Flores Drives were kept informed of the details and ultimately expressed their support for the project. However, city staff did not keep the residents along the proposed diversion pipeline route informed about the plan, at least in the early stages. In fall 1990 the committee expressed the desire to get residents of Bower Road and Silvia Court involved in the discussion about the pipeline to keep the project moving; however, Scott Holmes asked that they wait until after the Corps determined if the new alternative was feasible (Curtis 1990c; Curtis 1990d). This provides another example of a difference in opinion between the committee and city staff in how and when to involve residents in the planning process. In addition, Holmes' desire to limit the dispersal of information to the micro-level residents may reflect a deliberate effort to provide residents with fewer opportunities to oppose the project or to influence the project in ways not amenable to the city staff and committee.

Several communication issues came to light at a public meeting held as part of the EIR/S process in 1996. The Corps and Scott Holmes provided details on the new Marsh Diversion Alternative and Lynne Galal, project manager from the Corps, advised those interested that copies of the draft EIR/S were available at the local library branches or by contacting her directly (USACE and City 1996, Appendix K). Again this information was perhaps most useful to residents who were unable to attend the meeting, who still would not know about the availability of this information in the library. At the same meeting residents again expressed concerns about being unaware of the details of the flood control project and not having been asked for their feedback (USACE and City 1996, Appendix K). Specifically related to concerns about residents receiving communication during construction, Scott Holmes responded that city staff would provide updates to residents via mail and notes on their doors (USACE and City 1996, Appendix K).

As the project progressed communication from meso-level city staff to micro-level residents seems to have improved. Despite delays in the flood control project Scott Holmes and the committee tried to keep flooding on the minds of the residents and city staff. In October 1997 city officials staged a mock winter storm disaster, which was publicized in the ***Pacifica Tribune*** (Larsen 1997). Committee members mailed a letter and information pamphlet to residents in December 1997 advising them to be prepared for winter flooding given that the flood control project was not yet constructed (SPCFCC 1997). Scott Holmes occasionally sent out letters to residents providing them with updates, especially after a big event such as moving the creek to its new channel in December 2002 (Holmes 2002). However, as will be discussed in the next chapter, after the final plan was published and the project moved to the implementation phase, Scott Holmes and the Corps removed the diversion pipe from the project, apparently without widely publicizing the change.

Cumbersome Planning Process

Communication problems as well as the large number of elements involved in the flood control project led to a slow and cumbersome planning process. Planning for the project after the 1982 flood started off very quickly; however, progress soon slowed to a frustrating pace. The post-1982 flood control committee (meso-level element) completed its first report providing recommended solutions in May 1985, just 11 months after starting its task. Shortly thereafter the Corps (meso-level element) started a Section 205 flood control study and the momentum of the project slowed down. The city involved the Corps to gain funding and expertise for the project, but in return the logistics of the project became more complicated. The Corps requires numerous studies or phases be completed when it evaluates and plans a flood control project, and these steps can each take a year or more to complete, making the process lengthy and cumbersome. The reconnaissance study alone generally requires one year to complete and determines the scope of the problem, develops the possible solutions or alternatives, performs a cost/benefit analysis, and reduces the alternatives to those that are most feasible in order to determine if the Corps should participate in the flood control study (USACE and City 1996, Appendix K; USACE 1988). The Corps' conclusions also take into consideration whether or not the local sponsor expects to have the required funds for its share of the project (USACE 1988). During the next phase, the feasibility study, which can take up to three years, the most feasible alternatives are studied in depth to determine the recommended alternative (USACE and City 1996, Appendix K).

The Corps worked on the reconnaissance study starting summer 1985 and discussed their work to date at a public review meeting in March 1986; however, the final reconnaissance report was not published until summer 1988. The first phase of the flood control study, which usually required about one year, had taken three years.

The Corps initiated the feasibility study in 1989 (USACE and City 1998a); however, public feedback against the proposed floodwall in the Floodwall and Floodplain

Plan quickly brought the project to a halt. When Scott Holmes proposed the new Marsh Diversion Alternative, the Corps was required to perform the same reconnaissance study on it as it had on the other alternatives.

After 6 years the flood control project was still in the early planning stages and several people (individuals acting in meso-level roles) had moved on to other jobs or projects. The length of the process was clearly becoming a detriment as city staff retired and committee members resigned, taking with them their knowledge of the project. The individuals acting in meso-level roles influence the meso-level element they represent, so changing the individual in the role also alters the meso-level element. Scott Holmes was already in place as the city's new representative for the project when Mike Randolph and Ernie Renner resigned from their positions in 1990, and he injected new ideas into the project. However, the city still had to appoint new committee members from time to time, who along with any new staff at the Corps would require time to get up to speed.

Some residents (micro-level elements) also began to get impatient with the length of the process, especially as the 10-year anniversary of the 1982 flood approached (Pacifica Tribune 1991; Curtis 1991b). They took it on themselves to go out into their neighborhood to get other residents involved and called for a meeting (Curtis 1991b). The flood control committee held a meeting for the residents in April 1991 and discussed the need for funding, which it proposed be provided with a special assessment district and asked residents for their support in securing funding from the city council (Curtis 1991b).

By July 1991 the Corps advised city staff that a cost/benefit analysis of the new alternative suggested that benefits would greatly increase with the new alternative (Holmes 1991b), and the project moved forward. However, in January 1992 a reorganization at the Corps created the new Real Estate department with a new process required for flood control projects (SPFCC 1992a). Frustrated by another delay at the Corps, Patrick Hall volunteered to write U.S. Congressman Tom Lantos (meso-level element) to ask for his assistance with the project (SPFCC 1992a). In August 1992 representatives from the Corps attended a committee meeting and the project seemed to be moving forward again (SPFCC 1992b; Holmes 1992a); however, in September staff turnover at the Corps again slowed down the process. Patrick Hall requested Tom Lantos' support in making this project a high priority at the Corps (Hall 1992), and Scott Holmes asked the current and former mayors (meso-level elements) to also contact Lantos and State Assemblywoman Jackie Speier (meso-level elements) for their help (Holmes 1992b; Holmes 1992c).

In response to a letter from Lantos, Lieutenant Colonel Leonard Cardoza from the Corps updated Lantos in November 1992 on the Corps' work to date (Cardoza 1992). Cardoza defended the Corps, noting the many steps to the Corps' planning process. He detailed the work already completed by the Corps, including a hydraulic analysis on the new alternative, and work in progress or soon to follow, including a real estate analysis, detailed cost estimates, and a cost/benefit analysis. After the Corps completed this work, they would determine the economically justified alternatives and, if the city was still interested in pursuing the project, create a new Feasibility Cost Sharing Agreement (Cardoza 1992).

In 1993 the city and the Corps developed a new Feasibility Cost Sharing Agreement and the Corps continued to move forward on the feasibility study (USACE and City 1998a). Between 1993 and 1995 the Corps identified the Wetland Bypass Plan as its selected plan and moved on to study it as part of the EIR/S process. Issues discovered during the EIR/S process delayed the Corps final plan. Among these issues was the need to consider the effects of the project on the California Red-legged Frog and incorporate them into the Coordination Act Report (CAR) required by the USFWS (meso-level element). The USFWS completed the CAR in April 1997, which determined that no mitigation measures were required for the project since it provided a net gain in habitat (USFWS 1997). The CAR recommended measures to minimize the impacts of the project, mostly to the steelhead trout, including avoiding construction in the channel during spawning season (January-June), designing the bypass to limit injury to fish in or exiting the bypass, monitoring steelhead and riparian vegetation after construction, taking measures during construction to protect the red-legged frog, and improving the water quality of runoff entering San Pedro Creek in the area (USFWS 1997).

The Corps incorporated the recommendations of the CAR into the feasibility study, which was completed in late 1997 and published as part of the final detailed project report in January 1998. Instead of requiring three years, the feasibility study lasted approximately eight years. The total process of developing the detail plan required over 12 years.

Despite completion of the final detailed project report in January 1998, work on the project design continued into late fall 1999 (Hall 1999). Although LCLA had designed the wetlands restoration, the design of "the flood control system" and the diversion or bypass pipe was contracted to the engineering firm Moffatt and Nichol (City and USACE 2000). Moffatt and Nichol began work on the design only after completion of the final detailed project report.

Although often providing environmental protection measures or requiring public participation, the policies and procedures required when planning a flood control project significantly constrain the progress of the project. The Corps' policies and procedures alone were not the only cause of the slow and cumbersome process. Federal and state policies required the Corps and the city to coordinate the project with many different agencies, including the USFWS and the CDFG, which had their own requirements for the project. In addition, the Corps and other meso-level elements discovered issues requiring additional research as planning progressed, such as protection of the California Red-legged Frog. Elements at the micro level also slowed the project, including new representatives of a meso-level element or residents opposing the flood control plan.

Finding the means to address the policies and procedures as quickly as possible could help decrease the frustration by those elements involved in planning flood control. Likewise, the communication issues encountered during the planning process, demonstrate the need to get residents involved early in the process, so that they do not slow down the process when they do learn about a proposal late in the planning stages and oppose it. As with Todd Greene and other DeSolo Drive and Flores Drive residents, involving residents can bring to light any issues that will stop the project and initiate a search for alternatives. Finally, the city's and the committee's frustration with delays at the Corps may have been lessened if the Corps had communicated better with them to know that they were making progress on their study.

The many linkages generated in planning a flood control project complicate not only communication between elements but also the planning process. Understanding the policies and procedures of all linked elements would allow the decision makers in the meso-level roles to more efficiently plan a flood control project. Likewise, maintaining communication between all linked elements involved with the flood control project can decrease opposition to the project. Involving micro-level residents early in the planning process and keeping them involved may increase support for the project and decrease the likelihood that residents will try to stop the project later.

CHAPTER 6

INFLUENCE OF INDIVIDUAL ACTING IN MESO-LEVEL ROLE

Individuals acting in meso-level roles are pulled in one direction by their own values, ideas, and experiences and in another direction by the duties of the meso-level element they represent. This tension often modifies the response of the meso-level element. In the San Pedro Creek Flood Control Project, the influence of an individual on the meso-level element they represent has been most evident in the implementation phase, especially through Scott Holmes in his role working for the city.

As previously discussed many meso-level elements were influenced by the individual acting in the meso-level role. Scott Holmes, representative for the city, influenced the project by creating an innovative plan that included environmental restoration. He proposed a flood control plan that included environmental restoration, in part because he is an environmentalist and was open to non-traditional flood control methods. Holmes also worked with the Corps until they provided a representative amenable to environmental restoration along with flood control, who likewise altered the response from the meso-level Corps. Members of the flood control committee, several of whom had experienced repeated flooding of their homes, contacted politicians to request help funding the project or in moving it along at the Corps. California Assembly Member Lou Papan provides another example of a meso-level element choosing to act based on individual decisions when he sponsored legislation to deed the Caltrans land to the City of Pacifica. Several residents who were upset about the proposed floodwall later joined the meso-level citizens committee, altering its goals.

After years of developing the plan and getting approvals for the flood control project, city staff apparently removed implementation decisions from the public arena. Scott Holmes broke up the project implementation into phases to break up the funding requirements, so that funding would be required with each phase and not all at once, making it easier to obtain funding from the city council, grants, and the Corps (City of Pacifica 2000; Hall 2003). Breaking the project up into phases also allowed one phase of the project to move forward while the specifics were still being decided for another phase. As of January 2000 the project consisted of three phases. Phase I included restoration of the wetlands; Phases II and III continued wetlands restoration and included moving the stream into the new channel (City of Pacifica 2000). Public Works expected construction to begin on Phase I in May 2000 and last through June 2001 (City of Pacifica 2000).

Just one month later Scott Holmes reported that changes to Phases II and III might require a revised EIR, potentially delaying those phases by up to two years (SPCFCC 2000). These changes likely involved the underground bypass pipe, which the city (i.e. Holmes) and the Corps agreed to remove from the project by early 2000 (Lee and Fiedler 2000). After analyzing the pipe, the city (either Scott Holmes or significantly influenced by Holmes) and the Corps discovered that the cost to construct the pipe was far greater than the original estimate, perhaps as much as $20 million, in part due to the methods required to diffuse water pouring out of the pipe and into the wetlands (Galal 2003). To accommodate this change the city (again, likely Scott Holmes) and the Corps agreed to replace the Adobe Bridge and reduce the steep slope of the channel banks downstream of the Adobe Bridge (Lee and Fiedler 2000). Despite making significant changes to the plan, the representatives from the Corps and the city (i.e. Scott Holmes) did not revise the final project report or the EIR/S (Hall 2003). Whether based on past experiences or goals, these individuals decided to avoid another public review process, in effect disregarding procedures likely required of their meso-level elements. However, their decision may have prevented further delays in the project.

After 16 years of planning, construction finally began on the San Pedro Creek Flood Control and Ecosystem Restoration Project in summer 2000. By the time construction began on Phase I, meso-level elements (likely Scott Holmes) had already modified the phases of the project. These changes were largely at the discretion of Holmes and without public input. Phases I and II remained basically unchanged; however, Phase III reflected changes required by removing the diversion pipe, and a Phase IV was also proposed. Phase I would restore the wetlands, create a new, meandering stream channel, and west of Highway One would remove the berm on the north bank to allow water to flow north into a floodplain. Phase II would move the stream from the old channel into the new channel and raise the height of the berm on the north side of the creek. Phase III would replace the Adobe Bridge and regrade the creek banks from the bridge downstream to Peralta Bridge to reduce the slope of the banks. The proposed Phase IV could restore San Pedro Creek and its ecosystem from the San Pedro Valley County Park in the back of the valley down to the Adobe Bridge. Work on Phase II was expected to begin spring 2001, and on Phase III in fall 2003 (City and USACE 2000).

With several details of the project still in flux, city staff (i.e. Scott Holmes) continuously modified the phases as necessary. In 2001 as work on Phase I progressed (Photographs 5-6), the city was still negotiating with owners of property near the mouth of the creek to purchase their property to allow for the wetlands west of Highway One (Hall 2001). The city staff was also still working with the Corps on Phases I and II (Hall 2001), perhaps due to the delay in acquiring the property west of Highway One, but also because city staff were incorporating changes at the mouth of the creek into the Pacifica State Beach Master Plan (Larsen 2001). In fact by late 2001 the changes west of Highway One were moved to Phase II, and Phase III was described as working on the berm on the south side of the Linda Mar Shopping Center (Larsen 2001). City staff (i.e. Scott Holmes) estimated that Phases I, II, and III would be completed in 2003, but that the actual date could be moved up if city staff (i.e. Holmes) determined that the flood potential was too great (Larsen 2001).

In fact, Scott Holmes worried that San Pedro Creek was likely to overflow its banks again in late 2002 and decided to move the creek to its new channel one year earlier than planned (Photographs 7-12) (Holmes 2002). Although this cut short the time allotted for the new vegetation to grow in the restored area, the decision may

PHOTOGRAPH 5. New Floodplain and Stream Channel, Looking NE, March 2001.

PHOTOGRAPH 6. New Floodplain and Stream Channel, Looking NW, March 2001.

PHOTOGRAPH 7. Vegetated Floodplain with San Pedro Creek in New Channel, Looking East, Summer 2003.

PHOTOGRAPH 8. Vegetated Floodplain with San Pedro Creek in New Channel, Looking East, Summer 2003.

PHOTOGRAPH 9. New Floodplain, Looking NW Toward Ocean, May 2004.

PHOTOGRAPH 10. San Pedro Creek Flowing Through New Floodplain, Looking Upstream, May 2004.

PHOTOGRAPH 11. New Floodplain, Looking Upstream, May 2004.

PHOTOGRAPH 12. New Floodplain in Foreground, Homes Behind Berm in Background, Looking NE, May 2004.

have prevented flooding from a winter storm that closely followed the completion of the move (Hall 2003; Holmes 2003b). The winter storm caused flooding for houses on the north bank around Peralta Bridge when water backed up at the bridge (Holmes 2003b).

After the creek was diverted into its new channel in late 2002, Holmes advised residents that work completed on the reach between the Linda Mar Convalescent Home and the Highway One Bridge brought the reach up to a 500-year capacity from the original 4-year capacity estimated by the Corps (Holmes 2003a). However, Holmes noted that despite the increased capacity in this reach, work was still required in other areas in order to reach the 100-year flood capacity, so that homeowners would not have to purchase flood insurance (Holmes 2003a). Holmes later noted that the estimated 25-year flows proved the design was effective; the new berms were high enough and the streamflows deposited gravel in the expected locations (Holmes 2003b). Work remaining on Phase II that was expected to be completed in July 2003 included removing berms and fill on the western portion and planting in the eastern wetlands (Holmes 2002). Phase III slated for completion in 2004 now included widening the channel from the Peralta Bridge downstream to the convalescent hospital, as well as installing a new Highway One Bridge (Holmes 2002).

By fall 2003 with the exception of the work west of Highway One, the phases seemed to have dissolved into pieces of the project that the city's Department of Public Works would complete as funding became available. The city hoped to address the reach from Peralta Bridge to the convalescent hospital, which was originally part of Phase II, in 2003/2004 (Holmes 2003a). Caltrans decided not to replace the Highway One Bridge, so city staff added it to the city's list of items outstanding for the flood control project (Holmes 2003a). A separate project to restore Pacifica State Beach now included the flood control project's work on the area west of Highway One (Photographs 13-14) (Holmes 2003a).

Work on the area west of Highway One was completed in 2003-2004 as part of the Pacifica State Beach Master Plan (Holmes 2003a). By late September 2003 using grants and public funds the city purchased two homes on the beach, which it then demolished (Hunter 2003). After the demolition San Pedro Creek was widened near its mouth, a spit was created to form a coastal lagoon, and approximately two acres of tidally influenced wetlands were restored (Hunter 2003; Larson 2003-2004). The work at the mouth of the creek was completed by early November 2003 (Photographs 15-18) (Holmes 2003b). In early 2004 the Public Works Department addressed the problem of water pooling in the low-lying area north of Linda Mar Boulevard by adding two pumps to its pumping stations to increase capacity by up to ten times the previous capacity (Holmes 2004).

Work remaining as of early 2004 on the flood control project to provide 100-year flood protection included channel widening from the convalescent home up to Peralta (Holmes 2003b). The Department of Public Works planned to do this work itself beginning in 2004 or 2005, depending upon when the permits could be obtained

PHOTOGRAPH 13. Near Creek Mouth, Looking Upstream, March 2001.

PHOTOGRAPH 14. Future Site of Coastal Lagoon, Looking Upstream. San Pedro Creek flows under the San Pedro Road Bridge (and Highway One Bridge behind it), March 2001.

PHOTOGRAPH 15. New Coastal Lagoon, Looking South, May 2004.

PHOTOGRAPH 16. San Pedro Creek Flowing under San Pedro Terrace Road Bridge (and Highway One Bridge). Near creek mouth, coastal lagoon begins on the left, looking upstream, May 2004.

PHOTOGRAPH 17. New Coastal Lagoon and San Pedro Creek Near Creek Mouth, Looking South, May 2004.

PHOTOGRAPH 18. New Coastal Lagoon and San Pedro Creek Flowing Into Pacific Ocean, May 2004.

(Holmes 2003b). Public Works hoped to replace the Highway One Bridge (Map 2) in the 2006-2008 timeframe, but that timeframe depends not only upon obtaining funding (Holmes 2003b) but also on gaining public support for the new bridge, which could be difficult, given that opposition to the bridge already exists and that some residents think that the flood control projected has already been completed (Hall 2003). Work was also still outstanding to increase capacity at Adobe Bridge, but no specific timeframe had been established yet (Holmes 2004).

The outcome of the San Pedro Creek Flood Control Project to date has received very positive feedback. Patrick Hall expressed his satisfaction with the outcome, saying that the end product has turned out better than could have been imagined (Hall 2003). Todd Greene noted that the project is good for everyone; the Corps got a flood control project, the city got flood control, and the project area now has lots of wildlife (Greene 2004).

Although many elements influenced the development of the flood control plan, the city - and more specifically the person in charge of the project for the meso-level city, Scott Holmes - most significantly influenced the actual implementation of the plan. This influence is in large part due to Scott Holmes' own experiences, values, and goals. Many people, including committee members and representatives from the Corps, credit Scott Holmes for his flexibility in implementing the plan. Holmes broke the project into phases, because they are easier to fund than funding a single massive project. The phases also allow the project to increase flood protection for some areas, while waiting to resolve flood issues in others. The decision by Scott Holmes and the representative(s) from the Corps to remove the diversion pipe from the plan, not only made funding more feasible, but also eliminated a potential confrontation with residents along the pipe that could have delayed the project. If the project manager from the Corps had not supported the plan, they may have opposed removing the diversion pipe from the plan. Although the decision to remove the diversion pipe without going back through a public review process may have been outside of standard procedures, this decision allowed the project to proceed. These decisions made by the individuals acting in meso-level roles highlight the individuals' significant influence on the project outside of the bounds that their meso-level role or meso-level policies set.

CHAPTER 7

CONCLUSIONS

Evaluating the San Pedro Creek Flood Control Project as a hazard response using Risa Palm's integrative framework demonstrates the utility of this framework for understanding a real-world situation with all of its complicating factors. Elements at the micro, meso, and macro levels and the environment producing the hazard influenced the project, not only directly but also indirectly through linkages with other elements. For example, the macro-level environmental movement influenced the micro-level residents who influenced the meso-level city staff and flood control committee to produce an environmentally friendly plan (Figure 4). The large number of linkages between elements and the constraints accompanying each element created communication and procedural difficulties throughout the project. These identified difficulties can be addressed in the future to improve the efficiency of the response. Meso-level elements and in particular individuals acting in meso-level roles significantly affected the flood control project. Based on the experience of the San Pedro Creek Flood Control Project as a hazard response, Palm's framework should be modified to explicitly identify the significant influence of a micro-level individual acting in a meso-level role on the meso-level element they represent.

The flood hazard in the Linda Mar neighborhood in Pacifica, California exists along San Pedro Creek, a perennial stream in a watershed with steep hills draining into a short valley before emptying into the Pacific Ocean. Human alterations of the watershed increased the flood hazard over time, most recently by developing the area into a suburban community with a high percentage of impermeable surfaces and modified drainage network (e.g. culverts). These alternations increased the potential for flooding downstream by decreasing the lag time for the heavy rainfalls and increasing the peak runoff. All of these factors contributed to major flooding in Linda Mar in 1962, 1972, and 1982.

Many different elements at all levels influenced the response to the flood hazard along San Pedro Creek (Figures 2-4). After each major flood residents (micro-level elements) responded by calling on the city council and/or city staff (meso-level elements) to fix the problem, after which the city council initiated a flood control project. By evaluating how the meso-level objectives of the flood control project changed over time, many other elements influencing the flood control project quickly became evident. The proposed solutions to the flooding problem began in 1962 with the standard objectives to move water out of the area as quickly as possible, using channelization and other drainage methods. As the environmental movement (macro-level element) progressed in the 1960s and 1970s micro-level residents began calling for the meso-level city council and city staff to both preserve San Pedro Creek and to provide flood control. The macro-level environmental movement also influenced federal and state policies (meso-level elements) that by requiring environmental protection also placed constraints on new flood control projects, making it less feasible to use standard structural flood control methods, such as placing a creek in a concrete channel. However, the city council's stated objectives for the flood control committee after the 1982 flood still focused solely on providing flood control and the means to fund it, making no mention of protecting the creek and the environment. At the same time environmental protection measures significantly limited the standard methods available for flood control and the means to fund them. Officials slowly began to adopt new approaches to flood control originating with Geographer Gilbert White. For the San Pedro Creek Flood Control Project, Scott Holmes, a micro-level individual working in a meso-level context, pioneered the idea of using environmental restoration as part of the flood control solution, and the final objectives of the flood control project from the city's perspective became not only flood control but also environmental restoration.

A particular strength of Palm's framework lies in establishing the linkages between elements to present a more comprehensive picture of the influences on the flood control project (Figures 2-4). For example, Scott Holmes, the meso-level city representative, is often credited with developing and implementing the approved flood control plan. However, the integrative framework points to many influences and constraints on Holmes when he developed the new Marsh Diversion Plan (or Wetland Bypass Plan), including the environmental movement (macro-level influence) and environmentalists (meso- and micro-level elements), regulations at the USFWS and CDFG (meso-level elements), available sources of funding (meso-level elements), open land adjacent to the creek (although land was not immediately available from Caltrans, a meso-level element), and concerns of residents (micro-level elements). Although Holmes was certainly a significant influence in developing the flood control plan, the environmental movement may have been the most important influence on the plan, given the number of elements that were influenced by it, including government policies and individuals. However, Holmes was perhaps the most significant influence in implementing the plan, given his phased approach to funding and constructing the project, and his decision along with the Corps to remove the diversion pipe from the project without going back and revising the final detailed project plan, which would have delayed the project even further.

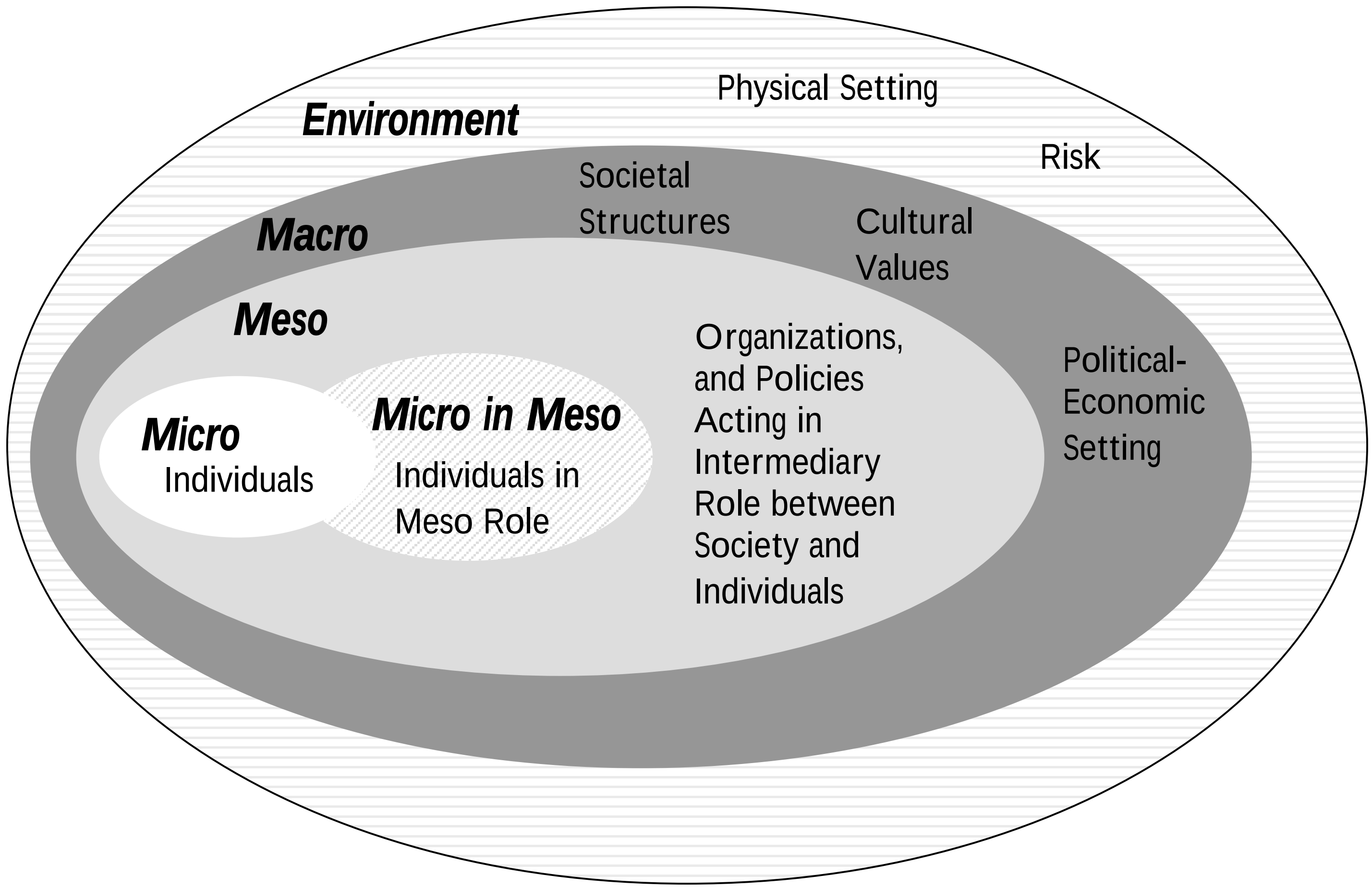
Planning and implementing the flood control project generated a large number of linkages between elements, often creating additional problems. (Note: The number of linkages as detailed in Palm's framework (Figures 2-4) increased noticeably from 1960 to the present day.) Each linkage increased the complexity of the project not only by involving a new element but also the policies and procedures of that element. The flood control project was at risk of stalling at several points due to the difficulties created by the many policies and regulations surrounding flood control, including the environmental impacts of a project. Ensuring that city staff understands these policies and regulations and the constraints they impose on hazard response before developing proposed solutions could speed up the cumbersome planning process. Another issue that plagued the flood control project was lack of or insufficient communication between elements. This communication break in the linkage between elements sometimes put the entire project at risk, as when a failure to communicate with creekside residents early in the process threatened the entire project later when they learned about the floodwall and opposed it. Involving the majority of residents who will be impacted by a project in the earliest stages of the project and updating them directly (e.g. by mail) on a regular basis should improve the relationship between city staff and the residents and may also reduce the delays in the planning process.

Meso-level elements are perhaps the most complicated level of elements to evaluate, and not just due to their many links to other elements. Holmes' role in the implementation of the flood control plan also points to the complexity of meso-level elements where an individual is acting in a meso-level role. Individuals acting in a meso-level role are usually required to interpret their role and/or the policies of their organization and in doing this their individual values, experiences, and goals can influence how they carry out their role. When Scott Holmes acts on behalf of the city, his actions may not always represent his meso-level role. By deciding not to consult all parties after deciding with the Corps to remove the pipe, Holmes may have disregarded requirements of his role, but at the same time may have acted in the best interest of the city and residents by keeping the project moving forward. In addition, Holmes was willing to consider methods outside of the standard flood control methods used by public works departments for decades, and was able to provide an amenable solution to the flood problem.

Members of the San Pedro Creek Flood Control Committee provide another example of the important influence an individual's experiences and goals can have on the meso-level element they represent. The role of the committee was not only to help the city develop a flood control project but presumably also to represent the residents. Although the committee generally supported many of the concerns expressed by different residents including protecting the environment, as this project demonstrates relying on a citizens committee to speak for the all residents can create tensions between city staff and the residents whose concerns have not been addressed. Committee members acted based on their experiences and values, and were unlikely to have represented the views of all residents. When city staff and the committee communicated directly with the residents, they were able to address residents' concerns and residents were less confrontational about the project.

Although when describing her integrative framework, Risa Palm acknowledges the significant influence an individual's values and experiences can have on the meso-level element they represent, she does not make this linkage explicit in her actual framework. The influence of individuals acting in meso-level roles, most significantly Scott Holmes, on the hazard response culminating in the San Pedro Creek Flood Control Project suggests that this connection should be incorporated into Palm's framework. A revised framework could include a new "Micro in Meso" sub-level straddling the micro and meso levels (Figure 5), to represent the importance of these micro-level individuals acting in meso-level roles.

FIGURE 5. Revised Integrative Framework with New Sub-Level. Modified from Palm 1990.



Comparing the three separate attempts at flood control projects provides additional insight into why the third project has succeeded (at least in part to date). After the 1962 flood the citizens Drainage Committee proposed major drainage improvements requiring $2 million in bonds to implement. Given that the flood seemed like a once in a lifetime event to some and that the entire community would be asked to fund the project through the bonds, the project likely had little public support and was eventually dropped. After the 1972 flood another citizens committee researched potential solutions to the problem. The repeated experience with flooding creating broader support for addressing the problem; however, an increased desire to protect the environment was not accommodated in the largely traditional structural flood control methods proposed and the project was dropped. Why did the third attempt at a flood control project ultimately succeed where the others had failed? In 1982 after the third and worst major flood in Linda Mar, many residents had several experiences with flooding and a more accurate perception of the flood hazard. Some of those residents became part of the third citizens' flood control committee and were determined to take action and see the project through to completion. The committee strengthened their linkage with micro-level residents by working with residents who opposed the project to incorporate their concerns and gain their approval. Some of these micro-level residents even joined the meso-level flood control committee. Likewise, Scott Holmes stepped into the meso-level role for the city at a point when the project was stalled due to opposition to the proposed floodwall. By developing a solution that addressed the concerns of most micro-level residents while also meeting the requirements of the involved meso-level elements, Holmes allowed planning to continue. Holmes' proposed flood control plan incorporating restoration also allowed the city to obtain funding from organizations interested in environmental restoration. In order to implement the project, Holmes also broke it into phases so that it could be funded in increments instead of all at once.

If this study had evaluated the flood hazard response from either the human ecology or the political economic perspectives, instead of using Palm's integrative framework, many influences would have been overlooked. A focus on human ecology would likely have missed the impacts of the environmental movement, federal and state regulations, and the availability of funding on the project. Likewise, if this study had concentrated on the structures and constraints of the political economic perspective, the influence of individuals opposing the project and other individuals supporting or pushing the project might not have emerged. In addition, this study finds the meso-level elements often neglected in the human ecology and political economic perspectives can have a significant influence on hazard response. For example, the post-1982 flood control committee helped keep the project moving forward for several decades, even getting help from state and federal politicians when the Corps delayed the project. Scott Holmes, representative from the city, joined in the committee's efforts in 1989 by proposing a new alternative that met the requirements of the different interests involved in the flood control project.

This study provided a broad sampling of the elements influencing the flood hazard response to flooding along San Pedro Creek. Factors that might lend additional insight into the hazard response include the impact of the real estate market on decisions at the meso- and micro-levels and the impact of other hazards in the area, such as landslides and earthquakes. More research into the individuals and how they get their news and information would also help the meso-level better communicate with the residents (micro-level) in the future.

As the San Pedro Creek Flood Control Project demonstrates, understanding a hazard response requires understanding influences coming from all levels, macro, meso, and micro, their environment, and the linkages between and among them. This complex interaction is highlighted well when placed into an integrative framework developed by Risa Palm; however, Palm's framework should be expanded to include a new "Micro in Meso" sub-level to elevate the significance of micro-level elements acting in meso-level roles.

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APPENDIX A: ALTERNATIVES CONSIDERED IN 1973-1975 SECTION 205 FLOOD CONTROL PROJECT

1. Nonstructural Plan (raising the foundation of structures)
2. Reservoir Plan (placing dam on the Middle Fork of San Pedro Creek)
3. Rectangular Concrete Channel Modification (includes replacing bridges)
4. Trapezoidal Rock-Lined Channel Modification (includes replacing bridges)
5. Underground Bypass System Modifications
6. Floodwall and Floodplain Modification (building wall from Peralta to Hwy. 1, creating floodplain free of vegetation on south side of creek, includes replacing bridges)
7. Levee and Bypass Channel Modification (includes channelizing parts of the creek)

(Source: USACE and City 1998, 2-2 to 2-3).

APPENDIX B: FLOOD CONTROL RECOMMENDATIONS FROM PHILIP WILLIAMS & ASSOCIATES, 1985

1. Increasing the stream capacity downstream of Peralta Bridge by creating a southern floodplain adjacent to a low-flow channel and an earthen levee to the north
2. Replacing the Highway One Bridge
3. Constructing detention basins on city or county land
4. Replacing Adobe Drive Bridge
5. Maintaining the channel to allow flood waters to travel downstream more quickly, including possibly dredging

(Source: Vandivere 1985).

APPENDIX C: SOLUTIONS CONSIDERED BY SAN PEDRO FLOOD CONTROL COMMITTEE, 1985

Structural Solutions:

1. Caissons in mouth of channel and on beach to reduce silt from tides.
2. Bedline channelization from Highway 1 to mouth of San Pedro Creek.
3. Lined embankment and unlined streambed channelization from Highway 1 to mouth of San Pedro Creek.
4. Concrete lining, including bedlining of channel from Peralta to Highway 1.
5. Banklined channel and unlined bed from Peralta to Highway 1.
6. Concrete lining of channel and bedlining with natural cunnette from Peralta to mouth of creek.
7. Replacement of Highway 1 bridge.
8. Extend and raise the berm; enhance levee on north side from Highway 1 east of DeSolo.

9A. Excavate south bank for additional capacity bet[ween] Peralta & Highway 1 & increase channel capacity from Highway 1 to mouth.

10. Diversion channel.
11. Replacement of Adobe Bridge.
12. Detention Basins.
13. Diversion of water runoff of creek to interior watersheds and/or pump stations.

Non-structural Solutions:

1. Selective vegetation removal.
2. Tree removal in creek channel.
3. Sacrificial south bank flood plain (California Department of Transportation [Caltrans]).

4. Floodproofing per FIA (raised flood elevation in flood plains.)
5. Floodproofing of existing structures.
6. Greenbelt the floodplain.
7. Relocate convalescent center.
8. Redesignating land use of Caltrans property.

(Source: SPFCC 1985, Appendix A).